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Factors influencing the right of citizens to safe drinking water in thecontext of war

Seym River at Baturyn in Chernihiv oblast. Leonid Andronov

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Contents

Introduction

The full-scale invasion of Russian troops into Ukraine had a devastating effect on the essential infrastructure, including water supply and treatment systems, exacerbating the triple humanitarian, economic and environmental crisis. Preliminary damage assessments demonstrate that the costs of this infrastructure may amount to billions of dollars, and that complete overhaul of many systems and change of approaches will be necessary. Only a fraction of the water and environmental impacts is explored so far, and these are likely to exacerbate in the coming years. Widespread devastation brought forth by war caused both deterioration and physical losses of water resources especially in the regions, where drinking water is scarce.

The adverse factors for the access of citizens to sufficient and safe water can be summarized as follows, not limited to these:

- Infrastructure destruction and degradation;
- Decreased revenues and asset availability versus overall high level of amortization;
- De-energization;
- Damage to water resources;
- Pollution;
- Destruction of hydrotechnical structures and water bodies;
- Weakened environmental control;
- Loss of access to monitoring sites;
- Migration (stress on water treatment facilities);
- Dependence of livelihoods on water;

General situation with water supply before the full-scale war

The situation with drinking water availability and supply in Ukraine had been demonstrating considerable uncertainties and vulnerabilities even before the full-scale war. Ukraine had been among the European countries with the least availability of drinking water. Below are but a few factors that influence the access to quality drinking water in Ukraine to date and will have even more prominence in the future:

- ***Climate change, gradually impacting the water level in rivers and increasing risks for agriculture***. With major drought events, such as the 2019-2020 water scarcity period, when low autumn and winter precipitation (at about 50-70% of the standards level) prevented spring flood and caused considerable water shortage, when the State Water Agency even considered water rationing among different types of users[1], this threat becomes more obvious.
- ***Insufficient protection of surface watercourses and groundwater tables.*** Tilling and nitrate pollution in the riparian areas, deterioration and conversion of wetlands, gradual pollution and over-

[1] https://davr.gov.ua/news/derzhvodagentstvo-vpershe-mozhe-obmezhiti-prava-vodokoristuvachiv

exploitation of groundwater pose considerable risks to the drinking water availability and quality at the backdrop of inadequate control and enforcement of the national environmental legislation.

- ***Geographic disparities and imbalances in the availability of and access to water resources***. Surface water resources in Ukraine are distributed unequally across regions, with a clear trend to decrease in the east and south, where, at the same time, the demand for water resources from industrial and agricultural consumers was the greatest. Moreover, hydrochemical characteristics of some of local rivers, such as increased hardness, chloride and sulphate content, and considerable pollution, render their water unusable for drinking consumption without complicated and costly treatment. The distribution and quality of groundwater in the south and east is considerably varying. In Donetsk region, the groundwater aquifers are scarce, and in some areas, such as Azov Sea region, high mineralization of many groundwater aquifers makes them unusable for drinking water supply. In Kherson region, for example, some communities have high quality artesian water resources, while in others the groundwater is very scarce. Some of the large cities with extensive industrial and household water demand, such as Mykolaiv (Dnipro-Mykolaiv pipeline) and Mariupol (Southern Donbas pipeline), were basically "on a lifeline" of drinking water supply from remote sources. The figure below shows an average annual river flow for different geographical and climatic regions of Ukraine, clearly highlighting generalized local water scarcities.

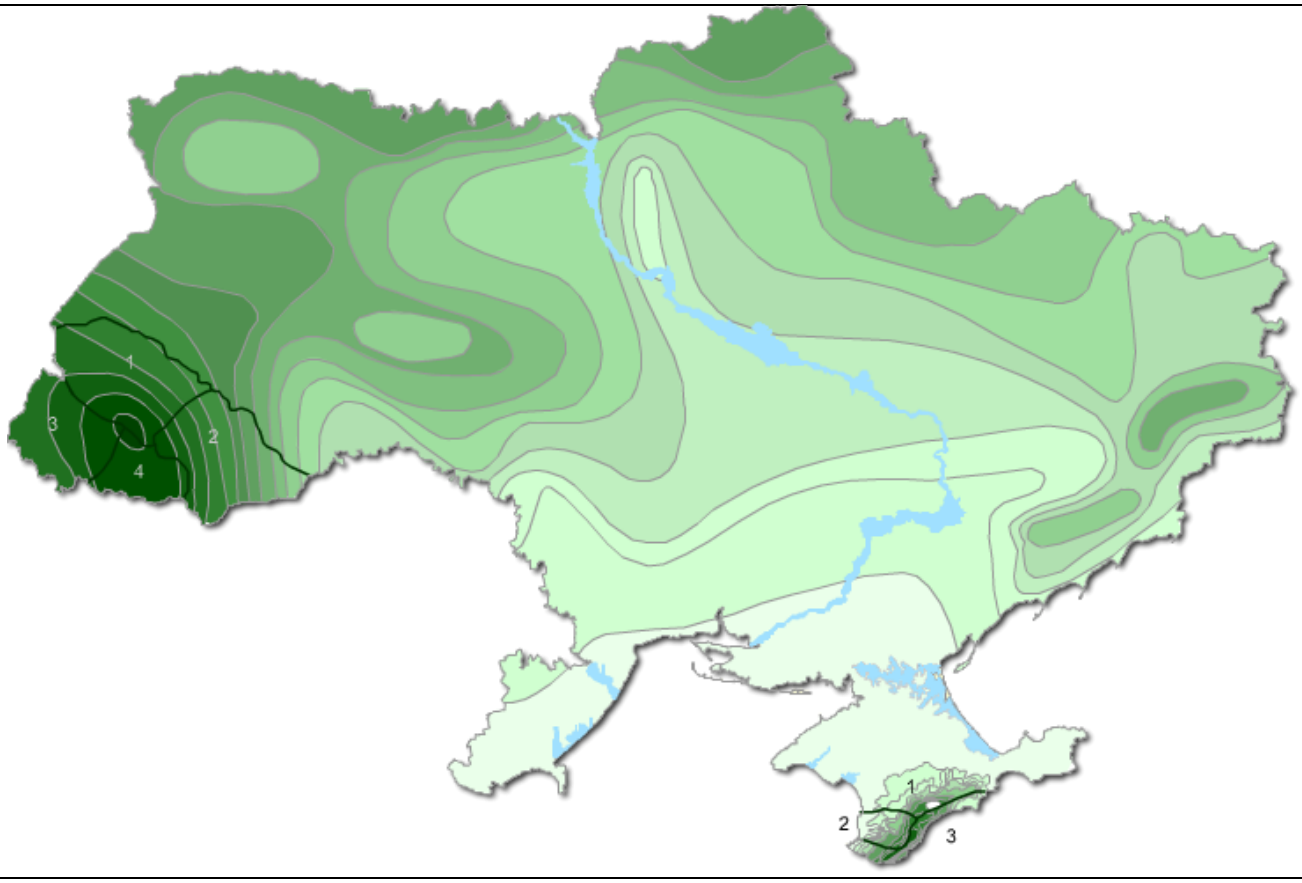
- **Transboundary water dialogue and cooperation**. The transboundary nature of many Ukrainian rivers always created certain sensitivities in terms of water resources use, be it water use policies of the neighboring countries or the impacts of economic activities and (mis)management within Ukraine that could potentially surpass its borders. After the full-scale Russian aggression, the transboundary factor will become another challenge, as the headwaters of two major rivers, Dnipro and Siverskyi Donets, are located on the territory of the aggressor state. Therefore, it is unlikely that the information on incidents that may have transboundary impacts on downstream areas is provided in timely and appropriate manner.

- ***Damage to the hydrotechnical structures.*** According to the State Water Resources Agency, only for the first 8 months of war, about 500 hydrotechnical facilities were damaged, and the volume of the water lost is 742.2 million cubic meters. These calculations, with the cut-off time of October 2022, do not include such major incidents of damage to water infrastructure as shelling of Karlivka Reservoir dam and, ultimately, the destruction of Kakhovka Reservoir, which alone contained 18 million cubic meters of drinking water, that is, about 40% of the country's annual freshwater resources.

- ***Destruction of water supply and treatment infrastructure.*** Damage to water supply and treatment infrastructure was widespread and extensive since the start of the full-scale war. Considering increased reliance of the urban population on centralized water supply and scarcity and unknown quality of alternative sources, this poses great risks for sanitary and epidemiological situation, as well as people's health. According to Rapid Damage and Needs Assessment (RDNA) Report, only by February 2023, the damage to the water supply infrastructure amounted to US$2.2 billion; of this amount, around US$0.9 billion was due to damage between June 1, 2022, and February 24, 2023[2].

[2] Ukraine Rapid Damage and Needs Assessment (RDNA) Report, https://t.ly/uVxPy

Fig. 1. Average annual river flow

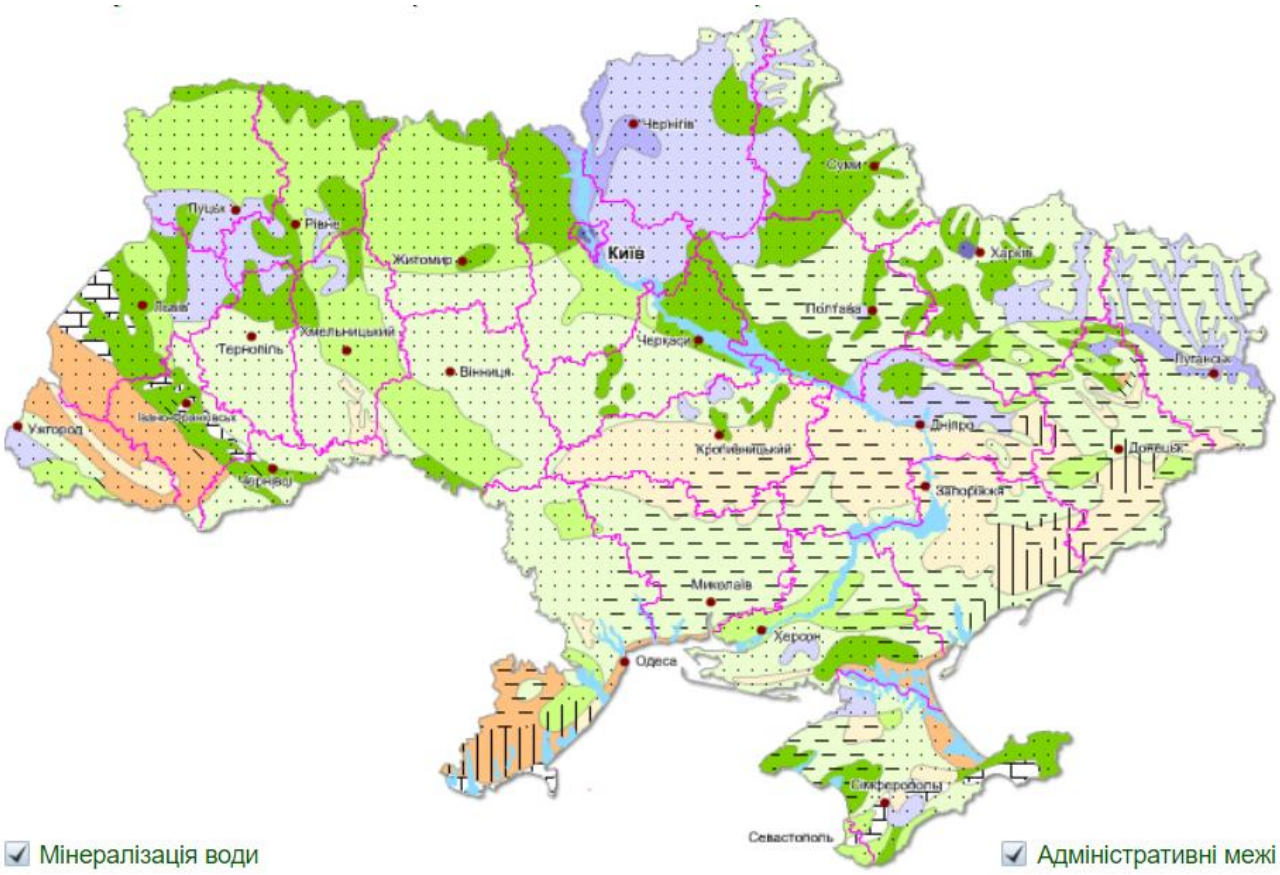


Average annual river flow (l/sec of km^2)

below 0.5	5.0 to 6.0
0.5 to 1.5	6.0 to 8.0
1.5 to 2.0	8.0 to 10.0
2.0 to 2.5	10.0 to 15.0
2.5 to 3.0	15.0 to 20.0
3.0 to 3.5	20.0 to 30.0
3.5 to 4.0	over 30.0
4.0 to 5.0	

Map source: https://river.land.kiev.ua/annual-flow.html

Fig. 2. Exploitation-ready resources of fresh and low-mineralization groundwater



Water mineralization (g/l)

	over 10		3 to 1
	5 to 3		below 1

Module of exploitation-ready groundwater resources (l/sec on km^2)

	over 10		2 to 1		0.1 to 0.05
	10 to 5		1 to 0,5		below 0.05
	5 to 2		0.5 to 0.1		

Areas without groundwater flow

Map source: https://geomap.land.kiev.ua/water-4.html

Overview of water supply and treatment infrastructure condition

While the international humanitarian law expressly prohibits attacks on the infrastructure indispensable for the survival of civilian population, the Russian forces committed numerous, widespread and indiscriminate attacks on the municipal water supply infrastructure

Prior to the full-scale invasion, water supply and treatment infrastructure of Ukraine was already grappling with a number of technical, structural and financial problems, such as high level of amortization of physical assets, low energy efficiency and obsolete technologies. Thus, as of 2022, according to the annual National Report on Drinking Water Quality and Water Supply and Treatment[3], the total length of water supply networks (not counting Donetsk, Zaporizhzhya, Luhansk, Kherson regions) was 92.136 thousand km, including 32.065 thousand km of worn-out and distressed, accident-prone pipelines, that is, 34.8% of the total length. During the year, 0.623 thousand km, or 1.9% of the necessary scope of pipelines were replaced. In 2021, the repairs level, however, was at 2.5%, therefore, much-needed repairs work became more complicated in 2022 due to the full-scale war challenges. The largest percentage of pipelines in unsatisfactory technical conditions was in Donetsk region (56.8%), Kharkiv (52.8%), Volyn (51.6%), Zaporizhzhya (50.9%) and Kirovohrad (50.7%). In 11 regions and Kyiv this indicator was at the level of 30-50%, in other regions – within 13-30%. Water purification and wastewater treatment quality are considerably affected by the unsatisfactory condition of the infrastructure.

Certain social factors may also influence the situation. Considering widespread reduction in economic activities and closing of numerous enterprises, water use was reduced in many communities closer to the frontlines, which on one hand, alleviated the burden on utility networks, and on the other, decreased the amount of revenues for water use, thus depriving the local utility companies of much-needed assets for repair works. In other areas with high concentration of IDPs and a rapid surge in the number of residents, the wastewater treatment systems have to cope with increased workload which causes poorer water purification quality.

Another characteristic feature of the Ukrainian water treatment and supply infrastructure is the significant differences in coverage between urban and rural areas. Most cities, with few exceptions, were provided with centralized water supply. As of 2022 (not counting Donetsk and Kharkiv regions), centralized water supply existed in 98.7% cities (no centralized supply in 4 cities), 90.3% urban-type settlements (absent in 46 urban-type settlements) and 23.4% villages (absent in 16,995 villages). Centralized wastewater collection was available in 95.9% cities (absent in 13 cities), 67.2% urban-type settlements (absent in 155 urban-type settlements) and 1.5% of villages (absent in 21,857 villages). Considering Donetsk and Kharkiv regions, there is a decrease in access to centralized water and sanitation services compared to 2021, in particular, in 2022, 98.3 % cities were provided with centralized water supply (absent in Siversk and Svyatohirsk, considering heavy fighting and proximity to the frontline); centralized water supply was available in 90.7 % or urban-type settlements (absent in 51 settlement) and 23.4 % of villages (absent in 18,350 villages); centralized sewage collection was provided in 95.5 % cities (absent in 16 cities), 66.4 % of urban-type settlements (absent in 185 urban-

[3] Draft National Report on Drinking Water Quality and Water Supply and Treatment for 2022, https://t.ly/gogsD.

type settlements) and 1.6 % villages (absent in 23,586 villages)[4]. The consequences of damage to the water infrastructure in urban settings are normally more severe than in rural areas, considering the complexity of water infrastructure, its interconnectedness with other types of services and density of the population dependent on it[5]. At the same time, the availability of emergency response and support services is typically greater in urban areas.

While rural water supply systems may be less centralized and, in some cases, more resilient to damage and blackouts (individual wells and water towers can have generator-powered pumps and usually several such sources are available), the water quality may be substandard or not properly controlled at all. The Brief Report on the Progress of the Water and Health Protocol Implementation of 2022[6], shows considerable proportion of substandard and low-quality drinking water samples. The State Consumer Protection Service and its territorial branches carry out control over water supply and treatment infrastructure; the Public Health Center of the MoH is another responsible entity. As of 30 December 2021, under the auspices of the State Consumer Protection Service were 62,631 water treatment facilities: 10,264 centralized water supply sites, 52,367 decentralized water supply sites and 1,977 water treatment sites. In the course of 2021, 12,383 water supply sites were checked (19.7% of total number), and violation of the sanitation and hygiene legislation was found on 6,619 water supply sites (53.5 % of inspected sites), that is, on2,495 (63.2 %) centralized water supply sites and 4,124 (48.9 %) decentralized supply sites. Among 17,326 centralized water supply samples tested during 2021, 2,646 (15.3 %) of the tested samples did not meet the standards. 7,604 samples were tested for compliance with microbiological standards, among them 12.3% turned out incompliant; 12,251 samples were tested for sanitation and chemical standards, and 16.4% were found incompliant.

Of the decentralized sources, 1,054 (28.2 %) of 3,732 samples were found incompliant: 26.4 % failed to meet sanitary and chemical standards, 26% - microbiological standards.

Another background problem is the nitrate content in decentralized (rural) water sources. In 2015, only 5.4% (17,000) of public and individual wells and springs were inspected; of these, 28.5% failed to meet the sanitary standards; the share of tested drinking water samples from decentralized water sources which turned out to be incompliant was as high as 23.5%. Water nitrate methemoglobinemia is a special concern for children aged under 3[7]. Water boiling actually increases the harmful impacts of such water, as nitrates are transformed into more dangerous nitrites.

[4] Draft National Report on Drinking Water Quality and Water Supply and Treatment for 2022, https://t.ly/gogsD.
[5] Massingham, E., Almila, E., & Piret, M. (2023). War in cities: Why the protection of the natural environment matters even when fighting in urban areas, and what can be done to ensure protection. International Review of the Red Cross, 1-24. doi:10.1017/S1816383123000395
[6] https://mepr.gov.ua/proyekt-korotkoyi-dopovidi-pro-progres-vykonannya-protokolu-pro-vodu-ta-zdorov-ya-za-2019-2021-roky-ta-informatsijne-povidomlennya/
[7] https://www.mdpi.com/2073-4441/15/11/1989

Water infrastructure damage

Destruction of water infrastructure in the areas most affected by fighting

In the first days of the full-scale invasion, numerous water treatment facilities were severely impacted by fighting. Since late February, **Chernihiv** Vodokanal (municipal water supply facility) was severely damaged. The city relies on high quality artesian water intake which allows to achieve drinking quality relatively easily. On 11 March 2022, a large diameter water pipe was damaged by an air strike[8]. Russian forces damaged water reservoirs, planted explosives at boreholes. On 14 March 2022, an air raid destroyed one of the Chernihiv Vodokanal's pumping stations, killing 4 people[9]. The facility territory was heavily littered with explosives and needed a thorough cleanup and demining. During March 2022, 3 out of 5 pumping stations were damaged and one was completely destroyed. Because of this, only one-third of city residents had some water supply.

Out of 5 sewage pumping stations, 2 were almost destroyed and in need of reconstruction[10]. The wastewater treatment system of Chernihiv has been obsolete already before the war, and large-scale reconstruction project was being planned and potential funding sources were explored. Reconstruction of air tanks was one of the key priorities, considering their energy inefficiency and the need to ensure constant supply of oxygen to the active silt[11]. The treated water is then dumped in Bilous river, a tributary of Desna, therefore, the malfunction of treatment facilities might have polluted Desna river, and hence, the Dnipro, deteriorating water quality in the intake points everywhere downstream these rivers. When Chernihiv was heavily shelled, there was a considerable risk of the sewage pumping stations failure, which might have caused sewage spills leading to surface watercourses and aquifers pollution. Heroic workers of the municipal Vodokanal tried their best to keep the stations working, and citizens had to dig latrines in the yards to reduce the sewage volume so that the damaged infrastructure with its limited capacity can still pump whatever amount of wastewater there was to the treatment facilities and treat it[12]. After the cessation of hostilities, Chernihiv is working planning to undertake comprehensive refurbishment of the water infrastructure.

During the Russian siege of Kyiv, **Irpin** Vodokanal (municipal water supply facility) was rendered inoperable[13]. Water supply in many towns around Kyiv was temporarily disrupted, the infrastructure suffered heavy damage. Because of fighting and road blockades, the work of services that could deliver drinking water, was prevented. According to the RDNA, the infrastructure damage alone in Kyiv oblast is assessed up to USD 192 million.

[8] https://lb.ua/society/2022/03/11/508983_cherez_nichniy_aviaudar_chernigiv.html
[9] https://zaxid.net/chetvero_lyudey_zaginuli_vnaslidok_bombarduvannya_vodokanalu_u_chernigovi_n1538337
[10] https://cheline.com.ua/news/vijna/ekologi-pokazali-rujnuvannya-yakih-zaznav-chernigivskij-vodokanal-cherez-rashistski-obstrili-foto-325736
[11] https://cn.suspilne.media/news/46926
[12] https://www.0462.ua/news/3566073/30-vibuhiv-odin-za-odnim-stini-hodorom-hodili-ak-pracivnica-vodokanalu-vratuvala-cernigivciv
[13] https://bigkyiv.com.ua/kyyiv-dopomozhe-z-podacheyu-vody-v-irpin-de-okupanty-povnistyu-znyshhyly-vodokanal/

In Luhansk and Donetsk regions, where fighting did not relent since February 2022, the damage to the water supply and treatment infrastructure made it completely dysfunctional, if not razed to the ground, in the frontline settlements. It should be noted that since the start of the Anti-Terrorist Operation (ATO) in 2014, its complex and high-maintenance water infrastructure has already suffered damage, and ensuring water supply across the contact line has always been a complicated technical and diplomatic task. Furthermore, both regions have very little suitable local sources and were mostly dependent on Siverskyi Donets. While some areas of Luhansk oblast benefited from the availability of artesian aquifers, Donetsk oblast received most of its consumer and industry water through the Siverskyi Donets – Donbas canal and a sophisticated water transportation infrastructure to bring it across considerable distances.

In **Luhansk oblast**, there were two key abstraction stations – Bilohorivska and Svitlychanska[14]. In addition, artesian aquifers were used in several locations, such as Lysychansk. Since 2014, Popasna District Water Supply Facility (Vodokanal) with the total length of pipelines of 741 km, provided drinking water to both government-controlled areas (GCA) and the so-called LPR. Most of the abstraction points were located on the GCA, while major part of the consumers (up to 1,000,000 people) resided on the temporarily occupied areas. Maintaining a shaky stability of water supply was to some extent mediated by the OSCE and the Red Cross. However, when the full-scale war broke out, heavy fighting was concentrated around key cities – Popasna, Rubizhne, Sievierodonetsk, Lysychansk. Since first days of March 2022, tens of thousands of households were left without water supply in the frontline areas of Luhansk region[15]. By mid-March, problems with water supply started in Lysychansk and Sievierodonetsk.

Since 29 March, Sievierodonetsk was left without water supply altogether, as a high-voltage line powering the water infrastructure was damaged. The shellings destroyed 5 special vehicles of the water engineering service, therefore, the repair works were complicated because of equipment shortage and continuous danger to the staff[16]. The supply of liquid chlorine for water disinfection also became problematic. Lysychanskvodokanal, Lysychansk municipal supply company, informed in early April, that chlorine delivery became impossible due to fighting[17], however, some districts could still use artesian water from an aquifer 50-60 m deep, which was suitable for drinking after boiling. On 12 April 2022, a Russian information warfare teams disseminated a fake news message that Ukrainian forces are about to blow up chlorine tanks on Popasna municipal water supply company in Bilohorivka. Ukrainian authorities were able to act in advance and evacuate all the chlorine from the facility, having replaced it with a safer, albeit more expensive, hypochlorite[18]. In mid-April, pumping stations were destroyed by fighting, and by May, the entire Luhansk region was left without water supply, and, for the post part, without power supply.

[14] Hirske territorial community natural calamity mitigation strategy for 2022-2028. Access mode: shorturl.at/pyIR2
[15] https://t.me/serhiy_hayday/4333
[16] https://t.me/serhiy_hayday/5225
[17] shorturl.at/ikpY3
[18] https://hromadske.ua/posts/z-bilogorivki-vivezli-zapasi-hloru-dlya-ochishennya-vodi-cherez-zagrozu-provokacij-rf-luganska-oda

On 5-8 May 2022, the Russian forces destroyed a water intake point (48.941904, 38.235501) of Popasna Vodokanal on Siverskyi Donets in Bilohorivka. There is no physical access to it and the functioning of water supply in Luhansk region can hardly be restored before the hostilities cease.

Fig. 3. Planet image of 7 May 2022 (satellite access kindly provided by Kharkiv Karazin University).

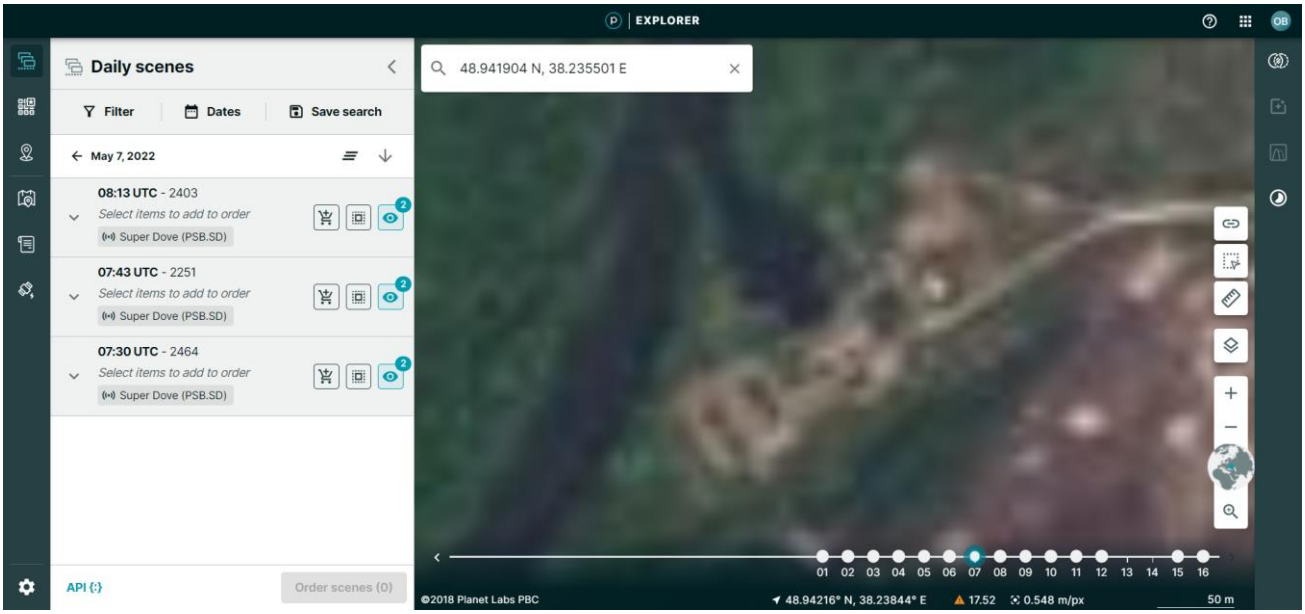


Fig. 4 A later image, of 12 May 2022, demonstrates extensive damage to the structure.

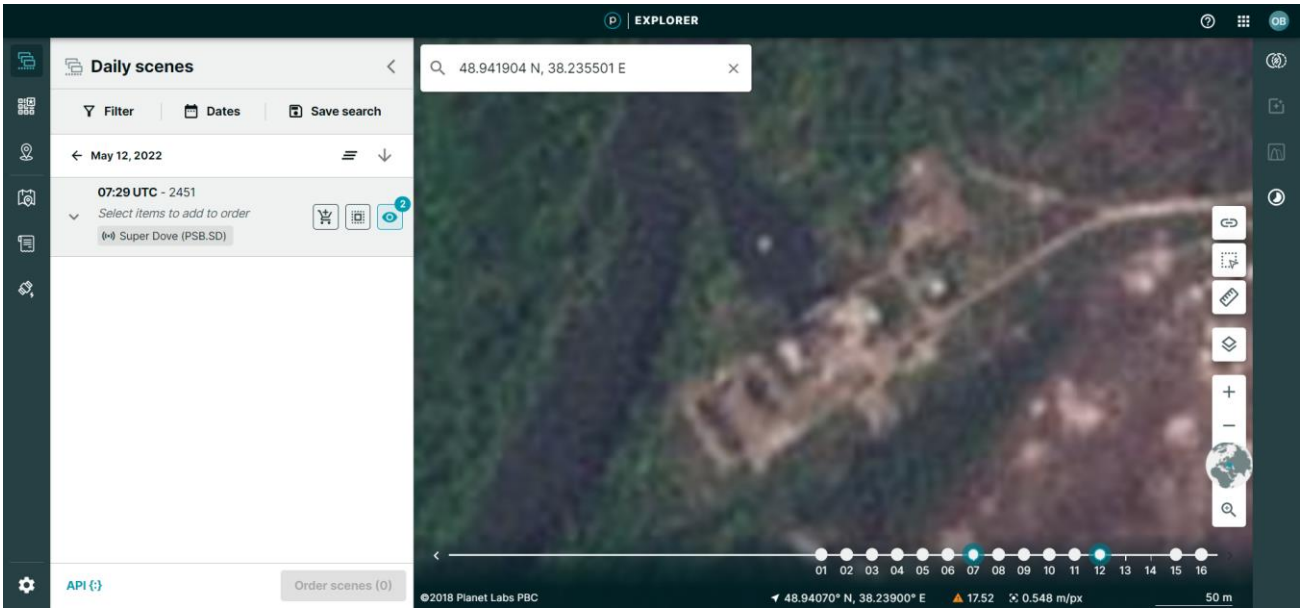


Fig. 5 A 2023 image of Google Maps showing a demolished water intake station and evidence of heavy fighting:

The State Emergency Service staff tried to maintain water trucking even despite serious dangers. Russian forces targeted places with large crowds of people, and water distribution locations became dangerous. On 27 June, Russian troops fired at a group of people standing in line for water at a tanker truck with Uragan MLRS. 8 people were killed on the spot, 21 were injured, one woman later died in the hospital, the body of another woman was found dead[19].

After Ukrainian forces had to withdraw from the area, the citizens were essentially left to their own means, and little information is available on the situation with water and sanitation. It is unlikely that the occupation regime is able or willing to meet humanitarian needs of the people to the proper standard. During the fighting in Sievierodonetsk, the water treatment installations of Azot factory, which provided sewage treatment for the entire city, was damaged by shelling. Moreover, the municipal sewage system, including pumping stations, was nearly destroyed, and untreated wastewater is flowing directly into Siverskyi Donetsk river[20]. In Lysychansk, some artesian water wells that could still provide good quality water, are at considerable threat of pollution with biological waste and mishandled industrial pollutants. After the establishment of the occupation regime, it was reported, that drinking water was provided to the people in the amount of 20 liters per week[21]. There is little information on how actual repair works progress. In Popasna city, destroyed by more than 90%, the occupants announced their intention to restore the structures that would maintain operation of the railway station and municipal water supply facility[22].

In Donetsk region, water supply has been even more challenging. Before the full-scale war, Voda Donbasu Company had been operating in both government-controlled areas (GCA) and across the contact line, servicing about 4 million people in total[23]. Donetsk region had quite unique

[19] https://t.me/luhanskaVTSA/3828
[20] https://uatv.ua/uk/misto-chastkovo-zabezpechene-vodoyu-kanalizatsiya-ne-pratsyuye-pro-opalennya-govoryty-ne-dovodytsya-golova-vtsa-syevyerodonetska-video/
[21] https://t.me/luhanskaVTSA/6831
[22] https://popasnaya.city/articles/252677/chastinu-popasnoi-planuyut-vidnoviti-prorosijski-okupanti-dlya-chogo
[23] Оцінка ризиків системи водопостачання КП “Компанія “Вода Донбасу” - 2017. Access mode:

Simplified scheme of water supply system operated by Voda Donbasu company (source: UNICEF, Risk assessment of the "Voda Donbasu" water system Report, 2019)

infrastructure built around Siverskyi Donets-Donbas Canal (SDDC) with 4 elevation stations lifting Siverskyi Donets water up to 200 m high (stations 1-3 must work synchronously) and 18 filtration stations, some of which were located on temporarily occupied territories. The South Donbas Water Way (SDWW) transported water to Mariupol.

As early as 19 February 2022, the shelling damaged 4 filtration stations, leaving numerous settlements without water supply[24]. Since 21 February, Avdiivka was cut off water supply, and it was never restored, however, some boreholes were providing minimal amounts. Moreover, the city's water treatment was ensured by Avdiivka Coke and Chemical Plant, and this function was supported for some time after the factory conservation after severe shelling incidents. All over Donetsk region, water delivery by the emergency services became essential to meet the basic needs of people and prevent a humanitarian disaster. However, this required huge technical and financial resources and distracted the capacity of the emergency services from responding to other situations, accelerated vehicle amortization by a magnitude and endangered the workers.

In Toretsk community, the fighting damaged a high-voltage power line to the 3-rd elevation station of Siverskyi Donets-Donbas Canal, cutting off the supply for Horlivka filtration station and leaving Toretsk community, Horlivka and Donetsk without water. Since then, Donetsk itself had been

https://www.unicef.org/ukraine/media/8966/file/UNICEF_Risk%20Assessment_Sep2019_UKR.pdf

[24] https://dn.gov.ua/news/vnaslidok-obstriliv-z-boku-okupantiv-znestrumleno-donecku-filtruvalnu-stanciyu-bez-vodi-zalishilos-ponad-29-tisyach-lyudej

dependent on very scarce backup sources, and even the tap water supplied at very limited time intervals was unsafe for drinking[25].

The water supply in the Pokrovsk community has been intermittent since the start of the full-scale war, as the Karlivska filtration station was constantly experiencing power outages due to enemy shelling. Even this water was essentially unfit for drinking due to insufficient purification. However, the community faced the double problem of regular repairs to the power supply of the filtering station in conditions of shelling and the need to save water from the Karlivske reservoir, the capacity of which got significantly depleted over time[26]. In September 2022, water from Karlivske reservoirs were distributed between Pokrovsk and Myrnohrad communities at a 3/3 days schedule. The attack on the reservoir dam in May 2023 posed a significant threat to these communities, despite the fact, that a unique water treatment project to purify Tsentralna and Krasnolymanska coal mine well water was introduced there[27], providing yet another emergency source.

In **Mariupol**, the destruction of the water supply system had the most serious consequences and spiralled into a humanitarian and ecological disaster, the true scale of which may hardly be assessed even after the liberation. Even before the war, the city experiences water stress caused both by natural factors (low supply of surface waters and their peculiar chemical composition, highly mineralized groundwater, with only few aquifers suitable for drinking water supply), and structural factors. A powerful industrial city with such large enterprises, such as "Azovstal" and Ilyich Metallurgical Plant, was actually on the "lifeline" of water from the remote sources.

On February 19, 2022, after the so-called DPR militants attacked the 1-st elevation pumping station of the first rise of the South Donbas Water Way, the city completely switched to supply from the Starokrymske reservoir[28]. Active hostilities began already on 24 February 2022, and from 2 March the city was under a complete blockade. The city's infrastructure, including electricity supply, pumping stations and water supply from the emergency storage, was destroyed by heavy artillery and aerial bombing in a premeditated, deliberate manner. The city had very scarce alternative sources and just a few wells considering the absence of the groundwater suitable for consumption; there were just about 20 observational boreholes around the city[29]. Moreover, following the 2011 cholera outbreak, several springs in the city were sealed[30].

The citizens had to melt snow, collect rainwater and tap the water from heating systems. Moreover, while queuing near the few available springs, people might get killed because of heavy shellings[31]. Later, unsafe water caused outbreaks of rotavirus infections[32]. Since April, the pollution and infection problem became especially acute because of the large number of improvised burials in

[25] https://www.svoboda.org/a/donbass-bezvodnyy-region-nedostatok-vody-v-okkupatsii/32400638.html
[26] https://vchasnoua.com/news/po-hrafiku-3-3-pokrovsk-ta-myrnohrad-otrymuvatymut-vodu-pocherhovo
[27] https://freeradio.com.ua/u-pokrovskii-hromadi-vodu-zi-sverdlovyny-bilia-shakhty-podaiut-u-vodohin-ta-shukaiut-inshi-dzherela-vody-va/
[28] https://mrpl.city/news/view/posledstviya-obstrela-v-mariupole-povysilas-zhestkost-vody-bolee-20-naselennyh-punktov-donetchiny-obezvozheny
[29] https://www.mediaport.ua/na-donbasse-net-kachestvennoy-pitevoy-vody-chernysh
[30] https://rus.lb.ua/society/2011/06/07/100144_istochnikom_vspishki_holeri_v_mari.html
[31] https://www.bbc.com/ukrainian/features-61297043
[32] https://www.donbasssos.org/mariupol-evacuation-story/

the yards, soil pollution by fuel, heavy metals and explosive components, as well as solid waste dumping. Virtually no data are available on the toll of the water factor on people's health, as the occupation administration did not provide any proper aid to the civilian population and was unlikely to keep medical records. According to the representatives of the city authorities in evacuation, all 22 pumping stations and about 50% of all pipelines if the city were damaged. The main sewage collection system of the city was about to collapse as well[33]. Since autumn, some repair works had been carried out; Starokrymske reservoir, which as used as a backup source before the full-scale war, became a key waterbody for the city. However, its capacity is likely to drastically decrease quite soon, and another one, Pavlopilske reservoir, had to be replenished from the SDDC, which is not going to happen anytime soon because the canal stopped functioning.

Bakhmut received its water supply from SDDC (about 60%) and two aquifers, Klischiivsky and Krasnosilsky. Already in May 2022, Russian artillery shelled the outskirts of Bakhmut, the city began to experience interruptions in electricity and water supply. Initially, there was a possibility of repair works, however, on 13 July, the water supply was stopped due to the blackout of the Artemivska (Bakhmutska) filtration station[34]. Repair work was prevented by heavy shelling. The power supply of aquifer pumping systems was damaged and never restored. In autumn 2022, the local authorities managed to run the pumps powered by generators to create an emergency reserve. About that time, the household waste leachate started threatening the groundwater quality, was waste management and disposal stopped several months ago[35]. In the course of severe fighting in 2023, the city was destroyed by 80%, and its utility systems are not operational and possibly cannot be repaired. Chasovoiarska filtration station in the near Chasiv Yar town was also likely damaged by shelling[36].

In **Slovyansk**, the water supply system relies on SDDC. Due to hostilities and power outages, water supply has been stopped since mid-May 2022. In addition, on May 27, the Second Donetsk Water Way was damaged. In early June there were several attempts to restore power supply, but on 4 June it was reported that it is still impossible to restore the water supply due to the Siverskyi Donets water level decrease at the Mayatsky intake point, which supplied it to the local filtering station. Presumably, this was caused by the destruction of the Oskilsky Reservoir, which served as a water bank in the summer months, stabilizing Siverskyi Donets flow[37].

In **Mykolaiv**, water infrastructure was damaged by shelling and missile attacks on many occasions. On 9 March 2022, mortar shells hit the sewage treatment plant of Mykolaivvodokanal near Halytsynove village, where 83% of city wastewater was treated. The mechanical wastewater treatment system was partially out of order. Backup sand traps, which are involved in the technological scheme of mechanical purification of wastewater from small debris and sand were

[33] https://mind.ua/news/20241606-sprobi-okupantiv-vidnoviti-vodopostachannya-v-mariupoli-mozhut-obernutisya-ekologichnoyu-katastrofoyu-me
[34] https://bahmut.in.ua/novosti/v-artemovske/3507-bakhmutyani-zalishilisya-bez-vodi-na-neviznachenij-termin-skilki-chekati-shcho-robiti-ta-v-chomu-prichina
[35] https://v-variant.com.ua/article/voda-tsinoiu-v-zhyttia/
[36] https://lb.ua/society/2022/11/20/536464_unochi_viyskovi_rf_obstrilyali.html
[37] https://freeradio.com.ua/vidnovyty-podachu-vody-u-slov-iansk-poky-nemozhlyvo-mer-mista/

destroyed. The biological treatment air tanks were also damaged. The structures generally worked, but it took more time to purify the water[38].

The city services were managing current repairs quite efficiently, until the main source of fresh water, Dnipro-Mykolaiv Water Way, was blown up by Russian forces. Mykolaiv was also dependent on Dnipro river freshwater supply from the intake with a capacity of 280,000 m^3/day located near the village of Mykilske, Kherson region. This place is downstream Kakhovsky Reservoir, which traps pollution from cities located upstream of the Dnipro, but also below the estuary of the Inhulets River, which is polluted by industrial effluents from Kryvyi Rih iron mining and industrial cluster. Along a the 73-km-long Dnipro-Mykolaiv aqueduct, unprepared water is transported to city treatment facilities with a capacity of 190,000 m^3/day[39]. The city of Mykolaiv is the main consumer of such water. There are no alternatives to such a scheme, because the water of the Southern Buh and Inhul is unsuitable for drinking even after purification, and Dnipro-Buh estuary, on top of this, has increased salinity. The damage occurred in the temporarily occupied territory of the Kherson region, near the village of Kyselivka, as a result of which repair work was impossible. The water supply throughout the city was discontinued since 15 April. The population of Mykolaiv before the war was about 480,000, and even if we take into account that according to various data, 30-40% of people moved to other locations, daily need for water remained very high. In the first days after the accident, people took water from the Southern Buh, collected rainwater. To address the situation, the works on well drilling started, mobile water treatment stations were delivered by charitable organizations. Later, the city authorities decided to supply the water from Buh estuary to the pipelines. This water, with high mineralization, increased chloride and sulfide content, could be used only for household purposes to ensure minimal sanitation[40]. Moreover, its high corrosivity caused the municipal water systems to deteriorate rapidly. After the liberation of Kherson, some repair works started to restore the Dnipro water intake. And yet, the destruction of the Kakhovka Dam and subsequent flooding damaged and polluted the water abstraction point, cutting off the supply of the Dnipro water once again[41].

In **Kherson**, the city itself is provided with high-quality artesian water from about 135 wells[42]. Meanwhile, the distribution of groundwater resources in the region is very uneven, and many communities rely on Dnipro water. Already in spring 2022, the water infrastructure in numerous communities, such as Chornobaivska, Novovorontsovska, Vysokopilska, Kochubeivska communities was destroyed. After the liberation, generators to power the wells became a first priority[43]. In autumn 2022 and spring 2023, numerous communities were affected by regular heavy artillery and mortar shelling, as well as air strikes. After the destruction of the Kakhovka Dam, the consequences were disastrous – many wells downstream were flooded and polluted, threatening to deteriorate the entire aquifer quality for a long time (and aquifer remediation is an extremely complicated and costly

[38] https://t.me/vodokanal1/1009
[39] https://mk-vodres.davr.gov.ua/vprovadzhennya-geoinformatsijnoji-sistemi-monitoringu-yakosti-vod-i-vodokoristuvannya-mikolajivskoji-oblasti
[40] https://t.me/vodokanal1/1219
[41] https://nikvesti.com/ua/news/incidents/270745
[42] http://wra-journal.ksauniv.ks.ua/archives/2019/2/12.pdf
[43] https://miskrada.kherson.ua/news/u-khersonskij-oblasti-70-naselenykh-punktiv-bez-svitla-j-vody-sytuatsiia-v-rajonakh-stanom-na-1-kvitnia/

process which is unlikely to be done in wartime conditions). In many other communities, such as Beryslavska, Mylivska, water table dropped to the current river level, that is, by up to 16 meters. Considering increased groundwater exploitation and decreased recharge once hydraulic pressure of the huge water mass of the former reservoir is gone, the groundwater depletion may become a very real threat, especially as there is no efficient groundwater accounting system.

In **Zaporizhzhya** region, most locations depend on Dnipro river with Dniprovske and (former) Kakhovske reservoir. Most of smaller rivers are not suitable for drinking water supply in terms of mineralization and chemical composition, as well as the content of pollutants. Their waters, mostly from spring floods, are used to fill ponds for technical water supply, irrigation and aquaculture. Reserves of groundwater suitable for potable use are unevenly distributed across the region. In 9 out of 20 districts, there are no exploitation-ready reserves of underground water and there is no technical ability to transport water from surface sources to areas that use groundwater or are waterless. 6% of settlements depend on water trucking even for household non-drinking needs. Along the entire frontline, especially in Orikhiv and Polohy districts, water supply stopped since early 2022. Local authorities tried to keep at least a few wells operational. In Huliaipole community, water trucking was ensured by the State Emergency Service that delivered about 10 tons every 3-4 days. Local services used a generator to keep a water tower in the city operational to maintain the sewage treatment functioning at a minimal level[44].

The situation in the occupied territories is also complicated. In Berdiansk, the pipeline providing the water from Kakhovka reservoir stopped operating in late 2022, and the city used Berda river water high in mineralization and sulphate content[45]. And since the reservoir destruction, there are very few options, if any, to ensure proper quality water supply.

In **Kharkiv** region, fighting and temporary occupation caused considerable problems with water supply. Kharkiv city itself has been affected by shelling and missile strikes for months, and the city water system was hit about 100 times in total. Partial repairs carried out before the full-scale invasion helped to maintain the system operational[46]. In Balakliya, following occupation and fighting, water supply was interrupted for a prolonged period[47]. In Izium, 80% of the residential buildings were demolished, and municipal utility systems were heavily affected[48]. Moreover, the region's hydrotechnical structures were targeted on many occasions – early in 2022, Oskilske reservoir was destroyed, and in September, attacks on Pechenizke reservoir dam threatened its integrity and might have caused severe flooding along with the loss of considerable amounts of drinking water. Moreover, decentralized water sources in de-occupied areas demonstrated high percentage of substandard and poor quality samples[49].

De-energization

[44] https://gylyajpole.city/articles/223044/u-gulyajpole-dostavili-vodu-ta-gumanitarnu-dopomogu
[45] https://primorka.city/articles/242332/okupanti-perevodyat-berdyansk-na-berdivsku-vodu
[46] https://suspilne.media/372211-voda-u-harkovi-pid-cas-vijni-ak-rosijski-udari-vplinuli-na-akist-ta-obsagi-postacanna/
[47] https://www.unicef.org/ukraine/stories/unicef-helps-repair-water-supply-system
[48] https://www.radiosvoboda.org/a/foto-ukrayina-viyna-izyum/32205486.html
[49] https://suspilne.media/416142-vidstouvati-ta-kipatiti-pro-akist-vodi-na-deokupovanih-teritoriah-harkivsini/

Loss of power supply is another important factor influencing the citizens' access to adequate drinking and household water. In centralized systems, a blackout renders the system incapable. Pumping stations that deliver water to the users stop functioning, water treatment systems are also threatened, as the functioning of biological purification tanks requires constant oxygen supply[50]. In decentralized settings, power supply, or at least the availability of a generator, is necessary to access the water in deeper wells (50 m and below), while most of the near-surface aquifers are usable for household needs only, depending on the locality and geological structure. According to the Assessment of Power Needs of Ukrainian Vodokanals report[51], the poor existing state of water infrastructure contributes to significant levels of energy consumption and high carbon emissions for daily operations. The water and sanitation sector of Ukraine is extremely energy-intensive. Obsolete and oversized infrastructure, outdated energy-intensive processes, historically low tariffs for water and sanitation services and electricity, and ongoing lack of attention to maintenance needs contribute to these immense power needs. Moreover, frequent blackouts accelerate the power equipment amortization.

The series of missile strikes at the energy infrastructure of Ukraine that started since 10 October 2022, caused massive blackouts accompanied by heating and water supply interruptions. The effects of de-energization on the water supply infrastructure are yet to be fully assessed. Around 1 November 2022, 80% of Kyiv was left without water supply following a barrage of missiles[52]. During the liberation of Kherson, Russian forces blew up or planted explosives on power grid, and the residents of a de-energized city had to collect water directly from Dnipro river[53]. On 23 November 2022, another wave of blackouts caused massive water supply interruptions[54]. According to UNICEF assessments, almost 7 million of children were at the risk of being deprived of essential services because of rolling blackouts in late 2022[55]. Procurement of powerful generators for the vodokanals became one of the priorities of the state funding and international humanitarian aid.

Pollution, capacity and water quality monitoring gaps

Conflict pollution, including technogenic disasters, failure of water treatment systems and legacy contaminants of abandoned and mismanaged industrial sites, impose additional stress on the water ecosystems and the health of surface waters and aquifers. This situation is exacerbated by the lack of capacity to monitor, test and address these threats. The access to numerous monitoring sites near the frontline is lost, many areas of severe pollution, such as slowly flooding coal mines in Luhansk

[50] https://suspilne.media/325816-na-mikolaivsini-vinikla-zagroza-zagibeli-bakterij-aktivnogo-mulu-u-comu-pricina/

[51] https://www.globalwaters.org/sites/default/files/washpals_2_ukraine_vodokanal_power_needs_assessment_report_final_1.pdf

[52] https://www.bbc.com/news/world-europe-63478704

[53] https://t.me/SobolevskyiYurii/634

[54] https://www.waterdiplomat.org/story/2022/11/extensive-damage-water-and-electricity-infrastructure-across-ukraine

[55] https://reliefweb.int/report/ukraine/almost-7-million-children-ukraine-risk-attacks-energy-infrastructure-cause-widespread-blackouts-and-disruption-heating-and-water

and Donetsk region, are inaccessible. Kakhovka dam disaster caused the transfer of a wide range of contaminants, including heavy metals, hydrocarbons, persistent organic contaminants and heavy metals, along considerable distances, as well as disturbance of the legacy pollution in riverbed sediments. Many of the sites of interest that should be inspected and monitored as soon as possible are inaccessible until the cessation of hostilities.

In conditions of the failure of centralized water supply and treatment systems, people are relying on whatever decentralized source of water they can access. The coverage with basic water monitoring is not sufficient and does not always reach rural and remote areas, despite the efforts of the State Consumer Service to ensure such monitoring within its area of responsibility.

Attacks on hydrotechnical structures important for water supply

Despite clear prohibition of attack on dams as structures containing dangerous forces, the Russian troops readily weaponized water in Ukraine, launching strikes at hydrotechnical structures on many occasions. While flooding and physical damage create an immediate emergency, long-term effects of losing a source of drinking water which defines local planning, infrastructure layout and water consumption needs may have not less devastation effects in the long-term perspective.

Oskilske reservoir

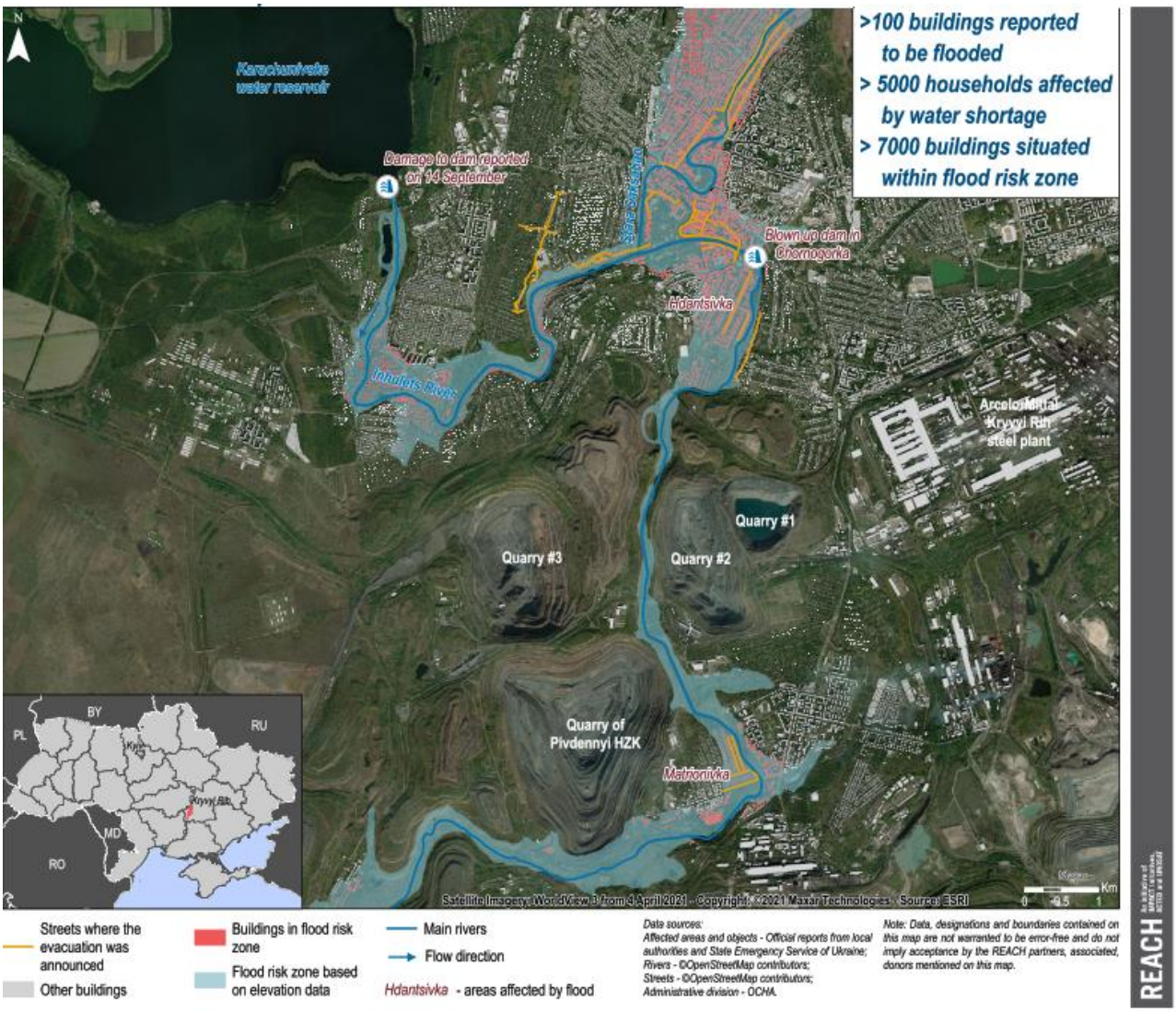
During the hostilities in Kharkiv Oblast, in March, the hydraulic structure of the **Oskilske** reservoir, the largest in the left bank of Ukraine, was damaged, causing loss of water and flooding of some areas of Svyatohirsk community. The reservoir was essential for Donetsk and Luhansk regions water supply, buffering the level of Siverskyi Donets during the hot season. In addition, the ecosystem of the reservoir was destroyed, hundreds of kilometers of spawning grounds were also significantly affected, as well as Chervonooskilsky Regional Landscape Park, which includes 4,000 hectares of the reservoir's territory. According to the calculations of the State Environmental Inspectorate, damage was caused in the amount of about 2.1 billion UAH, in particular, about 2 million units of fish died in the amount of 883.7 million UAH.

Karachunivske reservoir

On September 14-16, Russian troops launched missile attacks on the hydraulic structure of the Karachunivske reservoir in the city of Kryvyi Rih. The water level in the Inhulets River rose by 1-2 meters, as a result of which 112 houses were flooded. According to the calculations of the State Environmental Inspectorate, the leakage of water due to the destruction of the sluice amounted to 16,873 m^3, damages in the amount of UAH 77 million were caused. The study of water samples showed an excess of the established standards for iron content by 3 times (which is connected with the use of iron quartzite slagheap from local quarries and ore concentration factories to eliminate damage to the hydraulic structure and led to a temporary reddening of the water downstream), and

for ammonium nitrogen by 2.5 times, which indicates water pollution by sewage from private households.

Fig. 6. Karachunivske reservoir situational assessment:



Map source: REACH Initiative[56]

Pechenizke reservoir

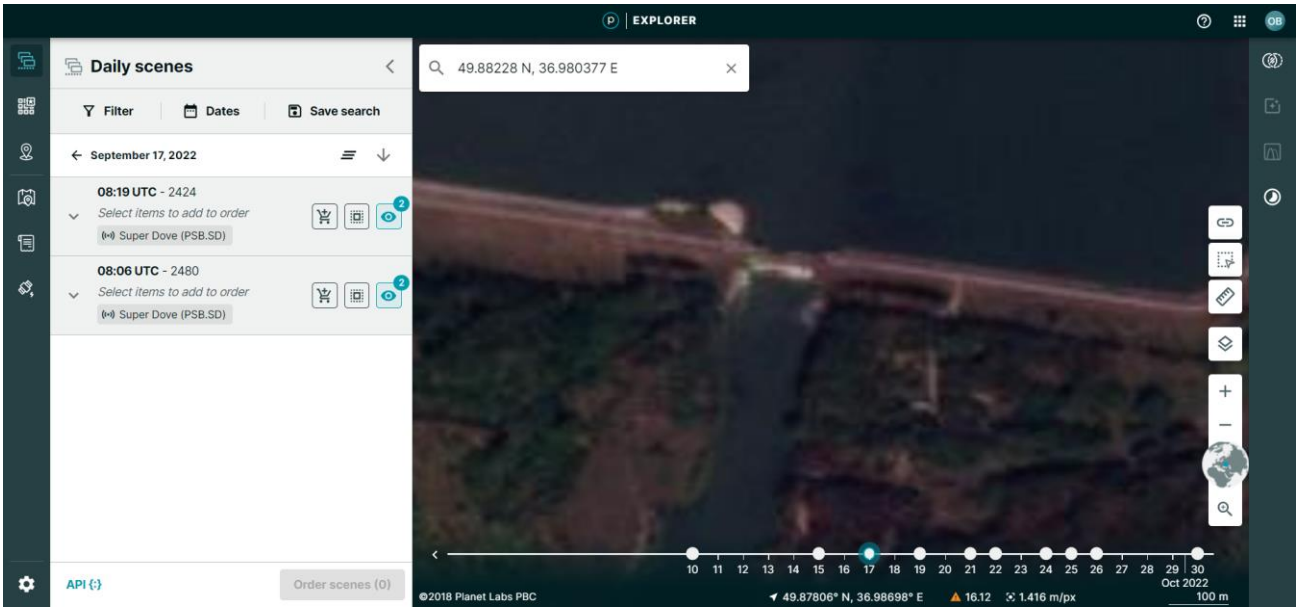
On September 20, the Russian invaders attacked the dam of the **Pechenizke** reservoir with 2 missiles[57]. On September 20-21, the shelling was repeated, in total, Russian troops launched eight strikes on the hydraulic unit of the Pecheneg Reservoir, using cruise missiles and S-300. During the last shelling on September 22, a rocket hit the ground near a hydrotechnical structure. The upper

[56] https://reliefweb.int/map/ukraine/ukraine-kryvyi-rih-ad-hoc-flood-risk-assessment-after-incident-14-sep-2022

[57] https://www.facebook.com/GeneralStaff.ua/posts/pfbid032pjQ1a2PE92p2NEYa7SUHcU2THxLbz7UHuRsZ6dPwtPHKuewycxz4Hj2r5fYjbhFl

lock of the dam was destroyed and there was an uncontrolled discharge of water, the exact volume of which is unknown. There was a threat of flooding of coastal villages, but catastrophic consequences were prevented.

Fig. 7. Pechenizke reservoir dam and sluice gate on 17 September 2022



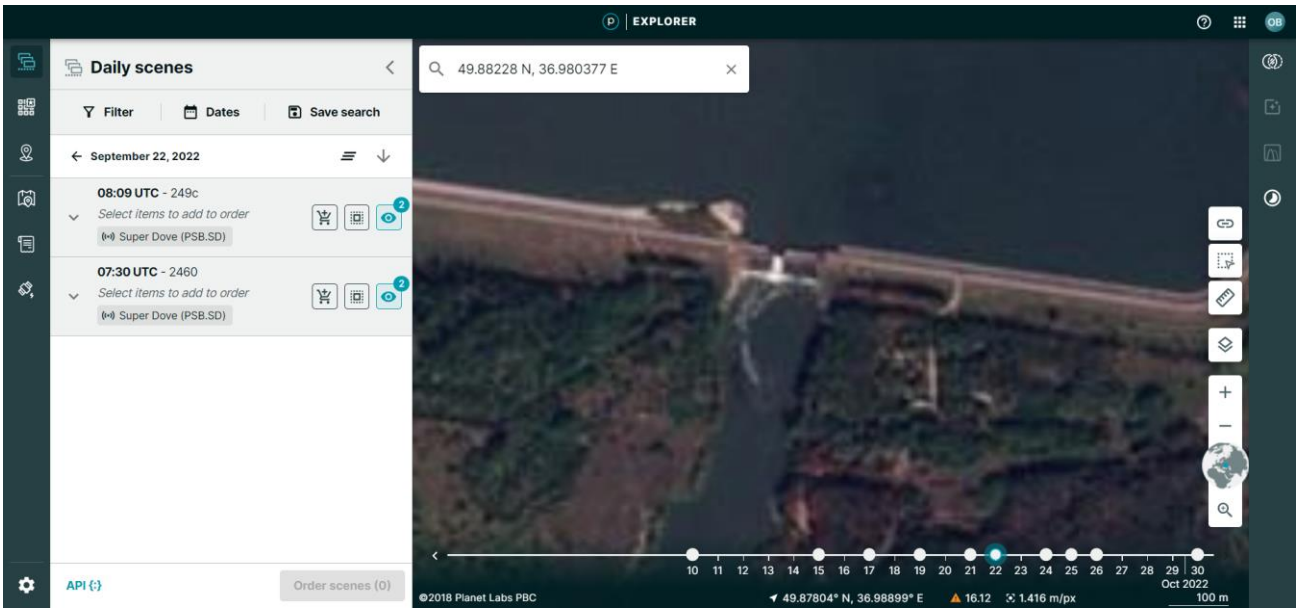
Pechenizke reservoir supplies water to the Kyivskyi, Saltivskyi, Nemyshlyanskyi, Industrialnyi, Slobidskyi, and Osnovyanskyi districts. The water of the reservoir is the best in the region in terms of hydrobiological and saline composition. It is purified at the "Donets" water treatment complex and is transported through five main water pipelines with a diameter of 900-1600 mm and a total length of 161.2 km[58]. According to the data of the Siverskyi Donetsk Basin Management Authority, only in January 2022, the intake of water from the Pechenizke reservoir in the city of Kharkiv amounted to 11.83 million m^3, the remaining 20.27 million m^3 were used for the needs of water intakes located downstream[59]. A sharp drop in the level of the reservoir would endanger the water supply of the million-strong city. A relatively large number of springs in the city of Kharkiv could theoretically provide at least emergency drinking water needs[60], but their availability and quality should be taken into account. The situation with household and technical water supply, however, could have become catastrophic.

[58] https://vodokanal.kharkov.ua/news/974

[59] Data from the Analysis of the state of water bodies and the supply of water resources in the sub-basin of the Siverskyi Donets River in January 2022.

[60] Оцінка забезпеченості та доступності ресурсів джерельних вод для населення Харківської області. А. М. Новікова, В. В. Яковлєв, Д. В. Дядін. Харківський національний університет міського господарства ім. О.М. Бекетова, 2020: https://www.researchgate.net/publication/349506617_Ocinka_zabezpecenosti_ta_dostupnosti_resursiv_dzerelnih_vod_dla_naselenna_Harkivskoi_oblasti

Fig. 8. Pechenizke reservoir dam and sluice gate on 22 September 2022 – damage to the dam and water spilling over it is clearly visible.



Karlivske reservoir

On 5 October 2022, Russian troops struck[61] the dam of the Karlivske reservoir, which is a major source of water supply for several communities in the Donetsk region, with Grad MLRS. Repeated shelling was recorded on December 15[62]. On 25 May 2023, Russian forces launched a major strike at the dam, causing serious destruction which threatened to flood the adjacent settlements Zhelanne-1, Zhelanne-2 and Halytsynivka[63]. Moreover, loss of a large amount of freshwater could have caused severe consequences, considering the fact that the capacity of this reservoir already had to be managed very responsibly and strictly rationed to ensure that the local communities will have minimum sufficient amount of water. The incident still caused local flooding and loss of 7.5 million m^3 of water[64].

[61] https://www.ukrinform.ua/rubric-ato/3586219-rosiani-za-dobu-obstrilali-sim-oblastej-ukraini-zvedenna-ova.html
[62] https://suspilne.media/339710-raketni-udari-po-harkovu-i-obstril-seredmista-hersona-ak-minula-nic-v-regionah/
[63] https://hromadske.ua/posts/na-donechchini-okupanti-zrujnuvali-greblyu-karlivskogo-vodoshovisha-tri-selisha-pid-zagrozoyu-pidtoplennya-ova
[64] https://suspilne.media/491623-pisla-obstrilu-dambi-z-karlivskogo-vodoshovisa-zijslo-75-mln-kubometriv-vodi/

Fig. 9. Karlivske reservoir and dam on 20 May 2023

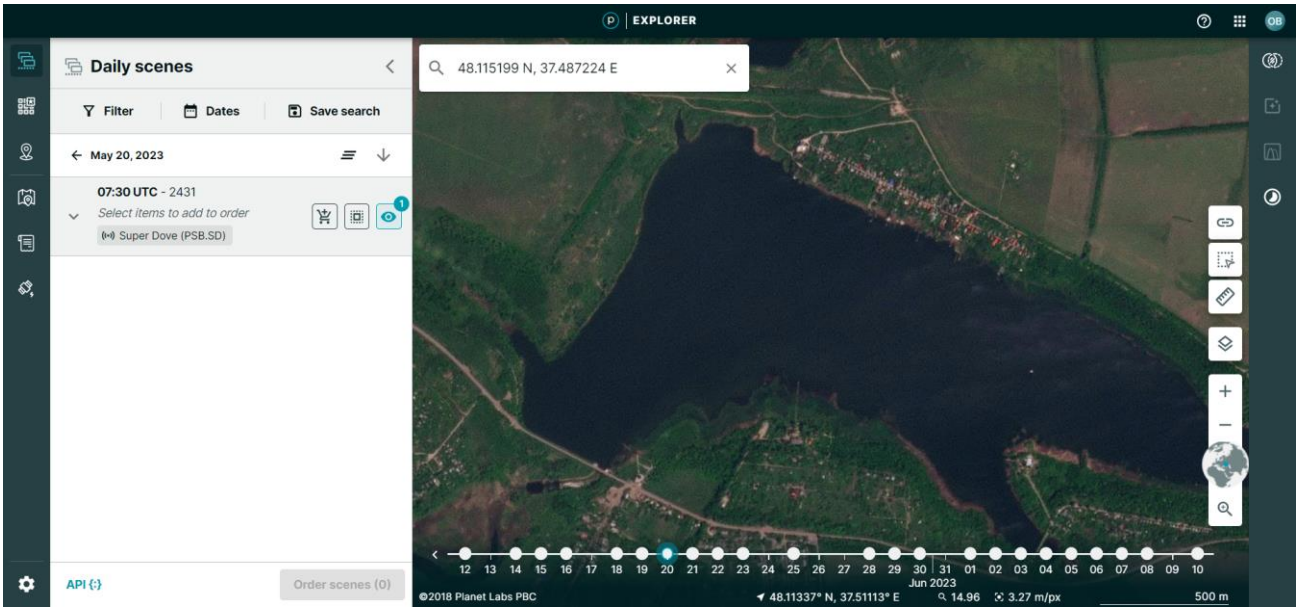
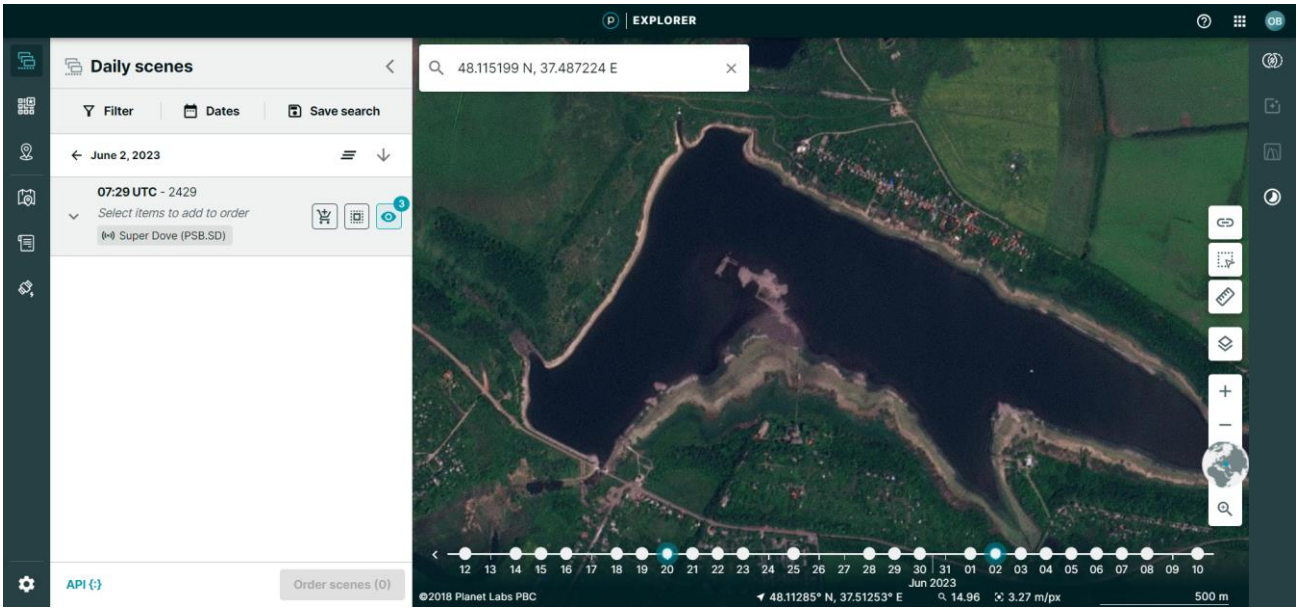


Fig. 10. Karlivske reservoir showing receded water level on 2 June 2023

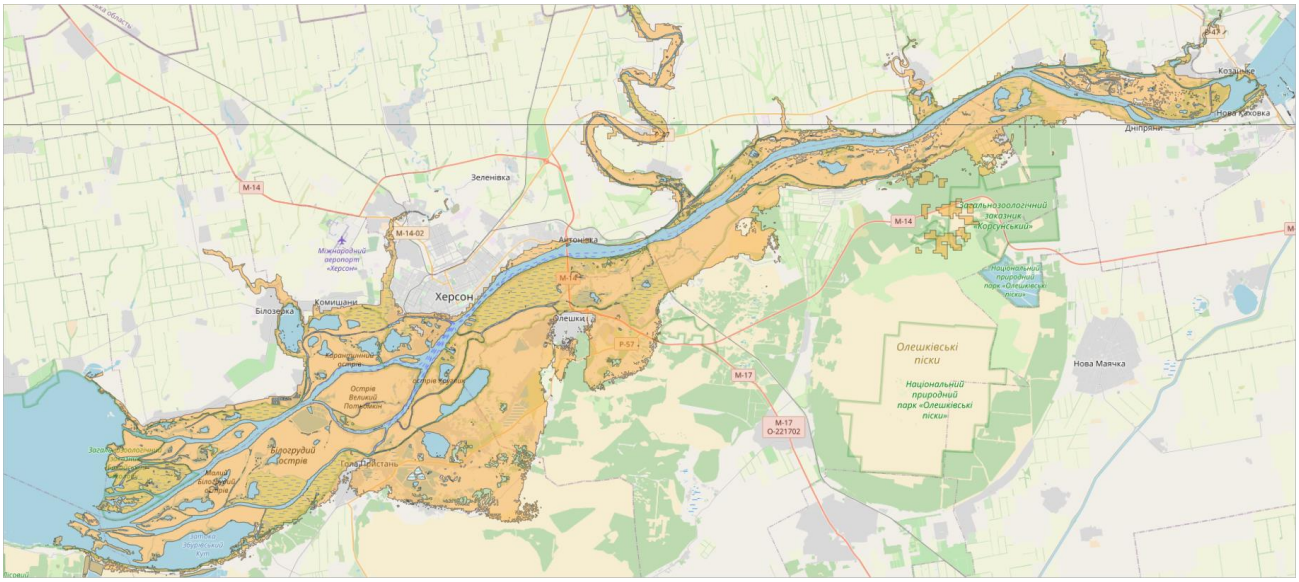


Kakhovske reservoir

The destruction of Kakhovka Dam on 6 June 2023 is an act of environmental terrorism of planetary scale. Due to the breach of the dam, more than 70% of the volume of the Kakhovske reservoir was lost in a few days, the level of the Dnipro River, the Dnipro-Buh estuary, the Inhul River, the Inhulets River, the Southern Buh River, and the Vysun River increased. As of 07:30 on June 6, Tyahynka, Lvove, Odradokamyanka of Beryslav district, Ivanivka, Mykilske, Tokarivka, Ponyativka,

Bilozerka, Ostriv microdistrict of Kherson city were completely or partially flooded, and at the same time, on the morning of June 6, flooding started in Nova Kakhovka, Dnipryany, Oleshky and other settlements on the left bank of the Dnipro river. The flooding developed for the next few days, peaking on 9 June, when 48 settlements and 3,625 houses were flooded only on the right bank of the Dnipro. The average water level was 4.61 m. 350 houses in 13 settlements of the Snihurivka community remained in the flooding zone. Data on the settlements on the left bank are less accurate and arrive with a delay, but it is clear that the scale of the disaster is even more severe. On June 12, it was reported that up to 17,600 houses were flooded or submerged in the Holoprystan community. According to the analysis of UNOSAT satellite images, 8,016 buildings were in the flooded zone in Oleshky. Water levels as of June 9, 2023 were used to analyze which environmental hazards are located in the disaster zone.

Fig. 11. Flooding zone along the Dnipro on June 9, ICEYE image data from June 7, 2023/analysis of UNOSAT Satellite Flood Waters Extent and Evolution over Khersonska Oblast in Ukraine as of June 13, 2023, cartographic base - Open Street Map.



The flooding zone covered Kherson industrial area with numerous chemical and metallurgical enterprises, River port, Naftogavan oil terminal, the pipeline of the Kherson oil refinery, Kherson Kuibyshev Shipbuilding Plant, Pallada plant, Maxigrain elevator, at least 2 gas stations, as well as washed diffuse pollution from the industrial areas that have never been properly rehabilitated. Kherson Komyshany district was affected with oil spills. In Oleshky, industrial area was flooded, including Glusco oil depot, Henkel Bautechnik Ukraine, the territory of the Kherson pulp and paper mill together with the former sedimentation tank, part of which was abandoned and needed reclamation. Water treatment facilities and old filtration fields with a total area of about 1,400,000 m^2 were flooded, causing severe biogenic contamination.

Lack of drinking water became probably the most severe and persistent problem after the dam destruction.

In Kherson, at least 2 intake points were destroyed, 17 of 140 wells flooded, 5 sewage pumping stations flooded. 30,000 persons were without access to drinking water in the first few days after the disaster. Destruction of the drinking water supply system and loss of access to drinking water in many communities of the Dnipropetrovsk, Kherson, and Zaporizhzhya regions is perhaps the most serious consequence of the Kakhovka dam breach, which is devastating at a strategic level. The Kakhovske reservoir was a source of water supply for 700,000 people. The water level decrease below 12 meters prevented the functioning of water intakes in the large urban communities of the Dnipropetrovsk region - Nikopol, Marhanets, Pokrov - and endangered the water supply in Apostolove, Zelenodolsk communities, as well as the city of Kryvyi Rih, which was by 70% dependent on the Kakhovka water. According to estimates by the UN and its humanitarian partners, more than 210,000 people in these areas urgently needed water in the first month after the disaster[65]. Based on the UNICEF WAH Cluster data, up to 700,000 people were left without water access. Extensive water delivery required the resources of the national and international organizations, efforts to find any suitable local sources, such as accelerated drilling of wells and rehabilitation of the old ones. In Ukraine, there was never a proper register of wells, thus, the affected communities often did not know what wells there are in their territory and what is their water quality and operational condition. In many communities, the aquifers hydraulically connected to the reservoir went dry, as the water level dropped by 15 meters and more.

Construction of large-scale water mains was initiated by the government to cover the needs of the affected communities in water.

[65] https://ukraine.un.org/uk/236801-%D1%96%D0%BD%D1%84%D0%BE%D1%80%D0%BC%D0%B0%D1%86%D1%96%D1%8F-%D0%B4%D0%BB%D1%8F-%D0%B7%D0%BC%D1%96-%D0%B2%D1%96%D0%B4-%D1%80%D0%B5%D1%87%D0%BD%D0%B8%D0%BA%D0%B0-%D1%83%D0%BF%D1%80%D0%B0%D0%B2%D0%BB%D1%96%D0%BD%D0%BD%D1%8F-%D0%BE%D0%BE%D0%BD-%D0%B7-%D0%BA%D0%BE%D0%BE%D1%80%D0%B4%D0%B8%D0%BD%D0%B0%D1%86%D1%96%D1%97-%D0%B3%D1%83%D0%BC%D0%B0%D0%BD%D1%96%D1%82%D0%B0%D1%80%D0%BD%D0%B8%D1%85-%D1%81%D0%BF%D1%80%D0%B0%D0%B2-%D0%B2-%D1%83%D0%BA%D1%80%D0%B0%D1%97%D0%BD%D1%96