THE ARTERY OF EASTERN UKRAINE

Summary of the Analysis of Water Issues in the Siverskyi Donets River and Programme of Measures to Address Them

THE AREA OF THE RIVER BASIN

OSCE Organization for Security and Co-operation in Europe
Project Co-ordinator in Ukraine

State Agency of Water Resources of Ukraine

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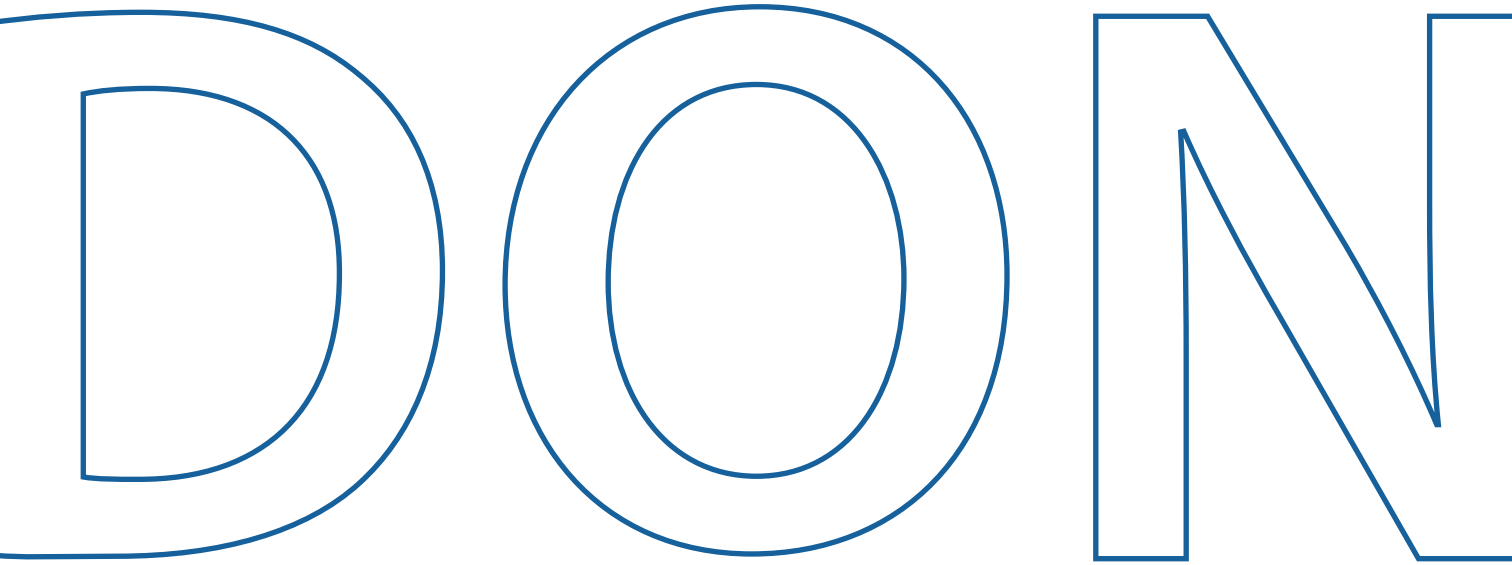

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1.

INTRODUCTION

After the breakout of hostilities in eastern Ukraine, the national and international community significantly increased its focus on the environmental issues in the region. In 2017, the OSCE Project Co-ordinator in Ukraine performed an assessment of the environmental damage caused by the military operations and prepared a set of recommendations for environmental recovery[1]. In response to the recommendations thus developed, in the following years the OSCE Project Co-ordinator in Ukraine supported a number of activities aimed at strengthening the monitoring and management of the Siverskyi Donets sub-basin (part of the Don basin), the main source of water supply in the eastern region[2].

Today, the issue of water security is critical not only in the regional but also in the national and global context. Pollution of water resources is identified by the public as Ukraine's most pressing environmental issue in general and in the eastern region in particular[3]. The Government of Ukraine pursues a strategic policy aimed at protecting water resources: the Strategy for Development of the Water Policy of Ukraine is in the final stage of elaboration, development of river basin management plans in line with the provisions of the EU Water Framework Directive is ongoing.

The Don river basin area (hereinafter "the Don basin") is influenced by various factors. Firstly, a significant impact is imposed by the historical past with an intense industrial load on the region's water resources, which is one of the highest in the country. Issues related to inefficient operation of obsolete treatment facilities, a large number of abandoned hazardous industrial waste storage sites, activities of unprofitable mining facilities, and other industrial activity factors require consistent and comprehensive solutions and significant investment.

Secondly, the planning of the transboundary river basin management takes place in non-standard and difficult conditions of the ongoing armed conflict, resulting in loss of control over a part of the river basin area. The impact of the hostilities on the state of water resources in the armed conflict setting has been studied insufficiently and mostly concerns relates to the socio-humanitarian aspects of access to water[4], however, the hazard brought by pollution of all the environment components caused by direct or indirect impact of the hostilities is an obvious fact.

1 Environmental Assessment and Recovery Priorities for Eastern Ukraine, 2017.

2 State of the Siverskyi Donets Basin and Related Risks under Military Operations. Technical Report, 2019.

3 "Guardians of the Donbas Environment. The Role of NGOs in Addressing Environmental Issues of the Donetsk and the Luhansk regions", 2021; Environmental Trends in Ukraine: Citizens' View. Sociological Survey Report, 2021.

4 Water in war: Understanding the impacts of armed conflict on water resources and their management (J. Schillinger et al., 2020).

Thirdly, it is important to take into account the worrying signs for the future associated with the growing trends related to risks of crisis situations, which may arise under the influence of climatic changes. As the eastern region is a low-water one, the issue of water scarcity in the river basins with a significant technological load in the context of climate changes requires special attention.

Through its project activities in 2018-2020, the OSCE Project Co-ordinator in Ukraine supported a number of studies in the Don basin, in particular, experts prepared a foundation for the river basin management plan, analyzed the main factors and pressures on the surface and groundwater, performed comprehensive screening of pollutants in the basin, and carried out targeted research on the impact of hazardous industrial facilities in the most vulnerable area near the contact line with subsequent simulation of accident-induced destruction of industrial waste storage dams in the researched territory. The next step in protecting region's water resources was development of the action programme to sustainable management of the river basin.

The list measures proposed for implementation within a framework of the said programme were developed following a review of the main water issues, discussions with local experts, representatives of local communities and were grouped by types in line with the structure of future river basin management plans[5]. This publication is a brief summary of the programme of measures developed for the river basin, including analysis of the issues identified as the basis of its development.

5 The procedure for development of river basin management plans is defined by the of the Cabinet of Ministers Resolution 336 of 18 May 2017 "On Approval of the Procedure for Development of the River Basin Management Plan". The first management plans are being prepared by the agencies for approval in 2024.

2.

THE DON RIVER BASIN

The Don river basin area (hereinafter "the Don basin") is a unit for development of a management plan per the hydrographic zoning of Ukraine. The river basin area is 55.25 thousand km² and includes the Siverskyi Donets sub-basin (99.3%) and the Lower Don sub-basin (0.7%). The Siverskyi Donets river basin in Ukraine accounts for 55% of the total catchment area, has an extensive hydrographic network of 290 rivers over 10 km long and is characterized by pronounced left-hand asymmetry: the left-bank part of the basin occupies 68% and the right-bank– 32% of its total area. One of the characteristic features of the basin in Ukraine is an uneven flow volume distribution with a background of high population density and industrial crowding in the basins of the right tributaries: the Udy (Kharkiv region), the Kazenyi and the Kryvyi Torets, the Bakhmutka (Donetsk region), the Verkhnia Bilenka and the Luhan (Luhansk region) rivers.

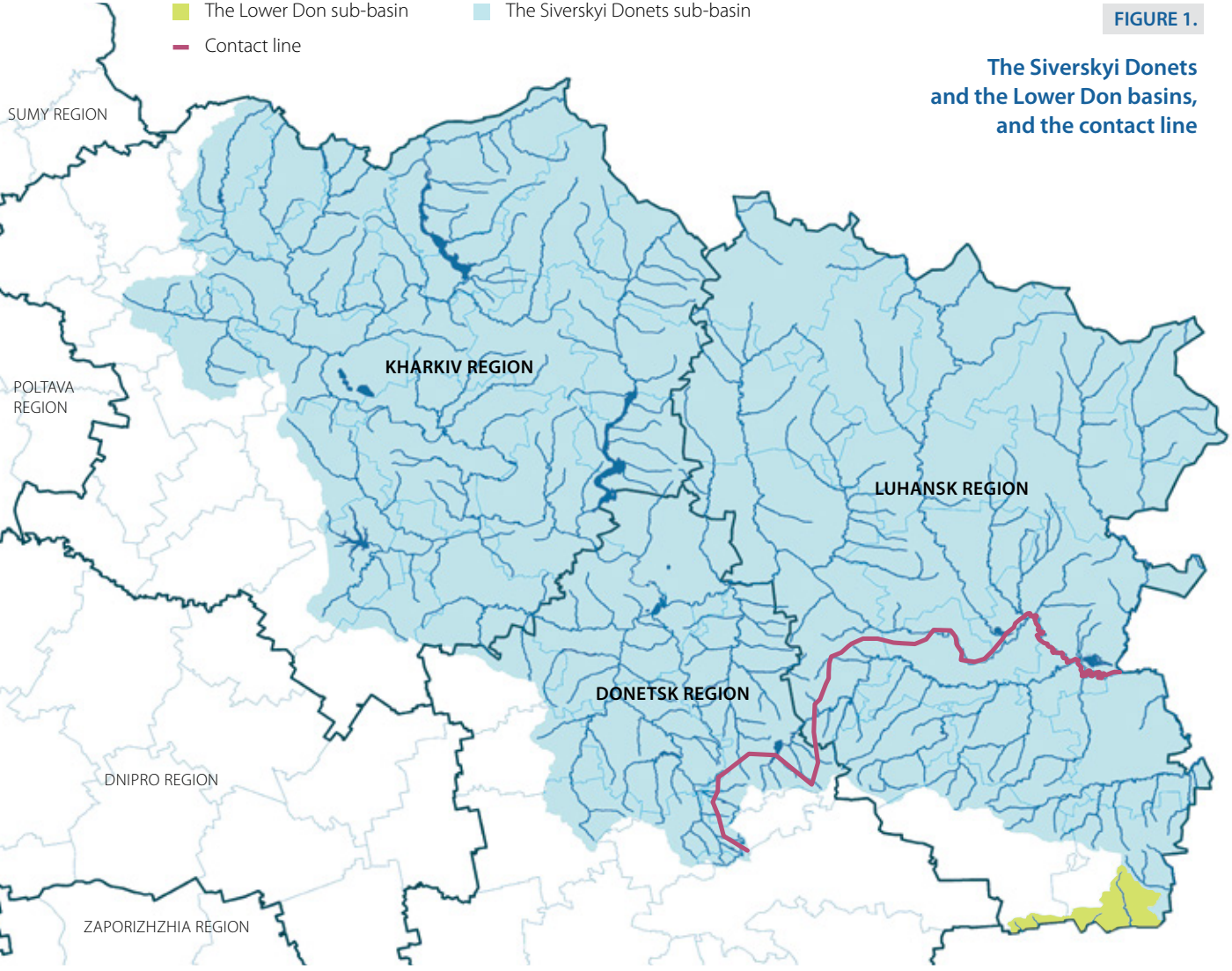
The Siverskyi Donets is a transboundary water body that crosses the state border of Ukraine with the Russian Federation twice (Kharkiv-Belgorod and Luhansk-Rostov regions). Some sections of the Derkul (about 75 km long) and the Siverskyi Donets (about 50 km long) rivers in the Luhansk region run along the state border.

Geographically, the Don river basin partially covers three regions: the Donetsk, the Luhansk and the Kharkiv regions. Since mid-2014, part of the Don basin within the Donetsk and the Luhansk regions is in the territory not controlled by the Government of Ukraine. For example, in the Donetsk region, the catchment area in the controlled territory decreased from 8.01 to 7.5 thousand km², the riverbed of the Siverskyi Donets is completely in government-controlled area, but the origins of the Kryvyi Torets and the Bakhmut (Bakhmutka) rivers are in the non-government controlled territory. The Siverskyi Donets basin area in the Luhansk region decreased in the government-controlled territory from 25.3 to 18 thousand km², whereas the Siverskyi Donets riverbed from the village of Svitlychne (406 km from the mouth) to the border with the Russian Federation (Rostov region, 222 km from the mouth), as well as the basins of the right tributaries – the Luhan, the Luhanchyk, the Velyka Kamianka and the Kundriucha – remained in the territory not controlled by the Government of Ukraine. The Lower Don basin within the Luhansk region is completely located in the non-government controlled area.

The total population of these regions within the river basin is 6.1 mln people, accounting for 14.6% of the total population of Ukraine. The basin is highly urbanized. The population density in the Kharkiv and the Luhansk regions is about 90 persons/km², and in the Donetsk region – up to 160 persons/km².

FIGURE 1.

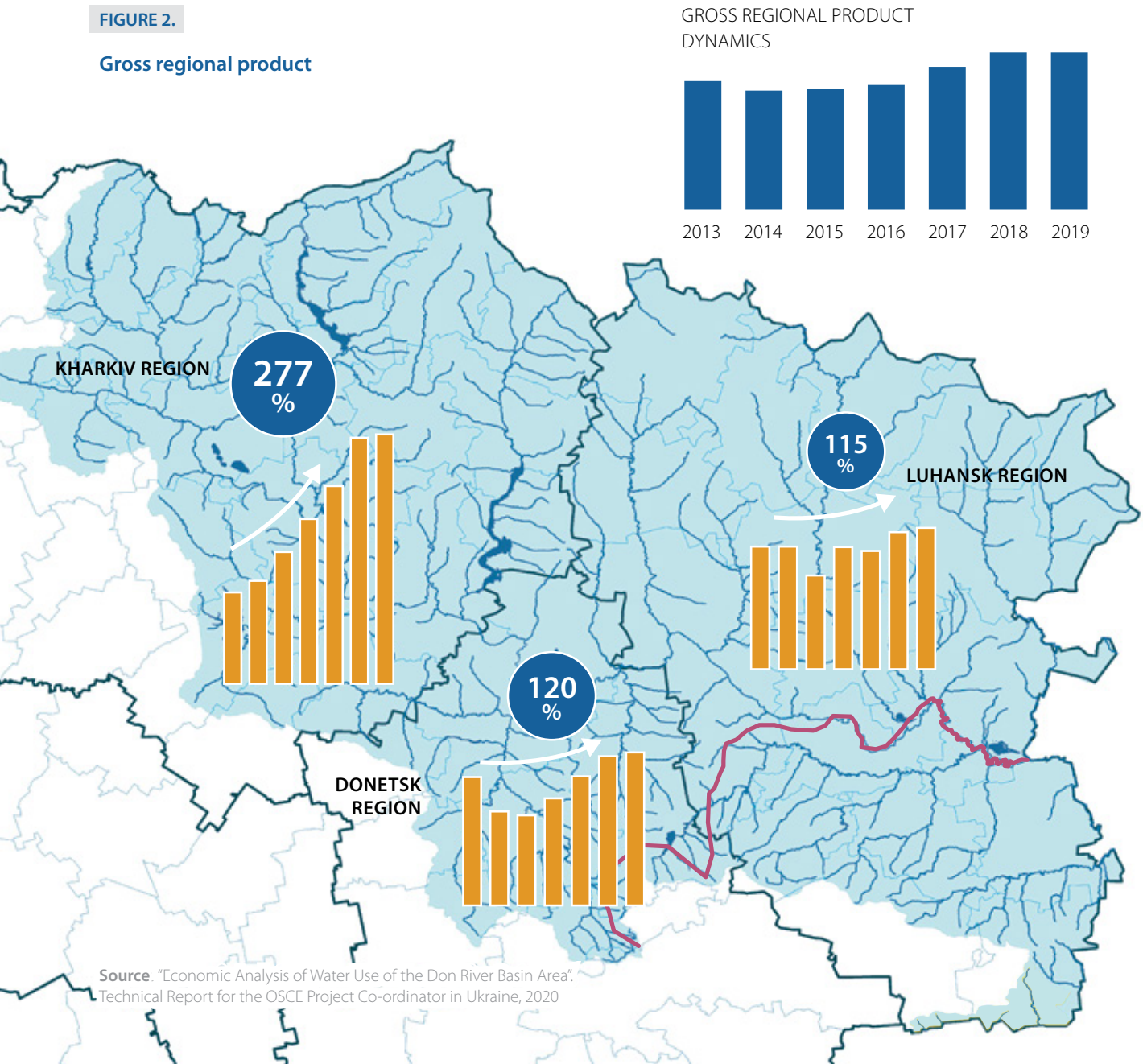
The Siverskyi Donets and the Lower Don basins, and the contact line



Source: State of the Siverskyi Donets Basin and Related Risks under Military Operations. Technical Report/ OSCE Project Co-ordinator in Ukraine, 2019

FIGURE 2.

Gross regional product



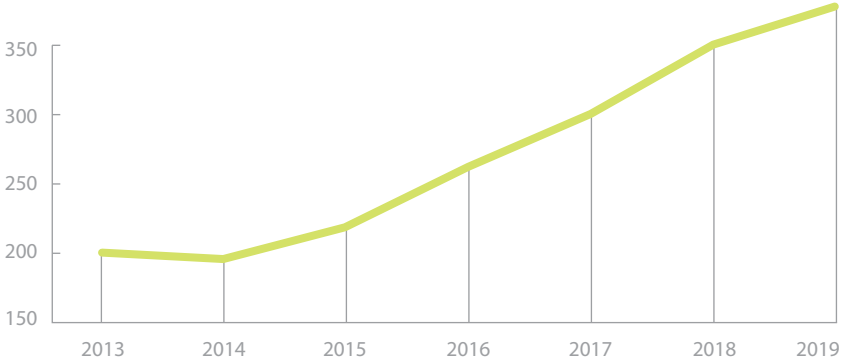
Source. "Economic Analysis of Water Use of the Don River Basin Area". Technical Report for the OSCE Project Co-ordinator in Ukraine, 2020

Due to the political situation, in 2013-2014 the basin GRP decreased by 4%, from UAH 196.3 bln to UAH 189.3 bln[6].

However, starting 2014, the GRP volumes have been increasing to UAH 361 bln in 2019. This indicates resumption of economic activity in the region.

FIGURE 3.

Dynamics of the GRP volumes of the Don River Basin,
bln UAH



Source: "Economic Analysis of Water Use of the Don River Basin Area". Technical Report for the OSCE Project Co-ordinator in Ukraine, 2020

The GRP per capita in the Don river basin is UAH 59 thousand, which is lower than the average for Ukraine (as of 2019, the GRP per capita is estimated at UAH 87 thousand). For non-government-controlled areas, this estimated indicator corresponds to UAH 22.6 thousand, which is 4 times lower than the average for Ukraine and 3 times lower than the value for this river basin. The highest GRP among the Don river basin's administrative regions is in the Kharkiv region, which was not affected by the hostilities. All the regions within the Don river basin are industrialized and create a high share of the country's GDP (10%).

The total GVA of water-dependent economic activities in the basin's total GVA is 47.2%, which indicates significant dependence of the river basin's economy on the use of water resources. The largest total share of the water-dependent sectors of economy in the GVA structure is concentrated in the Donetsk region – 72.5% and the smallest one in the Luhansk region – 31,4%. The GVA of the water-dependent economic activities created in non-government controlled area is 6% of the basin's total GVA. Also, the region, mainly the Luhansk region, is characterized by a high level of agricultural development.

6 Hereinafter is the state statistics data for the period after 2014, which usually relates to government-controlled area. The decline in indicators after 2014 may reflect both the real dynamics of the phenomena they describe and the reduction of statistical reporting by enterprises and organizations in the regions affected by the military conflict (also see Box).

FIGURE 4. **Sectoral structure of the economic activity in the basin**

GOVERNMENT-CONTROLLED AREA

141 companies / 16 economic sectors

Sector	Name	Number of companies
A	Agriculture, forestry, and fishery	5
B	Extractive industry and quarrying	26
C	Processing industry	50
D	Supply of electricity, gas, steam and conditioned air	11
E	Water supply; sewerage, waste management	42
F	Construction	3
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	2
H	Transport, warehousing, postal and courier activities	5
I	Temporary accommodation and catering	1
L	Real estate transactions	2
M	Professional, scientific and technical activities	1
N	Activities in the field of administrative and support services	1
O	Public administration and defense; compulsory social insurance	1
P	Education	2
Q	Health care and provision of social aid	5
R	Arts, sports, entertainment and recreation	1

NON-GOVERNMENT CONTROLLED AREAS

107 companies / 6 economic sectors

Sector	Name	Number of companies
A	Agriculture, forestry, and fishery	2
B	Extractive industry and quarrying	50
C	Processing industry	20
E	Water supply; sewerage, waste management	33
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	1
H	Transport, warehousing, postal and courier activities	1

Source: Ukrainian Hydrometeorological Institute (UHMI) / Osadcha N. et al., materials for UNICEF, 2021

Due to its geographical location and climatic features, the Don basin is low on water. The most problematic, low-water area is the Siverskyi Donets river in the Donetsk region, where the shortage of water resources is observed throughout the year[7]. The Siverskyi Donets accounts for 85% of water intake from surface sources and 80% of the total intake in the region. Irreversible water use from surface water bodies amounts to 600 mln m³ per year, also due to inter-basin water transfer to the Pryazovia rivers in the Donetsk region. The discharge of return (waste) water into the Don basin reaches about 800 m³ annually.

Water supply to the population and industry in the Don basin is ensured by a successfully operating complex and high-capacity water management complex with numerous canals, main water lines and reservoirs. An important factors which also determines the basin's specific features is the uneven distribution of the water balance of the Siverskyi Donets river. For example, the main flow regulators – Pechenihy and Oskil Reservoirs – are located in the Kharkiv region, and the largest riverbed intakes are in the Donetsk region (water intake in the Siverskyi Donets-Donbass Canal, water intake of the Slavic Thermal Power Plant) and the Luhansk region (drinking water intake of the Popasna District Water Services [Vodokanal]).

SOURCES OF INFORMATION FOR ANALYZING THE SITUATION IN THE DON BASIN

The greatest difficulty in analyzing water and environmental issues is lack or absence of data, especially from non-government-controlled areas. Therefore, for the analysis of water pollution, being the most significant issue, various data sets were used:

- statistical reporting data on water use based on the "2TP Vodohosp" template (annual) (https://e-services.davr.gov.ua/parlor/p-report-genn-advanced);
- technological characteristics and operational data on the operation of sewage treatment facilities (https://e-services.davr.gov.ua/parlor/p-report-genn-advanced);
- monitoring data on the status of surface water bodies obtained in the framework of the State Monitoring Programme (https://data.gov.ua/dataset/surface-water-monitoring);
- data of the state ecological control within administrative regions (https://inspections.gov.ua/);
- regional data on sanitary-epidemiological and social-hygienic monitoring (https://www.minregion.gov.ua/);

7 Data of the "Water Balance for the Siverskyi Donets River Sub-Basin", approved by the State Water Resources Agency of Ukraine dated June 13, 2019. https://www.davr.gov.ua/vodogospodarski-balansi-osnovnih-rajoniv-richkovih-basejniv

- data on surface water quality from the automated monitoring stations within the Donetsk region and high-hazard facilities based on the Donbas Environment Information System (http://www.deis.menr.gov.ua);
- information from the environmental impact assessment register (http://eia.menr.gov.ua/)
- data on permits for special water use (https://e-services.davr.gov.ua/)
- data from the national online platform, which contains up-to-date information on the state of the environment (https://eco.gov.ua/).

However, this data only partially reflects the situation in the river basin. Since 2014, the number of enterprises on both sides of the contact line which submit state statistical reports has decreased significantly[8]. Compared to the base year of 2013, the number of business entities, water users, that discharged into the Don basin, decreased to 40%, in particular in the Donetsk region, from 92 to 62, and the most significant decrease was recorded in the Luhansk region – from 103 to 26 (almost every 5th business entity does not provide information on the discharge of return water). In the statistical reporting data on water use based on the "2TP Vodohosp" template for 2020 there is no information on the following river basins which are in non-government controlled territory: the upper reaches of the Kryvyi Torets and the Bakhmut (Bakhmutka) river basins in the Donetsk region, almost the entire basin of the Luhan river (except for the upper reaches), the entire basins of the Velyka Kamyanka and the Kundriucha rivers, as well as the Siverskyi Donets riverbed and right-bank tributaries below the town of Svitlychne in the Luhansk region.

At the same time, the number of water conditions and water quality monitoring stations decreased and information from the territory not controlled by the Government of Ukraine was completely stopped: 37 of the 63 monitoring stations of the Siverskyi Donets Basin Administration of Water Resources with the beginning of the hostilities remained beyond the contact line[9]. Lack of access to the monitoring hydrogeological network in non-government controlled areas also makes it impossible to determine the status and identify the sources of technological pressure on groundwater.

Thus, today a significant area remains beyond the possibilities of full analysis and proposal of measures to improve the condition of the Ukrainian part of the basin, including 5% of the Siverskyi Donets catchment in the Donetsk and 27% in the Luhansk regions and all rivers of the Lower Don within Ukraine.

8 State of the Siverskyi Donets Basin and Related Risks under Military Operations/ OSCE Project Co-ordinator in Ukraine, 2019.

9 Five Years of Fighting in Eastern Ukraine: Environmental Issues Depicted Infographics. – K., 2019. It is worth noting that since 2019, the water monitoring system has undergone significant reforms. In accordance with the new water monitoring procedure, starting from 1 July 2020, the Siverskyi Donets Basin Administration of Water Resources has been performing surveillance monitoring of surface waters at 72 monitoring stations.

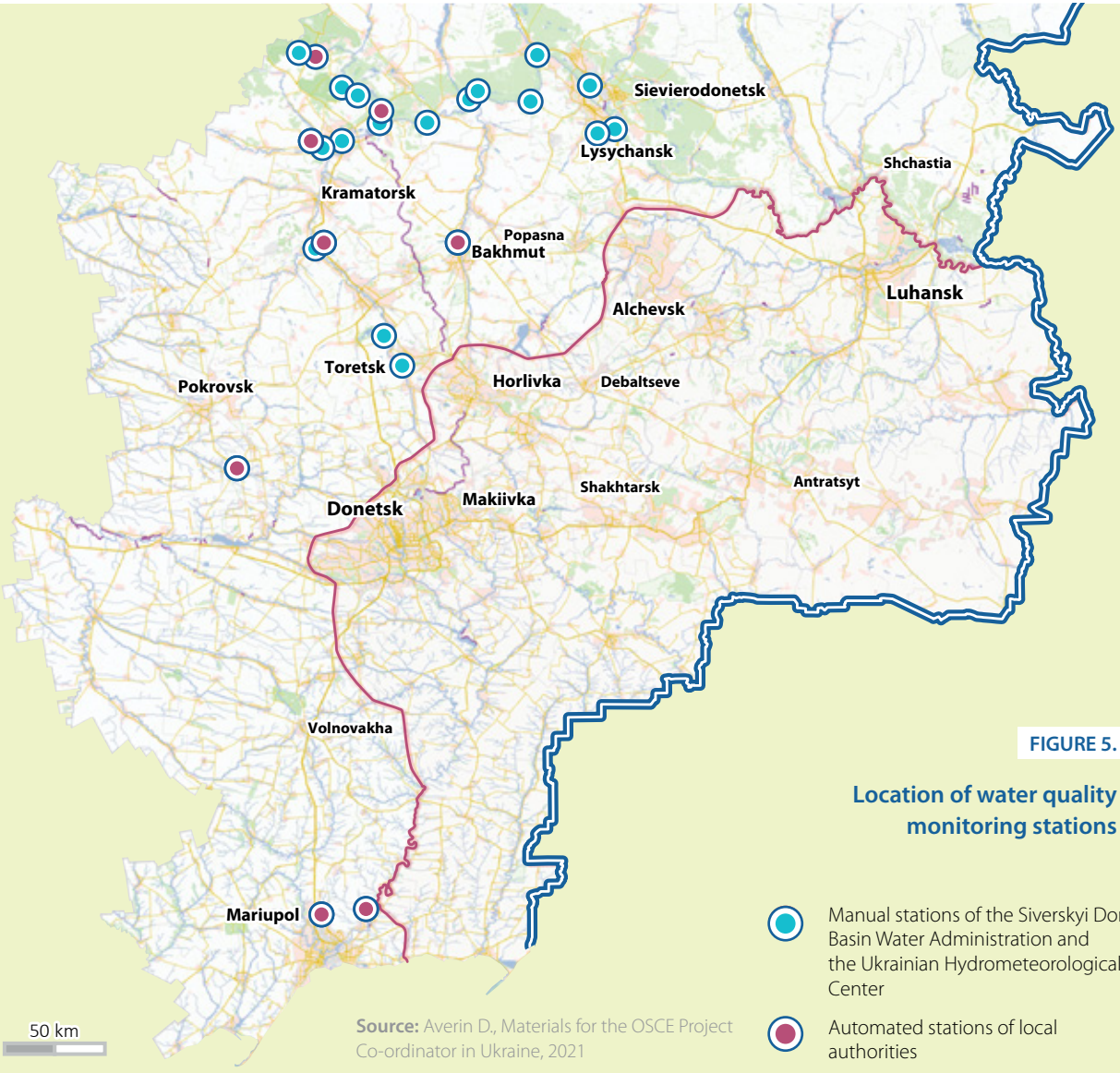


FIGURE 5.

Location of water quality monitoring stations

Manual stations of the Siverskyi Donets Basin Water Administration and the Ukrainian Hydrometeorological Center

Automated stations of local authorities

Source: Averin D., Materials for the OSCE Project Co-ordinator in Ukraine, 2021

3.

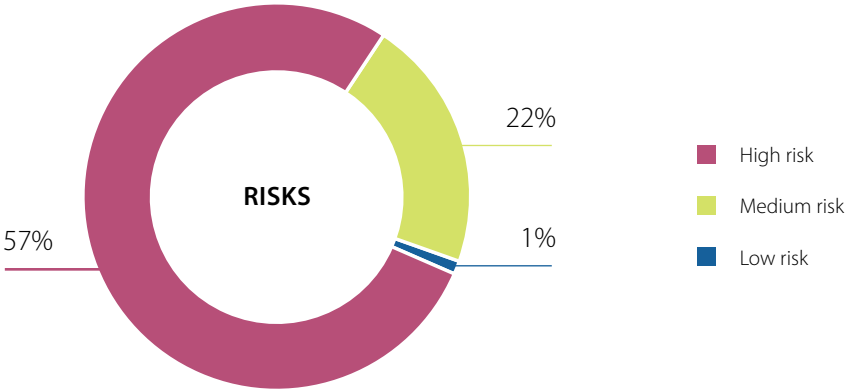
ENVIRONMENTAL ISSUES OF WATER RESOURCES IN THE BASIN

The main environmental issues of water resource in the Don river basin, according to the EU Water Framework Directive, include pollution and hydro-morphological changes of the surface water bodies, as well as pollution and depletion of groundwater resources.

Analysis of the risk of not achieving good ecological status for the whole basin based on the assessment of impact of human activities on surface waters showed that almost 80% of the river network length is facing a risk that good status will not be achieved.

FIGURE 6.

Risk of failure to achieve good ecological status for the Don basin river network



This risk is absent only for less than 1% of the basin's river network length.

The integrated assessment of the river basin's surface waters according to the 2019 monitoring data demonstrated that the ecological status of most water bodies is categorized as "moderate". In the Don basin there is no surface water body with an "high" ecological status.

Two facilities (the Siverskyi Donets river, the Pechenihy reservoir and the Vovcha river, the border with the Russian Federation) have a "good" ecological status. "Poor" ecological status was noted in three water bodies (the Udy, the estuary of the Eskhar, and the Kryvyi Torets, below the phenolic plant in Toretsk; the third water body was added on the basis of similarity).This data fully corresponds to the analysis of pressures and impacts of human activities within their boundaries[10].

10 Ukrainian Hydrometeorological Institute (UHMI) and National Academy of Sciences of Ukraine, involving experts from the Institute of Hydrobiology of the National Academy of Sciences / 2019 Assessment Results of the Ecological Status of the Don Basin Surface Water Bodies in Ukraine. The materials were provided by the State Water Resources Agency of Ukraine.

FIGURE 7.

Assessment of the ecological status of the Don basin surface water bodies

Source: Geoportal State Water Cadastre: the surface water bodies accounting http://geoportal.davr.gov.ua:81/

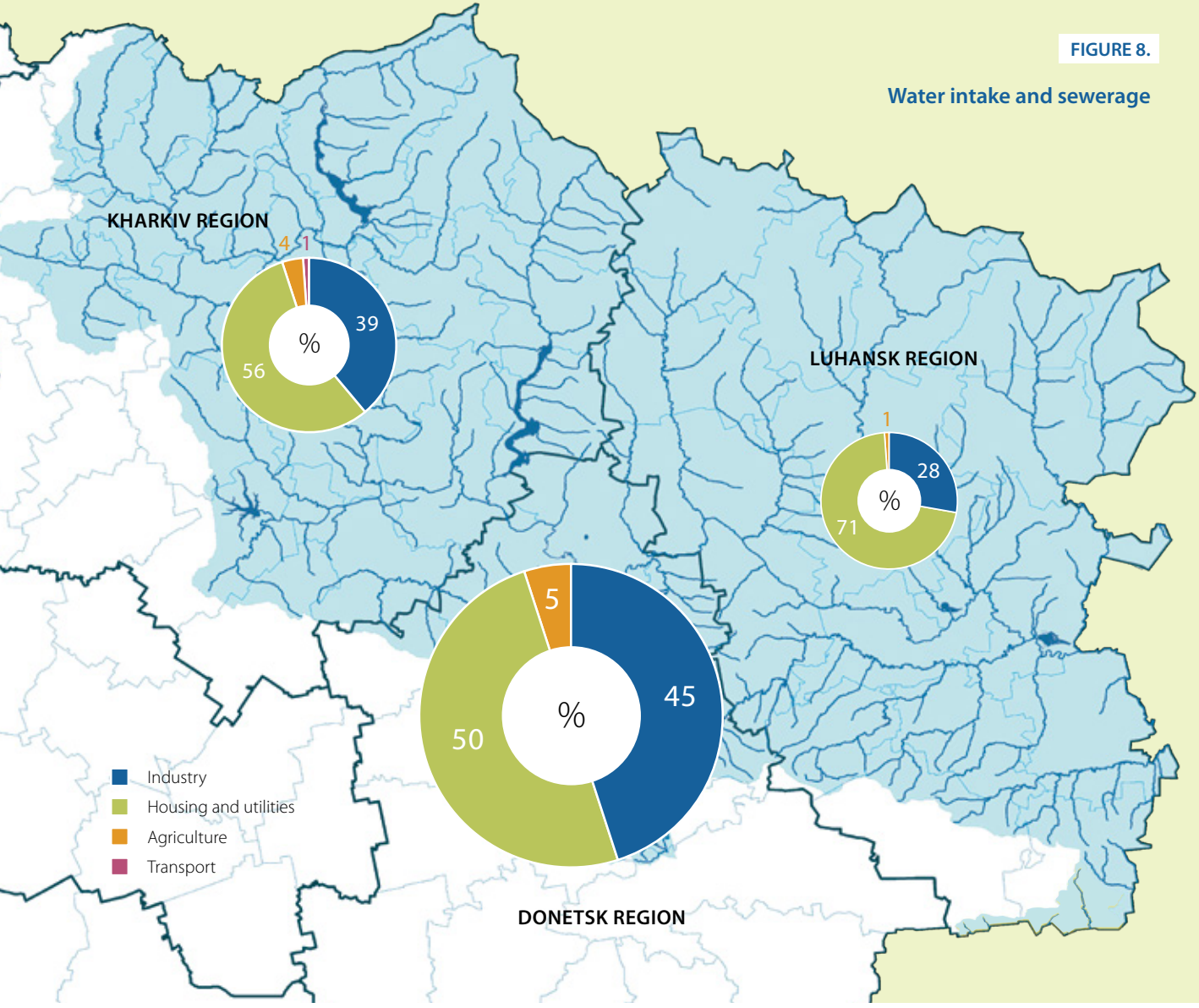
SURFACE WATER POLLUTION

Surface water is the main source of water (90%) in the Kharkiv and the Donetsk regions, where only 10% of water abstraction is groundwater. In the Luhansk region, the ratio of surface water to groundwater abstraction is 45% and 55%, respectively. The leader in water abstraction is the Donetsk region – 73%, followed by the Kharkiv region – 20%, with the Luhansk region accounting for the lowest percentage – 7%. The main source of water resources is the Siverskyi Donets river, from which 1122.6 mln m^3 were abstracted in 2020 (80% of the total basin abstraction). The main water users in the Don river basin are the industry, housing and utilities, agriculture, and transport.

According to the available statistical reports, excluding the enterprises in non-government-controlled areas and with the exception of four "Voda Donbasu" enterprises, the highest percentage of return (waste) water discharges was recorded in the Donetsk and Kharkiv regions. The Luhansk region accounts for only 4%. The largest percentage of polluted (untreated and insufficiently treated) wastewater in 2020 was discharged by economic entities of the Donetsk and Luhansk regions.

FIGURE 8.

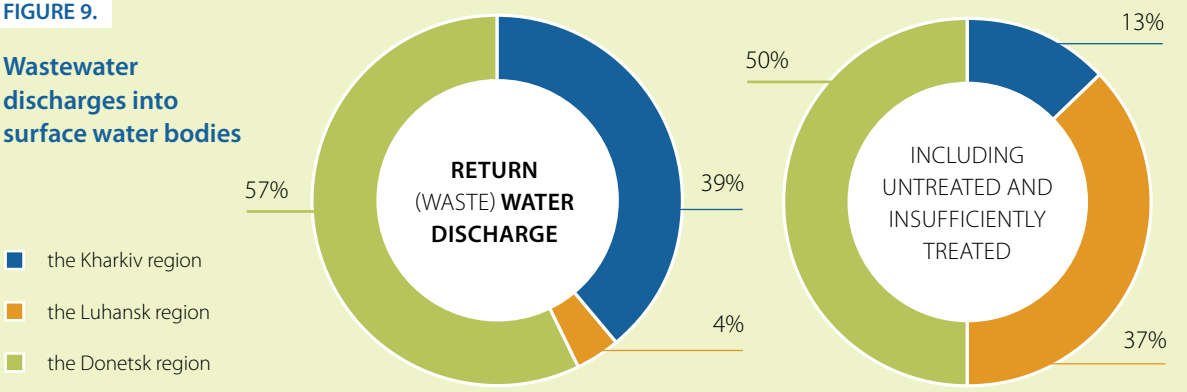
Water intake and sewerage



Source: "Economic Analysis of Water Use of the Don River Basin Area". Technical Report for the OSCE Project Co-ordinator in Ukraine, 2020.

FIGURE 9.

Wastewater discharges into surface water bodies

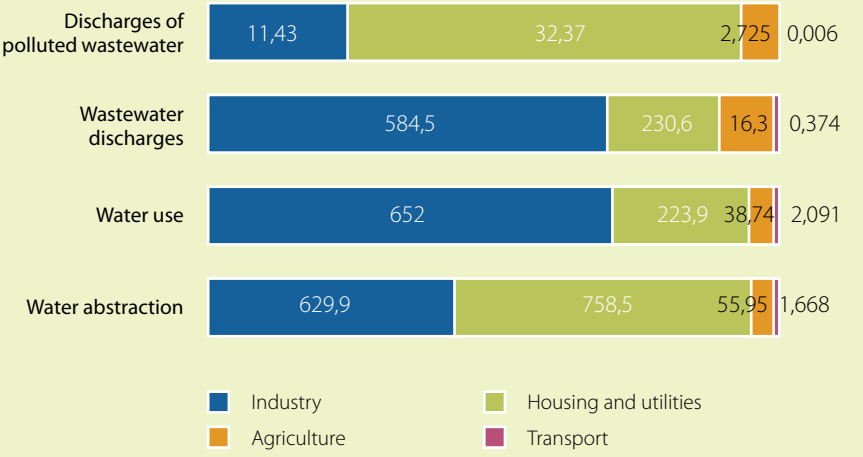


Over 70% of wastewater is discharged into surface waters by industrial water users, almost 28% by the housing and utilities sector and 2% by agriculture.

Most (70%) of polluted wastewater comes from housing and utilities water users and 24% is discharged by industrial enterprises.

FIGURE 10.

Characteristics of water use in the basin



Source: "Economic Analysis of Water Use of the Don River Basin Area". Technical Report for the OSCE Project Co-ordinator in Ukraine, 2020; data https://e-services.davr.gov.ua/parlor/p-report-genn-advanced

Organic and biogenic pollution in the Don basin is mostly caused by urban agglomerations (wastewater discharges). The largest of them is the city of Kharkiv, whose population exceeds 1.4 mln people. The city's wastewater is discharged into the Udy river basin and accounts for almost half (47%) of the Don basin's entire wastewater discharge, being several times higher than the river's natural flow. Thus, reconstruction of Kharkiv treatment facilities is the most urgent issue.

Unfortunately, the treatment facilities of all cities and towns in the Don basin as a rule use a biological type of wastewater treatment, which allows removing no more than 70% of the organic matter and 20-35% of biogenic substances. In addition, all existing community treatment facilities are operated extremely inefficiently, are obsolete and worn out, were built in the remote 70-80s of the last century, and require urgent upgrade and reconstruction.

Also a major source of pollution with organic and biogenic substances are individual households, mostly rural settlements, which do not have centralized or individual local sewerage. For instance, only 5% of villages in the Kharkiv region, 1% in the Luhansk region, 4% in the Donetsk region and up to 2% of all villages in the river basin have centralized sewerage[11].

Not only rural communities and villages, but also small cities (e.g. Pivdenne in the Kharkiv region) and some districts of large cities there have no centralized sewerage.

Wastewater is discharged into settling tanks, cesspools, and reservoirs arranged in the open ground, without waterproofing, or sealing. From there pollutants easily get into groundwater and are carried to surface water or are discharged to the terrain.

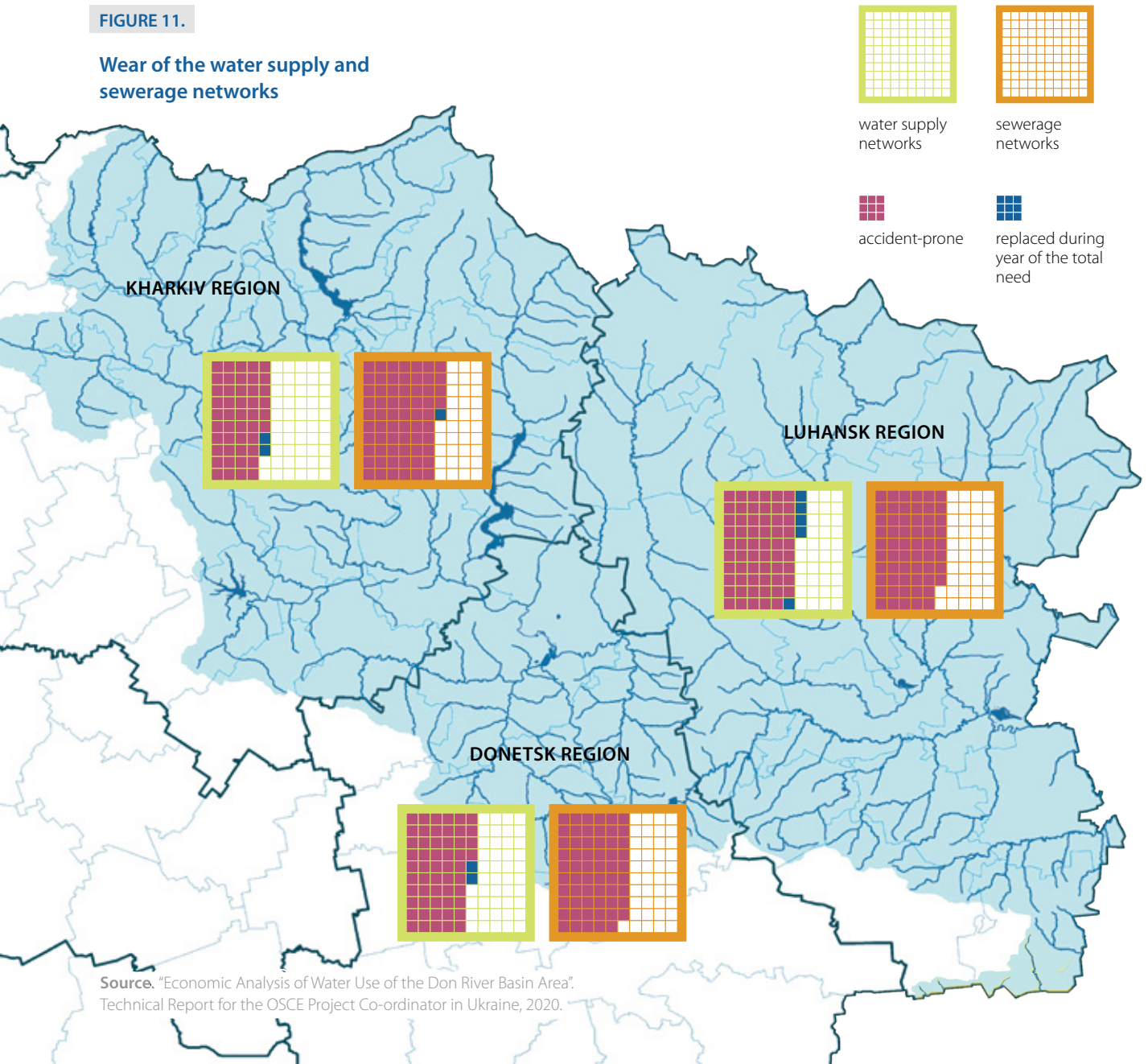
Organic pollution of surface water is mainly due to ingress of products of life into water, and the main hazard is intense oxygen consumption in the water for their oxidation. Polluted surface waters generate oxygen deficiency, which leads to significant violations of biological groups and death of certain species of aquatic living organisms.

Organic pollution of the Don basin is mainly due to urban agglomerations and partly to agriculture (farms, livestock complexes). Undoubtedly, the greatest impact on the state of surface waters is exerted by 8 agglomerations (cities) with a population over 100 thousand people, hosting 34% of the population.

11 https://www.minregion.gov.ua

FIGURE 11.

Wear of the water supply and sewerage networks



Source. "Economic Analysis of Water Use of the Don River Basin Area". Technical Report for the OSCE Project Co-ordinator in Ukraine, 2020.

Excluding non-government-controlled areas, almost 96% of organic pollution is generated in the basins of the Udy (which receives wastewater from Kharkiv) and the Kazenyi Torets rivers and also reaches the Siverskyi Donets riverbed. If compared with the statistics before the onset of armed conflict, in 2013 the discharge of these organic substances into the Luhan river was 17-22% of the volume for the entire basin.

Based on calculations, the discharge of organic pollutants from diffuse sources of rural households (private farms) in the Don basin significantly exceeds the total inflow from point sources.

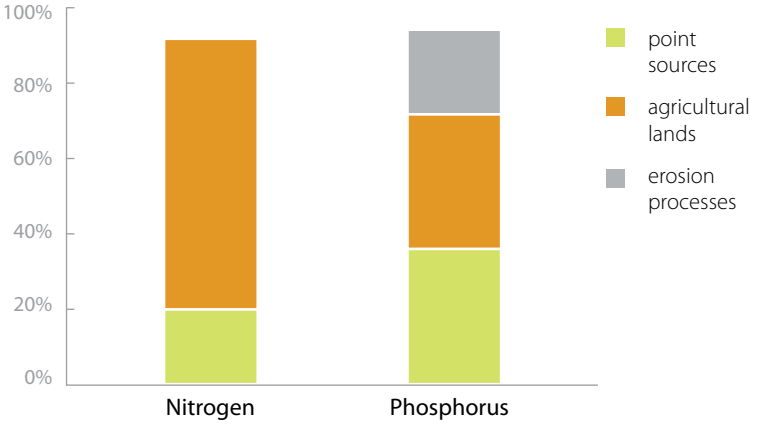
Most of the organic matter from diffuse sources gets into the Velyka Kamianka, the Kazenyi Torets, the bed of the Siverskyi Donets, the Udy, and the Aidar, which aggregate 60% of all organic pollutant inflows.

Ingress of **biogenic substances (nutrients)** into water is the driving force of eutrophication, which occurs with destruction of water body's productivity, imbalance of organisms in the aquatic environment, and deterioration of water quality.

Among the biogenic substances, the dominant role is played by compounds of phosphorus and nitrogen, and in some cases the situation may be affected by iron, silicon and molybdenum. Phosphorus has the most significant effect.

FIGURE 12.

Sources of biogenic substances (nutrients) **in the Don basin**



Source: Osiyskyi E. et al., 2021

The spatial distribution of nitrogen discharge is characterized by high heterogeneity. High importance of agricultural sources in the formation of nitrogen emissions is a prerequisite for existence of zones vulnerable to pollution with nitrate compounds. The highest values of phosphorus discharges are characteristic of the Udy and the Siverskyi Donets and are associated with the influence of wastewater from residential communities.

Pollution with biogenic substances also significantly depends on the inflow of wastewater from urban agglomerations, compared to which the inflow of nutrients from industrial and agricultural point sources is much lower[12].

The highest emissions of biogenic substances in 2020 were recorded for the Udy river, which receives discharges from Kharkiv (according to various indicators, 60-70% of the total discharge of biogenic substances in the basin) and the Kazenyi Torets (15-20%)[13].

The Luhansk region accounts for a small share of the total discharge of biogenic substances in the basin (3-7% according to various indicators), but wastewater there is completely polluted (insufficiently treated and untreated). Until 2014, the Luhan accounted for 12-34% of the discharge of biogenic substances from point sources.

Along with organic and biogenic substances, a significant amount of **hazardous substances**[14] enters the Don river basin. Unfortunately, monitoring of pollution with hazardous substances (heavy metals, organochlorine substances, pesticides and other plant chemical protection products) which come with the wastewater of industrial and municipal enterprises, as well as due to washing out from polluted landfills and accident-induced pollution had not been carried out at all until recently.

According to the 2020 water use reports, 121 economic entities discharged return (wastewater) which contained hazardous pollutants in the Don basin.

12 No business entity (water user) in the Don river basin indicated in the list of pollutants in return (waste) water the concentrations of total nitrogen or total phosphorus, so the analysis of the biogenic substances' impact used the total value of the above nitrogen-containing substances, while total phosphorus was conditionally equated to the phosphates shown (orthophosphates).

13 This is due to inefficient operation of sewage treatment facilities, their wear and virtual absence in some cities located in the Kazennyi Torets basin (Sloviansk, Myrnohrad, Druzhkivka, Kostiantynivka, Toretsk). In fact, among the agglomerations in the Kazenyi Torets basin only the sewage treatment facilities in Kramatorsk treat wastewater to the level which meets the norms.

14 Hazardous substances are shown in the list of pollutants for determining the chemical status and environmental potential of surface waters, supplemented with the Don basin-specific pollutants, as well as those pollutants that are discharged into the basin in large quantities, resistant to decomposition, toxic, demonstrate accumulating action, the list of which was approved by the Ministry of Environment Order No. 45 dated 06.02.2017 https://zakon.rada.gov.ua/laws/show/z0235-17#Text. The chemical status is determined in line with the Ministry of Environment Order No. 5 dated 14.01.2019 https://zakon.rada.gov.ua/laws/show/z0127-19#Text.

Among them, the largest volume is made of petroleum products, synthetic surface active substances, and heavy metals. However, it is not possible to determine the balance of discharges of hazardous substances using the actual state reporting data, as information on their concentrations in wastewater does not reflect the entire list of substances and actual volumes of discharges.

A pollutant screening[15], in surface water samples also revealed presence of other technological hazardous substances, such as bisphenol A, carbamazepine, antipyrine and derivatives (4-formylamino antipyrine and 4-acetamido antipyrine), imidacloprid, prometryn, terbuthylazine, and thiacloprine.

A recent review of permits for special water use of the enterprises operating within the Siverskyi Donets basin[16] also demonstrated that the plant protection group accounts for main share of the priority substances identified in the basin: pesticides, herbicides, insecticides and biocides, which enter the river network through diffuse washout, many of which are banned for use in the EU and in Ukraine.

The monitoring and screening data, as well as the analysis of reports on the wastewater discharged into the Don basin surface waters identified presence of such metals as aluminum, copper, zinc, barium, iron, lithium, strontium, vanadium, manganese, chromium, lead, nickel, mercury, and cadmium. The increased concentrations of copper and zinc can be related to both natural (washing out from rocks, soil) and technological (wastewater from housing and utilities companies, industrial enterprises, agricultural effluents), as well as hydrochemical factors (pH of the water environment, release of metals from organic compounds discharged into surface waters, ingress from bottom sediments as a process of secondary pollution of surface waters). Increased vanadium concentrations are most likely caused by washing out of the element from the rocks in which the river flows. The concentration of lead, chromium and nickel may be a consequence of these metals entering the surface flow and industrial wastewater. Since the highest concentrations of these metals are recorded and in the bottom sediments, it can be concluded that these pollutants regularly enter surface waters. Given the above, it is necessary to address the issue of establishing the background values for the above metals for the Don basin, which should be taken into account when assessing the impact associated with point and diffuse sources of pollution when developing classification schemes and to ensure reliable assessment of ecological and chemical status of surface waters.

15 Environmental Institute, s.r.o., Slovakia, October 2018 – Materials commissioned by the OSCE Project Co-ordinator in Ukraine.

16 Ukrainian Hydrometeorological Institute (UHMI) / Osadcha N. et al., materials for UNICEF, 2021.

Significant decrease in the values of ingressing pollutants (lead, manganese, vanadium, formaldehyde, aniline) in the Don Basin waters compared to 2013 is due to failure to report on the use of water resources by the economic entities located in non-government-controlled areas in the upper reaches of the basins of the Kryvyi Torets, the Bakhmutka, as well as the Siverskyi Donets and its right-bank tributaries in the Luhansk region downstream from the village of Svitlychne. In addition, in 2013, the basin received hazardous substances which were not specified in the statistical reports for 2020: bismuth, cadmium, cobalt, molybdenum, tin, rhodanides, mercury, antimony, fluorine, chromium (III), cyanides.

The main share of these hazardous substances came with wastewater discharged by enterprises of the Luhansk region, mainly into the basins of the rivers the Luhan (50 – 97%), the Velyka Kamianka (5 – 95%), the Kundriucha (3 – 23%) and the Nyzhnia Bilenka (3 – 39%).

WASTE AND PLASTIC POLLUTION

Household waste entering rivers and reservoirs, in addition to distorting the aesthetic value of natural objects, leads to water pollution and garbage congestion, which negatively affects the chemical and ecological status of surface water bodies. In addition to chemical contamination from the remnants of spent products and their packaging, the greatest threat to aquatic ecosystems is posed by plastic. Variously sized shredded plastic particles end up in aquatic organisms, in particular fish and birds, often causing their death. Household waste pollution of the riverbed, its banks and floodplains is a common phenomenon not only in the Don basin, but also throughout the country. This phenomenon is explained, first and foremost, by the following factors:

- lack of holistic national legislation in the field of household waste management,
- lack of conditions for collection, removal and disposal of household waste in all settlements, recreation areas,
- low waste management culture of the population,
- low operational efficiency of the utilities services,
- insufficient attention to awareness raising, especially in the rural areas.

Source: Yaroshevych et al. Overview of the Key Water and Ecological Issues in the Don River Basin, materials for the OSCE Project Co-ordinator in Ukraine, 2021.

INVASIVE SPECIES

The issue of alien species invading beyond their "native" habitats is of a global nature. Naturalization and further spread of invaders can cause irreversible phenomena in the environment, undesirable economic and social consequences. Currently, biological invasions are viewed as biological pollution, but unlike most pollutants that can decompose in natural ecosystems during self-cleaning processes and whose concentration is controlled by humans, alien organisms, when settling in a new habitat, begin to multiply uncontrollably and spread rapidly in the environment. This phenomenon can have unpredictable and irreversible consequences.

Further, introduction of invasive alien species leads to irreparable loss of biodiversity both due to immediate destruction of the aboriginal species by predators through food and spatial competition, and due to displacement of the aboriginal species, changes in their habitats, and hybridization. Alien species can also pose a threat to the region's biological safety.

There have been almost no special studies of alien species of hydrobionts in the Don basin within Ukraine, but 18 alien fish species (27% of the total ichthyofauna) have been registered in its water bodies. Several publications are devoted to cases of mass development of water lettuce *Pistia stratiotes*. There is information on invasive invertebrates whose life cycle is associated with aquatic ecosystems, in particular, appearance in the Don basin of southern mosquito species capable of transmitting pathogenic infections to humans.

Source: Yaroshevych et al. Overview of the Key Water and Ecological Issues in the Don River Basin, 2021.

HYDROMORPHOLOGICAL CHANGES

Among the nine river basins of Ukraine, the Don basin ranks sixth in the number of hydrological changes. The main issues of the Don basin are the over-regulation of rivers (ponds and reservoirs) and the straightening of their channels.

Dams and other artificial transverse structures located in riverbeds were built primarily for water accumulation, with its subsequent use for irrigation, water supply for the needs of the population and industry. Accumulation of water in ponds and reservoirs also provides flood protection of the areas below the dams. In 2019, there were 2,679 ponds in the Don basin[17], and according to the State Water Resources Agency of Ukraine, a significant part of them is in an unsatisfactory technical condition.

17 Water Fund of Ukraine: Artificial reservoirs – Reservoirs and Ponds: Handbook / V.V. Hrebin, V.K. Khilchevskyi, V.A. Stashuk, O.V. Chunaryov, O.Ye. Yaroshevych / Ed. V.K. Khilchevskyi, V.V. Hrebin, Kyiv, Interpress, 2014, 192 p.

Most of them were built in 1960-1980 using simplified design documentation; spillways normally do not meet modern requirements. Presence of dams and other structures transverse to the channels disrupts the continuity of water flow and sediment movement, as well as migration of fish and other aquatic organisms. Fish passes were not arranged in the structures earlier and, as a result, the population of different fish species have decreased or disappeared.

Hydrological changes affect water bodies through water abstraction and fluctuations in the water levels below dams, leading to changes in the river flow regime and distribution. Discharges, water abstraction, and artificial periodic fluctuations in the water levels are key pressures that require compensatory measures throughout the entire river basin. Fluctuations in the water levels below the Raihorodska Dam, located on the Siverskyi Donets river in the Donetsk region, exceed 0.5 m within 24 hours for most of the year, and the length of the Siverskyi Donets affected by water level fluctuations is 7.7 km.

Straightening of riverbeds in cities and towns has reduced the species composition and the quantity of fish, benthic invertebrates, higher aquatic vegetation, phytoplankton.

According to hydromorphological monitoring, in most cases surface waters deteriorate due to morphological changes in the floodplain. The coast and the coastal zone are less affected by technological factors, and the riverbed is even less so.

Of the 253 basin rivers, only 105 rivers (42%) have not undergone any hydromorphological changes and 14 rivers are fully defined as substantially changed: 9 rivers due to over-regulation, 4 rivers – a combination of straightening and over-regulation, one river – riverbed straightening. Most cases of hydromorphological changes occur on small rivers with a basin area of up to 100 km² [18].

18 In 2021, a survey of the current state of small riverbeds was performed as part of pilot projects to restore the natural state of small rivers in the Siverskyi Donets river basin. Implementation of such of project is carried out on behalf of the Ministry of Environmental Protection and Natural Resources of Ukraine.

GROUNDWATER POLLUTION

The main types of groundwater pollution from various technological sources in the basin are salt pollution (increased mineralization and concentrations of the chemical components of the main anionic-cationic composition), organic matter pollution (phenols, petroleum products, etc.), pollution with nitrogen compounds and metals.

The main activities that affect or can potentially affect the quality of groundwater in the Don basin area are agriculture and housing and utilities services, industry, and mining.

Potential pollutants entering aquifers by filtration from agricultural areas are compounds of nitrogen and phosphorus, pesticides. The ingress of these substances into groundwater is caused by application of fertilizers and tillage. Quantitative assessment of the degree of groundwater pollution by nitrogen compounds, pesticides, and other substances that enter groundwater as a direct result of agricultural activities is currently impossible due to lack of appropriate methodology for such assessment and a special monitoring network.

Today, the distribution of pressure, which potentially leads to diffuse groundwater pollution with nitrogen, phosphorus, and other compounds from agriculture, can be judged about only from statistical reports. The data[19] demonstrates decreased application of mineral fertilizers, in particular nitrogen ones in 2020 in all regions (compared to 2018-2019). At the same time, the average area of the lands treated with mineral fertilizers increased in 2020 in the Luhansk and the Kharkiv regions compared to 2018-2019. This testifies to a persisting risk of groundwater pollution with nitrogen compounds. One can also notice[20] the tendency towards reducing the use of pesticides for the harvest of agricultural crops within the Kharkiv region, and, conversely, increasing the use of pesticides in the Luhansk region. There is no reliable data suitable for assessing the state of pesticide groundwater pollution within the river basin, as the analysis of pesticide concentrations in water samples requires appropriate laboratory equipment, which is currently unavailable to the regional groundwater monitoring services. According to the State Research and Development Enterprise "Geoinform of Ukraine" generalized data, no spots of pesticide pollution were identified within the Kharkiv, the Luhansk, and the Donetsk regions at the monitoring network stations in 2019. Given the general trend towards increasing pesticide application, however, there is a risk of pesticide groundwater pollution within each region.

Geological features of the territory within the river basin are an additional factor in the active migration of pollutants from the earth's surface to the groundwater of marl-cretaceous aquifers, which are the main source of operational reserves of drinking groundwater throughout the Don basin. Therefore, within the river basin there is a significant risk of groundwater contamination in the quaternary and upper cretaceous sediments with nitrogen compounds coming from agricultural lands of the Kharkiv and the Luhansk regions.

The monitoring of the groundwater chemical status identified local areas of groundwater pollution with nitrogen compounds – within the town of Krasnorichenske, Svativskyi District, Luhansk region (left-bank slope of the Krasna river). The aquifer in the marl-cretaceous sediments of the upper cretaceous is polluted. According to the groundwater monitoring data (2018-2019), the aquifer within the watershed between the Aidar and the Krasna

19 http://www.ukrstat.gov.ua/operativ/operativ2018/sg/vmod/arch_vmodsg_u.htm; without non-government controlled area.

20 http://www.ukrstat.gov.ua/operativ/operativ2018/sg/vmod/arch_vmodsg_u.htm; without non-government controlled area.

rivers (Luhansk region) is at risk of nitrate pollution[21]. No nitrate pollution was detected or recorded in water samples taken from the monitoring network wells of the State Regional Geological Company "Donetskgeology" (Donetsk region) in 2018-2019[22].

In addition to agricultural land, the sources of pollution with nitrogen compounds should also include the facilities of major polluting enterprises. The chemical analysis of water samples taken from the observation wells network within large industrial enterprises revealed spots of pollution with nitrates, nitrites, and ammonium. In the area of SMA Inkor & Co LLC sludge storage facilities, which was included in the structure of PJSC "Avdiivka Coke Plant" (Donetsk region), and in the area of the city of Toretsk, underground water and groundwater is polluted with nitrates (> 50 mg/dm^3)[23].

The main point sources (except for housing and utilities services) of groundwater pollution with a number of compounds are industrial facilities. The main factors of pollution include discharge of wastewater into surface water bodies by major polluting enterprises and subsequent migration of pollutants into aquifers, direct discharge of return water into aquifers (Kharkiv region), as well as filtration of polluted groundwater from technological aquifers to the lower aquifers in the areas of the enterprises' surface infrastructural facilities (tailings, storages, waste disposal sites, etc.). Among the main pollutants entering groundwater from point sources are heavy metals, phenols, petroleum products, nitrogen compounds already considered, and others.

Mining enterprises discharge mine water by passing it directly from horizontal settling ponds and clarification ponds to, as a rule, adjacent ravines and river network. The mine wastewater quality control is performed by enterprises inadequately, especially within the mines located near the contact line and in the buffer zone (mines "Zolote", "Rodina", as well as "Artem mine", and others). Groundwater pollution at locations of mine water accumulation, pollution and discharge may potentially occur as a result of infiltration losses from mine water accumulation facilities.

No systematic studies are currently performed to establish changes in the groundwater chemical composition and formation of pollution spots due to discharge of additional volumes of polluted mine water.

21 Excerpts from the report "Measures for Groundwater Protection and Elimination of Its Pollution Sources, Groundwater Monitoring". – "Eastern State Regional Geological Company [Skhid DRGP]". Available at https://www.eco-lugansk.gov.ua/2013-12-12-00-50-06-3/2013-12-12-00-50-06/2013-12-12-00-50-06-3/pidzemni-vodi; 2020 Ecological Passport of the Kharkiv region, Kharkiv Oblast State Administration, 2020. – 183 p.

22 Information report "2020 Groundwater Monitoring of the Donetsk Oblast". – State Regional Geological Company "Donetskgeology", – 2021.

23 2020 Ecological Passport of the Luhansk Oblast, Luhansk Oblast Civil-Military Administration, 2020 – 155 p.

An additional factor that worsens the state of the underground and surface hydrosphere within the basin is closure of coal mining enterprises with insufficient environmental control and insufficient implementation of post-liquidation measures. Thus, uncontrolled flooding of mines in non-government-controlled area (*see Section 4*) leads to intensified water pumping from the operating mines located in controlled territory. Due to excessive discharge of water from the mines to the surface, it does not undergo sufficient treatment[24].

Groundwater abstraction is the location of the most active filtration processes in the aquifer. Intensive water abstraction (if water abstraction exceeds 50% of the operational reserves) may pull in groundwater from higher aquifers and pull in contaminated water spots. Such an unfavorable situation has developed within the Rubizhansk-Lysychansk industrial hub (Luhansk region). Water intakes Voievodivskyi (village of Voievodivka, outskirts of the city of Rubizhne, Luhansk region) are facing the risk of water quality deterioration due to pulling of pollution spots from the industrial site of Research & Production Enterprise "Zoria" LLC.

The volumes of groundwater mining at the water intake "Donetsk-2" (Donetsk region) in recent years has not exceeded 15%, but in the 90's intensive water abstraction at this water intake lowered the groundwater levels and increased the concentrations of the main components of salt composition, as well as the groundwater mineralization level, which caused radical changes in vegetation aggregations. The Kramatorsk group of water intakes (city of Kramatorsk, Donetsk region) is facing a pollution risk – the total volume of groundwater mining from water intake wells in 2019 amounted to 52% of the groundwater operational reserves approved for water intake.

24 Assessment of groundwater quality to identify deterioration of its chemical status as a result of an unfavorable water and environmental situation around the mines of the Pervomaisko-Kirovska group, part of which is located in non-government controlled area and imposes pressure in the form of additional water inflows to the operating "Zolote" mine (SE "Pervomaiskvuhillya", Luhansk region), was performed by experts of "Eastern State Regional Geological Company [Skhid DRGP]" in 2018. It was found that surface water quality in the Komyshuvakha river deteriorated (increased surface water mineralization from 2300 mg/dm³ up to 3100 mg/dm³, increased concentrations of sulfates and chlorides) over the period of mine flooding..

STATUS OF GROUNDWATER RESERVES

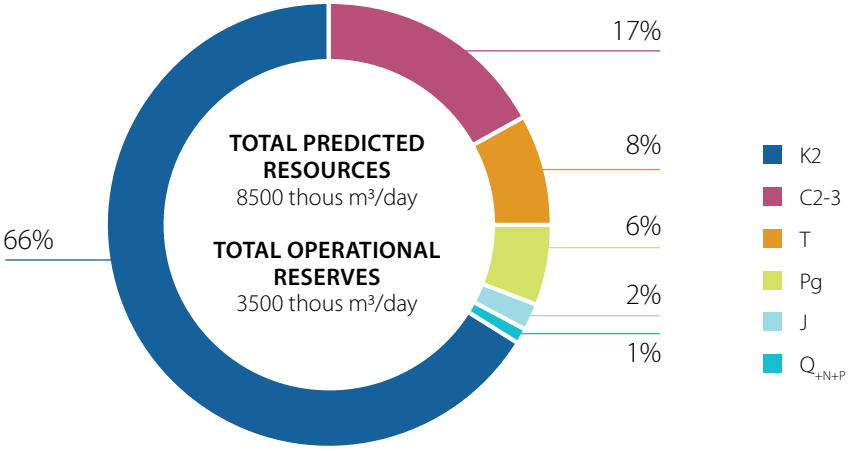
Projected groundwater resources within the basin are unevenly distributed. Most of them are concentrated within the Kharkiv and the Luhansk regions. Depletion of groundwater resources within the basin is mainly caused by mine drainage and disruption of the groundwater regime (formation of drainage zones and regional depression cones with reduced groundwater pressure) around mine allotments. The groundwater regime disturbance factors within the mines find their manifestation in the draining influence of mine openings, draining influence of drainage mine installations, change in the water exchange rates, forming of ground backwater from the aquifer surface.

The data analysis of 2014-2017 observations of the undisturbed groundwater levels (except for the carboniferous aquifer complex) within the river basin established absence of stable trends towards groundwater pressure (level) reduction. According to the state monitoring network for the groundwater and interstratal water level, in 2018-2019[25] the average annual level fluctuations were within the long-term averages.

25 The information is presented in the yearbooks on the groundwater status by the State Research and Development Enterprise "Geoinform of Ukraine".

FIGURE 13.

Groundwater resources



Source: Boiko K., Ulytskyi O. Overview of the Main Water and Environmental Issues in the Don River Basin Area. Groundwater, 2021

The average maximum water abstraction on the main water intakes does not exceed 50% of the groundwater operational reserves. In the last decade, there has been a significant reduction in water abstraction from aquifers in the general water use structure.

However, this is due not only to reduced groundwater needs for production (caused by reduced production capacity), but also to conservation of water intakes due to groundwater pollution and reduced number of water consumers (Joint Forces Operation, unavailability of water intakes located in the affected area[26]).

26 Today, of the large water intakes in the Luhansk region, only "Shchastynskyi" retained its operating capacity. Others are either completely decommissioned (Krymskyi, Kindrashivskyi, Aidarskyi, Vilkhivskyi, Derkulskyi) or do are not operated at full capacity (Petrivskyi), or are in non-government controlled areas (Krasnolymanskyi, Slovianoserbskyi, Lopaskynskyi, etc.). Other large water intakes with a capacity of more than 100 m³/day are located in the so-called "gray" zone of the Joint Forces Operation. Water intakes are inaccessible for accounting of water abstraction, reviewing the technical condition of wells, and monitoring the groundwater condition within the impact boundaries of water intakes. The general list of water intakes located in the affected area includes water intakes Vilkhivskyi, Kindrashivskyi, Aidarskyi (left-bank and right-bank group of wells – located on the right and left banks of the Siverskyi Donets River, respectively), Lopaskynskyi, Slovianoserbskyi, Krasnolymanskyi, Krymskyi. The Luhansk region has 4 water intakes (Metelkinskyi, Lisova Dacha, Chmyrivskyi, Shchastynskyi) with a productivity of > 1,0 thous m³/day on unapproved groundwater reserves (Regional Report on the State of the Environment in the Luhansk region in 2018. – Luhansk Oblast State Administration. Department of Ecology and Natural Resources, 2019, 88 p.). Due to lack of access to these water intakes, the information on their operating status and water abstraction modes is unavailable. If water intakes are not operated for a long time, the water intake wells should be eliminated by plugging in order to avoid ingress of pollutants into the aquifers..

4.

HOSTILITIES IN THE BASIN: CONSEQUENCES AND RISK FACTORS

The ongoing armed conflict in eastern Ukraine affected the entire system of environmental and natural resources habitat protection, including surface and groundwater. Thus, the analysis of the available data showed an increase in pollutants in some parts of the river network and in groundwater, with a high probability caused *inter alia* by the shutdown of treatment plants or reduction in their operating efficiency[27]. While the overall less efficient economic activity in the region today reduces the burden on the environment, certain phenomena and processes caused by the protracted conflict are becoming new serious risk factors that have to be taken into account when planning and protecting the use of water resources in the Don basin.

27 Environmental Assessment and Recovery Priorities for Eastern Ukraine https://www.osce.org/project-coordinator-in-ukraine/362566; Five Years of Fighting in Eastern Ukraine.: Environmental Issues Depicted in Infographics. https://www.osce.org/project-coordinator-in-ukraine/445366.

MINE FLOODING

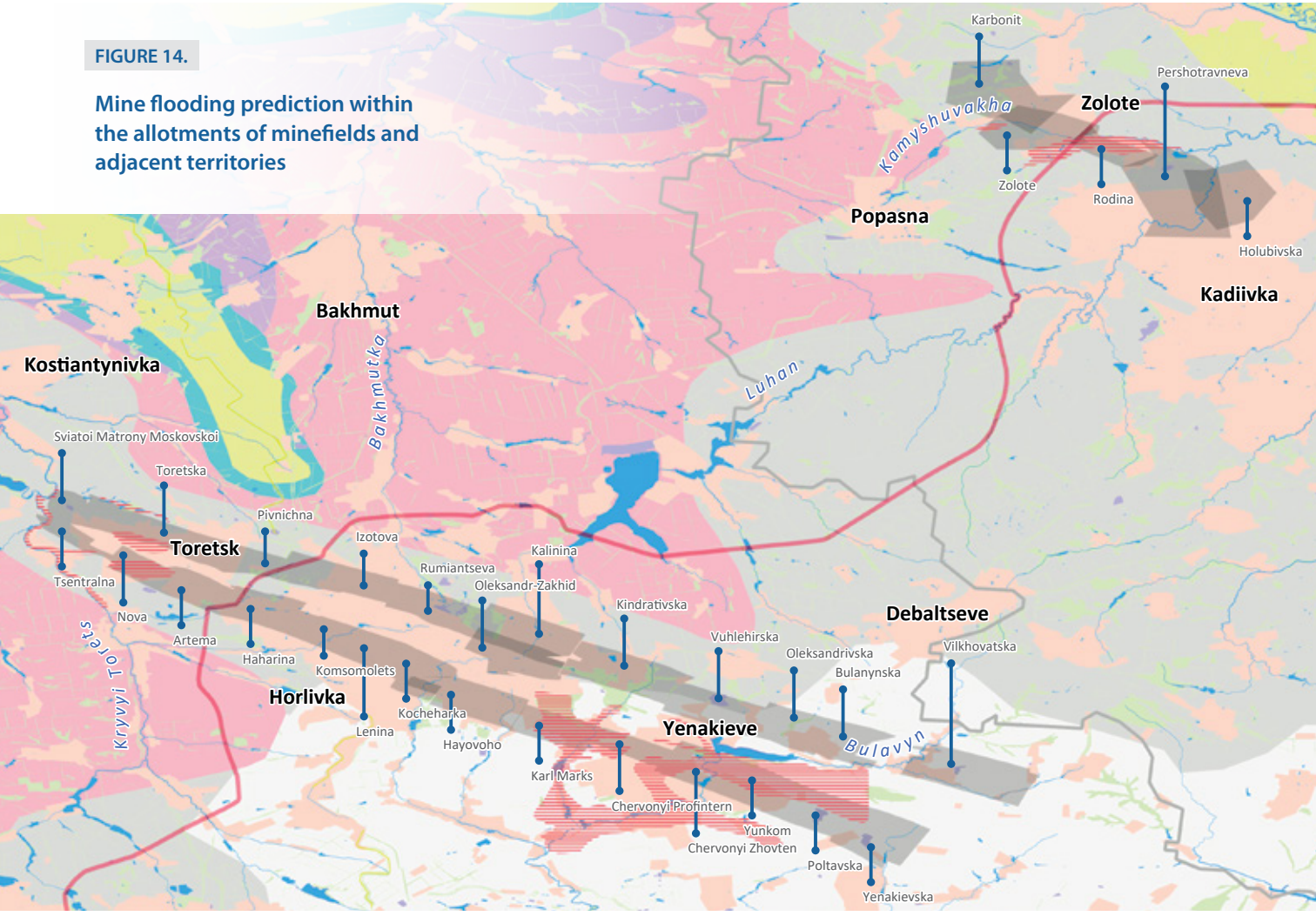
Among the most significant processes that potentially worsen the state of the basin's waters, as well as of its territory is flooding of coal mines located in non-government-controlled areas and hydraulically connected to the adjacent mines located within the river basin in the controlled territory. Such a problem has arisen within the Toretsk-Yenakievo mining and industrial agglomeration (Donetsk region) and the Almazno-Mar'ivskyi coal mining district (Luhansk region). The inflow of additional volumes of water from the flooded mines to the operating mines can trigger an emergency shutdown of the latter's drainage systems, and on a larger scale, cause their complete flooding.

In addition, within the areas adjacent to the flooded minefields, there is a developing risk of flooding of built-up areas and agricultural lands, as well as adverse changes in the chemical composition of groundwater and surface water (*see Section 3*).

The Toretsk-Yenakiyevo mining and industrial agglomeration has 27 mines. Four mines remained in the territory controlled by the Government of Ukraine.

FIGURE 14.

Mine flooding prediction within the allotments of minefields and adjacent territories



- Mine fields
- Projected flood areas
- Territories of residential communities
- Water bodies

Aquifers/aquifer system:

- C2-3 – in Middle-Upper Carboniferous Sediments
- P1 – in Lower Permian Sediments
- T – in Triassic Sediments
- J3-J2 – in Middle-Upper Jurassic Sediments
- K2 – in Upper Cretaceous Sediments

Source: Boiko K., Ulytskyi O. Explanatory Note on the Impact of Flooding of Some Donbas Mines on the State of Water Resources (Expert Assessment), 2021; with changes

The operating mines "Toretska" and "Tsentralna" are in drainage mode, the mine "Nova" is in the process of liquidation with the drainage support. At the same time there occurs uncontrolled flooding of mine workings (hydraulically connected to the above ones through the system of mine workings) located in non-government-controlled area "Artem mine", "Haharin mine", "Pivnichna" and others.

The main challenge of the integrated system of the mining hub in Toretsk today is to ensure hydraulic safety of the "Tsentralna" mine by intensifying the operation of the drainage complex and developing a clear response plan in case of additional inflow of highly mineralized mine waters from the "Nova" mine. If the drainage of the "Nova" mine stops, all available hydraulic connections, to a certain degree, will take part in the transit of mine waters to the mine workings of the "Tsentralna" mine.

Possible negative scenarios in case of further uncontrolled flooding of mine workings located in non-government-controlled area include failures of the drainage system of the "Tsentralna" mine, insufficient treatment of the additionally pumped mine water, pollution of surface water with untreated mine water, and further groundwater pollution. In a larger context, accident-induced flooding of the mines "Tsentralna" and "Nova" in case of failure of their drainage systems and water breakout through the system of mine workings may affect the hydrogeological regime with subsequent formation of floodplains and development of dangerous geological phenomena: land subsidence and landslides on the day surface. In the case of complete flooding of the "Artem" and "Nova" mines, the flooding is projected to develop into the floodplains of the Kryvyi Rih river (right bank), Zalizna Ravine, Dyliivska Ravine and into some parts of the city of Toretsk.

The increase in the groundwater levels, which will occur during subsequent flooding of the Horlivka-Yenakiyevo group of mines (including the "Karl Marks", "Chervonyi Profintern", "Chervonyi Zhovten", and "Yunkom" mines), will lead to development of flood zones. Based on the maximum expected deformations over the mine workings of this group of mines (6-9 m on the average), the predicted flooded area, with the groundwater level reaching the depths of 0-3 m, will be 84 km^2.

Within the Almazno-Mar'ivskyi coal mining district (Luhansk region), the existing drainage of the mine "Zolote" (SE "Pervomaiskvuhillia") (city of Zolote, Sievierodonetsk district) receives additional volume of water from the neighboring mines of the Kirov Group, which are flooded and located on non-government-controlled areas. These mines include "Rodina" (located in the contact line zone), "Pervomaiska", "Kirov", "Holubivska", "Bizhanivska" (located in non-government controlled areas). Increased discharge volume of higher-mineralization mine waters

from the mine "Zolote" led to deterioration in the Komyshuvakha river surface water quality. The existing three-stage drainage at the mine "Zolote", consisting of pumping units, has to work at the limit of its capacity to ensure reception of additional volumes of water. Today, the reservoirs in the mine "Zolote" levels do not meet safety regulations and will not be able to cope with additional volumes of incoming mine water without uprating their capacity.

The mines "Yunyi Komunar" and "Oleksandr-Zahid", which are located in non-government-controlled area, also pose an increased hazard to the environment. The "Yunkom" mine is known for containing in its workings a chamber of products formed following an experimental nuclear explosion; since 2018 the mine has been flooded uncontrollably. According to the available data, the mine field and the adjacent territory hosts up to 12 ecologically hazardous facilities (storage ponds, sludge storages, etc.) which adversely affect water and the environment (accelerated migration of pollution to the surface and ground water bodies). According to experts[28], flooding of the mine workings of the "Yunkom" mine does not exclude destruction of the explosive chamber and subsequent migration of radiation-contaminated waters in the ground currents.

Currently, however, the radiation contamination of mine waters is not monitored, so there is an urgent need for research and further projection of the hydrodynamic situation during flooding of the "Yunkom" mine and adjacent mines to assess the concentration of possible radionuclides in surface waters and to identify real measures to counter the negative consequences of this process[29]. The projected estimate of the groundwater flow distribution, as well as calculations of the actual and predicted mine workings flooding rates demonstrate that reaching of the critical flooding level, which will give rise to flooding areas and cause groundwater pollution by mine waters, is expected in late 2022.

28 Yakovlev Y. O., Yermakov V. M., Ulytsky O. A. (2019). Environmental Consequences of Flooding the Nuclear Explosion Chamber of the "Yukom" Mine (Tsentralnyi Donbas). Mineral Resources of Ukraine, (1), 38-44. https://doi.org/10.31996/mru.2019.1.38-44.

29 Sadovenko I.A, Rudakov D.V (2007) Projection of Long-Term Localization of the Radiation-Hazardous Facility in the Mine Field // Issues of the Environment. Donetsk: DonNT, 1-2, 20-25.

RISK OF INDUSTRIAL ACCIDENTS

A significant risk of hazardous pollutants entering the Don basin is posed by possible accident-induced pollution and the impact of polluted areas (landfills, industrial sites, etc.). In 2014-2021, 577 cases of operational disruptions at industrial enterprises related to hostilities were recorded in the territories of the Donetsk and the Luhansk regions, of which 447 cases (78%) occurred during the period of the most active hostilities in 2014-2016[30].

As a result of the hostilities, some cases of operational disruptions at industrial enterprises related to discontinued electricity, gas and water supply, disruption of industrial cycles, and destruction of enterprises' infrastructure could lead to pollution of surface water bodies and impact on the drinking water quality in the region. In total, since 2014, 99 facilities located in eastern Ukraine have been affected by hostilities, including enterprises of the metallurgical, chemical and coke chemical, energy-generating, machine-building, light and food industries.

30 www.deis.menr.gov.ua

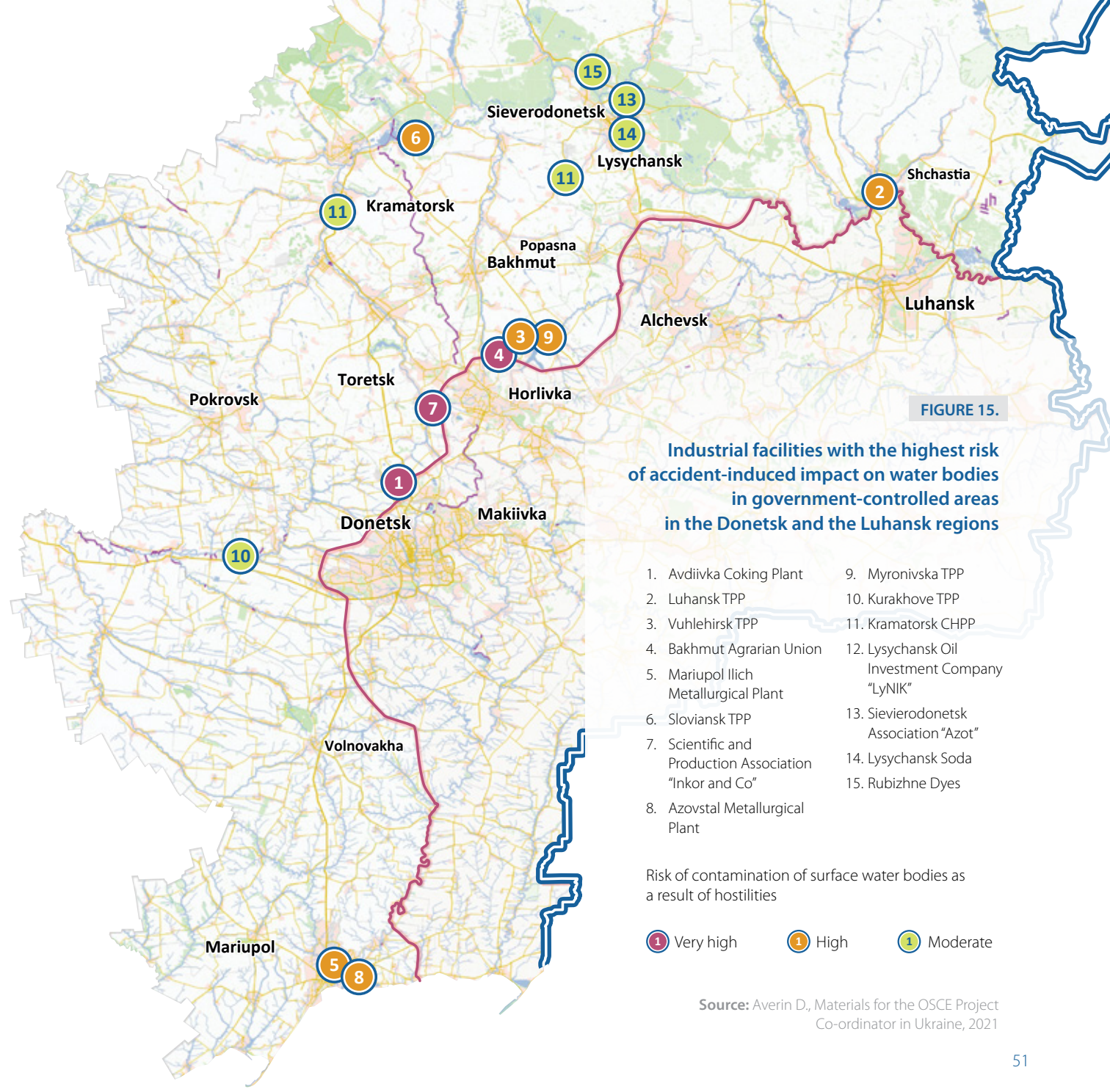


FIGURE 15.

Industrial facilities with the highest risk of accident-induced impact on water bodies in government-controlled areas in the Donetsk and the Luhansk regions

1. Avdiivka Coking Plant
2. Luhansk TPP
3. Vuhlehirsk TPP
4. Bakhmut Agrarian Union
5. Mariupol Ilich Metallurgical Plant
6. Sloviansk TPP
7. Scientific and Production Association "Inkor and Co"
8. Azovstal Metallurgical Plant
9. Myronivska TPP
10. Kurakhove TPP
11. Kramatorsk CHPP
12. Lysychansk Oil Investment Company "LyNIK"
13. Sievierodonetsk Association "Azot"
14. Lysychansk Soda
15. Rubizhne Dyes

Risk of contamination of surface water bodies as a result of hostilities

1 Very high 1 High 1 Moderate

Source: Averin D., Materials for the OSCE Project Co-ordinator in Ukraine, 2021

TABLE 1.

Risk analysis of the accident-induced impact on water bodies in government-controlled areas in the Donetsk and the Luhansk regions

#	Name of Company	Number of operational disruption cases at the enterprise	Distance from the enterprise to the contact line	Possible impact on drinking water supply in case of operational disruptions	Availability of hazardous tailings storage facilities
1	Avdiivka Coking Plant	■	■	■	■
2	Luhansk TPP	■	■	■	■
3	Vuhlehirsk TPP	■	■	■	■
4	Bakhmut Agrarian Union	■	■	■	■
5	Mariupol Ilich Metallurgical Plant	■	■	■	■
6	Sloviansk TPP	■	■	■	■
7	Scientific and Production Association "Inkor & Co"	■	■	■	■
8	Azovstal Metallurgical Plant	■	■	■	■
9	Myronivska TPP	■	■	■	■
10	Kurakhove TPP	■	■	■	■
11	Kramatorsk CHPP	■	■	■	■
12	Lysychansk Oil Investment Company "LyNIK"	■	■	■	■
13	Sievierodonetsk Association "Azot"	■	■	■	■
14	Lysychansk Soda	■	■	■	■
15	Rubizhne Dyes	■	■	■	■
		■ over 10 ■ from 4 to 10 ■ under 4	■ under 10 km ■ from 10 to 20 km ■ over 20 km	■ yes ■ no	■ yes ■ no

Source: Averin D., Materials for the OSCE Project Co-ordinator in Ukraine, 2021

Since 2014, some enterprises, including potentially hazardous facilities, have found themselves on non-government-controlled areas or on the conflict line in the immediate vicinity of the hostilities.

Due to such enterprises, the waters of the Kryvyi Torets and the Bakhmutka in the controlled area may be significantly affected (risk of hazardous substances entering watercourses from non-government-controlled areas). Contamination is likely to spread along the Siverskyi Donets riverbed, including in the area of surface drinking water intake from the Siverskyi Donets river for the needs of the Luhansk region, which is located in the village of Bilohorivka below the inflow of rivers (the state of the Siverskyi Donets in the area of water intake into the "Siverskyi Donets – Donbas Canal" for the needs of the Donetsk region is no longer affected by these tributaries, as they are located downstream).

One of the high-hazard facilities for water bodies are tailings storage facilities – complex water management, engineering structures, accumulators of liquid multi-tonnage wastes of various industries with long-term functionality, which are not only under the influence of the natural environment, but also of many socio-political and economic factors. According to the information available, the Donetsk and the Luhansk regions host 200 tailings storage facilities containing 939 mln tons of industrial waste, of which 75 facilities are located in government-controlled areas[31].

Tailings storage facilities are potential sources of accidental pollution with hazardous substances and significant impact of polluted areas on surface and groundwater through possible one-time emergency discharges and/or chronic leakages (outflows) due to failure of their structures. In this case, as a rule, hazardous substances contained in the waste of tailings storage facilities are released by "volley" discharge or gradually enter the nearest water bodies from the polluted areas.

The location of the tailings storages, being potentially hazardous facilities in the hostilities area in the immediate vicinity of the contact line, increases the risk of turning the existing hazards from these facilities into environmental disasters[32], including of a transnational scale.

31 https://www.minregion.gov.ua та https://inspections.gov.ua/

32 To reduce the negative impact of the ingress and transport of hazardous pollutants in the event of an accident – breakthrough of the tailings storage facilities' protective dams – measures were proposed for flow augmentation from the upper pond of the Kleban-Byk Reservoir. Unfortunately, it is impossible to make such flow augmentations in the volumes proposed by the research due to unsatisfactory condition of the hydraulic structures of Kleban-Byk Reservoir. Reconstruction of the hydroengineering facility, which is the only source of dilution of pollution and reduction of the negative impact on surface waters from the breakthrough of protective dams of tailings storages, needs to be reviewed and addressed without delay.

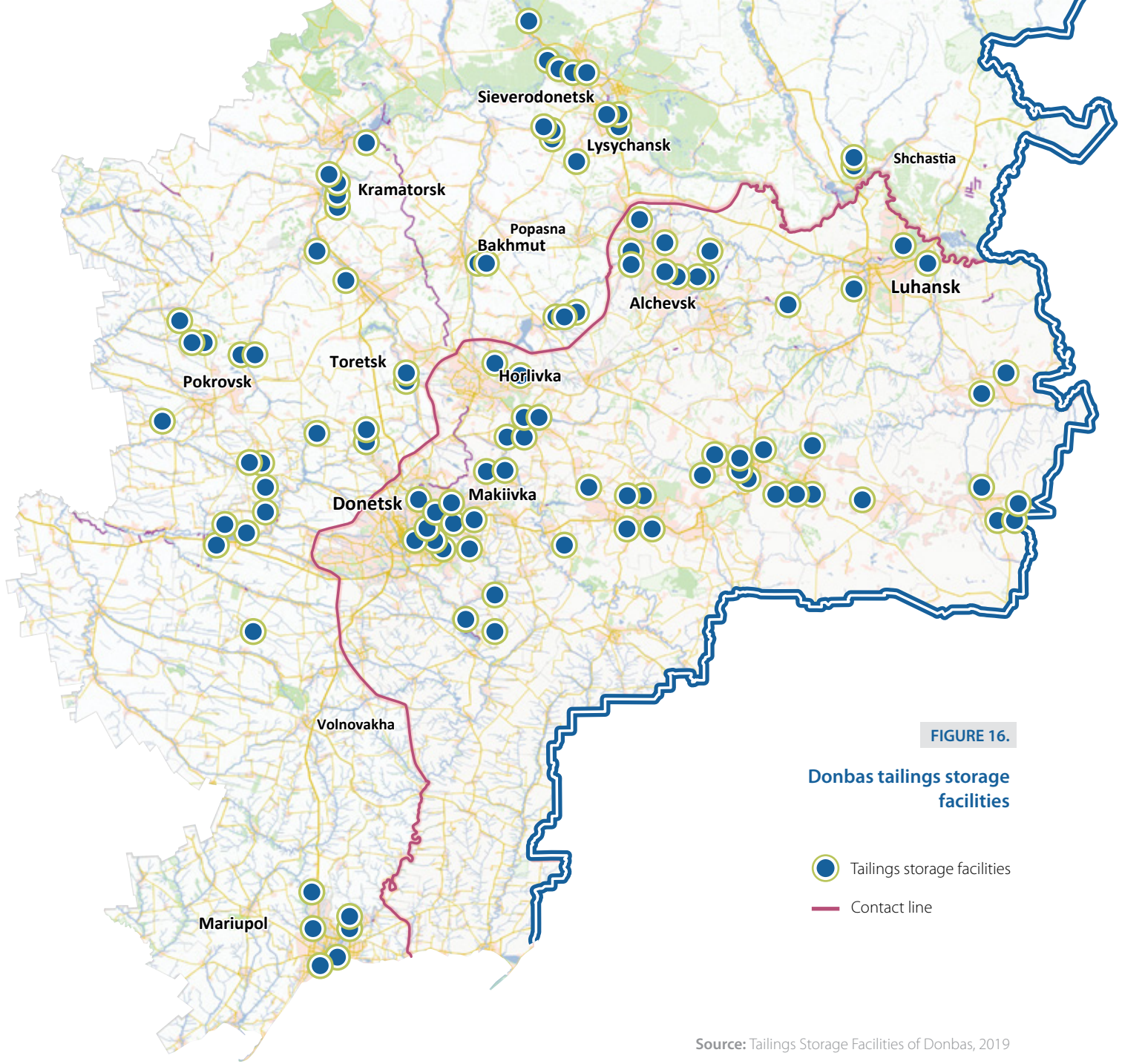


FIGURE 16.

Donbas tailings storage facilities

Source: Tailings Storage Facilities of Donbas, 2019

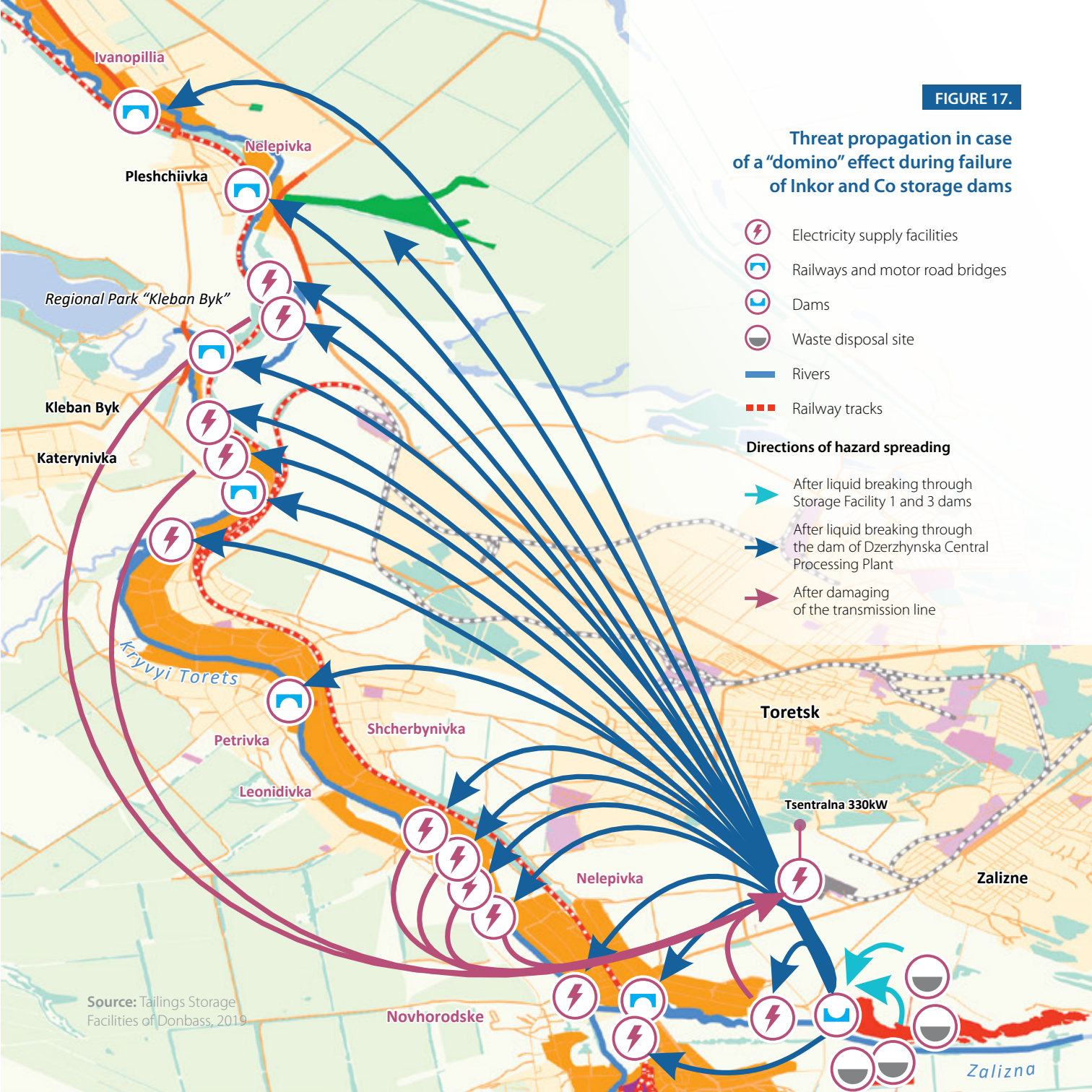

Ivanopillia
Nelepivka
Pleshchiivka
Regional Park "Kleban Byk"
Kleban Byk
Katerynivka
kryvyi Torets
Petrivka
Shcherbynivka
Leonidivka
Toretsk
Tsentralna 330kW
Nelepivka
Zalizne
Novhorodske
Zalizna
FIGURE 17.
Threat propagation in case of a "domino" effect during failure of Inkor and Co storage dams
Electricity supply facilities
Railways and motor road bridges
Dams
Waste disposal site
Rivers
Railway tracks
Directions of hazard spreading
After liquid breaking through Storage Facility 1 and 3 dams
After liquid breaking through the dam of Dzerzhynska Central Processing Plant
After damaging of the transmission line
Source: Tailings Storage Facilities of Donbass, 2019

FIGURE 18.

Simulation of pollution propagation in case of breakdown of Inkor and Co storage dams

TERMINATION OF BASIN COOPERATION

The political and armed conflict gave rise to territories where the situation is not controlled by the Government of Ukraine and complicates not only data collection and monitoring of the environmental situation (*see Section 2*), but also the actual solution of the water issues in the complex transboundary Don basin. Whereas before 2014 even interstate cooperation was pursued and fully implemented in the basin, today not only cross-border cooperation with the Russian Federation is impossible, but also any constructive interaction with the self-proclaimed administrations in non-government controlled area.

Thus, with few exceptions in the field of water supply, the scope of planning and implementation of measures in the Ukrainian part of the Don basin are limited not only by the borders of government-controlled territories, but, unlike most transboundary basins in Europe and the world, by practical impossibility of cooperation with the rest of the basin. This significantly reduces the potential efficiency of measures to improve the ecological status of the Don basin, especially to address long-term challenges that require a strategic and comprehensive approach across the basin.

CROSS-BORDER COOPERATION IN THE DON BASIN: CLOSED "WINDOW OF OPPORTUNITIES"

The experience of cooperation between the Siverskyi Donets Basin Administration of Water Resources of Ukraine and the Don Basin Water Administration of Russia goes back to the 1980s.

One of the initial stages of working out the interaction principles can be based on the experience gained at that time in passing floods and emptying wastewater reservoirs of chemical enterprises located in Ukraine, depending on the expected amount of floods needed for dilution and to comply with the MAC in the border sections.

The 1992 Agreement between the governments of the two countries on the joint use and protection of transboundary water bodies, including in the Siverskyi Donets river basin, defined the basic principles of water sharing, maintenance of hydraulic and water protection structures, implementation of recovery and conservation measures, conservation and recovery of bioresources, arrangements for monitoring of the surface water status, regular exchange of information and projections on flood development, as well as the expected water content in the low-water period.

Commissioners and their deputies were appointed to implement the Agreement. During Agreement implementation, the procedure for organizing water management in the Siverskyi Donets basin was agreed upon, a program of joint control over the hydrochemical condition of water bodies was implemented, and requirements for compliance with hydrological and hydrochemical parameters at the border stations were established. Issues which concerned the interests of the adjacent states, such as the determining of regimes for filling and operation of reservoirs during floods and summer-autumn lows, operation of wastewater storages, indicators of water balances, construction of water facilities, were addressed only after mutual agreement.

Meetings at the Deputy Commissioner level were held at least twice a year, working meetings of experts were held on specific issues, and the Siverskyi Donets basin working group included specialists of state ecological services, centers for sanitary inspection, geology and subsoil use, hydrometeorology, fish inspection, scientific and design organizations. Quarterly information was exchanged on the results of water quality observations at 10 border stations on 3 basin rivers, including 8 stations on the Siverskyi Donets river.

During floods, as well as in cases of declining water levels in Ukraine, hydrological data were transmitted weekly or daily.

The system of administrative decision-making support created through the efforts of both states increased the parties' awareness, made their activities transparent and predictable, and allowed for coordination of their efforts in decision formulation.

The Agreement identified possible accident situations, which required joint efforts for their prevention and response. Pro-active joint actions during the 1994 flood allowed for flooding of the Siverskyi Donets floodplains in the Donetsk and the Luhansk regions in the areas of underground drinking water intakes, thus reducing flood damages in other parts of the Don basin. In 1995, joint measures helped reduce pollution of the Siverskyi Donets river following a major accident at Kharkiv's treatment facilities, prevent deterioration of water quality in the Rostov Region, and ensure stable operation of the Donetsk, Kamiansk, and Bila Kalytva water intakes. An example of cooperation was repeated addressing of difficult situations on the Mius river, where even a slight flow rate increase raises the water level, causing flooding of residential communities in Russia.

Finally, when draining of the Pechenihy reservoir, on which Kharkiv's water supply depended, became critical in the extremely low-water summer season, the Russian side agreed to augment the flow from the Belgorod reservoir to help stabilize the situation.

To develop cooperation within the framework of the interstate agreement, it was proposed to conclude an Agreement on the Kundriucha river, the need for which was dictated by presence of drinking water-grade reservoirs on this river near Russia. The Agreement was signed by representatives of the regional administrations of the Luhansk and the Rostov regions in 1999.

Source: UNECE. Water Series No. 4. Transboundary Water Cooperation: Trends in the Newly Independent States. New York and Geneva, 2006. https://unece.org/DAM/env/water/publications/documents/waterseries4_r.pdf

5.

THE TRAJECTORY IS SET BY THE CLIMATE

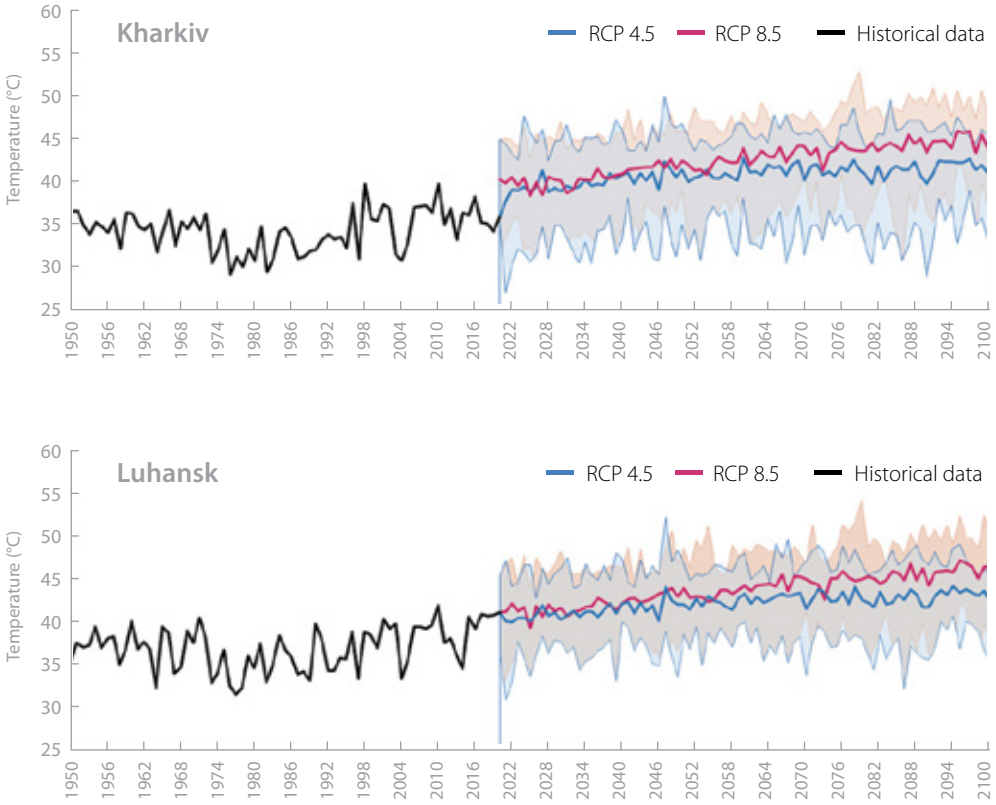
One of the main manifestations of regional climatic changes in the context of global warming is a significant increase in the air temperature, changes in the thermal regime and precipitation structure, growing number of dangerous meteorological phenomena and extreme weather conditions, the damage they cause to various sectors of economy and population.

Such tendencies are characteristic both for Ukraine as a whole and for the east of the country.

The most significant changes have been observed over the last thirty years, which turned out to be the warmest during the period of instrumental weather observations.

FIGURE 19.

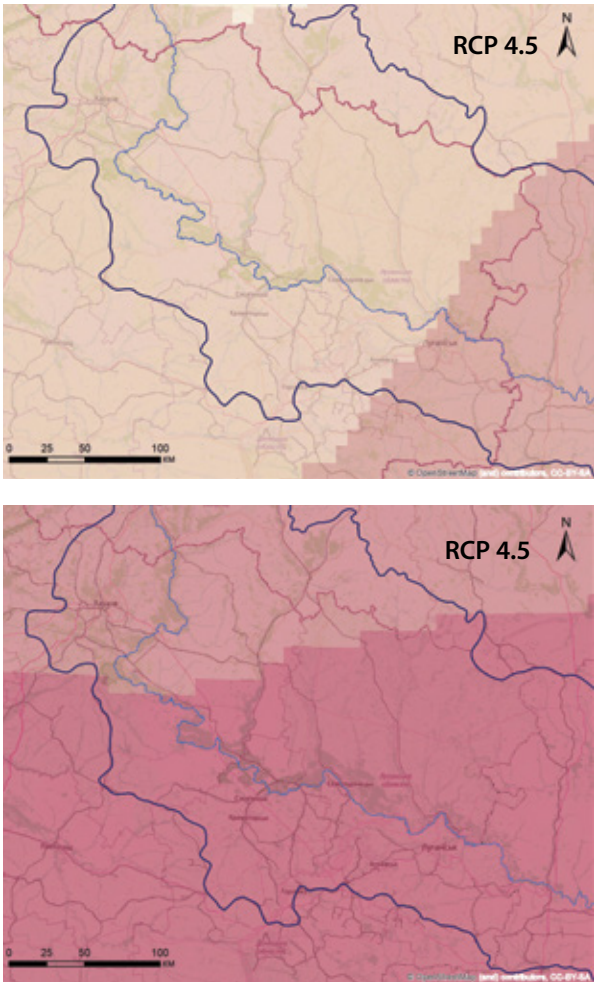
Climate change analysis: maximum temperature



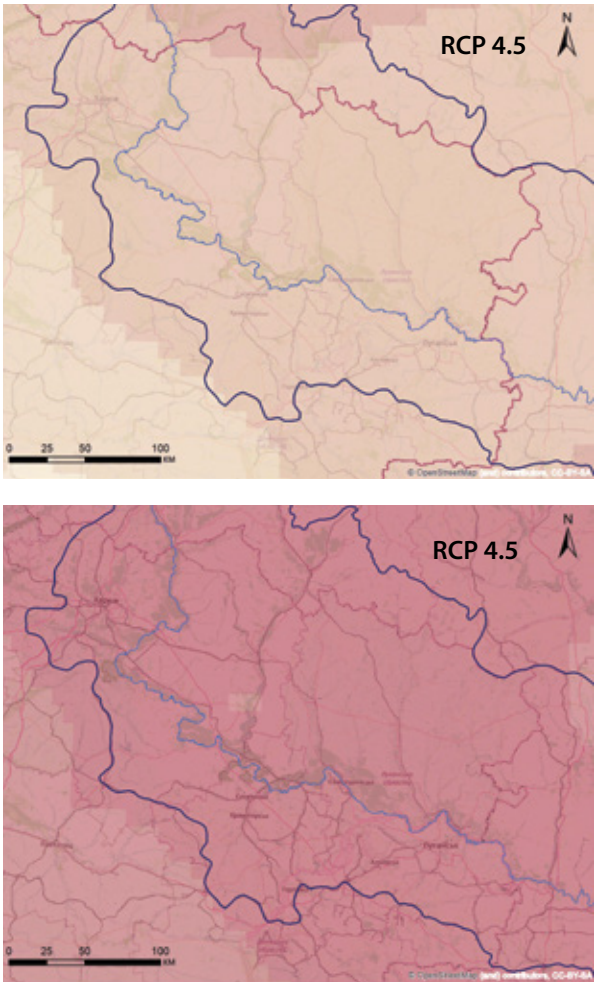
Source:
Diadin et al.,
Materials for UNICEF, 2021

FIGURE 20. **Climate change analysis**

Share of hot days



Maximum temperature



State border
Siverskyi Donets river
Siverskyi Donets river basin

Share of hot days, %

15 – 16
16 – 17
17 – 18
18 – 19
19 – 21

State border
Siverskyi Donets river
Siverskyi Donets river basin

Maximum temperature, °C

3,2 – 3,4
3,4 – 3,6
3,6 – 3,8
3,8 – 4,0
4,4 – 4,6
4,6 – 4,8

Source: Diadin et al., Materials for UNICEF, 2021

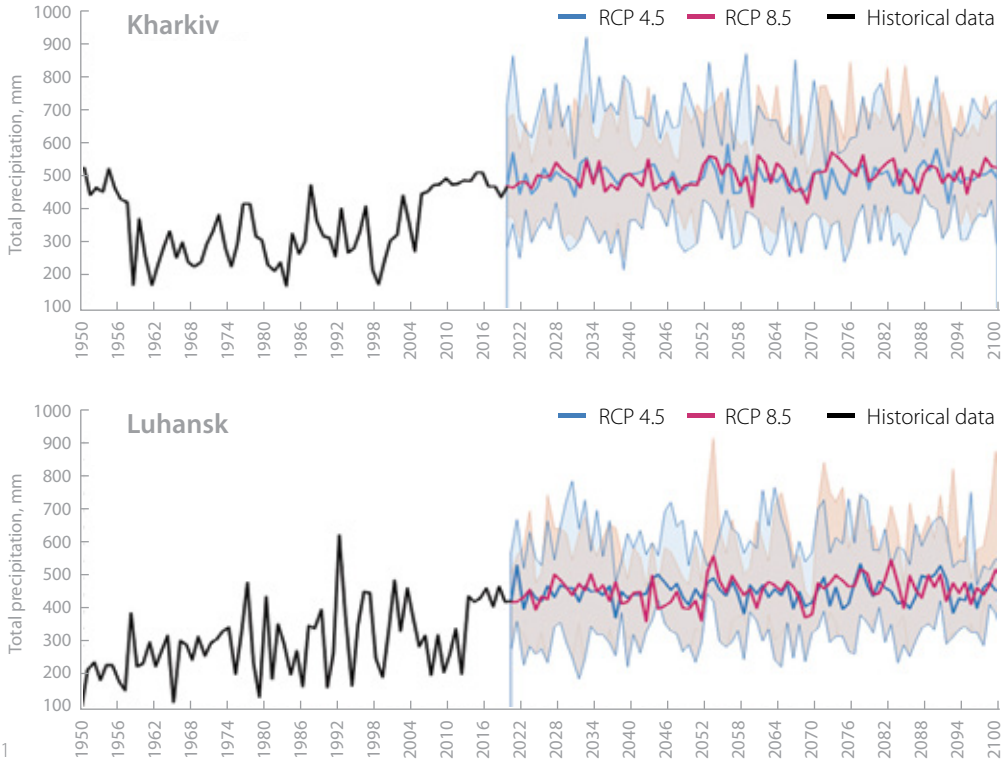
In 1991-2020 the Luhansk region witnessed a significant increase in the average annual air temperature, the rate of which was 0.56°C/10 years. These changes were three times the rate of change in the global temperature on the planet during the period. As a result, the average annual air temperature increased by 0.8°C compared to its long-term average values in 1961-1990.

Winter became warmer by 1.4°C, summer – by 1.0°C, spring – by 0.7°C, and autumn – by 0.5°C.

Compared to the climatic norm of 1961-1990, the annual rainfall over the past 30 years has not changed significantly, but there was a redistribution between the seasons – its amount decreased in summer (-6%) and winter (-10%) and increased in autumn (3%).

FIGURE 21.

Climate change analysis: total precipitation



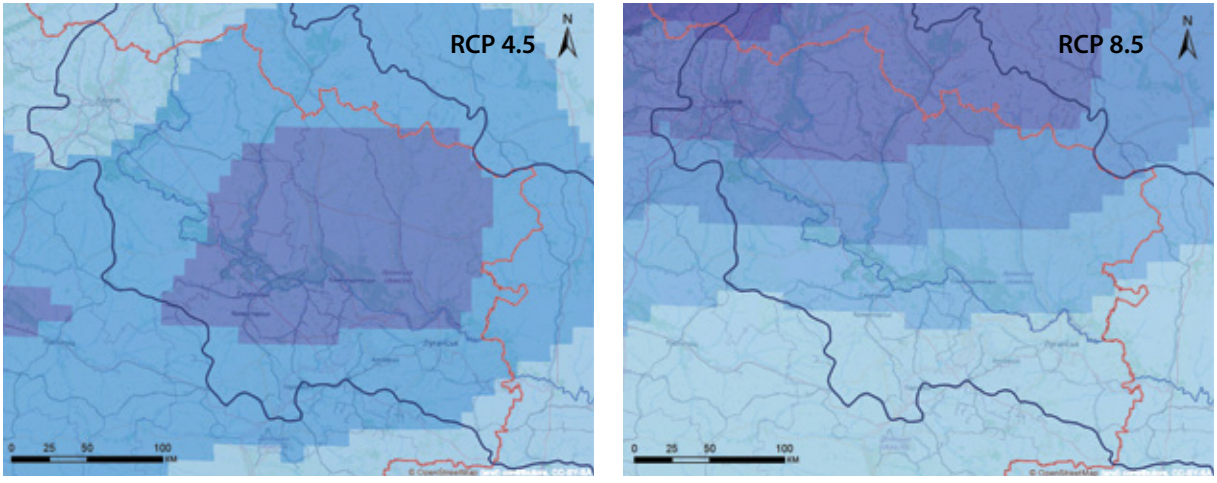
Source:
Diadin et al.,
Materials for UNICEF, 2021

Climate changes have already reflected on the intra-annual water flow distribution in the rivers. The spring high waters, which were characteristic of the rivers of the Don basin, have significantly decreased, which in turn has led to deterioration of riverbed washing, the water only rarely reaches the floodplain in the spring and does not feed the floodplain reservoirs.

According to some calculations[33], no significant changes in the average flow are expected in the Don basin until 2040. In 2041-2070, the projections for the Siverskyi Donets indicate a slight increase in the flow: 4-7% under different scenarios of global greenhouse gas emissions. That is, there will be no significant changes in the flow in this region during this period. At the end of the century (2071-2100), the flow is expected to increase by an average of +6%.

FIGURE 22.

Climate change analysis: total precipitation

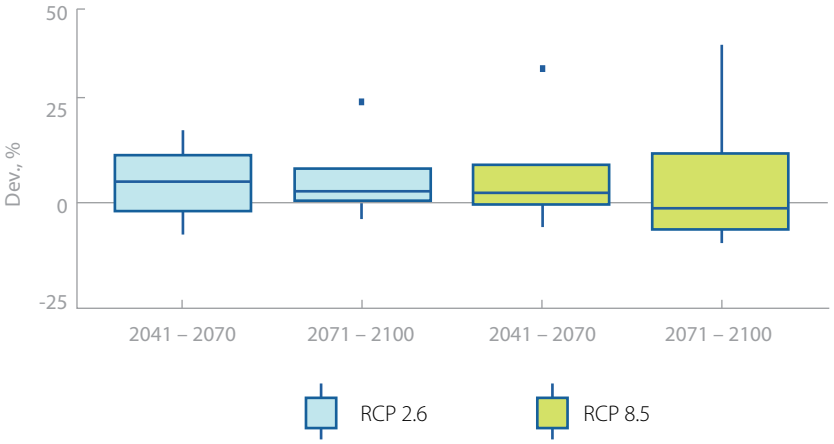


Source:
Diadin et al., Materials for UNICEF, 2021

33 Didovets I., Krysanova M., Hattermanna F., Lópeza M., Snizhkob S., Schmied H. Climate change impact on water availability of main river basins in Ukraine. https://www.sciencedirect.com/science/article/pii/S2214581820302354

FIGURE 23.

Projected changes in the average annual water flow of the Siverskyi Donets in accordance with greenhouse gas emission scenarios RCP 2.6 and 8.5



Source: Didovets I., et al., 2020

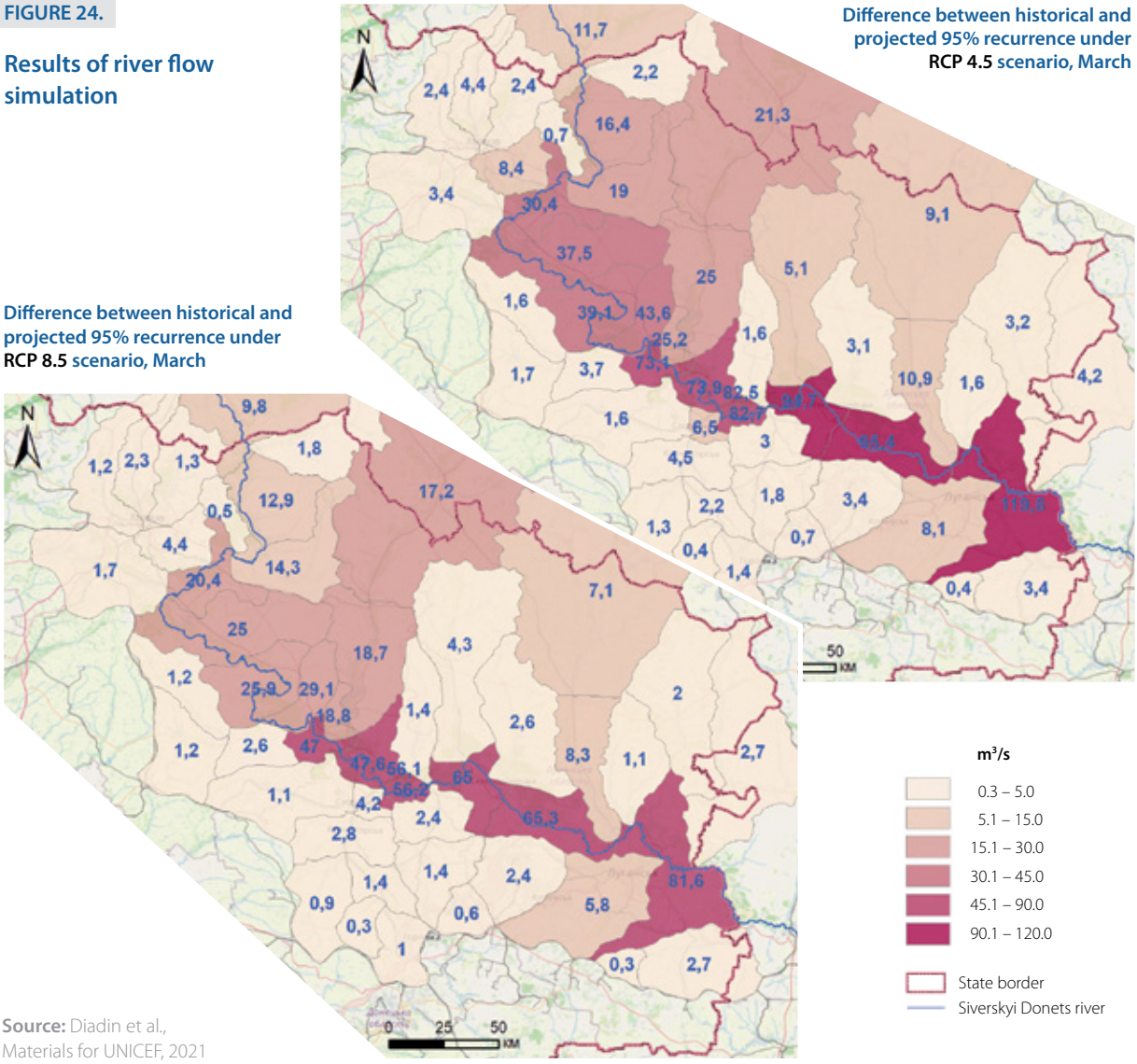
Of considerable interest are the projected results of the average monthly water flow rates. The simulation results showed[34] that in comparison with the last 20 years (2000-2020) to 2050, the water flow is projected to increase in the 95% recurrence in the Siverskyi Donets Basin, especially in March-April under RCP 4.5 and 8.5 scenarios). The average monthly flow will increase in all parts of the Siverskyi Donets basin in February-April, but in most of them the flow is expected to decrease in July-October according to the RCP 8.5 scenario, which is partly consistent with the results of the previous studies.

Based on the projected results of seasonal distribution of precipitation, the contrast in precipitation, air temperature and soil moisture indicators during the season is expected to increase. The risks of drought and water shortage in July-September are increasing relative to the historical period due to the projected increase in the maximum temperatures and the number of days without precipitation. The basin's southern part and the areas located on its periphery are characterized by the highest vulnerability to these changes. The irrigation water systems are especially vulnerabile to droughts and shortages of water resources.

34 Diadin et al., Materials for UNICEF, 2021

FIGURE 24.

Results of river flow simulation



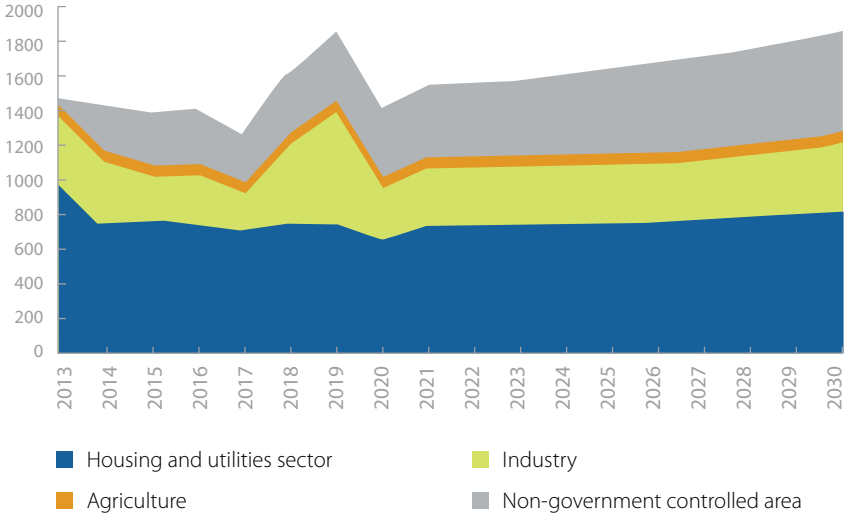
Source: Diadin et al., Materials for UNICEF, 2021

Today, the use of water resources in the basin does not exceed 25-50% of their availability.

However, the tendency towards increased total water abstraction combined with possible, at least according to some estimates, reduced flow in summer-autumn, rising temperatures, and increasing drought frequency and duration may limit water abstraction to meet the interests of all water users, including maintaining the necessary environmental flow volume.

FIGURE 25.

Dynamics of water intake in the Don basin and its projection based on the basic (realistic) **economic development scenario**



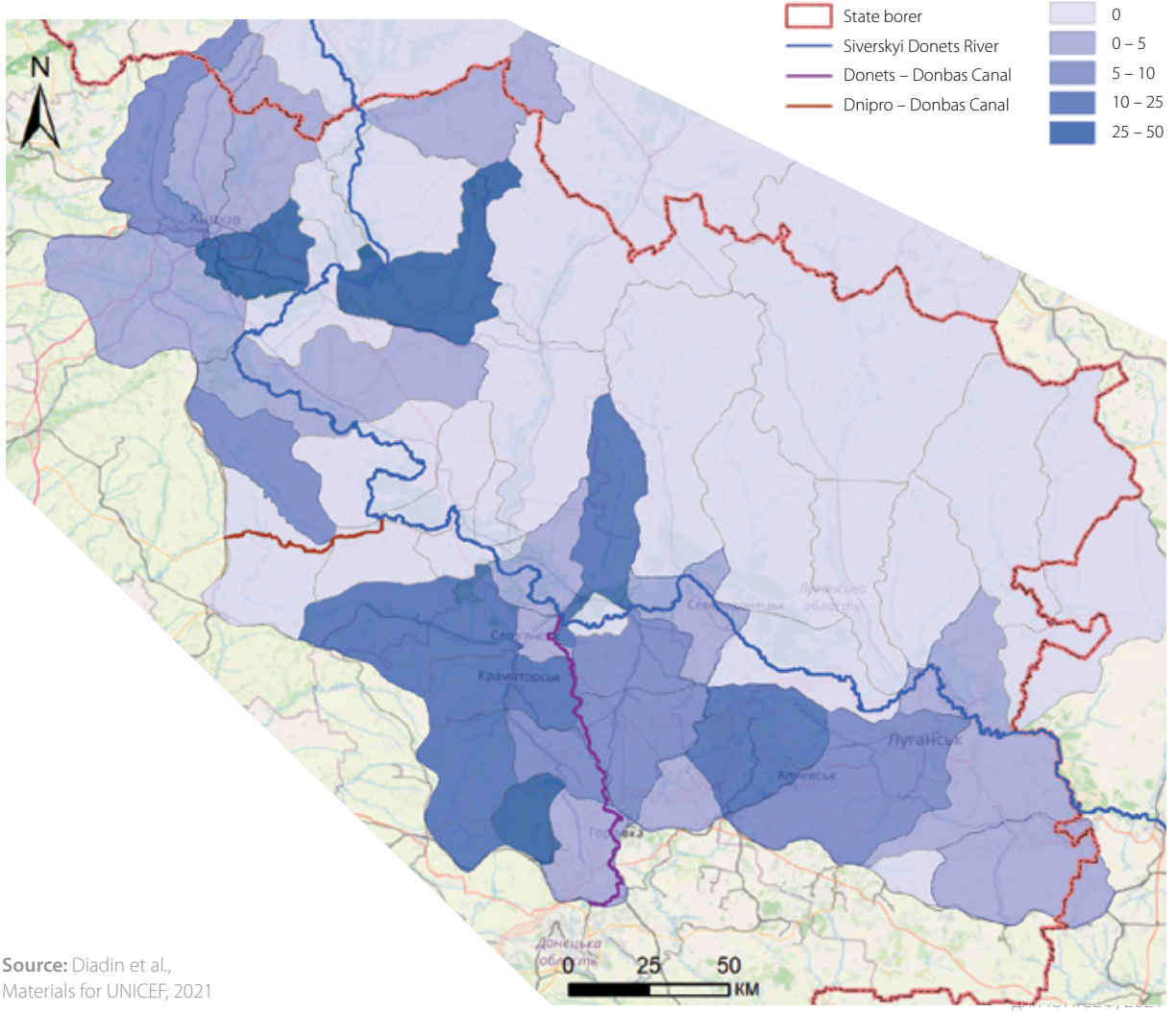
Source: "Economic Analysis of Water Use of the Don River Basin Area". Technical Report for the OSCE Project Co-ordinator in Ukraine, 2020

The projected increase in particularly heavy precipitation also increases the risk of high-water and floods in the basin and leaves the infrastructure vulnerable to a sharp rise in the water levels in the watercourses during the warm season. Negative manifestations of expected changes in the hydrological regime of rivers will also include:

- intensified riverbed and bank erosion;
- siltation and overgrowing of riverbeds (which, in particular, leads to their narrowing);
- loss of hydraulic diversity, disappearance of hydromorphological forms (riffles, backwaters, rapids and others);
- change of natural vegetation of the floodplain area adjacent to the riverbed, its overgrowing with bushes and trees.

FIGURE 26.

Assessment of the impact of climate changes on water consumption



Source: Diadin et al., Materials for UNICEF, 2021

Among regional ecosystems, wetland ecosystems – floodplain bogs, transitional relict bogs on pine terraces and bogs on high terraces of river valleys, especially in the central and southern parts of the sub-basin – are the most vulnerable to current and projected climate changes. Meadow ecosystems of river floodplains and high terraces of river valleys are also very vulnerable: their further xerophytization is expected to intensify. The spread of invasive species through the Dnieper-Donbas Canal may also intensify.

Due to climate change, water quality can be expected to further deteriorate by such indicators as the content of suspended solids, organic pollution (according to BOD5), dissolved oxygen, ammonium, sulfates, chlorides and phosphates. Such deterioration is likely to be due to longer summer low-water periods, growing water temperature during the warm period of the year, inflow of contaminated surface runoff from agricultural and urban areas after extreme rainfall. An increase in the concentrations of nutrients along with the growing water temperature during the vegetation period will increase the incidence of algal and cyanobacterial "blooms" and the water surface areas covered by such blooms not only in reservoirs and ponds, but also in slow-flowing rivers.

Manifestations of climate changes are not exclusively related to the impact on water resources and ecosystems, but also pose a threat to the economy, population and nature of the basin. Preventing their adverse effects is a task for a comprehensive program of territory adaptation[35], the content of which goes beyond measures which immediately address water and environmental issues.

35 Diadin et al. Analysis and Assessment of the Impact of Climate Changes in the Siverskyi Donets Basin. Materials developed for the UNICEF Office in Ukraine. – K., 2021.

TABLE 2. **The main climatic threats to residential communities of the Don basin**

Type of climate risks	Existing level of threat	Expected changes in intensity	Expected changes in the frequency of manifestation	Time frame
Extreme heat	↑	↗	↗	Already happening
Extreme cold	↓	?	?	Unknown
Extreme precipitation	⊙	↗	↗	Already happening
Droughts	↑	↗	↗	Already happening
Storms	⊙	↗	↗	Already happening
Landslides	↓	↗	↗	In the near future

TABLE 3. **Impacts of climate changes on sectors of economy and administration**

Sector	Expected impact	Probability	Time frame (prospects)
Buildings and structures	Damage to public and private houses, historic buildings	⊙	Medium-term
Transport	Destruction of transport infrastructure	↑	Medium-term
Energy	Increased electricity consumption in summer, power outages due to accident situations	↓	Nearest
Land use	Soil pollution, erosion, landslides, city flooding, reduced green areas	↑	Nearest
Agriculture and forestry	Decrease in crop yields, deterioration of green areas and suburban green areas	↑	Nearest
Environment	Deterioration of the environment, reduction of biodiversity	↑	Nearest and long-term
Healthcare	Influence of climatic phenomena on the population's state of health	↑	Nearest

↓ Low / Low ⊙ Medium / Medium ↑ High / high ↗ Growth ? Unknown

Source: Diadin et al., Materials for UNICEF, 2021, as amended

6.

PROGRAMME OF MEASURES TO IMPROVE THE STATE OF WATER RESOURCES

Programme of measures is an integral part of the river basin management plans currently developed pursuant to Ukraine's water legislation. Measures should aim at achieving good status of surface and groundwater by addressing the main water issues identified for a particular river basin. These issues essentially are pressures (or antropogenic pressures) on the aquatic environment that pose the biggest obstacles to achieving the environmental objectives.

The main water issues of all river basins in Ukraine, including the Don, include: surface and groundwater pollution, groundwater depletion, hydromorphological changes of rivers and reservoirs, and "other" issues that are determined taking into account the river basin' specifics[36]. As of November 2021, the assessment of the ecological status of the basin's surface waters, chemical and quantitative status, and groundwater status was not fully completed – subsequent assessment of the efficiency of measures was based on the risk assessment of failure to achieve good surface and groundwater status and assessment of the chemical status of surface waters based on the 2019-2020 monitoring data.

The programme of measures for the Don basin was developed in several stages. Initially, a long list of measures was drafted using which, based on the results of prioritization (ranking) by criteria of feasibility, magnitude, accessibility, sustainability and how soon the implementation can be started, and based on the discussions with stakeholders in the Luhansk, the Donetsk, and the Kharkiv regions, a short list of measures was developed.

Experts estimated the cost of programme implementation by distributing each of the proposed measures to one of three cost categories: from less than one million to over 100 million UAH (for the most expensive activities on reconstruction and construction of the treatment facilities).

Such distribution took into account the cost of implementing similar measures in the past, the estimated cost of the measure per person/unit, and other approaches that allow only a rough estimate of the cost range. A more accurate establishment of the cost of the measures requires additional financial and economic assessment.

36 Cabinet of Ministers Resolution 336 "On Approval of the Procedure for Development of the River Basin Management Plan". The programme of measures for the Don basin is developed in accordance with the standard structure of river basin management plans, set out in the annex to the Resolution and presented in a tabular form. The approaches provided in the EU guidelines and the experience of the EU member states (Slovakia, Romania, Lithuania) were also taken into account when formulating the program.

FIGURE 27.

Locations of the long and short list of measures to improve the status of water resources in the Don basin

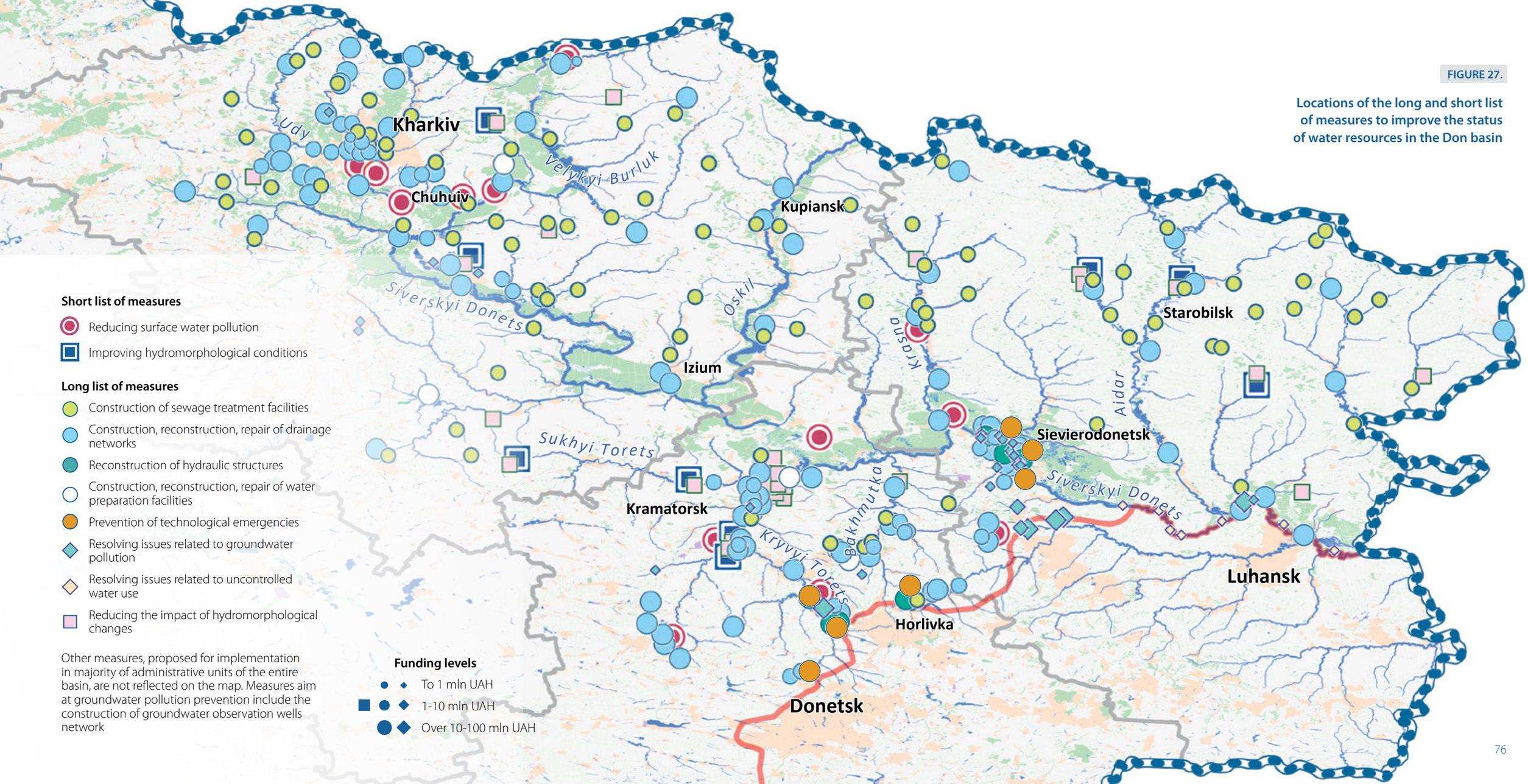


TABLE 4. Number and estimated cost of measures to improve the status of the Don Basin water resources

Measures	Sector	Number of measures by cost category			Estimated cost, mln UAH*
		A	B	C	
Reconstruction, repair and construction of treatment facilities and drainage networks	Housing and utilities companies		2	84	> 8000
	Industrial enterprises	3	26	33	> 3500
Pollution reduction and prevention of technological emergencies				7	> 700
	Agriculture	3[1]	90	2	> 1500
	Housing and utilities companies	4[2]		1	> 100
Reconstruction, repair of water treatment facilities				6	> 600
Development of town-planning and regulatory documents, educational activities	Central, regional, local authorities	3[1]			5-10
Reducing the impact of hydromorphological changes			26		25-250
Resolving issues related to groundwater pollution		20	10	4	> 500
Resolving issues related to uncontrolled groundwater use		7			< 5
Adaptation to climate changes		1	12[3,4]		40-130
Reducing surface water pollution with household waste, including plastic		3[1]	1		> 100
Reducing spread and negative impact of invasive species		5	5		5-10
Reducing the negative impact of the hostilities		3[3]	1		5-10
TOTAL		47	168[3]	137	> 15000 mln UAH

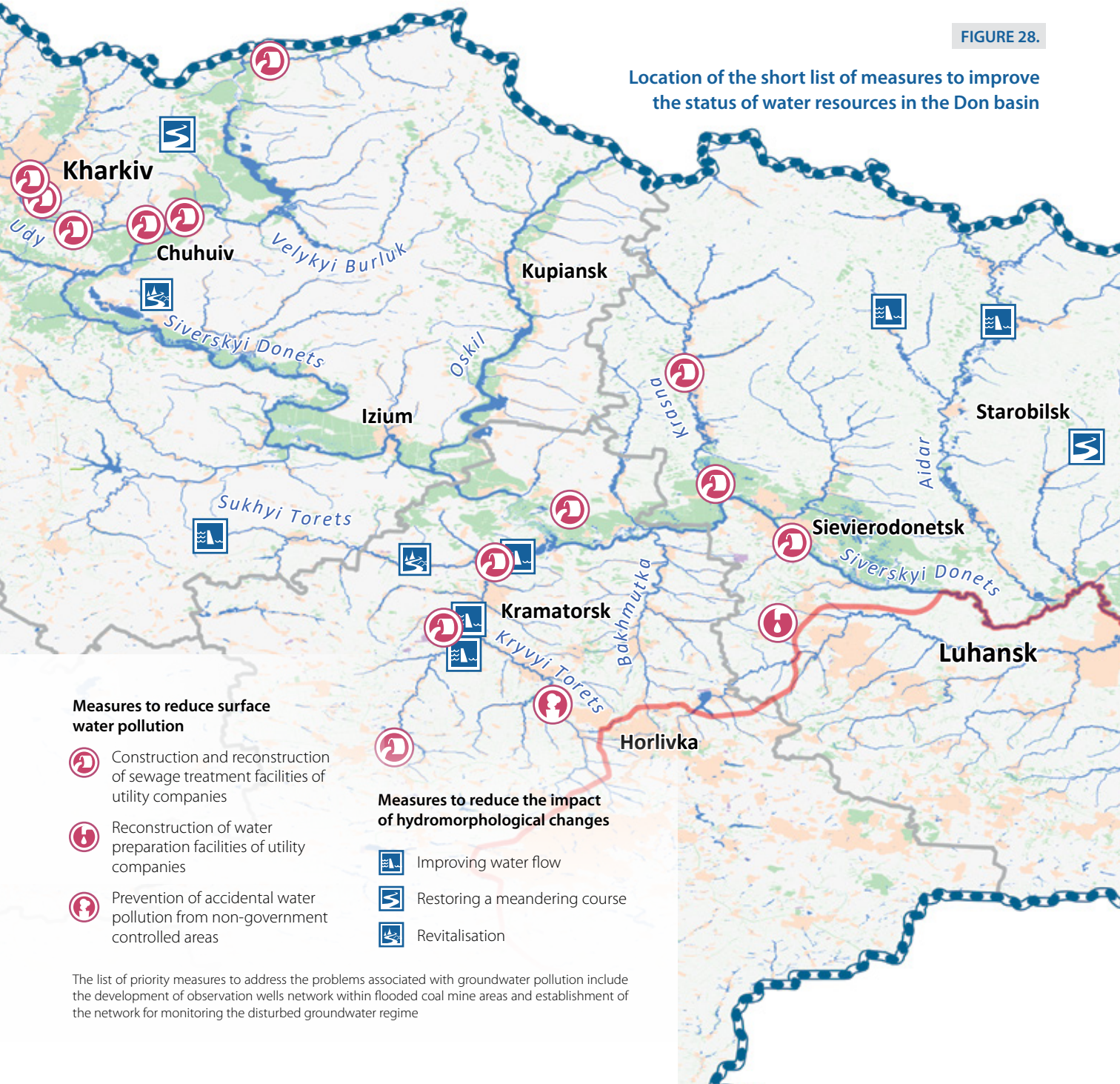
* To reflect the cost of work in Category C, a factor of 10 was used (the average cost of one event in this category was estimated – over 100 mln UAH)

Cost categories of measures:
A – under 1 mln UAH
B – from 1 to 10 mln UAH
C – over 10 mln UAH

Note:
1 The initial cost of some measures is indicated per residential community/ amalgamated territorial community, and the total cost is estimated taking into account the possible number of administrative units for their implementation.
2 Measures to minimize the risk of water pollution from non-government-controlled areas.
3 The number of measures is indicated taking into account independent implementation of some of them in each of the regions.
4 The initial cost of some activities is indicated per year, and the total cost takes into account the expenses over 6 years of implementation of such measures.

FIGURE 28.

Location of the short list of measures to improve the status of water resources in the Don basin



The list of priority measures to address the problems associated with groundwater pollution include the development of observation wells network within flooded coal mine areas and establishment of the network for monitoring the disturbed groundwater regime

SURFACE WATER STATUS

SURFACE WATER POLLUTION

To reduce pollution of the Don basin with organic, biogenic and hazardous substances (diffuse and point sources), the proposed measures are aimed at several types of economic entities:

- housing and utilities companies: reconstruction, capital repairs and new construction of treatment facilities, drainage networks and water conditioning facilities using the latest technologies;
- agricultural enterprises *(agriculture and related services)*: construction of sewage treatment plants; disposal of agricultural waste, composting, introduction of state-of-the-art technologies of waste processing and neutralization; prevention of technological emergencies, monitoring of stability of the hydraulic structures of manure storages, accumulators of hazardous animal waste; responsible and regulated use of mineral and organic fertilizers, chemical products for plant protection, including pesticides; creation of buffer zones between the water body and the utilized areas (planting of windbreaks, brushwood strips, unploughed areas of arable land); application of best agricultural practices, transition to organic production;

- industrial enterprises: new construction and reconstruction, capital repairs of treatment facilities and drainage networks using state-of-the-art technologies; prevention of technological emergencies, monitoring of stability of hydraulic structures of tailings, sludge storages, hazardous industrial waste storages, the use of state-of-the-art technologies for waste processing and neutralization.

A separate list of measures was proposed for executive committees of village, town, and city councils of amalgamated territorial communities concerning development of urban planning documentation, including design of coastal protection belts and water protection zones along watercourses within residential communities (development of draft general plans of residential communities, detailed territorial placement plans for community infrastructure facilities); control over creation of water protection zones and coastal protection belts, as well as over compliance with utilization of their territories (together with representatives of the State Environmental Inspectorate on the ground).

To reduce the ingress of phosphates into surface waters, it is necessary, first of all, to limit/reduce the concentration of phosphates and other phosphorus compounds in detergents used both for domestic and industrial washing and cleaning, while the restrictions should be implemented in several stages, which first and foremost require statutory regulation. Therefore, the list of measures also includes proposals to the Cabinet of Ministers of Ukraine and the Verkhovna Rada of Ukraine, line ministries and agencies to develop and improve the necessary regulatory documents.

Equally important are environmental awareness raising activities on considerate attitude to water resources for educational institutions (youth, schoolchildren), the public and the population (consumers). These activities may be supported by the departments of environmental protection and natural resources in the regions, Siverskyi Donets Basin Administration of Water Resources, regional offices of the State Water Resources Agency of Ukraine, and regional environmentally-focused NGOs.

Given the hostilities in the east of the country, a list of measures was proposed as a separate block to reduce pollution with organic, nutritional and hazardous substances with the aim of minimizing the possible impact on the housing and utilities companies located in non-government-controlled areas, in particular concerning the risks of industrial accidents and related water pollution.

The list of measures also includes some measures that were not implemented under previous regional environmental programmes, as well as those measures for which the design specifications and cost

estimates were developed for reconstruction, construction of sewage treatment plants and sewage networks in 2019-2020.

Generally speaking, a short list of measures to reduce surface water pollution includes 14 actions on eight rivers and one reservoir.

TABLE 5.

A short list of measures to reduce surface water pollution

River	Agglomeration, region	Action item	Business entity	Implementation dates, sources and amount of funding
the Kazenyi Torets	Sloviansk, Donetsk region	Construction (reconstruction, repair) of treatment facilities and drainage networks using state-of-the-art technologies	Communal Enterprise "Sloviansk Municipal Water Services" [Slovmiskvodokanal]	2026: state and local budgets, others, each project over 100 mln UAH
	Myrnohrad, Donetsk region		Communal Enterprise "Voda Donbasu"	
the Kryvyi Torets	Toretsk, Donetsk region			
the Siverskyi Donets	Lyman, Donetsk region			
	Lysychansk, Luhansk region		Communal Specialized Enterprise "Lysychansk Water Services" [Vodokanal]	
	Vovchansk, Kharkiv region		Communal Enterprise "Vovchansk"	
the Krasna	Svatove, Luhansk region		Municipal Communal Enterprise "Svatove Water Services" [Vodokanal]	
	Kreminna, Luhansk region		Communal Enterprise "Kreminna Water Supply and Sewerage"	

River	Agglomeration, region	Action item	Business entity	Implementation dates, sources and amount of funding
the Nyzhnia Bilenka	Popasna*, Luhansk region		Communal Enterprise "Popasna District Water Services" [Vodokanal]	
the Studenok	Chuhuiv, Kharkiv region		Communal Enterprise "Chuhuiv Water"	
	Eskhar, Kharkiv region		Communal Enterprise "Eskhar Water"	
	Kharkiv region		State Enterprise "Enterprise of the State Penitentiary Service of Ukraine"	2023: state budget, 20 mln UAH
the Lopan	Kharkiv, Kharkiv region		Communal Enterprise "Kharkiv Water Services" [Vodokanal]	2021-2026: international investment, 75.8 mln USD
Kleban-Byk Reservoir	Donetsk region	Reconstruction of hydraulic structures and development of new rules for their operation	Siverskyi Donets Basin Administration of Water Resources	2022-2024: державний та місцеві бюджети, інші, 39 млн грн

* non-government-controlled areas

The proposed measures will significantly reduce impact and pressures of human activities on the surface waters of the Don basin (e.g. the Udy river) and improve their status. Assuming that by 2026 the proposed measures get implemented, in particular in terms of reconstruction of the operating sewage treatment facilities and agglomerations' wastewater treatment, and meet the regulatory requirements, then untreated and insufficiently treated wastewater will not be discharged to the basin. According to 2020 data, the volume of polluted water in the Don basin was 90.945 mln m³ or 11.4% of the total discharge, i.e. the possible effect of reducing the discharge will correspond to this particular value.

At the same time, the projected volumes of water pollution with organic and biogenic substances may decrease by the same amount.

TABLE 6.

Volumes of organic and biogenic pollution from urban agglomerations before and after reconstruction of the sewage treatment facilities

Type of pollution	Indicators	Actual values in 2020, tons/year	Estimated value for 2026, tons/year	Change
Organic pollution	Biochemical Oxygen Demand (BOD5)	2504,5	2229,0	11%
	Chemical Oxygen Demand (COD)	11508,7	10243,1	
Biogenic pollution	Total nitrogen	8360,4	7440,1	
		746,9	665,0	

The comparison results should be considered indicative, as diffuse pollution from agglomerations is not taken into account in the calculations. The estimates of pollution for 2020 only uses the data on the volumes of discharges from point sources.

The expected discharge of hazardous substances as of 2026 cannot be estimated, but some effect related to their reduction is to be expected.

HYDROMORPHOLOGICAL CHANGES

The list of measures to improve the morphological status takes into account proposals from local governments, the Siverskyi Donets Basin Administration of Water Resources and the regional offices of the State Water Resources Agency of Ukraine in the Don basin. Three out of ten shortlist measures are aimed at reducing the impact of water flow and environment disruption, three more measures are aimed at reducing the impact of morphological changes, and four measures are aimed at reducing the impact of both water flow disruption and morphological changes.

The implementation of the shortlisted measures is envisaged on six rivers and one lake.

TABLE 7. **A short list of measures to improve the morphological status**

River	Amalgamated Territorial Community, village/town, region	Action item	Expected quality results
the Kazenyi Torets	Druzhkivka municipal community, Druzhkivka, Donetsk region	Elimination of three accident-prone dams	Restoration of the free flow of the Kazenyi Torets river, restoration of continuity of environments and sediment transport, increased riverbed capacity in the dam section, river revitalization
	Sloviansk municipal territorial community, Slovyansk, Donetsk region		
the Sukhyi Torets	Cherkasy Town Council, Cherkaske, Donetsk region	Clearing the riverbed	Clearing the river, improving the morphological characteristics of the riverbed, increasing the riverbed capacity, improving the living conditions of aquatic organisms
	Semenivka Village Council, Semenivka, Kharkiv region		
the Yevsuh	Yevsuh Village Council, Yevsuh, Luhansk region	Re-meandering the riverbed	Restoration of morphological characteristics of the Yevsuh river, improvement of living conditions for fish, benthic invertebrates, higher aquatic vegetation, phytoplankton, river revitalization
the Bila	Bilokurakyne Town Council, Bilokurakyne, Luhansk region	Elimination of the drainage system's regulating gates	Restoration of the free flow of the Bila river, improvement of the riverbed morphological characteristics, increasing the riverbed flow capacity, river revitalization
the Aidar	Novopskov Town Community, Rybiantsevo, Luhansk region	Clearing the riverbed	Clearing the river, improving the morphological characteristics of the riverbed, increasing the riverbed capacity, improving the living conditions of aquatic organisms
lake Male Kriachkovate	Slobozhanske Territorial Community, Donets, Kharkiv region	Lake revitalization	Restoration of the lake's morphological characteristics: water mirror area, volume, depth. Arrangement of rest and recreation areas for the population
the Babka	Staryi Saltiv Town Territorial Community, Fedorivka, Kharkiv region	Re-meandering the riverbed	Restoration of morphological characteristics of the Babka river, improvement of living conditions for fish, benthic invertebrates, higher aquatic vegetation, phytoplankton, river revitalization

GROUNDWATER STATUS

GROUNDWATER POLLUTION AND DEPLETION

The main measures include engineering and technical solutions aimed at eliminating the sources of groundwater pollution. Additional measures include legal, administrative, monitoring and other groundwater management tools, which are not related to construction and reconstruction.

The short list includes measures selected by criteria of feasibility of achieving groundwater status improvement, the magnitude of the impact from the measure (spreading the effect to several or more groundwater bodies), and the need for expeditious implementation of the measure.

Most of the proposed measures are recommended for inclusion in the regional environmental protection programmes which are supported through distribution of costs of the Regional Environmental Protection Fund.

The most efficient approach for overcoming diffuse groundwater pollution with nitrogen compounds and pesticides in absence of information is to implement pollution-prevention measures.

These measures should include restrictions on the use of fertilizers in the areas where the main aquifers used for drinking water supply are vulnerable to pollution with nitrogen compounds and pesticides. The proposed package of additional measures contains recommendations for prevention of diffuse groundwater pollution with nitrogen compounds and pesticides and relates to legal, monitoring and management tools.

The key measures to eliminate/reduce groundwater pollution from wastewater discharge included those that are primarily used for surface water bodies. The latter include reconstruction of treatment facilities and process equipment. Additional measures include setting stricter standards for indicators in permits for special water use, where an actual link between point sources and the existing groundwater pollution has been identified in the monitoring data.

The main measures to eliminate/reduce groundwater pollution from mine water discharges have been developed taking into account the expected significant effect (impact magnitude) due to improved status of both surface and groundwater as a result of their implementation – these are measures to develop the design specifications and the technical documentation for construction of mine water demineralization facilities.

Given the inevitability of environmental degradation due to uncontrolled mine flooding, the proposed key measures may be the only possible tool to reduce the impact of discharged highly mineralized mine water on the state of water resources. To reduce the impact of mine water discharges on groundwater pollution, the following additional measures can be considered: strengthening of environmental control at the operating mines and arrangements for additional control over the quality and volumes of mine water discharges.

The main measures to eliminate/reduce the integrated pollution of groundwater within the technological chains of enterprises include mainly elimination/conservation of relevant polluting facilities (or development of design specifications for their elimination/conservation). Additional measures are proposed to obtain the necessary and additional information on the status of groundwater within the impact range of the polluting facilities for further managerial decision-making.

Assessments of the existing groundwater monitoring system in the Don basin acutely demonstrate in some cases lack of primary hydrogeological information that would allow for adequate assessment of the groundwater chemical status and establishing a link between groundwater pollution and the relevant source of technological pressure.

Measures to create and maintain a permanent monitoring network within the impact range of the polluting facilities are included in both the short (priority) and the long lists of measures for the Kharkiv, the Luhansk, and the Donetsk regions.

The key measures to resolve the issues related to pollution (quality reduction) of drinking groundwater at water intakes include a review of the sanitary protection zones, developing an inventory of water intakes, and elimination of inactive water intakes. Additional ones emphasize the need to comply with the standards of Ukraine's current legislation in the field of protection and rational use of water resources, as well as drinking water.

The issues related to uncontrolled water use are proposed to be addressed through inventory-taking of the water intakes in the contact line zone, writing the groundwater reserves approved for these water intakes off the general state balance of minerals (groundwater), and liquidation/conservation of their wells; updating the projected groundwater resources, taking into account the groundwater current chemical status. Additional measures along these lines include strengthening of external environmental controls to identify unauthorized wells, informing of the public about the groundwater quality in the main operational aquifers, and carrying out awareness raising activities on administrative liabilities in the field of water management.

Due to lack of primary information on the status of groundwater (in terms of chemical composition and level) in the minefields and adjacent undisturbed areas, the key measures to overcome the issues related to uncontrolled mine flooding cannot be proposed for the first implementation cycle of the river basin management plan. Instead, the priority measure in the category of additional ones, which should be implemented expeditiously, is development and arrangement of a monitoring network, which should be accompanied by drilling of hydrogeological wells within the minefields in the Donetsk and the Luhansk regions, and ensuring continuous monitoring of the groundwater chemical status and regime.

The short list of measures in relation to groundwater includes eight measures within all three regions and several individual residential communities.

TABLE 8.

A short list of measures in relation to groundwater

Amalgamated Territorial Community, village/town, region	Action item	Business / implementing entity	Implementation dates, sources	Scope of funding
Donetsk region	Creation of a network of monitoring wells in the minefield area of the mines affected by mine flooding in non-government controlled areas	State Regional Geological Company "Donetskgeology"	Regional Environmental Protection Fund, international financial investments	1-10 mln UAH
	Establishing of a regional support network for monitoring the disturbed groundwater regime	Donetsk Region State Administration / State Regional Geological Company "Donetskgeology"	2025-2028: Regional Environmental Protection Fund	3.800 mln UAH
	Monitoring of the groundwater status		2025-2028: Funds of the monitoring subjects	9.130 mln UAH
Luhansk region		Luhansk Region State Administration / "Eastern State Regional Geological Company [Skhid DRGP]"	2025-2028: Regional Environmental Protection Fund	1.980 mln UAH

Amalgamated Territorial Community, village/town, region	Action item	Business / implementing entity	Implementation dates, sources	Scope of funding
Zolote, Hirske, Hirske Territorial Community, Luhansk region	Development of the design specifications for protection of the mine "Zolote" of SE "Pervomaisk-vuhillia" from flooding	Luhansk Region State Administration	2025-2028: Regional Environmental Protection Fund	1.480 mln UAH
Luhansk region	Measures for groundwater protection and elimination of its pollution sources, groundwater monitoring	Luhansk Region State Administration / "Eastern State Regional Geological Company [Skhid DRGP]"		1.480 mln UAH
Kharkiv region		State Regional Geological Enterprise	2021-2027: Regional Environmental Protection Fund	1-10 mln UAH
Kharkiv, Kharkiv region	Inventory of groundwater intakes in Kharkiv			1-10 mln UAH

OTHER ISSUES

CLIMATE CHANGES

The main measures for preventing adverse effects of climate changes include clearing riverbeds and reservoirs from excessive vegetation and silt within cities, drinking water intakes, recreation areas/ beaches, as well as other individual areas with mandatory preservation of the natural morphological characteristics of the riverbed and banks. Also, the main measures should include planting trees on the river banks (primarily within residential communities) to shade the water surface.

Additional measures include monitoring and additional studies in the Don basin to establish the impact of climate changes on the ecological and chemical status of water bodies; increasing the number of meteorological stations and the volume of the monitoring data on the air and soil temperature, precipitation, and other indicators; development of drought management plans (including ecological droughts); integration of data from the Hydrometeorological Service and agricultural farms; laying out of coastal protection belts within residential communities and prohibition of construction /plowing up there.

LITTERING WITH HOUSEHOLD WASTE

The main measures aimed at solving this issue include elimination of garbage dumps and landfills located within water protection zones and flood zones. Additional measures include arrangements by local authorities of services to remove household waste from the population of all the territorial communities; arrangements for separate collection of plastic, glass, and other secondary raw materials that can be processed; conducting regular information campaigns and public events on garbage collection.

INVASIVE SPECIES

According to the Convention on Biological Diversity, measures to mitigate the effects of invasions by alien species should be primarily preventive in nature, but effective control of invasion processes is usually not possible primarily due to lack of a biodiversity monitoring system. The measures proposed include elaboration (development) and adoption of the National Strategy for Invasive Alien Species Management in Ukraine until 2030 and the National Action Plan; conducting research to determine the list of invasive species, their distribution, impact on the ecosystem and monitoring them on a regular basis as part of state water monitoring; acquisition of special equipment for clearing water bodies, mechanical extraction of invasive plant species (for example, water lettuce) and their utilization.

MILITARY CONFLICT

The environmental consequences of the hostilities are pollution of surface and groundwater, land subsidence, air pollution, destruction of and damage to natural reserve fund facilities, forest fires, etc. The risk of water pollution consists both in destruction of hazardous facilities during shelling and explosions and in an uncontrolled condition when no one guards or operates them. There is no access to such facilities, many of them being in unsatisfactory condition already before 2014.

The key measures to reduce the negative effect of the hostilities are related to establishment of a rapid response system, minimization or prevention of the consequences of pollution of both surface and groundwater from non-government controlled areas.

Additional measures include inventory taking of all hazardous facilities, accidents at which can lead to pollution of rivers flowing from non-government controlled areas; establishment of new and maintenance of the existing automatic stations for recording pollution, as well as control of chemical parameters in all watercourses of the rivers flowing from non-government-controlled areas and the combat zone; it is also important to resume reporting on water use of the facilities located in the territory not controlled by the government of Ukraine.

7.

FUNDING OPPORTUNITIES

Financial support for the Programme of measures to improve the state of water resources in the Don river basin (Section 6 of the River Basin Management Plan) is one of the most challenging issues to implement. The scope of capital investments in recovery and protection of the basin's water resources is growing from year to year, but their share in relation to capital and current expenditures ranges between 4% and 9.5% in the Donetsk and between 2% and 7% in the Luhansk region. In Kharkiv region, the situation is slightly better, where investments ranged between 5% in 2015 and 17.6% in 2019. The dynamics of expenditures on maintenance of the state water complex does not allow the Siverskyi Donets Basin Administration of Water Resources to significantly increase expenditures on maintenance of the water infrastructure.

The payback of the costs associated with the water factor (recovery of water resources) in the Don basin in the 2019 estimates is at the level of 89%. This means that capital investments (including from the state and local budgets) are not fully covered by taxes and mandatory payments for the use of water resources, as provided for in Art. 9 of the EU Water Framework Directive.

TABLE 9. Balance of revenues and capital expenditures according to 2019 indicators in the Don river basin

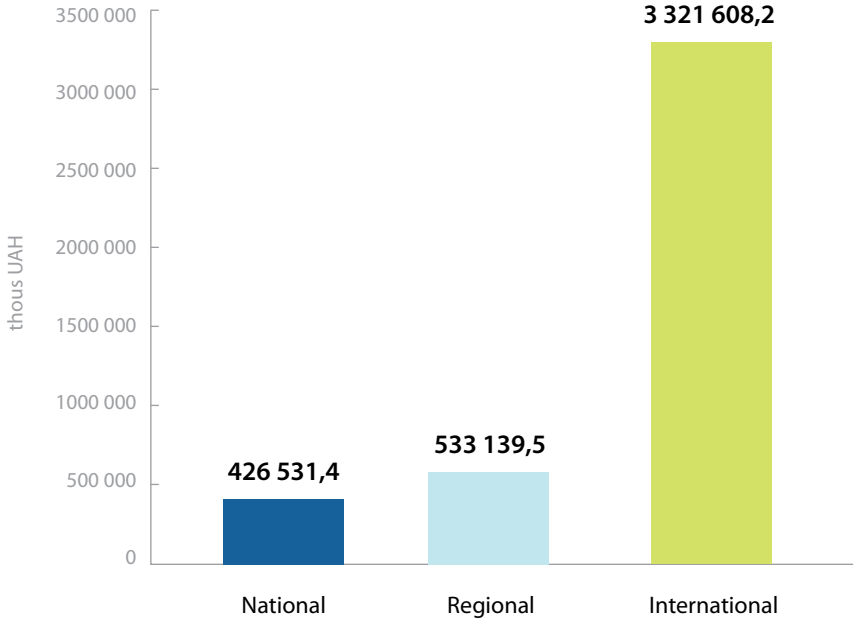
REVENUES	thous UAH	EXPENDITURES	thous UAH
Rental fee for special water use (state and local budgets)	119 847	Capital expenditures for recovery and protection of water resources (including from the state and local budgets)	121 890
Environmental tax for discharges into water bodies (state and local budgets)	18 065	Expenditures from the state budget for operation of the state water complex	42 732
Rental fee for water bodies (parts thereof) provided for use on lease terms (local budgets)	504		
Fee for special use of aquatic bioresources (local budgets)	367		
Total	**138 619**	**Total**	**164 622**

Taking into account that more than 50% (50.6% in 2017, 63.3% in 2018, and 68.1% in 2019) of the capital investment volume consists of the companies' own funds, the situation is obviously critical at 89% coverage level in 2019, when capital investments in recovery and protection of water resources cease to be covered by the companies' fiscal payments.

This level of covering the cost indicates an imbalance in the budgets of all levels. The gap between the financial needs and the opportunities is partially covered by national and regional target programmes, within which it is envisaged to finance a significant part of the measures for the Programme of measures to improve the state of water resources in the Don river basin.

FIGURE 29.

Funding sources of the actions aimed at improving the ecological status of the surface water in Don basin in 2019-2020



Source:
Ukrainian Hydrometeorological Institute (UHMI) / Osadcha N. et al., Overview of Programmes and Actions in the Siverskyi Donets Basin, materials for UNICEF, 2021.

Recent analysis of the implemented national, regional targeted programmes and international projects showed that the total scope of investment in the actions aimed at improving the environmental status of the Don basin surface water in 2019-2020 amounted to UAH 4 281 279.104 thousand. The dominant share of the cost, specifically 77.6% came from international loan programmes and international assistance. The share of the cost from regional environmental funds was 12.45%, whereas the smallest contribution comes from state programmes[37].

International investment and technical support continue to be important resources for development of Ukraine and its eastern region. Many international organizations have been working in the east of the country after the military conflict broke out. Due to the impact of the armed conflict and mass displacement of people within the country, a significant number of organizations began working to assist victims of the armed conflict, develop civil society in the conflict-affected regions, increase social cohesion and reconciliation, restore critical infrastructure, promote economic development, entrepreneurship and employment, etc.

Most international organizations working in the Donetsk and the Luhansk regions do not deal exclusively with environmental challenges, however environmental issues are to some extent addressed within other priorities and programmes.

Working with such organizations, finding new partners is a priority for state, local, production and non-profit organizations interested in full implementation of the Programme of measures and ultimately in improving the water resources of the Don basin

37 Osadcha N. et al., Overview of Programmes in the Siverskyi Donets Basin. Materials developed for the UNICEF Office in Ukraine. K., 2021.

TABLE 10.

International organizations that are actively involved in water and environmental issues of eastern Ukraine

International Development Banks	World Bank European Investment Bank
Other intergovernmental organizations	European Union UNDP United Nations International Children's Emergency Fund (UNICEF) Food and Agriculture Organization of the United Nations (FAO) OSCE
Bilateral assistance programmes	UK, USA, Finland, Switzerland, Sweden
Foundations and non-profit organizations	Clean Technology Foundation International Renaissance Foundation International Committee of the Red Cross ACTED "Environment People Law"

Sources: "Guardians of the Donbas Environment. The Role of NGOs in Addressing Environmental Issues of the Donetsk and the Luhansk regions", 2021; Environmental Trends in Ukraine: Citizens' View. Sociological Survey Report[38]; Materials of the Preliminary Report with an Overview of Nature Protection Programmes in Relation to Actions That Concern Water Resources; own analysis.

38 The search for international organizations engaged in addressing environmental issues in the Donbas was conducted by analyzing websites which publish announcements on donor programmes, grant contests, opportunities for NGOs and their activities, as well as during questionings and clarifying interviews with representatives of NGOs who participated in the study.

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39 Except for such sources as boxes, illustrations and tables. The text of the publication does not specify on purpose the use of the reports and project materials and other resources listed in this section.

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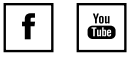

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