STATE OF THE SIVERSKYI DONETS BASIN AND RELATED RISKS UNDER MILITARY OPERATIONS

Technical report

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

Ministry of Ecology and Natural Resources of Ukraine

Contents

LIST OF ABREVIATIONS

CD	Central Donbas
CM	Communal enterprise
EU	European Union
GCA	Government controlled areas
LLC	Limited Liability Company
MAC	Maximum Allowable Concentration
Minecology	Ministry of Ecology and Natural Resources of Ukraine
NGCA	Non-government controlled areas
OJSC	Open Joint Stock Company
OSCE	Organization for Security and Co-operation in Europe
PJSC	Private joint stock company
PSGS	Public Service of Geology and Subsoil
RPE	Research and production enterprise
SD BAWR	Siverskiy Donets Basin Administration of Water Resources
SE	State Enterprise
SESU	State Emergency Service of Ukraine
SWB	Surface water bodies
TPP	Thermal power plant
WPI	Water pollution index

INTRODUCTION

In November 2017, the OSCE Project Co-ordinator in Ukraine presented an overview of the environmental issues and priorities for environmental recovery in eastern Ukraine[1]. The short-term follow-up actions recommended by the survey included, among others:

- Systematize the available data about the environmental situation and environmental hazard sources in the conflict-affected area; arrange for broad dissemination of the respective data and free access to them;
- Take an inventory of information gaps on the environmental situation and environmental hazard sources in the conflict-affected area; arrange for targeted studies to fill those gaps;
- Arrange for unimpeded access to existing information about the environmental situation and natural resources in the Donetsk and Luhansk Regions;
- Regular refinement and update of information on the industrial and municipal facilities that have already become, or hold the potential to become, major sources of environmental hazard as a result of the hostilities;
- Restore, expand, and automate monitoring on pollution control, and environmental reporting in the said area;
- Respond to the impact resulting from the altered flow and deterioration in the quality of mine waters; modernize the principles and practices of mine operation, decommissioning and rehabilitation;
- Modernize the use and protection of the region's surface waters based on the river basin approach considering international experience.

[1] OSCE Project Co-ordinator in Ukraine, 2017

In 2018, the OSCE Project Co-ordinator in Ukraine developed and implemented a project "Assisting the Ministry of Ecology and Natural Resources of Ukraine in Improving Environmental Monitoring Mechanisms". The main objective of the project was to lay the basis for the Siverskyi Donets River Basin Management Plan within the Kharkiv, Luhansk, and Donetsk Regions in accordance with the requirements of the new legislation of Ukraine in the field of protection and use of water resources, as well as requirements of the EU Directive "Establishing a Framework for the Community Action in the Field of Water Policy" (2000/60/EU). Following up on the 2017 recommendations, an important part of the project was to study further the surface and groundwater status, the existing and potential sources of their pollution and improve monitoring system in the conflict-affected area in eastern Ukraine, including non-government controlled areas (NGCA).

This review summarizes the results of the studies and provides newer field and analytical data to state authorities and general public, results of the expert analysis of the situation, and outlines areas for further activities.

The review was prepared by Mr. N. Denisov ("Zoï" Environment Network, Switzerland) based on the project results obtained in 2018. The preparation of the survey, inter alia, used materials and evaluations by Ms. K. Boyko (State Information Geological Fund of Ukraine), Ms. N. Bilotserkivska and Ms. I. Sydorenko (Siverskyi-Donets Basin Administration of Water Resources), Mr. V. Yermakov, Mr. O. Ulytskyi and Ms. O. Luniova (Research Institute of Ecological Safety and Management of the State Ecological Academy of Postgraduate Education and Management), Ms. O. Koshlyakova (Institute of Geology), Mr. Yu. Nabyvanets and Ms. N. Osadcha (Ukrainian Hydrometeorological Institute), Mr. E. Osiyskyi (Basin Administration of Water Resources of the Tysa River), Ms. M. SKobley, Mr. O. Yaroshevych, as well as State Regional Geological Company "Vostok" and the State Regional Geological Company "Donetskgeology" of the Public Service of Geology and Subsoil of Ukraine, and Institute of Environmental Protection of the Slovak Republic. Comments and consultations were prepared by Mr. D. Averin.

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BASIN, WATER USE AND CHANGES OVER THE PERIOD OF HOSTILITIES

The Siverskyi Donets river basin in Ukraine (Fig. 1.1) accounts for 55% of the total catchment area, has an extensive hydrographic network of 290 rivers that stretch over 10 km 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 Siverskyi Donets river 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 rivers Udy (Kharkiv Region), Kazennyi and Kryvyi Torets, Bakhmutka (Donetsk Region), Verkhnya Bilenka and Luhan (Luhansk Region).

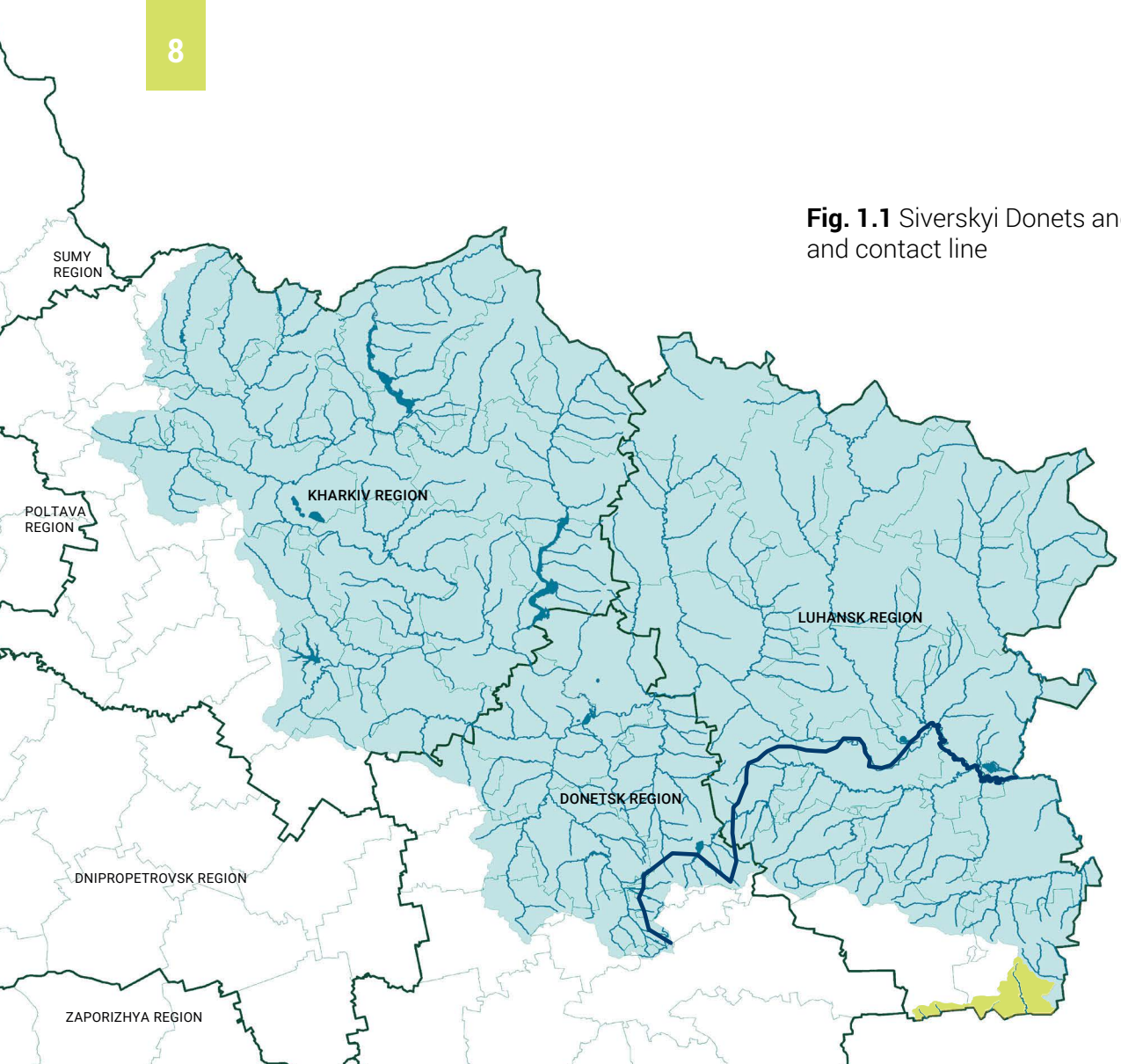


Fig. 1.1 Siverskyi Donets and Lower Don river basins and contact line

Table 1.1 Changes in the Siverskyi Donets river basin territory due to hostilities

	2013	2014	
		GCA	NGCA
The Siverskyi Donets in Ukraine	Bed length 723 km Catchment area 54.8 thous km^2	Bed length 539 km 47.5 thous km^2 (87%) of the catchment area with the Kharkiv Region	Bed length 184 km 7.3 thous km^2 (13%) of the catchment area
including in the Donetsk Region	Bed length 95 km Catchment area 8.01 thous km^2	Bed length without changes Catchment area 7.5 thous km^2 (95%)	Outlet of the Kryvyi Torets, outlet of the Bakhmutka (12 km) within the limits of Horlivka, the Karapulka with the Luhansk Reservoir
including in the Luhansk Region	Bed length 253 km Catchment area 25 thous km^2	Bed length 69 km Catchment area 18 thous km^2 (73%), including the catchment of the left tributaries (the Aydar, the Yevsuh, the Tepla, the Verkhnye-Olkhova, the Derkul), which flow into the Siv. The Donets in the NGCA	The bed length down of the Svitlychansk catchment to the border is 184 km Right tributaries with a total catchment area of 7 thous km^2: the Luhan (299 km), the Luhanchyk (289 km), the Velyka Kamyanka (214 km)*, the Kundryucha (18 km)*

* Discharge in the territory of the Russian Federation

From the second half of 2014, the territory of the Siverskyi Donets river basin has undergone changes in the Donetsk and Luhansk Regions (Table 1.1). In general, 87% of the catchment area, or 47.5 thousand km^2, and 539 km of the river bed with a total length of 723 km remain in the GCA, including unchanged territories in the Kharkiv Region. The boundaries of the Siverskyi Donets river basin in the Donetsk Region are in the territory of the Lyman, Slovyansk, Kostyantynivka, Bakhmut, Yasynuvata, Pokrovsk, Dobropillya, Oleksandrivka Districts, as well as towns of Horlivka, Avdiyivka, Toretsk in the Donetsk Region.

Avdiyivka, Toretsk, Horlivka and part of the Yasynuvata, Bakhmut districts in the Kryvyi Torets and the Bakhmutka (Bakhmut) river basins are located in the NGCA or are in the so-called "gray" zone on the combat line and directly in the combat area. From a hydrographical point of view, the area of hostilities and and the NGCA, host a watershed between the Siverskyi Donets river basin and the Pryazovya rivers, which forms the surface flow of the Siverskyi Donets (river outlets, numerous ravines) in the Donetsk Region and determines the direction of pollution distribution in the event of possible (unpredictable) damage to the engineering infrastructure on the contact line both in the GCA and the NGCA.

Due to the agreed management decisions of the Interagency Basin Commissions (Siverskyi Donets Basin Administration of Water Resources (SDBAWR), State Emergency Service, executive bodies, water users) regarding flow distribution, establishment of optimal operation modes of the balancing reservoirs and water management systems, water resources coming from the GCA along the Siverskyi Donets are characterized by stable quality, as well as surface flow volumes sufficient to maintain the required water levels and stable operation of the river channel water intakes, including the NGCA in the Luhansk Region. In the GCA, the main volume of water to the population and branches of economy is supplied through 28 multi-purpose reservoirs, for which the operation modes were established at a total volume of 1,756.87 mln m^3 (according to 2017 data). In total, control is exercised over 16 reservoirs totaling 1,122.35 mln m^3, including 10 totaling 899.3 mln m^3 in the Kharkiv Region and 6 totaling 223.05 mln m^3 in the Donetsk Region. Due

to the hostilities, starting the second half of 2014, the operation modes of the reservoirs in the Luhansk Region have not been established.

According to the state water use inventory data based on the "2TP-vodohosp" template, in 2013 the water resources in the Siverskyi Donets river basin were consumed by 2,242 water users, including 1,055 in the Donetsk Region and 581 in the Luhansk Region, which accounts for 73% of their total quantity in the basin. The total intake volume was 1,471 mln m^3, including 1,095.2 mln m^3 intaken in the Donetsk and Luhansk Regions, which is 74% of the total basin catchment. Independent intake from the SWB was done by 279 water users, including the fish industry (177 non-abstractive water users), including Donetsk – 251 (of which 172 in the fish industry), Luhansk – 28 (of which 5 in the fish industry). The main volume of surface water – 657.4 mln m^3 – was intaken from the Siverskyi Donets, of which 86% was intaken by enterprises of the "housing and communal services" sector.

According to the state water use inventory, in 2017 in the Siverskyi Donets river basin, reports were submitted by 1,233 water users, including 487 in the Donetsk Region (a more than double shrinking over 2013), in the Luhansk Region – 177 (a more than triple shrinking). The water intake in the Donetsk Region showed almost no decrease in 2017 compared to 2013 due to the fact that the main water user in the Region – CE "Donbas Water" – intakes water in the GCA, with 95% of the Siverskyi Donets basin territory remaining within the Region boundaries. In the Luhansk Region, the volume was reduced 5 times due to the fact that 27% of the Siverskyi Donets Basin area remained in the NGCA, where water was intensively used (basins the Luhan, the Velyka Kamyanka, the Kundryucha, as well as the river bed of the Siverskyi Donets down of Svitlychne village).

In 2013, water was returned to the SWB of the Siverskyi Donets in the Donetsk and Luhansk Regions by 195 water users in the volume of 329.9 mln m^3 (49% of the total return in the basin), including polluted – 182 mln m^3 (94% of polluted return in the basin). The largest volume of discharge was to the SWB of the Luhan (35%), the Kazennyi Torets (27%), the Siverskyi Donets (20%) and the Velyka Kamyanka rivers (9%) by

enterprises of the coal, chemical and petrochemical industry, machine building, housing and communal services. The main volume (59%) of polluted return water was discharged by 66 enterprises of the coal industry sector, 54% of which were in the Luhan river basin, 22% in the Kazennyi Torets river basin.

In 2017, reports on discharge of return water were submitted by 91 water users, 63 of which in the Donetsk Region (at almost 1.5 time decrease), 28 in the Luhansk Region (a 3.7 time decrease). Some of the economic entities located both in the GCA and NGCA did not submit reports on water disposal (23 – Donetsk Region, 82 – Luhansk Region).

Due to a reduced number of reporting enterprises, the volume of inventoried wastewater discharges has also dropped (Table 1.2):

- in the Kazennyi Torets river basin – from 88.9 to 86.9 mln m^3, including in the Kryvyi Torets river basin exceeding 2 times – from 44.1 to 21.9 mln m^3 due to the mines of Horlivka, of which now (according to unofficial sources) Yu. O. Gagarin Mine is not operating. Along the Kazennyi Torets river bed, the wastewater discharge has increased due to grown discharges from Kramatorsk Ferroalloy Plant LLC (40 km, the Kazennyi Torets) compared to 2013 by 23.8 mln m^3;

- in the Bakhmutka river basin – from 6.4 to 3.9 mln m^3, mainly due to Kalinin Mine, which is not operating now (similarly);

- in the Luhan river basin – from 116.8 to 8 mln m^3; the number of reporting companies has decreased from 63 to 5, of which the main volume of discharges were by Zolote Mine of the State Enterprise (SE) “Pervomaisk Coal” and Vuhlehirska TPP of PJSC “Centrenergo”.

Thus, according to the 2017 data, it is not possible to reliably assess the situation in the Siverskyi Donets river basin in relation to the man-induced load associated with water intake and discharge of pollutants into SWB. It is especially difficult to perform such an assessment for the NGCA.

Table 1.2 Submittal of state reporting by water users in the Donetsk and Luhansk Regions and official inventory of surface water intake and wastewater discharge volumes in the Siverskyi Donets river basin

	Surface water intake		Wastewater discharge	
	2013	**2017**	**2013**	**2017**
Donetsk Region	1055 reports (629.8 mln m^3)	487 reports (591.2 mln m^3)	92 reports (111.9 mln m^3)	63 reports (105.1 mln m^3)
Luhansk Region	581 reports (121.8 mln m^3)	177 reports (36.6 mln m^3)	103 reports (215 mln m^3)	28 reports (41.5 mln m^3)

ASSESSMENT OF WATER BODIES IN THE NON-GOVERNMENT CONTROLLED AREAS

The analysis of the monitoring data and the water management balance of the Kazennyi Torets, the Kryvyi Torets and the Bakhmutka (Bakhmut) from 2013 to 2017 allows an assumption that the water resources are used by the economic entities in the NGCA in the basins of these rivers almost in the volumes of 2013. According to open and unofficial sources, in the Kryvyi Torets river basin in the NGCA, the following economic entities continue their economic and production activities and discharge return water (wastewater) to the Siverskyi Donets river basin: OJSC "Yasynovskyi Coke Plant" (Makiyivka), SE "2-BIS Mine", PJSC "Panteleimonivskyi Refractory Plant", PJSC "Elastomer", KPZ TV "Vuhlyk", JV "V. I. Lenin Mine". Information on the water users in the Luhansk Region, located in the NGCA, which discharged wastewater into the Siverskyi Donets river basin in 2017, is practically absent.

In absence of systematic statistics, the impact can be assessed and the changes can be tracked only approximately using general information on the pollution sources in the NGCA (Annex 1), available incomplete data on the water use for 2013 and 2017, monitoring data for 2013-2017, and additional analytical information. According to the assessment performed within the framework of preparation of the Siverskyi Donets River Basin Management Plan (Table 1.3, Annex 2), a significant part of the Siverskyi Donets river basin in the NGCA (all rivers by ecological and 5 by chemical criteria) and their homogeneous sites – SWB (all SWB by environmental and 7 SWB by chemical criteria) – remain in the risk zone or possibly risk to fail achieving good ecological and chemical conditions. However, it is impossible to objectively assess the impact of changes on the surface water body status in the NGCA in 2017 due to a partial or complete lack of data on the use of water resources, although the enterprises in these territories may still be operating[2].

[2] In addition, the comparison of the risk assessments of failure to achieve a good chemical status is quite controversial. Since 2016, in connection with the new "Procedure for State Accounting of Water Use", approved by the Minecology as of 16.03.2015, No. 78, the

Currently, flooding of coal mines has been occurring in the NGCA of the Donbas (see "Underground Waters" section), whereas uncontrolled makeshift coal mines are being set up, and municipal wastewater treatment facilities, water supply, sewage networks, hydrotechnical structures (flood protection dams, water management systems) and other infrastructure facilities are becoming inoperable. The achievement of the good ecological and chemical status of the Siverskyi Donets river basin waters is possible only with implementation of cardinal environmental measures throughout several cycles of the river basin management planning and might take several decades. The sources of risk also include uncontrolled discharges of the return (waste) water by enterprises and agglomerations (including due to malfunction of treatment facilities and emergencies), the risk of possible human-made accidents along the combat line (see section Hazard and Predicted Consequences of Accidents) and unpredictable consequences of the hostilities.

Table 1.3 Results of the expert assessment of the main human-induced loads and their impact on the status of the rivers in the S. Donets river basin located in the NGCA

Color coding in the Table:
Risks of meeting good

ecological status	chemical status
predominantly under risk (3)	predominantly under risk (2)
intermediate status	intermediate status
predominantly, possibly, under risk (2)	predominantly witahout risk (1)

"2 TP Vodhosp" (annual) report does not show any pollutants in the unused discharges of mine and quarry waters; accordingly, the category of water quality is not determined. Until 2016, the mine and quarry waters were classified as polluted.

River	Ecological status / potential		Chemical status		Changes in the ecological / chemical status
	2013	2017	2013	2017	
Siverskyi Donets	3	3	2	2	= / =
Kryvyi Torets	3	3	2	1-2	= / <
B. Zalizna	3	2-3	2	1-2	< / <
Zalizna	3	3	2	1	= / <<
Ocheretova	3	2	2	1	<< / <<
Kazennyi Torets	3	3	2	2	= / =
Bakhmutka (Bakhmut)	3	3	1-2	1	= / <
Luhanka	3	3	1-2	1-2	= / <<
Olkhivka	3	3	1-2	1	= / <<
Vasyukova	3	3	1-2	1	= / <<
Bila	3	3	1-2	1	= / <<
Dovha	3	3	1-2	1	= / <<
Chernushyna	3	2-3	1-2	1	< / <
Lozova	3	3	1-2	1	= / <<

B. Komyshuvakha	3	3	1-2	1	= / <<
Komyshuvakha	2-3	2-3	1-2	1-2	= / >
Lomovatka	3	3	1-2	1	= / <
Karapulka	2-3	2-3	1-2	1	< / <
Luhanchyk	3	3	1-2	1	= / <<
C. Kamyanka	3	3	1-2	1	= / <
M. Kamyanka	3	3	2	1	= / <<
Kundryucha	3	3	1-2	1	= / <
C. Burhustka	2-3	2	1-2	1	< / <
B. Talova	3	2-3	1-2	1	<< / <<
C. Provallya	2-3	2	1-2	1	<< / <
Dovzhyk	2-3	2-3	1-2	1	= / <
Medvizhka	2-3	2-3	1-2	1	= / <

The numbers (1-2-3) correspond to the status of the SWB marked for the river / along its stretch.

<< significantly improved = without changes

< improved > deteriorated

Notes:

All areas of water bodies, shown in the table, were obtained based on the impact analysis, are located in the NGCA (see Annexes). The status assessment in 2017 was carried out using the expert assessment method based on the available data. It is impossible to perform a reliable assessment due to partial or complete lack of reliable data on the use of water resources in the NGCA.

The assessment of the man-induced load from diffuse pollution sources and hydromorphological changes is taken into account through the results of the report “Analysis of the Main Man-Induced Loads and Their Impacts in the Siverskyi Donets River Basin Area”.

The assessment of changes in the risk of failure to achieve a good chemical status is quite controversial. Since 2016, in connection with the “Procedure for State Accounting of Water Use”, approved by the Minecology as of 16.03.2015, No. 78, the “2 TP Vodhosp” (annual) report does not show any pollutants in the unused discharges of mine and quarry waters. Until 2016, the mine and quarry waters were classified as polluted.

Table 1.4 Changes in the human-induced impact on the surface waters in the NGCA between 2013 and 2017

	Ecological status		Chemical status	
Risk of failure to achieve a good ecological and chemical statuses				
	2013	**2017**	**2013**	**2017**
Under risk	25 rivers / 78 SWB	21 rivers / 70 SWB	16 rivers / 42 SWB	4 rivers / 7 SWB
Intermediate status	2 rivers / –	1 river / –	5 rivers /	1 river / –
Possibly under risk	- / –10 SWB	5 rivers / 18 SWB		
Without risk			6 rivers / 46 SWB	22 rivers / 81 SWB
Changes between 2013 and 2017				
Improved	7 rivers / 8 SWB		24 rivers / 36 SWB	
Remained unchanged	20 rivers / 80 SWB		2 rivers / 51 SWB	
Deteriorated	-		1 river / 1 surface water body	

Note: Surface water body is a body (uniform areas) of surface waters identified by the requirements of the EU Directive "Establishing a Framework for the Community Action in the Field of Water Policy" (2000/60/EU). For rivers in general, the estimate is based on the comparison of the status of its individual stretches (identified SWB).

SURFACE WATER STATUS AND ITS CHANGES BASED ON THE MONITORING DATA

Prior to the beginning of hostilities in eastern Ukraine in 2014, the monitoring of the Siverskyi Donets basin waters (Fig. 1.2, Table 1.5) was conducted by the Siverskyi-Donets Basin Administration of Water Resources (SDBAWR) laboratory at 66 posts (including 13 in the Donetsk Region and 24 in the Luhansk Region), located on the rivers: Siverskyi Donets, Vovcha, Tetliha, Bereka, Udy, Oskil, Kazennyi and Kryvyi Torets, Bakhmutka (Bakhmut), Kundryucha, Velyka Kamyanka, Derkul, Luhan, Yevsuh, Aydar, Lower and Upper Bilenka[3]. Since escalation of military activities in 2014, the number of posts has been reduced to 41, of which 7 are cross-border (6 at the "inlet" in Ukraine and 1 at the "outlet" of the NGCA in the Luhansk Region). It is extremely difficult and practically impossible to trace the situation in the area of hostilities within the Luhansk Region, as most of the monitoring posts are currently not operating (the Luhan, the Luhanchyk, the Velyka Kamyanka, the Kundryucha).

Since Quarter IV of 2014, no monitoring has been carried out at three posts adjacent to the Rostov Region in the Siverskyi Donets river basin in the Luhansk Region: the Siverskyi Donets (Popivka village), the Kundryucha (Dovzhanskyi Reservoir) and the Velyka Kamyanka River (Herasymivka village)[4].

In 2018, monitoring of the surface waters in the Siverskyi Donets river basin was carried out at 41 posts (since 2017, 1 station was commissioned on the Bakhmutka River – 55 km, above the town of Bakhmut; however, 1 station was closed along the Siverskyi Donets river bed), including 11 in the Donetsk Region territory (10 in 2017) and 6 in the Luhansk Region. Thus, the number of the monitoring posts compared with 2013 reduced by 25, including 18 posts, reduced due to hostilities.

[3] In addition to the SDBAWR monitoring, the basin also has operating monitoring posts of the State Emergency Service of Ukraine (see, e. g., OSCE 2017).

[4] For the same reason it is impossible to carry out the status analysis of the S. Donets right tributaries in the Luhansk Region located down of Svitlychne village (406 km), including at the border station with the RF.

Table 1.5 SDBAWR water quality monitoring posts

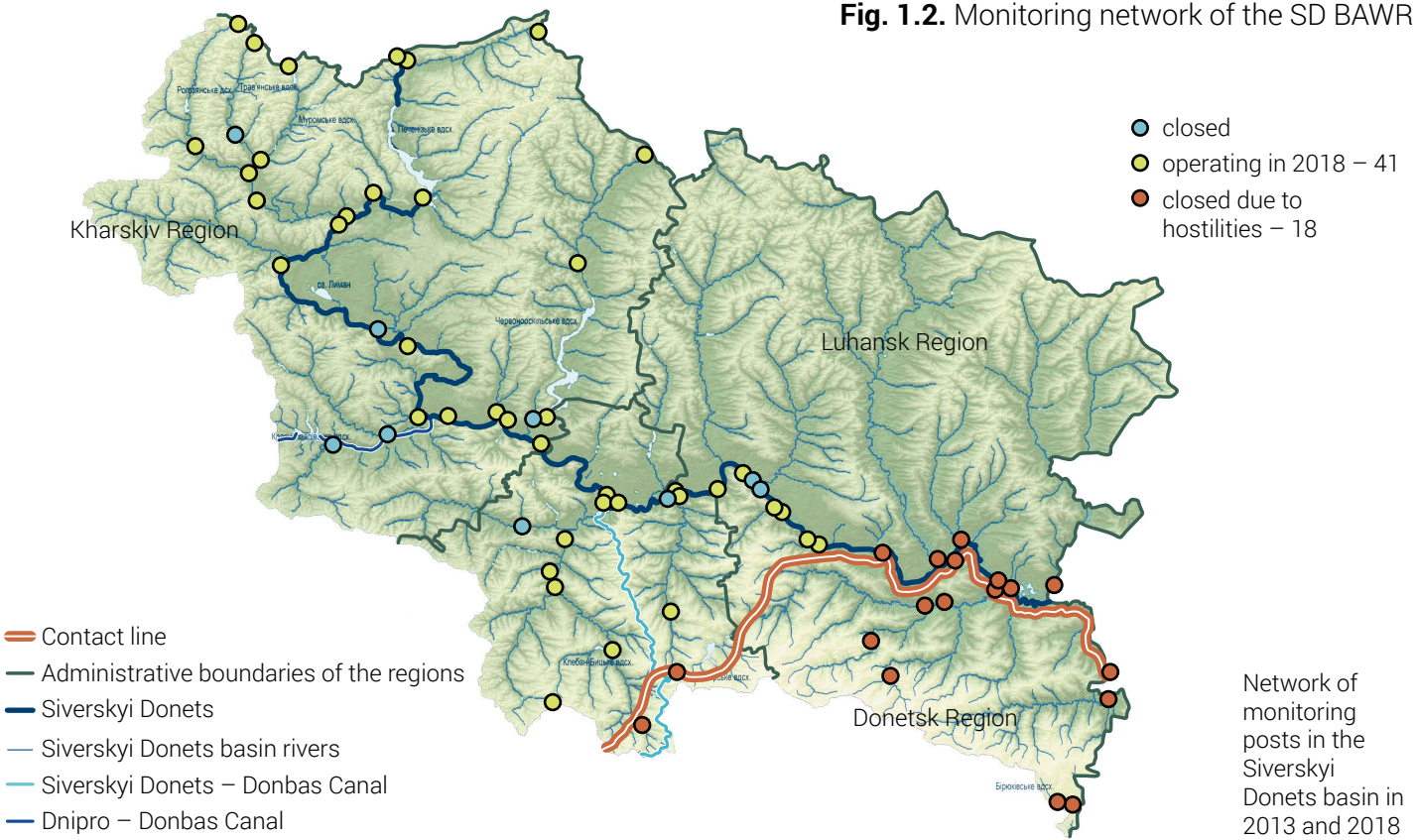
	2013	2015	2018
Donetsk Region	13	11	11
Luhansk Region	24	6	6
TOTAL in the river basin	66	41	41

The quality and quantity of water resources coming from the GCA along the Siverskyi Donets are characterized by stable quality, as well as flow volumes sufficient to maintain the required water levels and stable operation of the river channel water intakes, including in the NGCA. This is ensured by adoption of the SD BAWR coordinated management decisions on flow distribution and establishment of optimal operation modes of the balancing reservoirs and water management systems in the territories located above in the Kharkiv and Donetsk Regions.

The express analysis of the available monitoring data for the Siverskyi Donets basin waters for 2013-2017 confirmed the earlier conclusions[5] that the concentration of the key indicators at all the monitoring posts of the Siverskyi Donets water course and in the mouths of the main tributaries fluctuated within 5-10%

[5] OSCE Project Co-ordinator in Ukraine, 2017

Fig. 1.2. Monitoring network of the SD BAWR



Network of monitoring posts in the Siverskyi Donets basin in 2013 and 2018

of the long-term annual average values depending on the water content period. High natural content of salt parameters is observed in the Siverskyi Donets down of the confluence of the Oskil. The increased content of organic matter is traditionally recorded in the Udy and the Lopan rivers due to discharge of wastewater from the CE "Kharkivvodokanal". Every year, the nitrogen concentration of ammonia nitrogen and orthophosphates in the Udy river gradually increases, which adversely impacts a growing concentration of these biogenic substances in the Siverskyi Donets. High natural concentration of salt indicators is observed in the Siverskyi Donets down of the confluence of the Kazennyi Torets and the Bakhmutka rivers.

In the past three years, the concentration of dangerous synthetic and non-synthetic pollutants in most of the Siverskyi Donets river basin monitoring posts is below the long-term average annual values. In particular, in 2017, the SDBAWR laboratory did not reveal certain hazardous pollutants in the surface waters at the monitoring posts, such as mercury and phenols. There is a steady tendency for dependence of the concentration of dangerous pollutants (nickel, cadmium, lead) in the Siverskyi Donets on the influx of tributaries – directly down of the Udy, the Kazennyi Torets and the Bakhmutka rivers[6].

[6] It is worth noting that the available information on water pollution with synthetic and non-synthetic pollutants of the S. Donets river basin area is very limited, and the list of measured parameters includes only metals (nickel, cadmium, mercury, lead) included in the Minecology Order of 06.02.2017, No. 45 "On approval of the List of pollutants for determination of the chemical status of the surface water and groundwater bodies and the environmental potential of an artificial or substantially altered surface water body".

Fig. 1.3. Monitoring data of the SD BAWR in 2013

Quality class per Water Pollution Index in the Siverskyi Donets basin in 2013

Fig. 1.4. Monitoring data of the SD BAWR in 2018

Table 1.6 Data of the state monitoring of water at the posts of the Kazennyi Torets, the Kryvyi Torets, the Bakhmutka river basins and down of their confluence along the Siverskyi Donets river bed (2017-2018)

Substance	Shares of the Maximum Allowable Concentration (MAC)						
	Kazennyi Torets	Kryvyi Torets	Bakhmutka	The Siverskyi Donets down of the Kazennyi Torets confluence	The Siverskyi Donets down of the Bakhmutka confluence	The Siverskyi Donets, drinking water intake for the Luhansk Region	The Siverskyi Donets down of Lysychansk
Ammoniumnitrogen	2.2-2.8	2.8	0.6-1.7	1	1.1	0.7	0.95
Aluminum	0.9-1.3	0.8	0.9-1.1	0.7	0.8	0.8	1
Biochemical Oxygen Demand (BOD5)	1.5-2.2	2.2	2.1-2.2	1.9	1.9	1.6	1.9
Total iron	1.8-2.3	2.1	2-2.1	1.3	1.6	1.05	1.9
Cobalt	0.9-1.2	1.2	1.1-1.3	1	1	0.7	0.9
Manganese	4.5-11	4.3	7.1-9.4	4.6	5.9	3.7	3.7
Copper	3.7-4.3	3.8	4.2-4.5	3.2	3.3	2.3	2.4
Petroleum products	0.9-2.7	2.4	0.9-1.3	0.8	0.8	0	0
Nitrites	1.1-5.2	5.2	3.7	1.4	1.6	1.34	1.8
Sulfates	7-16.7	7.6	9.4-10	3.7	3.9	3.9	4.1

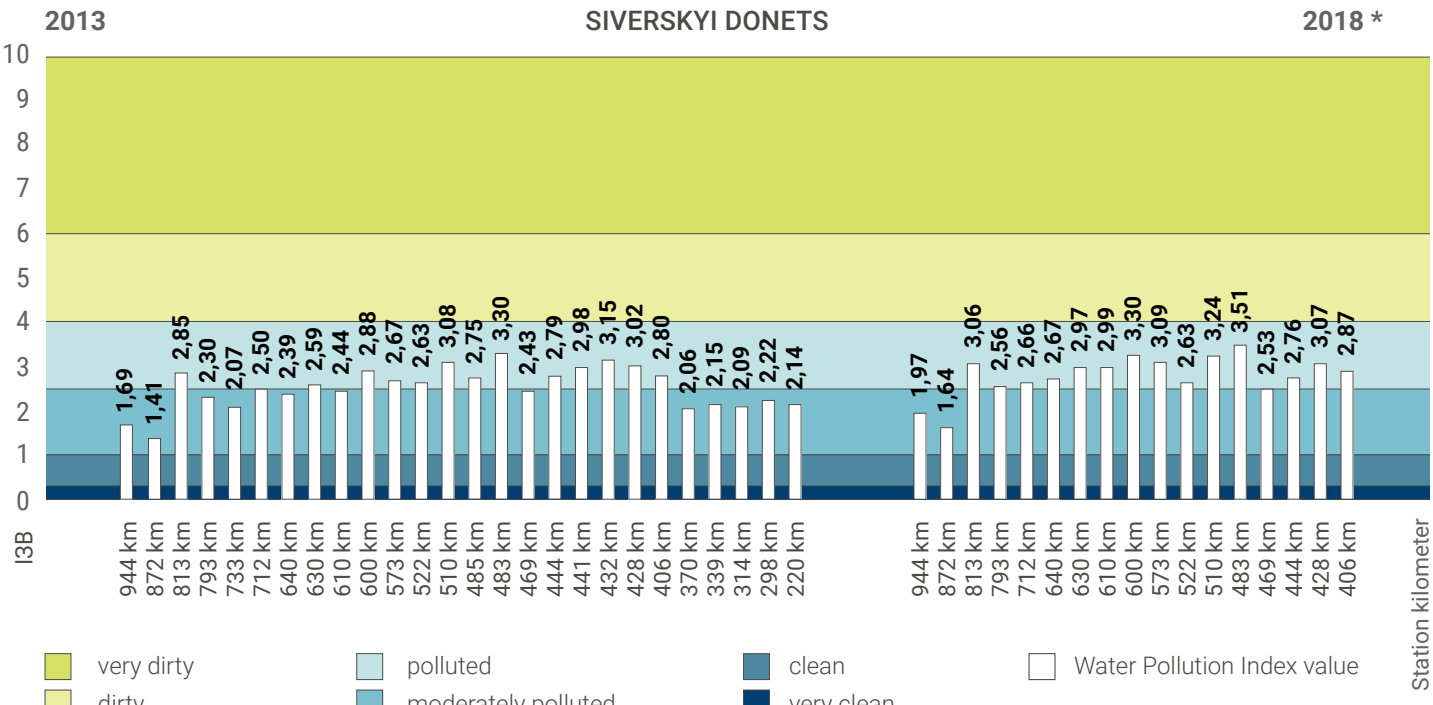
Chromium (VI)	4.3-7.5	6.4	6-6.9	5.5	5.7	3.2	5.7
Zinc	2.1-2.5	2.4	2.1-2.5	2	2.2	0.8	2.1
Lead	0.22-0.33	0.3	0.34-0.45	0.25	0.29	0.26	0.34

According to the analysis of the monitoring data (Table 1.6) at the monitoring posts located down of the area of hostilities (the Kazennyi Torets, 134 km, Hrodivka village), the Kryvyi Torets (1 km, Karlivska dam), the Bakhmutka River (2 km, Dronivka village), the S. Donets (428 km, down of Lysychansk), the S. Donets (406 km, Svitlychne village), the Upper Bilenka (1 km, Lysychansk), the Lower Bilenka (1 km, Nyzhnye village), the concentration of salt, organic, biogenic and hazardous synthetic and non-synthetic pollutants (metals) were at the level of long-term annual average values for these watercourses. Thus, by comparing the monitoring data for the last five years with a milestone of 2013, there are no clear and consistent trends towards deterioration of the surface water status of the Kazennyi Torets, the Kryvyi Torets, and the Bakhmutka rivers.

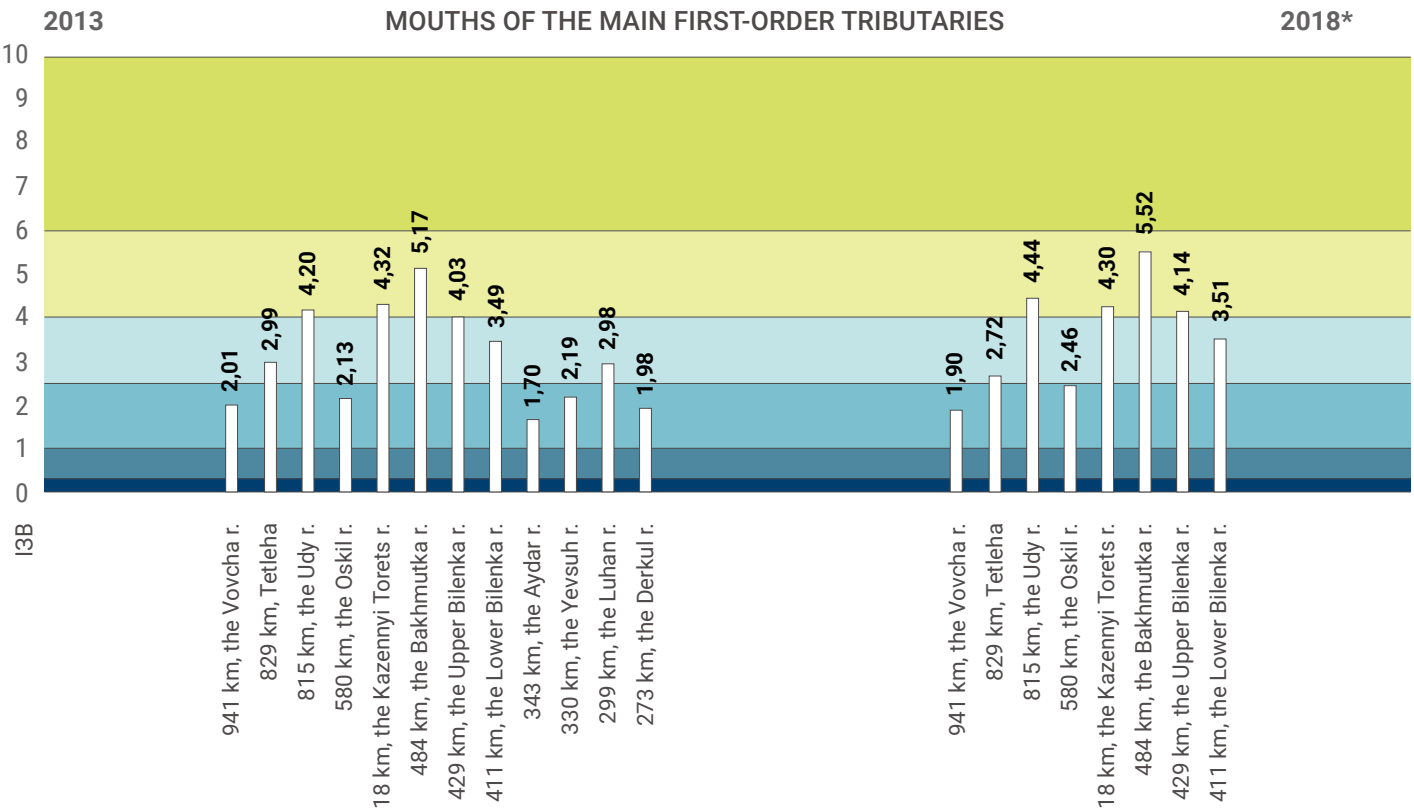
According to the monitoring studies over nine months of 2018 (Fig. 1.3-1.5), the concentration of pollutants in the SWB of the Siverskyi Donets river basin also fluctuated within the long-term annual average values without a tendency to deterioration. The quality class along the Siverskyi Donets watercourse and the mouths of the main tributaries was within the limits of 2013, there is a slight fluctuation within the values of the corresponding class.

In 2018, the OSCE Project Co-ordinator in Ukraine's project "Assisting the Ministry of Ecology and Natural Resources of Ukraine in Improving Environmental Monitoring Mechanisms", conducted field studies on the Siverskyi Donets and its tributaries (the Udy, the Oskil, the Kazennyi Torets, the Kryvyi Torets, and the Bakhmutka). Surface water samples were taken and analyzed by the SDBAWR laboratories and the Institute of Environmental Protection (Slovak Republic). In addition, samples of sediments from the said rivers were analyzed by the Institute of Environmental Protection.

Fig. 1.5 Comprehensive assessment based on the of Water Pollution Index (WPI)



* 9 months of 2018


2013
MOUTHS OF THE MAIN FIRST-ORDER TRIBUTARIES
2018*
10
9
8
7
6
5
4
3
2
1
0
ІЗВ
2,01
2,99
4,20
2,13
4,32
5,17
4,03
3,49
1,70
2,19
2,98
1,98
1,90
2,72
4,44
2,46
4,30
5,52
4,14
3,51
941 km, the Vovcha r.
829 km, Tetleha
815 km, the Udy r.
580 km, the Oskil r.
518 km, the Kazennyi Torets r.
484 km, the Bakhmutka r.
429 km, the Upper Bilenka r.
411 km, the Lower Bilenka r.
343 km, the Aydar r.
330 km, the Yevsuh r.
299 km, the Luhan r.
273 km, the Derkul r.
941 km, the Vovcha r.
829 km, Tetleha
815 km, the Udy r.
580 km, the Oskil r.
518 km, the Kazennyi Torets r.
484 km, the Bakhmutka r.
429 km, the Upper Bilenka r.
411 km, the Lower Bilenka r.

The metal concentration measurements results are consistent with the monitoring data (see above), especially high concentrations are noted in the Bakhmutka (which also had increased concentrations of barium, lithium and non-radioactive strontium, which were not detected by the monitoring program).

The results of pollutant identification showed an excess of the average annual concentration of the Environmental Quality Standard[7] for pesticides, plasticizers, pharmaceuticals, polychlorinated biphenyls and other industrial pollutants. Excessive di (2-ethylhexyl) – phthalate and brominated biphenylethers were recorded in samples of the surface waters of the S. Donets (Ohirtsevo village, down of the Rayhorodska dam, down of Lysychansk town), the Oskil, the Kazennyi Torets and the Kryvyi Torets. The sediment samples showed increased concentrations for p, p'-DDT (banned pesticide since 1972), p, p'-DDD, p, p'-DDE in the S. Donets (Lysychansk) and the Kleban-Byk reservoir, polyaromatic hydrocarbons in all sediment samples; polychlorinated biphenyls were found in the S. Donets (Ohirtsevo and down of Lysychansk), the Udy, the Kazennyi Torets (Rayhorodok) and the Kryvyi Torets (Karlivska dam). A possible cause of increased concentrations of pesticides is excessive or uncontrolled use in the previous years, and of polychlorinated biphenyls – availability of industrial waste ponds.

Comparison of the analysis results for the sediments (Table 1.7) with the results of the studies before 2014 (Table 1.8) did not show significant changes in heavy metal concentrations during the period of hostilities.

[7] Directive 2013/39/EU and the draft Methodology for classifying a surface water body to one of the surface water body ecological and chemical status classes, as well as classifying an artificial or substantially modified surface water body to one of the ecological potential classes of an artificial or substantially modified surface water body was prepared for approval by the Order of the Ministry of Ecology and Natural Resources of Ukraine.

Table 1.7 Analysis results for metal concentrations in the sediments of the Siverskyi Donets river basin (September 2018)

Sampling point	Li	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Cd	Ba	Hg	Pb
T1	4.08	1.52	13.5	19.8	143	5.03	4.88	2.69	11.5	45.1	0.0411	107	<0.0320	4.76
T2	3.57	0.816	9.26	25.1	82.8	3.28	4.88	8.93	25.5	24.5	0.606	93.0	<0.0320	4.68
T3	4.39	1.11	11.8	10.9	135	3.82	4.17	3.85	13.4	72.4	0.042	82.3	<0.0320	5.73
T4	21.7	3.17	71.2	55.6	410	24.9	26.5	14.0	47.6	56.1	0.119	197	0.0829	15.7
T5	13.5	1.30	33.1	61.8	1554	11.2	18.1	21.8	153.1	232	1.96	217	0.202	23.3
T6	45.9	3.27	94.4	112	1215	42.6	48.0	78.5	625	116	16.1	605	2.96	140
T7	18.7	2.06	42.8	42.5	461	14.0	21.8	125	119	140	0.187	201	0.0516	13.0
T8	6.37	1.03	13.7	18.6	186	5.31	5.55	11.6	27.0	45.1	0.132	132	0.0916	6.52
T9	37.9	3.60	83.5	90.4	367	27.2	46.9	22.8	53.8	126	0.141	256	0.0571	16.6

T1 – the Siverskyi Donets, 944 km, Ogurtsovo, Russian Federation border
T2 – the Udy, 3 km, mouth, Eskhar village
T3 – the Oskil, 9 km, Chervonyi Oskil village
T4 – the Siverskyi Donets, 522 km, Rayhorodska dam
T5 – the Kazennyi Torets, 1 km, mouth, Rayhorodok village
T6 – the Kryvyi Torets, 1 km, mouth, Karlivska dam – the Kazennyi Torets tributary
T7 – the Bakhmutka
T8 – the Siverskyi Donets, 428 km, down of Lysychansk, Luhansk region
T9 – Kleban-Byk reservoir

Note: in mg/kg (iron and titanium – in g/kg) of dry weight. Data received by the Institute of Environmental Protection (Slovak Republic) upon the request of the OSCE Project Co-ordinator in Ukraine.

Table 1.8 Analysis results for metal concentrations in the sediments in 2006-2018

	Li	Cr	Mn	Ni	Cu	Zn	Cd	Hg	Pb
Siverskyi Donets									
2018[1]	4.08 –21.7	18.6 –55.6	143 –410	4.88 –26.5	2.69 –14.0	11.5 –47.6	0.0411–0.132	<0.0320 –0.0916	4.76 –15.7
2014[2]	3,06 –10,71	10,96 –90,04	103 –661	11,40 –165,60	2,34 –44,06	4,62 –23,19	0.10 –2,11	0,0013 –0,160	2,56 –12,13
2006[3]		69,0 –155,0	270,0 –520,0		64,0 –131,0	41,0 –144,0			4,0 –62,0
Udy									
2018[1]	3.57	25.1	82.8	4.88	8.93	25.5	0.606	<0.0320	4.68
2014[2]	1,50 –21,19	8,92 –51,80	121 –704	6,24 –72,50	0,50 –20,49	3,73 –25,91	0.10 –0,82	0,002 –0,111	0,50 –16,27
2006[3]		7,0 –174,0	50,0 –1450,0		39,0 –137,0	27,0 –136,0			4,0 –62,0

[1] Data received by the Institute of Environmental Protection (Slovak Republic) upon the request of the OSCE Project Co-ordinator in Ukraine.

[2] Data from O. M. Beketov Kharkiv National University of Municipal Economy, Kharkiv. (Vystavna, Reshetchenko, Dyadin 2015; the actual time of the study is not indicated).

[3] Data from the Ukrainian Research Institute of Ecological Problems (Vasenko et al. 2006).

HAZARD AND PREDICTED CONSEQUENCES OF ACCIDENTS

Based on the data retrieved from the state water use inventory data for 2013 and 2017, the monitoring data on the surface water status over the said period, the information on the existing infrastructural component (availability / absence / destruction of sewage treatment facilities, collectors, drains, storage pools, settling ponds, tailing ponds), taking into account changes in the basin territory of the Siverskyi Donets, the list of enterprises was compiled. The list includes enterprises located both in the GCA and the NGCA that can have a potential impact on the SWB due to termination of standard operational cycles of the treatment facilities, destruction of settling ponds etc., including through hostilities (Table 1.9, Annex 2).

It should be noted that the quality status of the Siverskyi Donets in the GCA, including due to activities in the NGCA, is affected by Kazennyi Torets (518 km from the mouth) and the Bakhmutka (484 km from the mouth) basins, where intensive economic activity within the basins of these watercourses takes place. The quality status of the Siverskyi Donets in the area of the water intake to the Siverskyi Donets – the Donbas Canal for the needs of the Donetsk Region (522 km from the mouths) is not affected by these tributaries, since they are located down the stream. The identified tributaries affect the drinking surface water intake for the needs of the Luhansk Region from the Siverskyi Donets, located in Bilohorivka village (467 km from the mouth) down of the confluence of these tributaries.

In the Kryvyi Torets river basin (Fig. 1.6), the main potentially hazardous facilities are located in the NGCA and within the contact line or in the so-called “gray zone”, and as a result of pursuing / suspension / termination of economic activity or other force majeure circumstances may significantly impact the Siverskyi Donets basin water status. Although the potentially hazardous facilities are located 186-152 km from the drinking water intake of the CE ”Popasna District Water Service Company” for the needs of the Luhansk Region, according to SDBAWR calculations, taking into account the flow velocity for different periods of the year, the contaminated water travel time to the drinking water intake will be three-four

Table 1.9 A number of potentially hazardous facilities with ecological and hydrodynamic hazards on the Siverskyi Donets river basin (according to the Register of potentially hazardous facilities)

	2013		2018			
			NGCA		GCA	
	Donetsk Region	Luhansk Region	Donetsk Region	Luhansk Region	Donetsk Region	Luhansk region
With ecological hazard	22	25	5	15	17	10
With hydrodynamic hazard	13	26	6	17	7	9
TOTAL in the Donetsk Region	35		11		24	
TOTAL in the Luhansk Region		51		32		19

Note: PJSC "Bakhmut Agrarian Union" has not been included in the Register (2016), but its activities can threat / or can pose threat to water bodies under military activities.

Facilities in the GCA in Luhansk Region are located below the drinking water intake in the Luhansk Region, the impact on the border area (village Popivka).

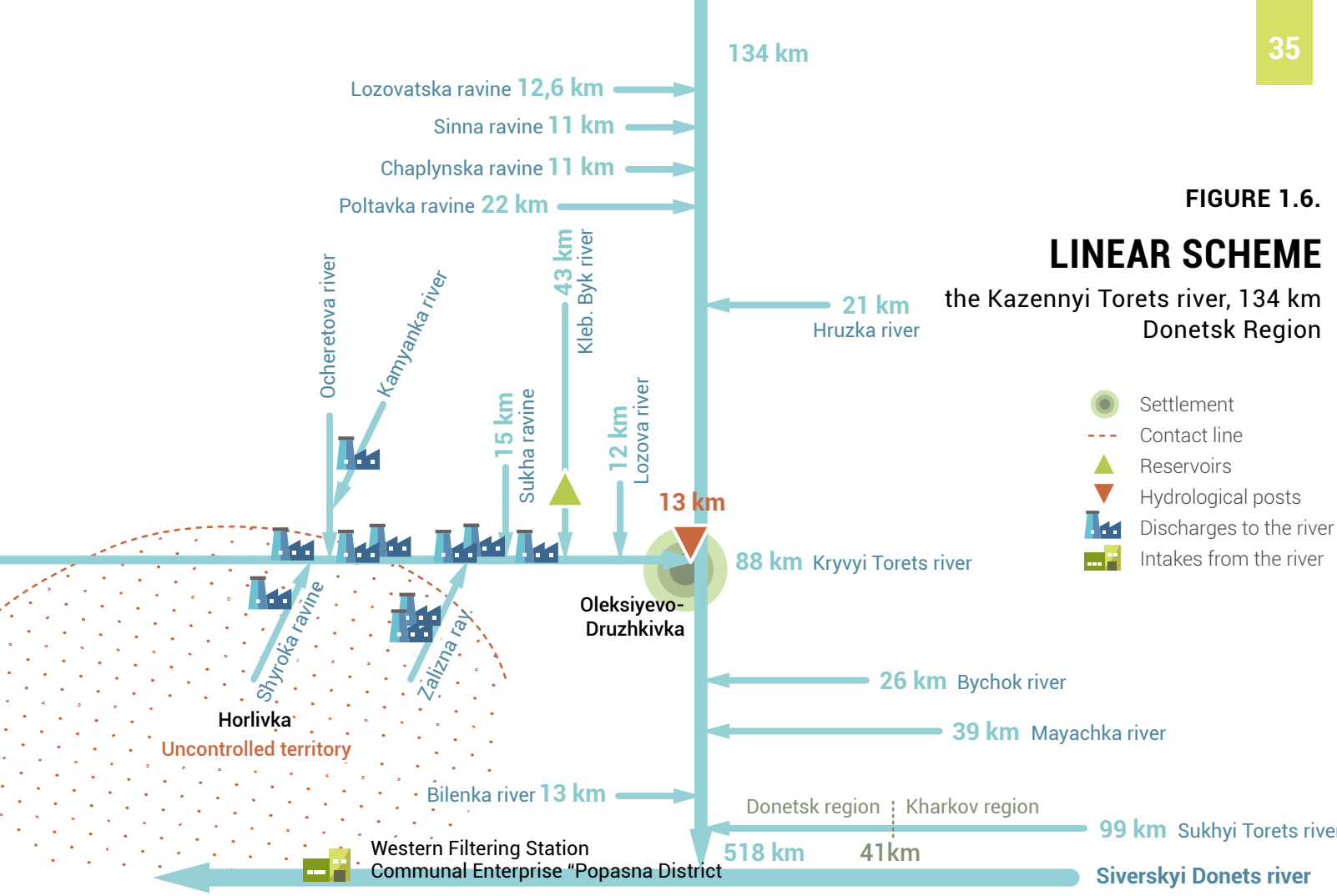


FIGURE 1.6.

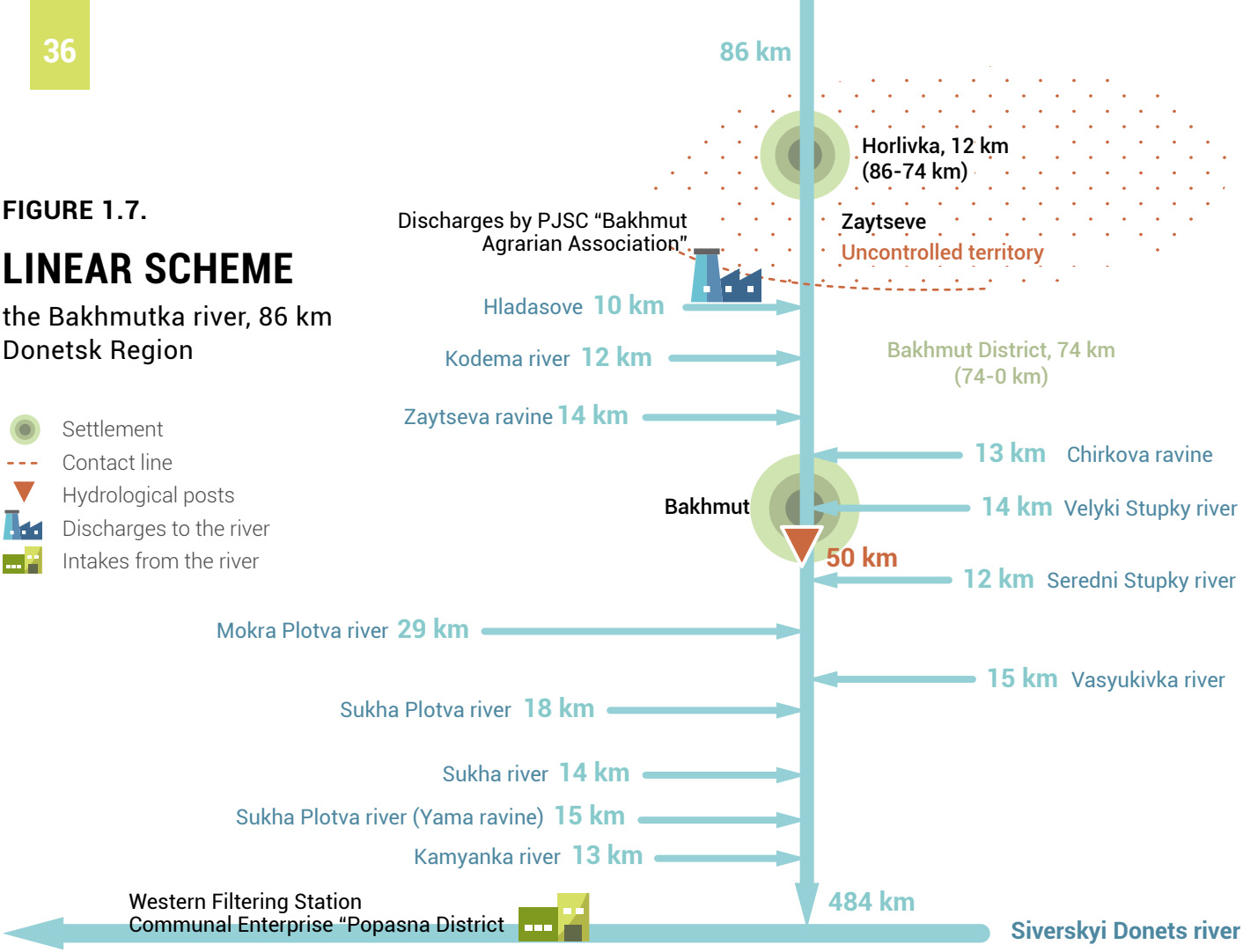
LINEAR SCHEME

the Kazennyi Torets river, 134 km
Donetsk Region

FIGURE 1.7.

LINEAR SCHEME

the Bakhmutka river, 86 km
Donetsk Region



days for high water content and eight-10 days in the low-water period (Annex 3).

Within the limits of the Bakhmutka river (Fig. 1.7), significant hazard is posed by the activity of PJSC "Bakhmut Agrarian Union"; as a result of the wastewater discharge, the wastewater travel time to the drinking water intake for the Luhansk Region will be from one day in the high water period to four days in the low-water period (Annex 3), which considerably reduces decsion-making time for preventing measures.

During this time, in case of timely receipt of information, including from automated monitoring posts (after their construction on the Kryvyi Torets and the Bakhmutka – see below), it is possible to make managerial decisions on increasing the water content of the Kazennyi Torets and the Siverskyi Donets through changes in the operation modes of the Kleban-Byk (the Kleban Byk river, 29 km from the Kryvyi Torets mouth) and Chervonooskilskyi (the Oskil river, 580 km from the Siverskyi Donets mouth) reservoirs to dilute pollution along the course of the rivers Kryvyi Torets, Kazennyi Torets and Siverskyi Donets (annual flow volume of the Kazennyi Torets is 8-15% of the Siverskyi Donets flow volume down of the Kazennyi Torets mouth).

The risk assessment for the possible emergency discharge of pollutants at the treatment facilities, sludge ponds, and other industrial waste storage facilities in the Luhan river basin (Fig. 1.8) is performed for the boundary station of Popivka village as there are no drinking water intakes in Ukraine from the Siverskyi Donets down of the Luhan confluence and to the border.

The travel time from the potentially hazardous facilities in the Luhan river basin, located at a distance of 124-96 km from the RF border, will be 1.5-2.3 days for high water content and four-six days in the low-water period (Annex 3). The lack of timely and reliable information on operation disturbance and emergency situations on the water bodies in the NGCA reduces the possibility of regular monitoring of changes on the Luhan river basin water bodies and their transboundary consequences.

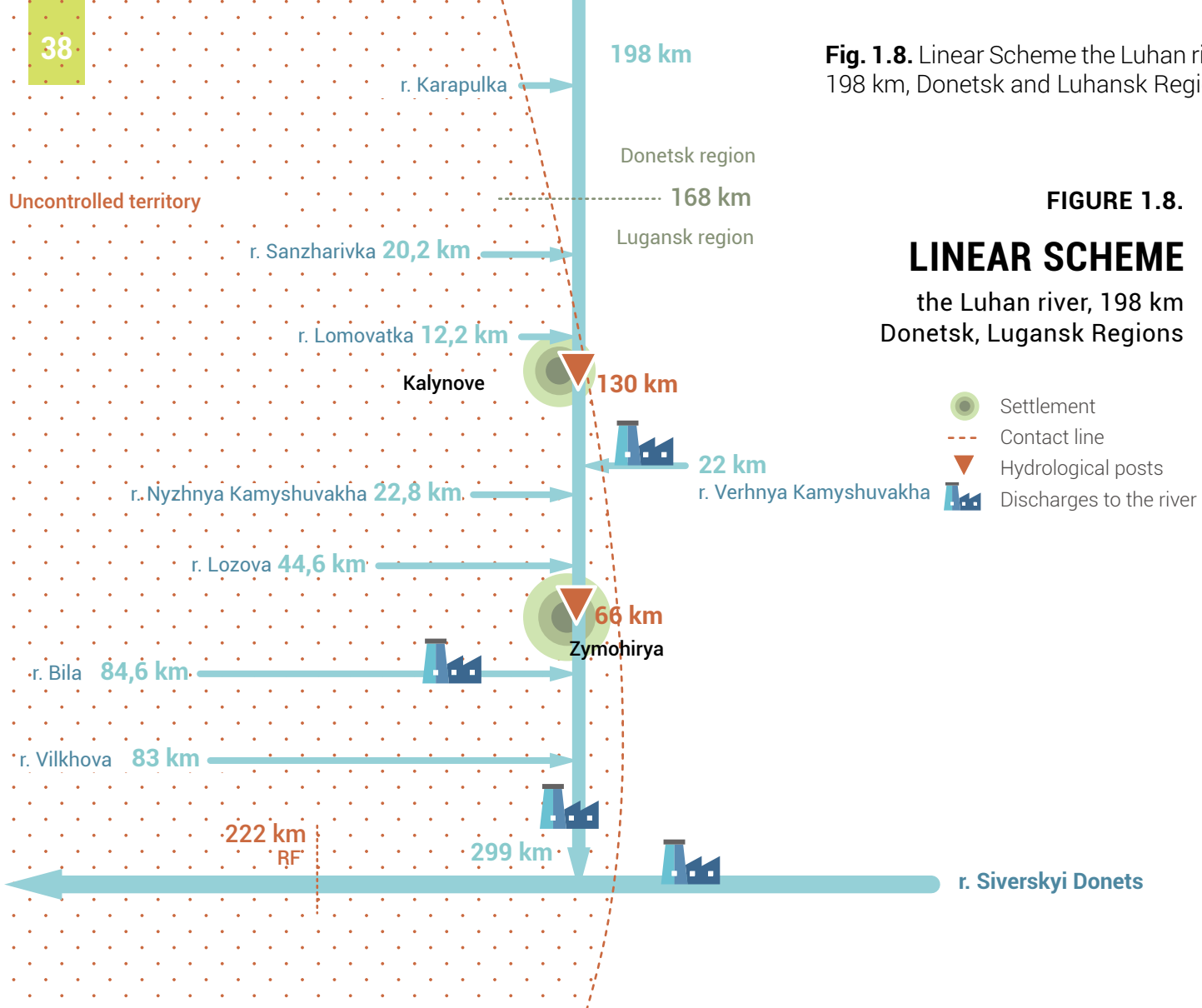


Fig. 1.8. Linear Scheme the Luhan river, 198 km, Donetsk and Luhansk Regions

FURTHER STEPS: SURFACE WATERS

Among the possible areas to further support management of the surface water resources in eastern Ukraine the two can be identified as short-term priorities in connection with the military activities,:

- establishment of a network of water quality monitoring on water bodies, including development and complementing, taking into account the region-specific situation, the monitoring program needs to comply with the requirements of the EU Directive "Establishing a Framework for the Community Action in the Field of Water Policy" (2000/60/EU) and in line with the Decree of the Cabinet of Ministers of Ukraine (CMU) from 19 September 2018 #758 "On Approving the Procedure for State Monitoring of Water Resources";

- Continuation of the analysis of possible sources and consequences of man-induced accidents from the point of view of the surface water status, including sources of drinking water supply, and participation in preparation and support of a system of emergency response measures.

DEDICATING THE MONITORING SYSTEM TO SURFACE WATER QUALITY

Following the analysis of the surface water status in the Siverskyi Donets river basin carried out with support of the OSCE Project Co-ordinator in Ukraine, detailed recommendations for development of a water body status monitoring system were prepared. The new program consists of proposals for diagnostic monitoring in 2019. The monitoring program primarily includes water bodies with significant (largest) man-induced loading, monitoring posts for the transboundary impact on water bodies, as well as impact from the NGCA, water bodies that are valuable in terms of natural reserve fund and its further classification as "reference" maintaining natural and unchanged conditions.

In the mid-term, it is worthwhile expanding the observation system and developing a concept for

monitoring the SWB of the Don river basin for the entire six-year cycle which makes up the River Basin Management Plan.

The recommendations are in line with the objectives and requirements of the EU Water Framework Directive, which also provides for "investigative monitoring" in order to take into account the basin peculiarities, including monitoring of individual actual or potential situations that may complicate achievement of the "good" ecological or chemical status of the waters. Investigative monitoring shall be carried out where the reasons for water quality deterioration are unknown and also for the water body areas where accidents occurred to assess their effects and impact. The investigative monitoring may include sampling points for checking background concentrations of heavy metals. It may also include may also include river basin areas where wastewater is discharged from the most significant point sources pollution; monitoring of sediments and biota. The investigative monitoring provides information to develop an action program to achieve the environmental goals necessary to respond to the effects of an emergency human-made or natural deterioration of surface waters.

To strengthen the information base and regular monitoring of the surface water quality in the military activities zone, taking into account the specifics of the location of the operating and potential sources of hazardous impact on surface waters, an effective means is to use automated monitoring points on the Kazennyi Torets (mouth – Rayhorodok village), the Kryvyi Torets (mouth – the Karlivska Dam), and the Bakhmutka (above Bakhmut town – 55 km from the mouth, and mouth – Dronivka village)[8]. Establishment of automated posts will reduce the time of receipt/

[8] In 2017, at the expense of the regional environmental protection fund of the Donetsk Region, a project was developed for implementation of an automated monitoring system for systematic monitoring of the surface water bodies in the basins of the Kazennyi Torets, the Kryvyi Torets and the Bakhmutka rivers and assessment of their impact on the Siverskyi Donets (above the drinking water intake of the CE"Popasna District Water Service" for the needs of the Luhansk Region). There are plans to construct automated posts for monitoring the quantitative and qualitative water indicators with real-time definition of water levels and qualitative indicators (water temperature, pH, chemical oxygen demand, ammonia nitrogen, nitrates, suspended substances, electrical conductivity (mineralization), dissolved oxygen). Two similar monitoring stations have been successfully operated in the S. Donets basin area in the Donetsk Region (AVIS S. Donets-1, Rayhorodok, Rayhorodska dam, and AVIS S. Donets-2, Svyatohorsk, a rescue station

collection/processing of reliable information on the status of the most hazardous basin areas and will increase the time for making balanced management decisions on reducing the risk of pollution of the S. Donets river basin. It is especially important to have reliable and prompt information on the status of the Bakhmutka (Bakhmut), where the time for "simulated pollution travel" is only one to four days, which significantly reduces the time for management decisions on preventing the pollution effects.

An automated system is also suggested to be installed for monitoring of the Siverskyi Donets quality status in the area of the surface water intake of the CE "Popasna District Water Services" within the boundaries of Bilohorivka (in order to prevent the risks for sustainable drinking water supply for the needs of water users of the Luhansk Region) and Lysychansk (for the purpose of monitoring the GCA along the Siverskyi Donets at the outlet station), which is envisaged by the "Regional target program for environmental monitoring of the Luhansk Region for the period up to 2022".

In the future it is advisable to combine all automated stations (posts) into a unified system of data collection, processing, generalization and analysis of situation with reference to potentially hazardous risks of surface and groundwater pollution of the Siverskyi Donets river basin for making quick decisions on development of effective measures to respond to and minimize the negative man-induced or natural consequences.

To accomplish these tasks, it is necessary to provide the subjects of state monitoring over the S. Donets surface and groundwater status, in particular the structures of the State Water Resources Agency, Public Service of Geology and Subsoil, State Emergency Service, with modern analytical equipment and proper financing. The OSCE Project Co-ordinator in Ukraine experience in the field studies in the Siverskyi Donets river basin in 2017 and 2018 demonstrates the need for systematic intercalibration of the sampling methodologies and analytical equipment available to the chemical analysis laboratories that perform state monitoring of the surface and groundwater quality. Such work, including with involvement of overseas laboratories in intercalibration, should also be continued.

ANALYSIS OF SOURCES AND CONSEQUENCES OF HUMAN-MADE ACCIDENTS AND EMERGENCY RESPONSE MEASURES

On the regional level, it is necessary to develop an action plan for organizations with competence over preparation of decision-making on emergency prevention and a data exchange protocol in the event of their occurrence. If implemented, the following measures to prevent and promptly respond in case of possible emergencies on the water bodies of the Siverskyi Donets will ensure control and timely implementation of measures to prevent the risks of accidental pollution of the Kazennyi Torets, the Kryvyi Torets and the Bakhmutka river basins, including by potentially hazardous facilities located in the NGCA.

Further updating, detailed refinement, revision of the compiled list of potentially hazardous facilities in the S. Donets basin, which cause or may cause the risk of surface and groundwater pollution. Where possible, the list should include potentially hazardous facilities both in the GCA and the NGCA. The list should be adapted and approximated to the maximum degree to the current realities. In order to expand and refine the list of potentially hazardous facilities that cause the risk of surface and groundwater pollution, it is necessary to involve both the executive authorities, responsible divisions of the State Emergency Service, State Water Resources Agency, Public Service of Geology and Subsoil, and local authorities, as well as the economic entities that can cause such a risk.

Certification of the water management systems, reservoirs, ponds, canals, water conduits, protective structures, etc., development of new (updated) operating regulations and modes of their operation should be performed, taking into account the situation in the Siverskyi Donets river basin. Detailed information about them in the future should have practical application in determining the possible impact on the water status in emergencies, as well as operational prevention of and response to human-made and natural emergencies.

The establishment of optimal operation mode of the most important water management facilities – the Kleban-Byk reservoir (the Kryvyi Torets river basin) and the Chervonooskilskyi reservoir (the Oskil river basin)

could be used for possible minimization (elimination) of potential water pollution risks by maintaining the hydrological regime in the low-water period, dilution of pollutants and sustainable functioning of drinking water intakes in the Siverskyi Donets river basin[9].

In order to ensure the reliable operation of the Kleban-Byk water reservoir and the possibility to regulate the discharge within the "Regional Programme for Cleaning River Channels during 2018-2022" the reconstruction of hydro unit of the Kleban-Byk reservoir is planned for 2019.

After the afore mentioned measures are in place, it is necessary to update the standard operational procedures of Kleban-Byk Reservoir (1987), managed by the SD BAWR and perform additional assessments of possible usage of accumulated runoff for dilution of pollutants in case of emergency in the sub-basin of Kryvyi Torets river.

[9] As indicated above, dilution of concentrations of hazardous polluting substances (increased water content) by supplying (transferring, flow augmentation of) water from storage reservoirs is an effective mechanism for reducing the risks of possible watercourse pollution. For the Kryvyi Torets, it is water supply (flow augmentation) from the Kleban Byk reservoir (volume 27.8 mln m^3), and for the Siverskyi Donets itself – from the Chervonooskilskyi reservoir (435.1 million m^3). In particular, in 2017 spilling (flow augmentation) from this reservoir were adjusted taking into account the hydrometeorological and water management situation, water intake into the Siverskyi Donets –Donbas Canal, and flow augmentation through the Rayhorodska Dam. The spilling in 2017 amounted to 766.3 mln m^3. The volume of the Kazennyi Torets flow is only 8 to 15% of the Siverskyi Donets flow volume, therefore increasing its water content will significantly reduce the risks of polluting drinking water intake for the Luhansk Region.

GROUNDWATER STATUS

The groundwater of eastern Ukraine is an important modern and potential source of industrial, agricultural and communal water supply[10]. Within the Siverskyi Donets river basin, which covers most of the territory of the region and part of the territory beyond, they belong to three geological eras -the Paleozoic, Mesozoic and Cenozoic.

Within the administrative units of the Luhansk Region, groundwater monitoring is carried out through state- and regional-level monitoring networks. In general, the state level monitoring in the Luhansk Region in 2017 consisted of 42 monitoring wells (18 in natural and slightly disturbed conditions, 24 in disturbed conditions); the regional level includes 84 monitoring wells, of which 28 are in natural and slightly disturbed conditions, and 56 in disturbed conditions. The state monitoring network covered the aquifers in the Quaternary deposits – 13 monitoring points and the Cretaceous deposits – 29 monitoring points. Other wells remained in the NGCA.

The State Regional Geological Company "Donetskgeology", within the framework of state groundwater monitoring in the Donetsk Region, has 54 monitoring wells (23 sectors) on its balance sheet, 47 of which are intended for studying the groundwater status in natural and slightly disturbed conditions, and 7 in disturbed conditions. Due to hostilities, monitoring is currently performed at 25 points of the monitoring network (including 21 points in the groundwater natural regime, 4 in the slightly disturbed regime).

In qualitative terms, most of the Cenozoic and part of the other aquifers and complexes today have an

[10] The development of groundwater probable operational reserves in the Luhansk Region was 2.21%. The Upper Cretaceous aquifer has been 2.53% developed, and the coal one – 0.02%. The mineral water reserves have been 2,0% developed. In the Donetsk Region, the amount of groundwater extraction in 2016-2017 was 9.5% of the approved reserves. By the ratio of water demand and operational resources of groundwater with mineralization of up to 1.5 g/dm^3, the territory of the Donetsk and Luhansk Regions in general, according to the degree of groundwater security, is classified as underdeveloped.

unsatisfactory status due to pollution resulting from economic activities. At present, groundwater in the Mesozoic deposits and in the Paleogene-Neogene deposits of the Cenozoic has the best quality status. The quantitative status, except for the aquifers in the coal deposits, is relatively good (Fig. 2.1, Table 2.1).

However, there are changes in the hydrodynamic conditions. The past decade witnessed reduction in groundwater extraction, which is associated with reduction of industrial capacity and decrease in number of water consumers (inevitably linked to the military activities). Reducing the volumes of water intake led to the beginning of groundwater level restoration and elimination of depression craters that existed around some water intakes (Svitlychanskyi and Zhytlivskyi). At the same time, such a situation does not indicate any improvement in the groundwater quality, but just the contrary – of groundwater contact during level restoration with the man-created aeration zone, which contains high concentrations of soluble pollutant compounds, worsens the groundwater quality. This situation is typical for groundwater of carbonate aquifers in the Luhansk Region, where, along with specific hydrodynamic conditions, there is a dense placement of hazardous industrial enterprises LLC "Rubizhansky Krasitel", LLC RPE "Zorya", PJSC "Severodonetsk Association Azot", OJSC "Lysychansk Soda", PJSC "LYNIK" and others.

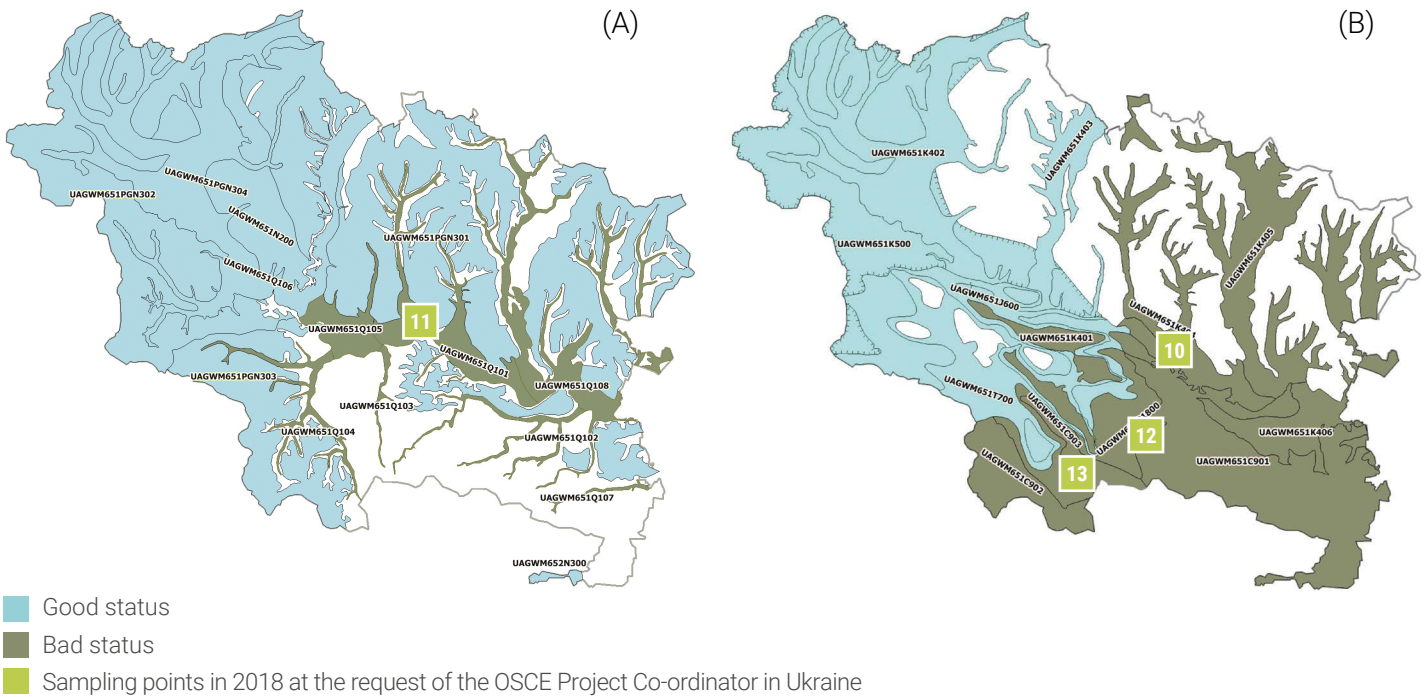
Table 2.1 Groundwater in the Siverskyi Donets basin

Water body name and lithology of deposits	Prevailing type of use	Chemical / quantitative composition (credibility of information)
In the alluvial deposits of the Quaternary system (sand with layers of clay, sandy loam) [11]	Agriculture, discharges from industrial enterprises. Widely used by the rural population	☹ * / ☺ (high credibility) * pollution with nitrates, nitrites, phenols and other hazardous substances
In the alluvial deposits of the Pliocene terraces (soil, sands of alluvial deposits)	Agriculture, water supply of rural population and small facilities	☹ * / ☺ (low credibility) * pollution with nitrates, nitrites

In the formations of the Paleogene on the Neogene system (sand with layers of clay, sandstones and siltstones)	Agriculture, industry, for local water supply. It is the main source of water supply for individual facilities and communities	☹* / ☺ (high credibility) * pollution with nitrates, nitrites;
In the Upper Cretaceous deposits (marl, sandstones, sand, chalk) [10]	Agriculture; water supply of communities; industry	☹* – ☺ / ☺** (high credibility) * concentration of rhodanides, cyanides, nitrates is observed
In the Alb-Cenomanian deposits (sand and sandstone of the Albaceous with layers and lenses of clay)	Agriculture; water supply of communities (large cities and towns); industry	☺ / ☺ (low credibility)
In the Jurassic system deposits and complexes (sand and sandstone with layers and lenses of clays and layers of limestone)	Water supply of communities, industry. Used for local water supply	☺ / ☺ (high credibility)
In the deposits of the Triassic system (sand and sandstone)	Water supply of communities, balneological water supply	☺ / ☺ (high credibility)
In the deposits of the Permian system (sandstones with cross-sections of argillites, siltstones, limestones and dolomites) [13]	Water supply of communities, industrial hubs, private water supply, irrigation	☺ – ☹ / ☺ (requires monitoring data)
In the sandy-clay deposits of the coal system (sandstones with alternating argillites, siltstones, with low-strength layers of limestone and coal) [12]	Centralized and private water supply of communities, industrial hubs, mining industry	☹* / ☹** (high credibility) * local pollution with nitrogen compounds, salts, heavy metals, phenols ** operation exceeding groundwater reserves

[12] Sampling points in 2018 at the request of the OSCE Project Co-ordinator in Ukraine

Fig. 2.1 Preliminary assessment of groundwater quality status in the Mesozoic and Paleozoic deposits in the Cenozoic (A), Mesozoic and Paleozoic (B) deposits



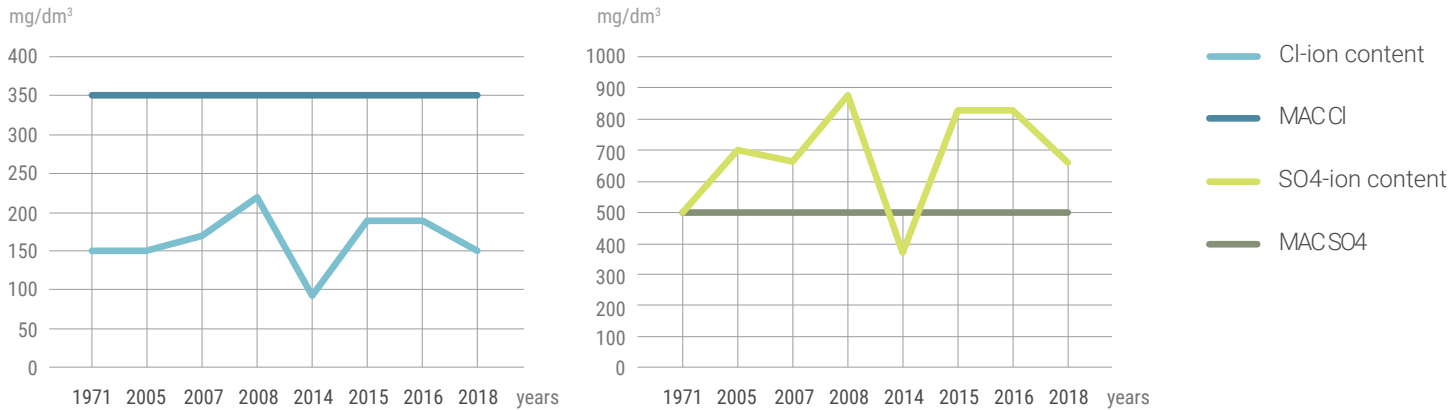
For quantitative analysis of changes during hostilities, the long-term regular monitoring data was compared with the results of the sampling from four wells (Fig. 2.1, Table 2.1) in 2018 at the request of the OSCE Project Co-ordinator in Ukraine. The wells selected are characterized by extensive use of groundwater in the alluvial Quaternary deposits by the local population (point No. 11 – village of Stara Krasnyanka, Kreminna District of the Luhansk Region), groundwater in the Upper Cretaceous deposits (point No. 10 – Syrotyne, Popasna District of the Luhansk Region), groundwater in the coal system deposits (No. 12 – "Pakharskyi" water intake, CE "Luhanske" of the Luhansk Town Council, village of Vozdvyzhenka, Bakhmut District of the Donetsk Region), and groundwater in the Permian deposits (No. 13 – operating water intake of Research & Production Association "Incor & Co" LLC in Novhorodske, Kostyantynivka District of the Donetsk Region).

It will be seen from the analysis of the long-term dynamics from the start of operation that the water indicators at the "Pakharskyi" water intake (point No. 12) have significantly deteriorated since 1971. (Fig. 2.2). For instance, at the beginning of water intake commissioning into operation, the water was of the hydrocarbonate-sulfate calcium-sodium type with a mineralization level of 1.34 g/dm^3 and sulfate concentration of 497 mg/dm^3. In 2008 (37 years from water intake commissioning into operation), the water mineralization reached 1.9 g/dm^3, and the concentration of sulfate ions exceeded the critical value amounting to 876.9 mg/dm^3; the water changed to the chloride-sulfate type (with prevailing anions), with Mg and Na as prevailing cations[11]. As of 2018, there was also an excess of sulfate ions relative to MAC at 630 mg/dm^3, and the type of water in 2018 was bicarbonate-sulfate magnesium-sodium.

Thus, in the water, which is selected in a capture well, the hydrocarbonate ions were replaced with sulfate ions with a significant excess of the MAC norm and unnatural increase in mineralization. Considering that the water supply unit is in the coal mine-affected zone of the CD, the coal industry should be viewed as a source of aquifer pollution.

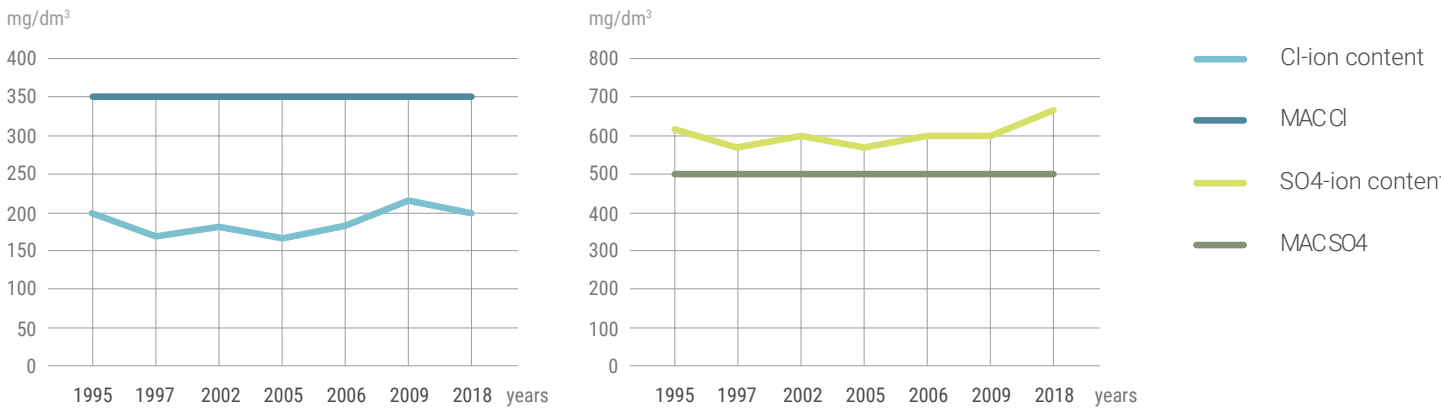
[11] The increased concentration of sulfate ions in the water of coal deposits can be due to the coal industry associated with discharges of mine water and actual development of the latter in the Central Donbas.

Fig. 2.2 Changes in the content of chlorine and sulfate ions at the "Pakharskyi" water intake



The analysis of this water sample from the water intake well of the Research & Production Association "Incor & Co" LLC (point No. 13) indicates excessive sulfate ions concentration (653 mg/dm^3) in the water surveyed compared to the national norm (MAC 500 mg/dm^3). However, the estimation of the change in the water ionic composition from 1995 to 2018 on the basis of retrospective data provided by the State Regional Geological Company "Donetskgeology" Central Laboratory showed that during the examined period, the water composition had not changed significantly (Fig. 2.3). The type of water by its ionic composition is hydrocarbonate-sulfate (characteristic for low-mineralized waters of this aquifer complex), sodium magnesium-calcium. Increased sulfate concentration is probably due to specific geological and hydrogeological conditions of the territory and is associated with washout of salts of the salt-containing complexes of the Slavic suite. The background levels in the area require additional research.

Fig. 2.3 Changes in the concentration of sulfate and chlorine ions at the Research & Production Association "Incor & Co" LLC" water intake



Analysis of the nitrate concentration in the water of this intake also indicates long-term nitrate contamination, which exceeds the MAC and the EU standards.

Based on the analysis of water samples at points No. 10 and No. 11, the general physical-chemical parameters (Ph, Ec, DO) are within the normal range. The content of metal ions (Pb, As, Cd, Hg) does not exceed the MAC either. However, screening of water samples to detect variously originating pollutant groups allowed identification of the substances in the water samples, which until now have not been detected by regional laboratories:

- pharmaceuticals,
- pesticides,
- personal care products,
- industrial,
- narcotic substances, etc.

In all the samples, Bisphenol A (a chemical of the class of phenols) was detected. Although its concentration does not exceed the generally accepted European norm (NORMAN ECOTOX database 240 ng/l), presence of this component in groundwater indicates organic contamination.

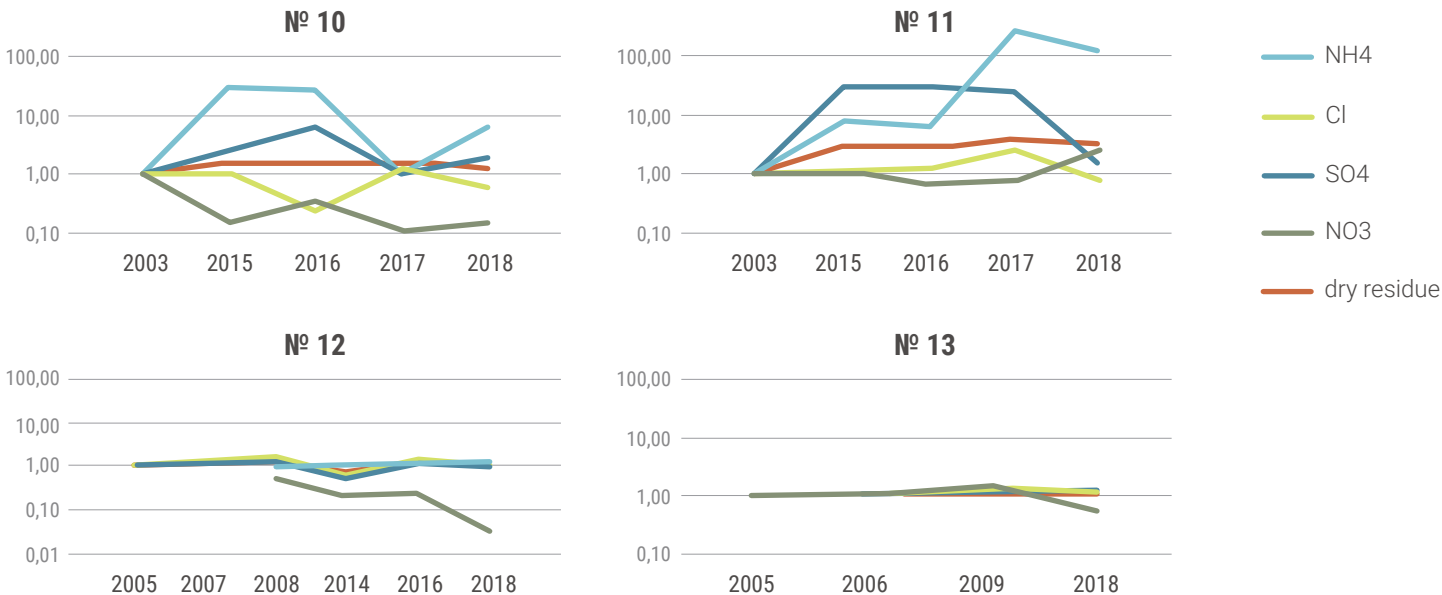
The highest concentration of Bisphenol A was recorded at point No. 12, and the largest number of pollutants (6 out of 12 surveyed, in the other three samples – 4 components) of organic origin – at point No. 11 (water from the alluvial aquifer). All identified compounds belong to pesticide groups (Anabazin, Bentazon, Dinitrophenol, Dinotreb, Metolachlor), industrial pollutants (Benzoic acid, Bisphenol A), substances of personal care products and pharmaceutical compounds. Pyrohalol, used in industry for the synthesis of dyes, was found at point No. 10. All detected substances are in the quantities not exceeding the allowable concentrations[12].

A comparative analysis of the dynamics of water quality over the period of hostilities (Fig. 2.4) shows that in all the wells between 2015 and 2017 (except point No. 13 for which data is not available between 2009 and 2018) there was a "spike" in the concentration of sulfates and chlorides (at point No. 11, the sulfate ion content increased 25-30 times over the previous data), followed by a relative decrease and fluctuations in concentrations. The "Pakharskyi" water intake well (point No. 12) – the only one surveyed with 2014 data – records a relative decline in the concentration of chlorides and sulfates in the initial period of hostilities over 2008 (probably due to a decline in production and water intake), which changed in 2016 recording a spike.

Points No. 10 and No. 11 demonstrated a significant spike and growth in ammonium concentration, presence of which is often associated with centralized agricultural and household wastewater. At the same time, in some wells, during hostilities, the concentration of nitrates and nitrites, often associated with the use of fertilizers, decreased (except point No. 11, where it has been growing again since 2017). Point No. 11 also showed lithium, silicon and organic pollution.

[12] The wells at points No. 10 and No. 11 were drilled to study the groundwater regime near the water intakes (Metelkynskyi and Volodynskyi respectively), whose water is used for drinking water supply.

Fig. 2.4 Relative change in the groundwater quality over the period of hostilities



Note: the base year for comparison is shown first. Even though the concentration of detected organic pollutants does not exceed the MAC, the fact of their detection further raises the question of the functioning of the sanitary protection zone and identification of the pollution source.

With the exception of point No. 11, and not taking into account the initial spike and the recent growth in ammonium concentration, during the period of hostilities the quality of groundwater in the wells surveyed did not deteriorate significantly, which can be explained by suspension or decrease in the production volumes of the enterprises that were sources of pollution and a general decrease in water intake[13]. Meanwhile, the quality of water in the alluvial Quaternary deposits (point No. 11), often to the greatest extent those susceptible to pollution from the surface, including from small sources, deteriorated by many indicators.

[13] However, the general tendency of water intake reduction can be traced back not to the beginning of hostilities, but somewhat earlier. Accordingly, starting 2012, the water quality indicators have been generally improving, including quantitative and qualitative indicators (except the groundwater where intensive man-induced impacts have led to irreversible changes in the quality status). Also, point No. 13 has no monitoring records between 2009 and 2018, which makes it difficult for a detailed analysis.

COAL MINE FLOODING AND ITS CAUSES

Coal (and other) mines of the Donbas are the most significant source of influence on the status of groundwater in the east of Ukraine. Compared with the situation at the end of 2017[14], the status of mines has changed significantly (Table 2.3).

This is due to a continuing rise in the water levels in the mines where the drainage has been suspended earlier. In those suspending drainage in 2018, including CD mines "Vuhlehirska", "Red October" and "Yunkom".

The analysis of the mine water level during active flooding of 20 coal mines in the CD between November 2017 and September 2018 indicates a steady tendency towards its rise, however, at different rates (Fig. 2.6): from practically complete stabilization (the mines Izotov, Oleksandr-West, Oleksandrivska, Olkhovatska, Gagarin, Poltavska, Yenakiyevska) to one and a half – two meters a day till October-November 2018 (the mines Rumyantsev, Hayovyi, Marx).

As of today, 15 out of 20 CD mines have already been flooded more than a half (Fig. 2.5-2.6). With great probability, it can be argued that mine flooding with subsequent rise in the groundwater level and decreasing depression size will increase the upwelling (deep) groundwater supply, develop waterlogging and flooding, as well as water saturation and decrease in the strength of the lower horizons of rocks with occurrence of highly gradient sediments and disrupted rock continuity[15].

[14] OSCE Project Co-ordinator in Ukraine, 2017

[15] According to a simulation, the predicted depth of groundwater occurrence in 50% of the Central Donbas coal-bearing horizon is 20.0 m or less, due to which this area is capable of local flooding of human-made facilities, development of the existing and formation of new groundwater pollution centers. Almost all the Central Donbas mines located on the southern and northern wings of the Main Anticline are hydraulically interconnected in the depths range of 230-1080 m.

Table 2.2 Status of coal mines in eastern Ukraine

	January 2014	November 2017 *	November 2018 *
Operating mines	150	104 (29 / 75)	99 (24 / 75)
In the water draining mode	14	17 (1 / 16)	14 (2 / 12)
In the process of flooding	36	36 (1 / 35)	39 (1 / 38)
In the liquidation stage	100	70 (6 / 64)	70 (6 / 64)
Mines are not taken into account due to its abolition	0	0	5/0
Total	**227**	**227 (37 / 190)**	**222 (33 / 189)**

* In parentheses: GCA / NGCA

Fig. 2.5. Scheme of hydraulic connections and level of mines flooding in the northern section of Central Donbas group of mines over the period of 01.11.2017-01.11.2018

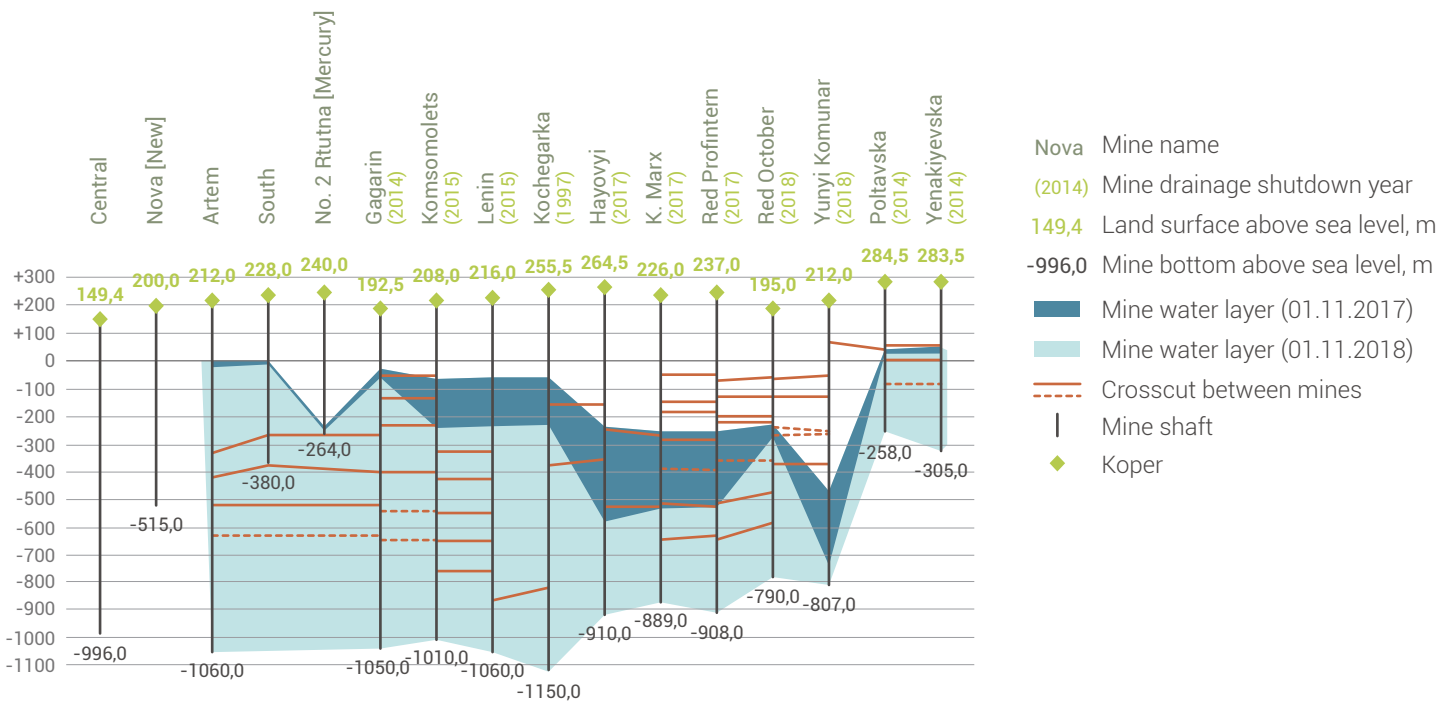


Fig. 2.6. Scheme of hydraulic connections and level of mines flooding in the southern section of Central Donbas group of mines over the period of 01.11.2017-01.11.2018

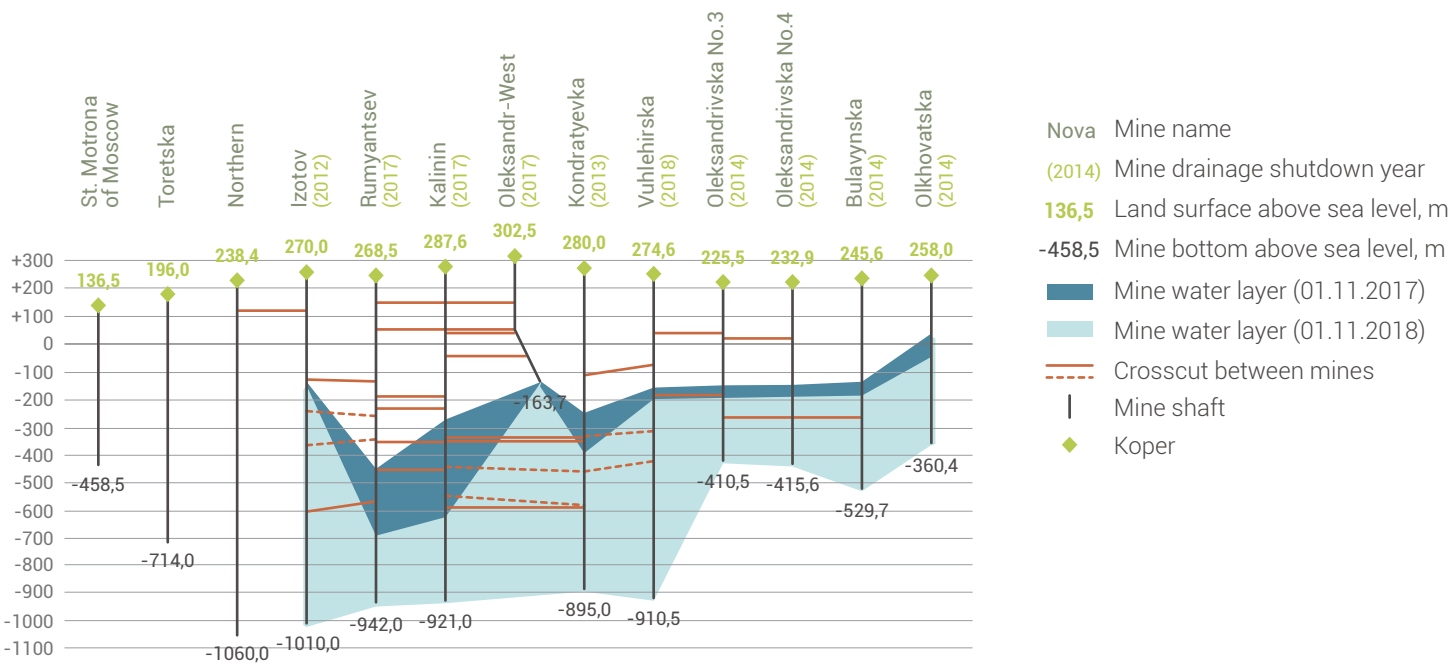
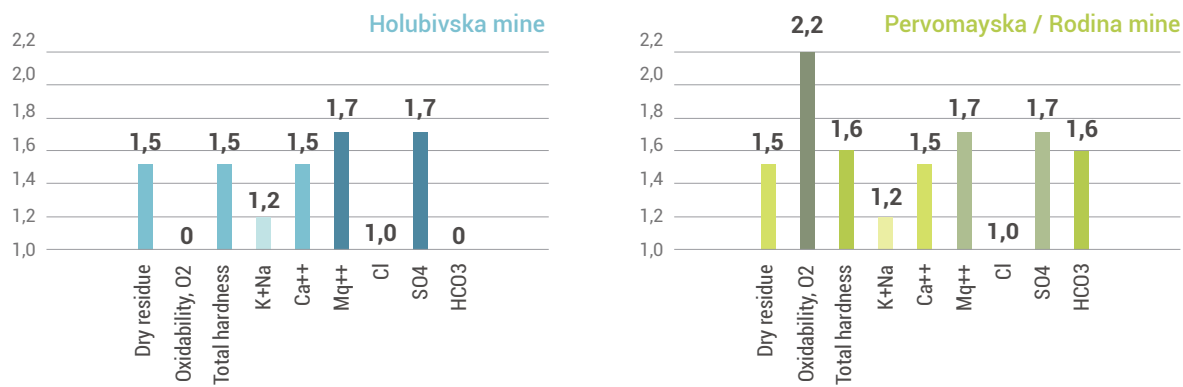


Fig. 2.7. Schematic cross-section of the Pervomaysk group of mines in the Luhansk region and the level of mines flooding as of 01.11.2018

The Luhansk Region (Fig. 2.8) there is a threat of a hydrogeological hazard due to flooding of the mine openings with mine waters of the non-operating mines “Pervomayska” and “Holubivska” of the Pervomayska Group located in the NGCA and hydraulically connected with the operating mines of the SE “Pervomayskvuhillya”: “Zolote”, “Karbonit”, “Hirska” located in the GCA. Given the spatial distance from the point of cross-flow of mine water from the mine “Rodina” to the mine “Zolote”, the estimated level of “Rodina” flooding is at an absolute value of 88.5 m.

Fig. 2.8 Predicted relative change in the mine water composition after flooding



Forecast of changes in the hydrochemical situation in the mines “Holubivska”, “Pervomayska” and “Rodina” demonstrate (Fig. 2.8) that the flooding may be expected to cause a 20-70% increase in the values of the salt composition of mine waters (except for chloride concentration). The mines “Pervomayska” and “Rodina” are expected to double the growth rate for concentrations of organic substances and hydrocarbons.

The dangerous impact of mine flooding can significantly increase in the spring of 2019 with a simultaneous increase in the cross-flow of various human and natural (mainly groundwater soluble salts) pollution from the NGCA. The facilities that remain highly hazardous include the mine “Yunkom”, “Mykytivskyi” mercury mine, the Horlivka Chemical Plant, mine openings “Oleksandr-Zakhid”, which are polluted with highly-toxic chemical compounds – benzene, toluene, phenol, methanol, chlorobenzene, formaldehyde, monoethanolamine and others.

FURTHER STEPS: GROUNDWATERS

Up-to-date data on the groundwater status in the eastern Ukraine, the dynamics of coal mine flooding, and changes in the mine water composition are absolutely necessary for timely analysis of the situation and decision-making in case of dramatic developments. Regular updates, analysis and dissemination of the available information should continue.

At the same time, to expand the information framework of such analysis, the monitoring network of wells has to be upgraded and modernized for monitoring the groundwater quantity and quality. A more effective monitoring system is required to obtain complete and up-to-date data on the qualitative and quantitative status of the groundwater, geodynamic status of the rock mass, chemical and ecological status of the artificial and natural landscapes. The starting point for this may be the recommendations made when developing the Siverskyi Donets Basin Management Plan.

In the modern context, the quantitative prediction of the probable effects from a continuing rise in the mine water level is complicated both due to difficulties with obtaining sufficient amounts of information and because of predominance of disturbed hydrogeological conditions in the east of Ukraine. At the same time, it is relevant and possible to make forward-looking analyses of the qualitative tendencies in situation developments based on spatial mathematical and cartographic modeling using geoinformation technologies, which allow using limited inputs more efficiently. A spatial database thus developed and continuously populated and updated will allow further identification of specific facilities for a more detailed analysis and accumulation of information for quantitative predictions.

Finally, due to more flooding of territories, the relevance of studying the adverse geomorphological processes in the region is increasing, including subsidence of soils in the areas of settlements and at the locations of critical infrastructure facilities. Detection and quantitative analysis of such phenomena requires satellite data and modern methods of remote sensing data processing.

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ANNEX 1 Updated assessment of the main man-induced loads and their impact on the status of the SWB in the Siverskyi Donets basin located in the NGCA

Surface water body name	Surface water body code	Surface water body type	Length, km	Ecological status / potential		Chemical status	
				2017	2013	2017	2013
Siverskyi Donets	UADN00008	UA_R_16_XL_1_Ca	72,53	3	3	2	2
Kryvyi Torets	UADN00262	UA_R_16_S_1_Ca	11,98	3	3	1	2
Kryvyi Torets	UADN00263	kIZMPV	18,45	3	3	2	2
Zalizna ravine	UADN00284	UA_R_16_S_2_Ca	4,59	2	3	1	2
Zalizna ravine	UADN00285	UA_R_16_S_1_Ca	12,60	3	3	2	2
Zalizna	UADN00291	UA_R_16_S_1_Ca	11,32	3	3	1	2
Ocheretova	UADN00275	UA_R_16_S_1_Si	2,09	2	3	1	2
Kazennyi Torets	UADN00247	kIZMPV	12,50	3	3	2	2
Bakhmutka	UADN00355	UA_R_16_S_2_Ca	2,67	3	3	1	2
Bakhmutka	UADN00356	UA_R_16_S_1_Ca	6,66	3	3	1	1
Bakhmutka	UADN00357	UA_R_16_S_1_Si	4,37	3	3	1	2
Luhanka	UADN00507	UA_R_16_S_2_Ca	4,98	3	3	1	2

Luhanka	UADN00508	kIZMPV	5,91	**3**	**3**	**1**	**1**
Luhanka	UADN00510	UA_R_16_M_1_Si	0,84	**3**	**3**	**1**	**1**
Luhanka	UADN00512	UA_R_16_M_1_Ca	63,19	**3**	**3**	**2**	**2**
Luhanka	UADN00513	UA_R_16_L_1_Ca	20,07	**3**	**3**	**1**	**2**
Luhanka	UADN00514	UA_R_16_L_1_Si	28,14	**3**	**3**	**1**	**2**
Luhanka	UADN00515	UA_R_16_L_1_Ca	79,16	**3**	**3**	**1**	**2**
Olkhivka	UADN00568	UA_R_16_S_2_Ca	8,70	**3**	**3**	**1**	**1**
Olkhivka	UADN00569	UA_R_16_S_1_Ca	10,70	**3**	**3**	**1**	**1**
Olkhivka	UADN00570	kIZMPV	3,60	**3**	**3**	**1**	**1**
Olkhivka	UADN00571	UA_R_16_M_1_Ca	61,89	**3**	**3**	**1**	**2**
Vasyukova	UADN00572	UA_R_16_S_2_Ca	6,30	**3**	**3**	**1**	**1**
Vasyukova	UADN00573	UA_R_16_S_1_Ca	8,87	**3**	**3**	**1**	**2**
Bila	UADN00552	kIZMPV	10,06	**3**	**3**	**1**	**1**
Bila	UADN00553	UA_R_16_S_1_Ca	7,12	**3**	**3**	**1**	**2**
Bila	UADN00554	UA_R_16_M_1_Ca	29,52	**3**	**3**	**1**	**2**
Bila	UADN00556	UA_R_16_M_1_Ca	39,38	**3**	**3**	**1**	**2**
Dovha	UADN00565	kIZMPV	3,37	**3**	**3**	**1**	**1**

Dovha	UADN00566	UA_R_16_S_1_Ca	11,22	3	3	1	2
Chernushyna	UADN00559	UA_R_16_S_2_Ca	4,97	2	3	1	2
Chernushyna	UADN00560	kIZMPV	1,53	3	3	1	1
Chernushyna	UADN00561	UA_R_16_S_2_Ca	2,61	2	3	1	2
Chernushyna	UADN00562	UA_R_16_S_1_Ca	6,76	3	3	1	1
Lozova	UADN00546	UA_R_16_S_2_Ca	3,81	3	3	1	1
Lozova	UADN00547	kIZMPV	1,06	3	3	1	1
Lozova	UADN00548	UA_R_16_S_2_Ca	5,02	3	3	1	1
Lozova	UADN00549	UA_R_16_S_1_Ca	11,39	3	3	1	2
Lozova	UADN00550	UA_R_16_M_1_Ca	30,50	3	3	1	2
Lozova	UADN00551	UA_R_16_M_1_Si	1,27	3	3	1	1
B. Komyshuvakha	UADN00537	UA_R_16_S_1_Ca	5,04	3	3	1	2
B. Komyshuvakha	UADN00538	kIZMPV	1,10	3	3	1	1
B. Komyshuvakha	UADN00539	UA_R_16_S_1_Ca	11,64	3	3	1	2
B. Komyshuvakha	UADN00540	UA_R_16_M_1_Ca	5,97	3	3	1	1
Komyshuvakha	UADN00542	UA_R_16_S_2_Ca	1,91	2	2	1	1
Komyshuvakha	UADN00543	UA_R_16_S_1_Ca	15,36	3	3	2	1

Komyshuvakha	UADN00544	UA_R_16_M_1_Ca	6,67	**3**	**3**	**2**	**2**
Komyshuvakha	UADN00545	UA_R_16_M_1_Si	3,55	**3**	**3**	**1**	**1**
Lomovatka	UADN00535	UA_R_16_S_2_Ca	3,87	**3**	**3**	**1**	**2**
Lomovatka	UADN00536	UA_R_16_S_1_Ca	12,31	**3**	**3**	**1**	**1**
Karapulka	UADN00520	UA_R_16_S_2_Ca	4,01	**2**	**3**	**1**	**2**
Karapulka	UADN00521	UA_R_16_S_1_Ca	5,57	**2**	**2**	**1**	**1**
Karapulka	UADN00522	kIZMPV	1,04	**3**	**3**	**1**	**1**
Karapulka	UADN00523	UA_R_16_S_1_Ca	1,35	**2**	**2**	**1**	**1**
Karapulka	UADN00525	UA_R_16_S_1_Ca	3,05	**2**	**2**	**1**	**1**
Karapulka	UADN00526	UA_R_16_M_1_Si	3,19	**3**	**3**	**1**	**1**
Luhanchyk	UADN00585	UA_R_16_S_2_Ca	19,00	**3**	**3**	**1**	**1**
Luhanchyk	UADN00586	UA_R_16_S_1_Ca	8,99	**3**	**3**	**1**	**1**
Luhanchyk	UADN00587	UA_R_16_M_1_Ca	70,92	**3**	**3**	**1**	**2**
C. Kamyanka	UADN00637	UA_R_16_S_2_Ca	7,15	**3**	**3**	**1**	**1**
C. Kamyanka	UADN00638	UA_R_16_S_1_Ca	12,35	**3**	**3**	**1**	**1**
V. Kamyanka	UADN00639	UA_R_16_M_1_Ca	3,00	**3**	**3**	**1**	**1**
C. Kamyanka	UADN00640	kIZMPV	6,18	**3**	**3**	**1**	**1**

V. Kamyanka	UADN00641	UA_R_16_M_1_Ca	54,17	3	3	1	1
V. Kamyanka	UADN00642	UA_R_16_L_1_Ca	33,02	3	3	1	2
M. Kamyanka	UADN00643	UA_R_16_S_2_Ca	9,84	3	3	1	2
M. Kamyanka	UADN00644	UA_R_16_S_1_Ca	9,07	3	3	1	2
Kundryucha	UADN00672	UA_R_16_S_2_Ca	5,52	3	3	1	1
Kundryucha	UADN00673	kIZMPV	1,60	3	3	1	2
Kundryucha	UADN00674	UA_R_16_S_2_Ca	1,79	3	3	1	2
Kundryucha	UADN00675	kIZMPV	8,80	3	3	1	2
Kundryucha	UADN00676	kIZMPV	5,60	3	3	1	1
C. Burhustka	UADN00679	UA_R_16_S_2_Ca	8,89	2	3	1	2
C. Burhustka	UADN00680	UA_R_16_S_1_Ca	13,16	2	2	1	1
B. Talova	UADN00677	UA_R_16_S_2_Ca	11,24	2	3	1	2
B. Talova	UADN00678	kIZMPV	2,98	3	3	1	1
C. Provallya	UADN00664	UA_R_16_S_2_Ca	3,30	2	2	1	1
C. Provallya	UADN00665	UA_R_16_S_1_Ca	1,52	2	2	1	1
C. Provallya	UADN00666	UA_R_16_M_1_Ca	10,76	2	3	1	2
Dovzhyk	UADN00654	UA_R_16_S_2_Ca	4,80	2	2	1	1

Dovzhyk	UADN00655	UA_R_16_S_1_Ca	5,97	3	3	1	1
Dovzhyk	UADN00656	kIZMPV	2,14	3	3	1	2
Dovzhyk	UADN00657	UA_R_16_S_1_Ca	3,49	2	2	1	1
Dovzhyk	UADN00658	UA_R_16_M_1_Ca	15,15	3	3	1	1
Medvizhka	UADN00647	UA_R_16_S_2_Ca	7,31	3	3	1	1
Medvizhka	UADN00648	UA_R_16_S_1_Ca	9,48	3	3	1	2
Medvizhka	UADN00649	UA_R_16_M_1_Ca	9,99	2	2	1	1
Medvizhka	UADN00650	kIZMPV	2,59	3	3	1	1
Medvizhka	UADN00651	UA_R_16_M_1_Ca	3,19	3	3	1	1

Note: The assessment of the man-induced load on the surface water body status from diffuse pollution sources and hydromorphological changes are taken into account through the results of the report "Analysis of the Main Man-Induced Loads and Their Impacts in the Siverskyi Donets Basin Area". It is impossible to carry out a reliable assessment of changes in the SWB located in the NGCA due to partial or total lack of objective data on the use of water resources. Also, since 2016, in connection with the "Procedure for State Accounting of Water Use", approved by the Minecology as of 16.03.2015, No. 78, the "2 TP Vodhosp" (annual) report does not show any pollutants in the unused discharges of mine and quarry waters. Until 2016, the mine and quarry waters were classified as polluted. Accordingly, discharges of pollutants with mine waters were not taken into account in the status assessment in 2017.

ANNEX 2 List of enterprises with discharges from the NGCA (2013)

River	Km	Enterprise	Discharges, ml m³
Kryvyi Torets	0079	Yasinovskyi Coking Plant, Makiyivka	0,0749
	0077	Panteleymonivka Refractory Plant	0,0767
	0070	Yasynuvatskyi Machine Building Plant, Yasynuvata	0,0533
		Communal Heat Supply Enterprise "Vuhlyk", Horlivka	0,2508
	0066	Donetsk Regional Production Office of CE"Donbas Water"	0,0101
	0065	Donetsk Regional Production Office of CE"Donbas Water"	1,9246
		CJSC "Elastomer", Horlivka	0,0276
Zalizna	0012	"2-Bis" mine, Horlivka	1,2626
	0010	Production Office of Water Supply and Sewage Management of CE"Donbas Water"	8,2553
		Yu. O. Gagarin mine, Horlivka Executive Directorate for Mine Liquidation	5,5000
Zalizna ravine	0016	Mine Office 1, Lenin mine, SE "Artemvuhillya", Horlivka	5,2671
		Private Enterprise "Lyagova I. F.", Horlivka	0,0002
	0010	Komsomolets mine, SE "Artemvuhillya", Horlivka	0,9962
		Yu. O. Gagarin mine, Horlivka Executive Directorate for Mine Liquidation	0,0705
	0007	Regional Office for Canal Operation of CE"Donbas Water", Horlivka	1,4840
		"Epicenter K" LLC, Horlivka	0,0056
Ocheretova	0016	Yasynuvata Production Office of Water Supply and Sewage Management	1,3029
Shyroka	0003	Makiyivka Regional Production Office of CE"Donbas Water"	1,6714
		Makiyivka Production Office of Water Supply and Sewage Management of CE"Donbas Water"	1,4200
Bakhmutka	0086	Mine Office 2, Kalinin mine, SE "Artemvuhillya", Horlivka	1,8423
		Track maintenance station, Horlivka	0,0028
	0075	Production Office of Water Supply and Sewage Management of CE"Donbas Water"	0,1653

Luhan	0196	Central Enrichment Factory “Uzlovska” LLC, Horlivka	0,0198
		Mine Office 1, Kalinin mine, SE “Artemvuhillya”, Horlivka	3,3442
	0127	Cetral-Irmino mine, SE “Ukrvuhletorfrestructuryzatsiya”, Antratsyt	0,3417
	0125	INTER-INVEST VUHILLYA LLC, Pervomaysk	1,9838
	0121	Pervomaysk Department “Luhanskvoda” LLC	0,7282
	0117	Holubivska mine, Kirovsk	7,7018
	0115	Kirovsk Department “Luhanskvoda” LLC	0,0254
	0086	Kirovsk Forging Plant “Centrokruz”	0,0400
	0067	Bryankivskyi Department “Luhanskvoda” LLC	0,0309
	0038	Southern Office “Luhanskvoda” LLC, Luhansk	0,8840
	0036	Luhanska mine, Yubileyne	1,1166
		CJSC Group Enrichment Factory, Luhansk	0,0367
	0028	Southern Office “Luhanskvoda” LLC, Luhansk	0,0126
	0026	Lugansk Repair and Mechanical Plant	0,0073
	0025	Avtomotozapchastyna, Luhansk	0,1331
	0023	Distillery, Luhansk	0,0018
	0021	OJSC Steel, Luhansk	0,0692
		OJSC Luhanskteplovoz, Luhansk	3,1671
	0019	Luhansk office, “Luhanskvoda” LLC	13,2244
	0012	Green Management and Development Combine, Luhansk	10,7059
Olkhovaya	0052	Zaporozhska mine, Antratsyt division, Krasnyi Luch	0,0084
	0040	Lutuhynska mine, SE “Luhanskvuhillya”, Lutuhyne District	2,2141
	0038	Lutuhyne division, “Luhanskvoda” LLC	1,0217
		Lutuhyne State Research and Production Roller Combine	0,0239
	0002	Casting and Mechanical Plant, Luhansk	0,0602
		Luhansk Tube Plant	0,0113
		Lyvarnyk LLC, Luhansk	0,0411
		Luhansk Tube Rolling Plant	0,0244
B. Vasyu-kovka	0006	UVKHV, Petrovske Municipal Council	0,1350
		Petrovsky State Chemical Association, Petrovske	0,151
	0002	Petrovsky State Chemical Association, Petrovske	0,5383

Bila	0076	Perevalsk Department "Luhanskvoda" LLC	0,0236
		Fashchivska mine, SE "Luhanskvuhillya", Fashchivka, Perevalsk District	3,9103
		Fashchivka Communal Company, Perevalsk District	0,054
	0066	"Cosmonauts" Enrichment Factory (Maloivanivska mine)	0,2893
	0046	Romanivska mine, Luhanskvuhlebudrestructuryzatsiya	5,3284
	0045	Fashchivka Communal Company, Perevalsk District	0,0589
	0042	Perevalska mine, Luhanskvuhlebudrestructuryzatsiya, Perevalsk	4,5476
	0036	Perevalsk Meat Processing Factory	0,0163
	0034	Perevalsk Department "Luhanskvoda" LLC	0,0362
	0021	XIX CPSU Congress mine, Luhanskvuhillya, Lutuhyne District	1,5843
	0016	Bilorichenska mine, SE "Luhanskvuhillya", Lutuhyne District	0,96
	0007	Alchevsk Production Office of Water Supply and Sewage Management	10,0765
	0003	Bilorichenskyi Communal Services, Bilorichenskyi	0,0275
Dolgaya	0007	Metallurgical Combine, Alchevsk	1,2324
Chernukhina	0013	Kosior mine, Luhanskvuhlebudrestructuryzatsiya	0,8785
	0007	Agro-Chornukhinski Chicken, Perevalsk	0,0605
Lozova	0038	Verhilivska mine, SE "Luhanskvuhillya", Bryanka	1,956
	0036	OJSC "Red Banner", Perevalsk District	0,0025
	0032	Nikanor mine, Perevalsk District	3,7376
	0030	Nikanor-New mine, Zorynsk, Perevalsk District	2,4306
	0023	Artem mine, Luhanskvuhillya, Perevalsk District	4,0333
	0020	Perevalsk Department "Luhanskvoda" LLC	0,1117
	0015	Metallurgical Combine, Alchevsk	0,2549
		Alchevsk Production Office of Water Supply and Sewage Management	0,0161
Kamyshe-vakha	0020	Bryankivska mine, SE "Ukrshakhtzakhyst", Bryanka	4,0902
	0010	Stakanov Rail Car Building Plant	0,2647
		Stakhanov Department "Luhanskvoda" LLC	3,1142
	0010	Rodina mine, Zolote	0,6995
	0005	Pervomayska mine, SE "Pervomayskvuhillya", Pervomaysk	2,5466
Lomovatka	0013	Lomovatska mine, Lomovatka, Bryanka	3,679
Karapulka	0020	Vuhlehirska mine, SE "Ordzhonikidzevuhillya", Vuhlehirsk	1,4636

Siverskyi Donets	0406	Svitlychansk office, “Luhanskvoda” LLC	0,0122
	0370	Luhanska mine, Yubileyne	0,0135
	0306	Luhansk office, “Luhanskvoda” LLC	7,544
	0252	Medical Service, OJSC “Krasnodonvuhillya”	0,0201
	0228	CE”Vodokanal”, Krasnodon	0,4326
Kundryucha	0230	Sverdlovsk Department “Luhanskvoda” LLC	0,0069
	0228	Sverdlov mine, OJSC “Sverdlovskekolohiya”	2,186
	0220	Chervonyi Partyzan mine, SE “Sverdlovanthracite”	2,2109
B. Burhusta	0018	Chervonyi Partyzan mine, SE “Sverdlovanthracite”	0,7
Talova	0010	Dovzhanska-Kapitalna mine, Sverdlovsk	6,4098
Velyka Kamyanka	0050	Pivdenna mine department, Revavtomatyka LLC, Krasnodon District	0,5301
	0046	Barakov mine, Sukhodilsk	0,4524
		Samsonivska-Zakhidna mine, Krasnodon District	0,8571
		Molodohvardiysk Production Office of Water Supply and Sewage Management, Krasnodon District	0,0636
	0035	Tyulenin mine, Krasnodon	2,4118
		Donetsk mine, Luhanskvuhlebudrestructuryzatsiya, Krasnodon	0,0262
	0021	Agroukrptakha LLC, Krasnodon District	0,0231
Verkhnye Provallya	0070	Sverdlovsk Department “Luhanskvoda” LLC	0,2968
	0024	Chervonyi Partyzan mine, SE “Sverdlovanthracite”	3,1335
B. Dolzhyk	0022	Sverdlovsk Department “Luhanskvoda” LLC	1,2772
	0021	Voykov mine, Krasnodon mine department, Sverdlovsk	3,996
	0020	Centrospilka mine, OJSC “Sverdlovskekolohiya”	1,7241
Medvezha	0018	East Coal Company LLC, Sverdlovsk	0,6008
Kamyanka	0010	Cosmonaut mine, DTEK Rovenkyanthracite	3,1965
		Rovenky Department “Luhanskvoda” LLC	0,1926
Mala Kamyanka	0014	V. V. Vakhrusheva mine, DTEK Rovenkyanthracite	1,5505
	0013	V. V. Vakhrusheva mine, DTEK Rovenkyanthracite	3,0451
	0009	Frunze mine, DTEK Rovenkyanthracite	0,2412
	0008	Frunze mine, DTEK Rovenkyanthracite	5,545
Luhanchyk	0065	Leninka, Sverdlovsk Directorate for Mine Liquidation, SE “Luhvuhlestructur”	0,2627

ANNEX 3 List of business entities that impose a significant man-induced load on the status of the SWB of the Siverskyi Donets basin.

Business entity	Discharge	Possible risks	Hazardous substances pollutants 2	Travel time 4
Private JSC "Avdiyivka Coking Plant"	Poshtovyi Loh ravine – Kamyanka (4 km) – Ocheretova (6 km) – Kryvyi Torets (70 km)	Burst of a sludge pool dam (1981, volume 4.68 mln m^3; burst of a storage pool dam (1981, 4.2 mln m^3); damage/destruction of sewage systems (discharge, sludge, phenol); – damaging/shutdown of an ammonia and phenolic water biochemical treatment facility (1964, 5.7 thous m^3/day), damage/shutdown of treatment facilities (1976, 33 thous m^3/day); discharge of Avdiyivka untreated effluent; 2013-2,058 mln m^3 (insufficiently treated wastewater), 2017-0,149 mln m^3 (untreated)	Hazardous specific pollutants (phenols, rhodanides, resins, oils, petroleum products), biogenic and organic substances	Up to 14-15 days to the water intake
Phenol Plant, Research & Production Association "Incor & Co" LLC	Kryvyi Torets (57 km)	Burst of a sludge pool dam, 2 km to Novhorodske (9,95 hectares – total surface area, 2,4 hectares volume 0,42 mln m^3, 2017-40% filling; burst of a sludge pool dam, 10 km to Horlivka (15,65 hectares, 0,515 ml m^3); damage to the sewage system: household, phenol (2 km), sludge (1.5 km); 2017 0.160 mln m^3 (insufficiently treated wastewater)	Hazardous specific pollutants (phenols, petroleum products), biogenic and organic substances	3-8.5 days to the water intake

PJSC Central Enrichment Factory "Dzerzhynska"	Kryvyi Torets (48 km)	Damage/shutdown of complex treatment facilities (mechanical treatment, 1972, 34 thous m^3/day; burst of household, industrial, collector and drainage sewage systems, 2017-0.012 mln m^3 (insufficiently treated wastewater)	Hazardous specific pollutants (petroleum products), biogenic and organic substances	
Central mine	Kryvyi Torets (48 km)	Damage/shutdown of complex treatment facilities (mechanical treatment, 5.5 thous m^3/day); burst of a settling pool dam (519 m^3), 2017-1.931 mln m^3 (low frequency – hazardous substances mine waters)	Hazardous specific pollutants, biogenic and organic substances	
Torezka mine	Bezimenna ravine – Kryvyi Torets (45 km)	Damage/shutdown of complex treatment facilities (mechanical treatment, 5.5 thous m^3/day); burst of a settling pool dam (900 m^3); clarification pond (272 thous m^3). 2017 p. – 1,936 mln m^3 (low frequency – hazardous substances mine waters)	Hazardous specific pollutants, biogenic and organic substances	3-8 days to the water intake
Donetsk Regional Production Office of CE"Donbas Water"	Kryvyi Torets (65 and 66 km)	Damage/shutdown of complex treatment facilities (biological treatment, 8.83 thous m^3/day); 2013-1.935 mln m^3 (insufficiently treated wastewater), 2017-1.242 mln m^3 (insufficiently treated wastewater)	Biogenic and organic substances	3.5-9 days to the water intake
Makiyivka Production Office of Water Supply and Sewage Management of CE"Donbas Water" (Makiyivka)	Shyroka ravine (3 km) – Kryvyi Torets (79 km)	Damage/shutdown of complex treatment facilities (biological treatment, 32.16 thous m^3/day); 2013-3.091 mln m^3 (wastewater treated to standard quality), 2017-2.647 mln m^3 (wastewater treated to standard quality)	Biogenic and organic substances	4-9.5 days to the water intake

OJSC "Yasynovskyi Coking Plant" (Makiyivka) 1	Kryvyi Torets (79 km)	Damage/shutdown of complex treatment facilities (mechanical treatment, 0.96 thous m^3/day); 2013-0.075 mln m^3 (wastewater treated to standard quality), 2017 – data unavailable.	Hazardous specific pollutants (phenols, rhodanides, resins, oils, petroleum products), biogenic and organic substances	3.5-9.5 days to the water intake
Horlivka Production Office of Water Supply and Sewage Management of CE"Donbas Water" (Horlivka) 1	Zalizna ravine (10 km) – Kryvyi Torets (56 km)	Damage/shutdown of complex treatment facilities (biological treatment, 96.10 thous m^3/day); 2013-8.255 mln m^3 (insufficiently treated wastewater), 2017-5.508 mln m^3 (insufficiently treated wastewater)	Biogenic and organic substances	3.5-9 days to the water intake
SE "2-Bis" mine (Horlivka) 1	Zalizna ravine (12 km) – Kryvyi Torets (56 km)	Damage/shutdown of complex treatment facilities (physical-and-chemical treatment, 6.4 thous m^3/day); 2013-1.263 mln m^3 (insufficiently treated wastewater), 2017 – data unavailable; suspension/shutdown/ damage of the mine water removal system (according to mass media)	Hazardous pollutants (mercury), biogenic and organic substances Mercury-containing waste (cinnabar), mercury vapor 3	3.5-9 days to the water intake
Private JSC "Bakhmut Agrarian Union"	Hladosov stream – Bakhmutka (Bakhmut, 72 km)	Damage/shutdown of complex treatment facilities (biological treatment, Novoluhanske), damage of a storage pool hydraulic structure (1100 thous m^3), dissolution pool (50 thous m^3) 2017, no pumping out, storage pool overfill in 2015-2017, violation of the effluent dissolution procedure (1/3 storage pool, 2/3 – Vuhlehirsk reservoir) and irrigation water supply to the Agro-Soyuz LLC fields.	Biogenic and organic substances	1-4 days to the water intake

Zolote mine, SE "Pervomaysk-vuhillya" (Zolote)	Kamyshuvakha (7 km) – Luhan (87 km)	Damage/shutdown of complex treatment facilities (mechanical treatment, 12.6 thous m^3/day); 2013-3.860 mln m^3 (insufficiently treated wastewater), 2017-5.021 (hazardous substances referred to low-frequency); suspension/shutdown/damage of the mine water removal system (water influx rate 260 m^3/hour), flooding of the operating mines "Karbonit" and "Hirska"	Highly mineralized mine waters containing hazardous substances (lead, nickel, cadmium), specific pollutants (vanadium, manganese cobalt, chromium, antimony) 3	
PJSC Central Enrichment Factory "Uzlovska" 1	Luhan (196 km)	Damage/shutdown of complex treatment facilities (mechanical treatment, 1974, 25 thous m^3/year); 2013-19.8 mln m^3 (wastewater treated to standard quality), 2017 – data unavailable. (from open information sources – the enterprise is operating)	Biogenic and organic substances	
Luhansk office, "Luhanskvoda" LLC (Luhansk) 1	Luhan (19 km) Siverskyi Donets (306 km down of Mykolayivka)	Damage/shutdown of complex treatment facilities (Verhunivska biological treatment plant, Phase 1, 25 thous m^3/day; 1982 – Phase 2, 17 thous m^3/day), 2013-13.224 mln m^3 (wastewater treated to standard quality), 2017 – data unavailable. Damage/shutdown of complex treatment facilities (Zhovtneva biological treatment plant, 1974, 164 thous m^3/day); 2013-7.544 mln m^3 (wastewater treated to standard quality), 2017 – data unavailable. Damage/destruction of sewage collectors, wastewater pump station, chlorinators, etc.	Hazardous pollutants (nickel, lead), specific substances (chromium, zinc, copper, manganese), petroleum products, synthetic surface-active substances, biogenic and organic substances	1.5-3.5 days to the RF border

Alchevsk Production Office of Water Supply and Sewage Management (Alchevsk) 1	Bila (7 km) – Luhan (40 km)	Damage/shutdown of complex treatment facilities (biological treatment, 69.7 thous m^3/day); 2013-10.077 mln m^3 (wastewater treated to standard quality), 2017 – data unavailable.	Specific substances (heavy metals: zinc, copper, manganese), petroleum products, synthetic surface-active substances, biogenic and organic substances	2.5-6 days to the RF border

1 NGCA
2 Biogenic substances: ammonia nitrogen, nitrates, nitrites, phosphates
3 May get into aquifers
4 To the water intake of the CE"Popasna District Vodokanal [Water Services]" or state border

2018