

Report on damages and losses to infrastructure from the destruction caused by Russia's military aggression against Ukraine as of June 2023

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July 2023

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PREAMBLE

This report presents the results of an assessment of the damage and losses to Ukraine's economy caused by Russia's military aggression. **The report covers the period from February 2022 to June 2023.**

In this report have been assessed:

- **damage** (complete or partial destruction) to the physical infrastructure of Ukraine as a result of the full-scale war.
- **losses** changes in economic flows as a result of the full-scale war; loss of income in various sectors of the economy, additional costs associated with the full-scale war, future losses that the economy will suffer as a result of the full-scale war.

The assessment of damages and losses was carried out within the framework of the National Council for the Recovery of Ukraine from the full-scale war by the analytical team of Kyiv School of Economics (KSE) together with the Ministry of Communities, Territories and Infrastructure Development, the Ministry of Economy of Ukraine, the Ministry of Health of Ukraine, under the coordination of the Ministry for Reintegration of the Temporarily Occupied Territories of Ukraine and in cooperation with other relevant ministries and the National Bank of Ukraine.

The overall damages and losses assessment was carried out in accordance with the World Bank methodology and in close cooperation with the World Bank dedicated team, taking into account a significant amount of microdata collected by the relevant authorities and local civil and military administrations since the beginning of the full-scale war.

The assessment methodology involves the use of direct and indirect methods, statistical data and certain assumptions, in particular regarding the extent of damages in areas where active hostilities are still ongoing, where physical inspection is limited due to danger (e.g. mined areas), or which are located in the territories occupied by the aggressor. To assess the value of damaged and/or destroyed assets, the average values are calculated based on data from the State Statistics Service, relevant ministries on procurement conducted through the Prozorro system, etc., applying adjustment factors according to the level of damages to the facilities. To assess the value of damaged or destroyed assets of large commercial facilities and identified institutions, information from financial statements relevant as of the latest available date is used.

At the same time, information on the actual (compared to the previous assessment) state of damage to facilities in the liberated and government-controlled territories of Ukraine is used as a “proxy” to clarify assumptions about the level of damages and the extent of destruction.

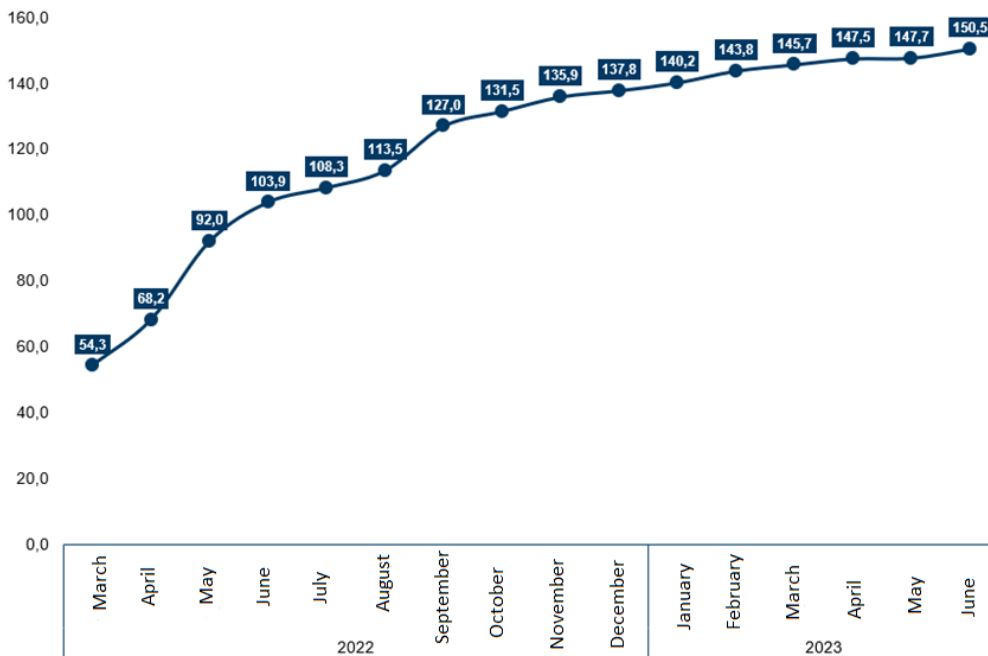
The research methodology is described in more detail in the materials of the working group “Audit of damages incurred as a result of the full-scale war” at the link:

<https://www.kmu.gov.ua/storage/app/sites/1/recoveryrada/ua/audit-of-war-damage.pdf>.

Economic damages and losses due to the destruction of assets. Key findings

Since the beginning of the full-scale Russian military invasion, the total amount of **damages** to residential and non-residential real estate and other infrastructure has amounted to more than **\$150.5 billion** (at replacement cost).

Dynamics of the aggregate estimate of damages to the Ukrainian economy, \$ billion

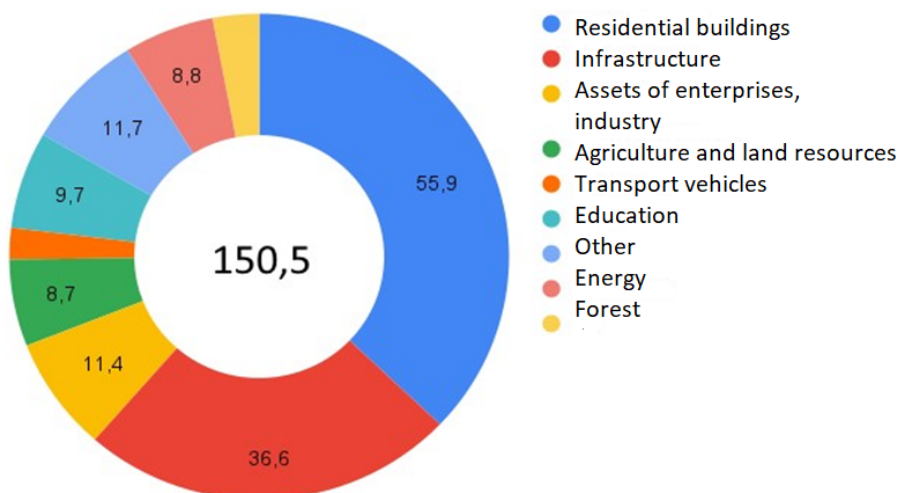


Source: Kyiv School of Economics

Residential buildings (37.1% or \$55.9 billion) and infrastructure (24.3% or \$36.6 billion) accounted for the largest share of total **damages**. Damages of business assets amounted to at least \$11.4 billion and continue to rise. Other \$8.7 billion was due to damages in the agricultural sector as a result of the full-scale war.

The total damages from destruction and damage to public sector facilities (social facilities and institutions, educational, scientific and healthcare institutions, cultural facilities, sports facilities, administrative buildings, etc.) amounted to about \$15.6 billion.

Damages by type of property, \$ billion



Source: Kyiv School of Economics

Total estimate of infrastructure damages as of June 2023

Property type	Assessment of damages, \$ billion	Share of damages by property type, % of total sum
Residential buildings	55.9	37.1%
Infrastructure	36.6	24.3%
Assets of enterprises, industry	11.4	7.5%
Education	9.7	6.5%
Agriculture and land resources	8.7	5.8%
Energy sector	8.8	5.8%
Forestry fund	4.5	3.0%
Transport vehicles	3.1	2.1%
Healthcare	2.8	1.8%
Communal services and utilities	2.7	1.8%
Trade	2.6	1.8%
Culture, tourism, sports	2.4	1.6%
Administrative buildings	0.5	0.4%
Digital infrastructure	0.5	0.3%
Social sector	0.2	0.1%
Financial sector	0.04	0.01%
Total	150.5	100%

Source: Kyiv School of Economics

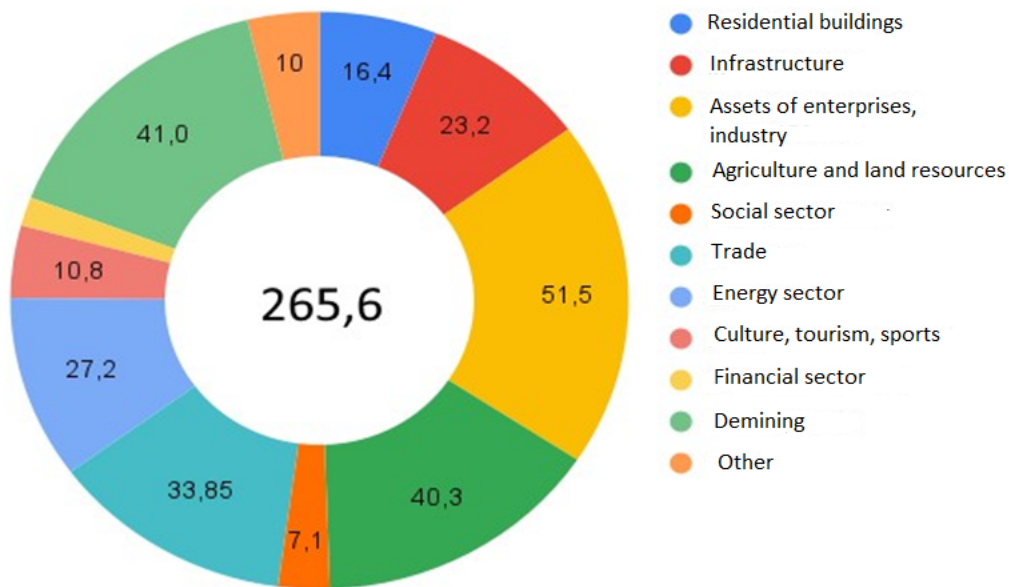
In turn, the **amount of losses** incurred by Ukraine due to the loss of income in various sectors of the economy, additional costs associated with the full-scale war, as well as future losses that the economy will suffer as a result of the full-scale war, amount to **\$265.6 billion**.

In the total amount of **losses**, the largest losses were incurred in the assets of enterprises and industry (19.4% or \$51.5 billion), as well as in agriculture and land resources (15.2% or \$40.3 billion). Losses in the retail sector as a result of the full-scale war amounted to \$33.85 billion (or 12.7%). The energy sector also suffered losses of at least \$27.2 billion (or 10.2%).

The total losses from destruction of infrastructure (transport infrastructure, roads, railways, aviation and port facilities) amounted to \$23.2 billion (or 8.7%) and continue to rise.

Also, according to preliminary estimates, demining costs will amount to about \$41 billion, which in turn is 15.4% of the total monetary estimate of losses.

Losses by property type, \$ billion



Source: Kyiv School of Economics

Total estimate of infrastructure losses as of June 2023

Property type	Assessment of losses \$ billion	Share of losses by sector, % of total sum
Assets of enterprises, industry	51.5	19.4%
Agriculture and land resources	40.3	15.2%
Trade	33.9	12.7%
Energy sector	27.2	10.2%
Infrastructure	23.2	8.7%
Residential buildings	16.4	6.2%
Culture, tourism, sports	10.8	4.1%
Social sector	7.1	2.7%
Financial sector	4.3	1.6%
Communal services and utilities	3.5	1.3%
Healthcare	2.7	1.0%
Education	2.1	0.8%
Digital infrastructure	1.4	0.5%
Transport vehicles	0.3	0.1%
Administrative buildings	0.040	0%
Total	224.6	
Demining	41	15.4%
Along with demining needs	265.6	100%

Source: Kyiv School of Economics

In the first weeks of the full-scale war, in late February and early March, hostilities took place in 10 regions. As of June 2023, hostilities continued in Kharkiv, Luhansk, Donetsk, Kherson and Zaporizhzhia regions. The regions of Ukraine most affected by the hostilities are those where the fighting took place: Donetsk, Kharkiv, Luhansk, Mykolaiv, Zaporizhzhia, Kyiv and Chernihiv regions. The cities that suffered the most during the full-scale war are: Maryinka, Mariupol, Irpin, Kharkiv,

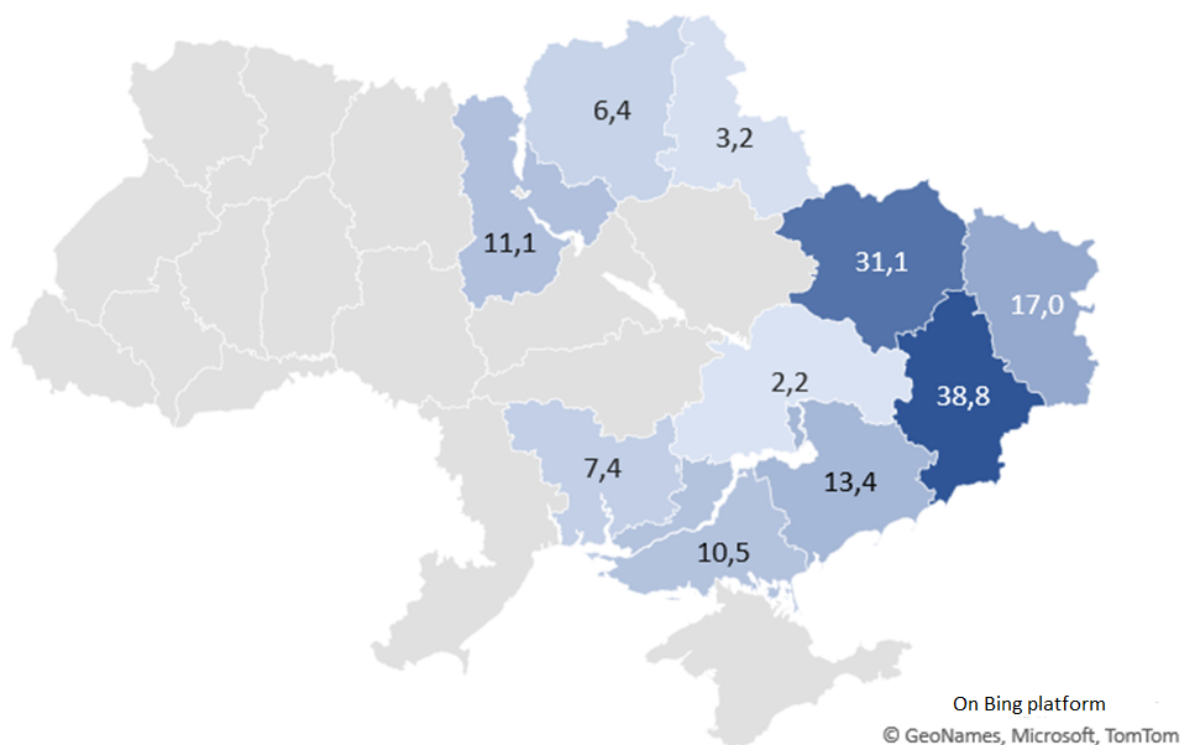
Chernihiv, Sievierodonetsk, Lysychansk, Vuhledar, Sumy, Rubizhne, Izyum, Mykolaiv, Bakhmut, Volnovakha.

The explosion of the Kakhovka hydroelectric power station in June 2023 caused at least \$2 billion of damages. The main sectors affected by this terrorist attack are: housing (\$950 million), energy (\$586 million), transport infrastructure (\$311 million), industry (\$105 million), and agriculture (\$25 million).

In addition, the estimated amount of damage to the environment is estimated at \$1.5 billion, with additional costs for the construction of water pipelines at \$41 million.

The damages and losses caused by the hydroelectric power station explosion are included in sector sections of the report.

10 most affected regions of Ukraine, \$ billion



Source: Kyiv School of Economics

Total estimated damages by region as of June 2023*

Regions	Estimated damages, \$ billion
Vinnytsia	412
Volyn	39
Dnipropetrovsk	2 222
Donetsk	38 807
Zhytomyr	1 057
Zakarpattia	15
Zaporizhzhia	13 378
Ivano-Frankivsk	325
Kyiv	9 992
Kirovohrad	345
Luhansk	17 033
Lviv	212
Mykolaiv	7 434

Odesa	725
Poltava	661
Rivne	101
Sumy	3 208
Ternopil	76
Kharkiv	31 084
Kherson	10 526
Khmelnysk	79
Cherkasy	118
Chernivtsi	84
Chernihiv	6 439
Kyiv city	1 205

** Not all categories of losses are subject to decomposition at the regional level*

Source: Kyiv School of Economics

The final assessment of the extent of damage and losses will be possible only after the end of hostilities in Ukraine. The report is structured by sector sections: a general assessment of damages and losses is provided for each sector. There are summary tables with data for each sector/industry at the end of the report in annexes.

SOCIAL SECTOR

Residential and administrative buildings

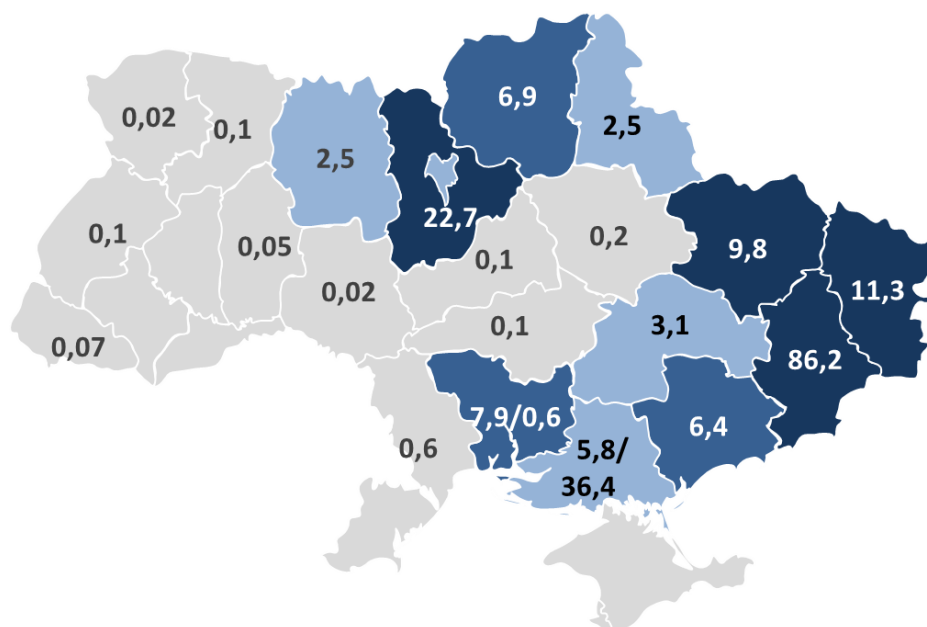
Active shelling of cities with rockets and artillery is part of Russia's tactics of warfare, which leads to significant destruction of housing in cities and towns, especially those located near the front line. As of June 2023, more than 50% of the housing stock in a significant number of cities and towns was damaged or destroyed as a result of the Russian Federation's hostilities. This requires not only the restoration of individual buildings, but also the comprehensive restoration of cities, the development of new urban planning documentation and other measures.

The most heavily damaged housing stock was found in the cities of Mariupol, Kharkiv, Chernihiv, Sievierodonetsk, Rubizhne, Bakhmut, Maryinka, Lysychansk, Popasna, Izyum and Volnovakha. For example, according to preliminary estimates, 90% of the housing stock in Sievierodonetsk was damaged, while cities such as Bakhmut and Maryinka have almost no undamaged buildings. At the same time, the number of damaged residential buildings (both multi-storey and individual houses) is increasing due to the ongoing active hostilities in Kharkiv, Luhansk, Donetsk, Zaporizhzhia, Kherson regions and the temporary occupation of part of Ukraine's territory, as well as throughout the rest of the country due to regular rocket attacks.

According to preliminary data from the regional military administrations, as of June 2023, the total number of destroyed or damaged housing facilities is **about 167.2 thousand buildings**, of which 147.8 thousand are private (individual) buildings; 19.1 thousand are multi-storey buildings; 0.35 thousand are dormitories.

As a result¹ of the explosion of the Kakhovka hydroelectric power station, almost 37,000 residential buildings were at risk of flooding, most of which are located in Kherson region (with varying degrees of flooding - completely flooded, partially flooded and possibly flooded). About 1,000 of the buildings at risk are multi-storey buildings, and the rest are private buildings².

Regional distribution of the number of destroyed or damaged housing stock, thousand units



Source: Kyiv School of Economics

¹ This publication has been prepared using data provided by the EMITTER project, which is implemented with the financial support of the European Union. Its contents are the sole responsibility of the project and do not necessarily reflect the views of the European Union.

The total area of damaged or destroyed facilities by shelling is **88.9 million square metres**, which is **8.6% of the total area of the housing stock** of Ukraine. According to preliminary estimates, 16.9 thousand residential buildings (with a total area of 15.6 million square metres) were partially damaged (the degree of destruction is less than 10%); 84.5 thousand residential buildings (with a total area of 48.12 million square metres) were moderately damaged (the degree of destruction is more than 10% or less than 40%); 65.8 thousand residential buildings (with a total area of 25.24 million square metres) were completely destroyed (the degree of destruction is more than 40%).² Based on the results of detailed site-specific technical inspections of buildings, this ratio may vary.

The area of buildings in the flood zone totalled another 4.8 million square metres.

Thus, the housing of about 1.4 million households (about 3.4 million people) is damaged or destroyed.

According to preliminary estimates, the value of damages for the residential buildings is \$55.86 billion.³ This is more than a third of Ukraine's total damages as of February 24, 2023.

Just to return the housing to its previous condition, it will be necessary to incur expenditures in the following areas:

- current repair of residential buildings;
- major repairs or reconstruction of residential buildings;
- new construction;
- restoration of the adjacent territory near residential buildings (fences, benches, landscaping, children's and sports grounds, etc.);
- purchase of durable goods (furniture, household appliances).

In addition, according to preliminary data, 630 administrative buildings were destroyed or damaged as a result of hostilities, including: 580 buildings of state and local authorities; 50 administrative service centres. According to preliminary estimates, the value of damage to administrative buildings is \$0.54 billion.

Losses to the housing stock amount to \$16.4 billion, which include increased costs to support the industry (\$0.1 billion), additional rental costs (\$11.4 billion), and costs for dismantling and removing construction waste (\$4.9 billion).

Healthcare facilities

Damages from the destruction of healthcare facilities amounted to \$2.78 billion. In total, at least 1,203 healthcare facilities have been damaged or destroyed since the start of the full-scale war.

As part of the project, the calculation of damages includes an assessment of damage to healthcare facilities, including hospitals, polyclinics, dentists, consultative diagnostic centres, medical offices, obstetric stations, outpatient clinics, rehabilitation and health centres, laboratory and blood centres, and outbuildings of healthcare facilities. Damages to private healthcare facilities were calculated separately.

The data on the destruction of the relevant healthcare facilities were obtained from the Ministry of Health for public facilities, microdata for private facilities, and open sources.

To calculate the losses, the following information was used: the number and cost of beds, the area of the facilities, the average cost per square metre, the cost of similar facilities in the Prozorro public procurement system, and open source data on the extent of damage to the facilities.

² The distribution of data on the degree of damage was based on the analysis of site-specific data and expert assumptions.

³ In calculating direct losses, the values of the indirect cost of housing construction by regions of Ukraine as of January 01, 2022, approved by the [order No.53 of the Ministry of Regional Development dated February 17, 2022](#), as well as other components of the replacement cost, which were calculated based on market values and expert assumptions, were used as the base values.

Damage to healthcare facilities accounts for about 1.2% of Ukraine's total losses. In terms of types of healthcare facilities, the full-scale war has destroyed or damaged the most outpatient clinics - 350 - and hospitals - 368, with hospitals accounting for 74% of the total damage to the sector. As of June 2023, at least 24 private medical facilities were damaged. However, the documented damage primarily concerns state-owned facilities.

More than half of the damages to the healthcare sector is concentrated in two regions - Donetsk and Kharkiv.

The estimate of **losses** to the healthcare sector was **\$2.7 billion**, which consists mainly of lost income of private medical institutions, taking into account the suspension of operations due to security risks, and the departure of some healthcare recipients from Ukraine.

Educational institutions and scientific infrastructure facilities

The education sector is one of the most affected by the war in terms of the number of destroyed, damaged and lost infrastructure facilities. In total, almost 3,400 educational institutions were damaged as a result of the hostilities, and the educational process in schools and other institutions was suspended for a long time in many regions.

This has forced the government to cut spending on education from the state budget in order to allocate part of the money to more urgent needs, such as defence, disaster relief and increased social protection needs.

Damages from the destruction of educational institutions amounted to \$9.7 billion. In total, at least 997 educational infrastructure facilities have been destroyed and 2,380 damaged as a result of the hostilities. Over the past month, 4 schools in Kherson region and 3 schools in Mykolaiv and Kirovohrad regions have been damaged or destroyed. The educational institutions whose damage is being assessed under the project include: pre-school (kindergartens), secondary (schools), out-of-school, pre-university (colleges and technical schools), higher (institutes, universities, academies) and specialised educational institutions.

The main losses in the field of education related to secondary, pre-school and vocational education institutions, due to their prevalence and attractiveness for use by the aggressor's forces during hostilities. Despite the fact that active hostilities took place in 11 regions, educational institutions were damaged in 18 regions.

There were no losses as a result of these damages and destruction of educational institutions in Volyn, Zakarpattia, Ivano-Frankivsk, Poltava, Ternopil and Chernivtsi regions.

The largest losses from the destruction and damage to educational institutions were in Kharkiv, Donetsk, Chernihiv, Zaporizhzhia and Kyiv regions.

Among the damaged and/or destroyed educational facilities, the largest number of schools (1,684) and kindergartens (960).

The scientific infrastructure has also suffered losses, with preliminary estimates suggesting that 117 movable and immovable property items of 34 institutes and other institutions of the National Academy of Sciences of Ukraine have been destroyed, damaged and seized for the needs of the Armed Forces of Ukraine. The preliminary total estimate of damages for NASU research institutions alone is \$7.8 million.

The estimate of **losses** in the education sector was **\$2.08 billion**, which includes lost income of private educational institutions, taking into account the suspension of activities due to security risks and the departure of some recipients of educational services from Ukraine; as well as a reduction in budget expenditures on education and science.

Social protection

As a result of large-scale hostilities in various regions of Ukraine, social welfare institutions have suffered, including destroyed and damaged social centres, geriatric facilities, sanatoriums, children's homes and camps, residential institutions, and homeless shelters.

Over the course of more than a year of full-scale warfare, damages to state`s social welfare institutions has amounted to \$0.2 billion (at replacement cost).

The methodology used to analyse damages includes destruction and damage to social welfare institutions under the jurisdiction of the Ministry of Social Policy of Ukraine. The assessment is based on the data on destruction and damage to social welfare institutions provided by the Ministry of Communities, Territories and Infrastructure Development of Ukraine.

Social centers, sanatoriums and residential institutions accounted for the largest share in the total number and cost of damages.

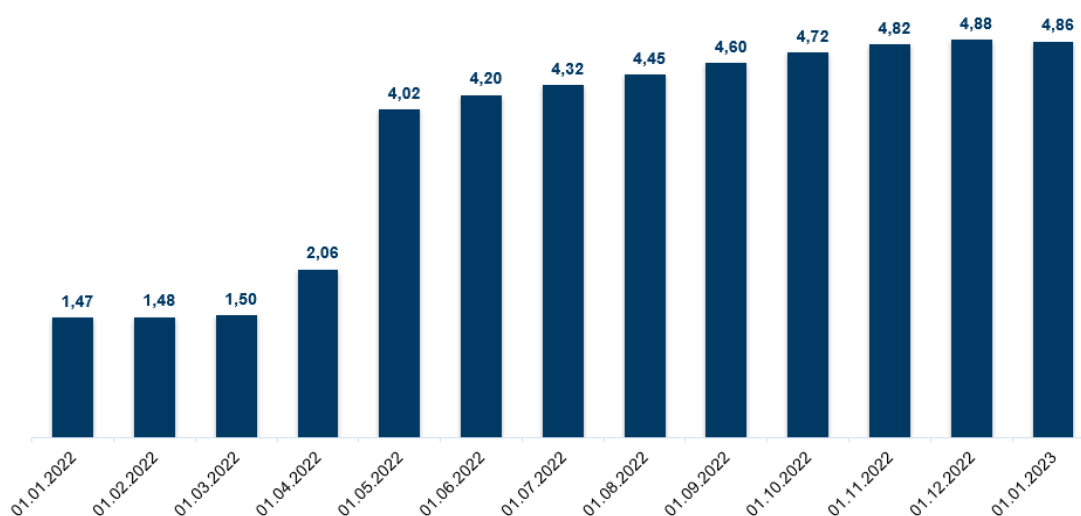
Among social welfare institutions, the smallest number of destroyed or damaged institutions and, accordingly, damages were documented compared to other infrastructure facilities in the country. The damaged social welfare institutions are located in Kyiv and the following regions: Kyiv, Donetsk, Dnipropetrovsk, Zhytomyr, Zakarpattia, Zaporizhzhia, Luhansk, Mykolaiv, Sumy, Odesa, Kharkiv, Kherson, and Chernihiv regions. Destroyed social welfare institutions are located in Luhansk, Donetsk, Zaporizhzhia, Kyiv, Mykolaiv, Sumy, Kharkiv, Kherson, Chernihiv regions and Kyiv city.

As a result of the Russian aggression, the number of people in need of social protection from the state has increased significantly. According to the Pension Fund of Ukraine, social benefits in 2022 were given to 32.9 thousand people who were disabled as a result of the full-scale war, 33.5 thousand people who were released from active duty due to disability, and 21.9 thousand family members who lost a breadwinner - a military personnel. For this, the Government allocated UAH 5.1 billion.

Over the year of full-scale war, millions of Ukrainians have been forced to become internally displaced persons (IDPs) or refugees. According to the Ministry of Social Policy of Ukraine, the number of registered IDPs during the period of martial law increased by 3.3 million people to almost 5 million. In 2023, half of them needed accommodation allowance payments.

Total expenditures for accommodation allowance payments to IDPs amounted to \$1.7 billion in 2021 due to an increase in recipients to 1.4 million people.

Dynamics of the number of IDPs in 2022, million people



Source: Ministry of Social Policy of Ukraine

The largest number of people moved from the areas where active hostilities were taking place at the beginning of the full-scale invasion, particularly Donetsk region - 526.1 thousand people,

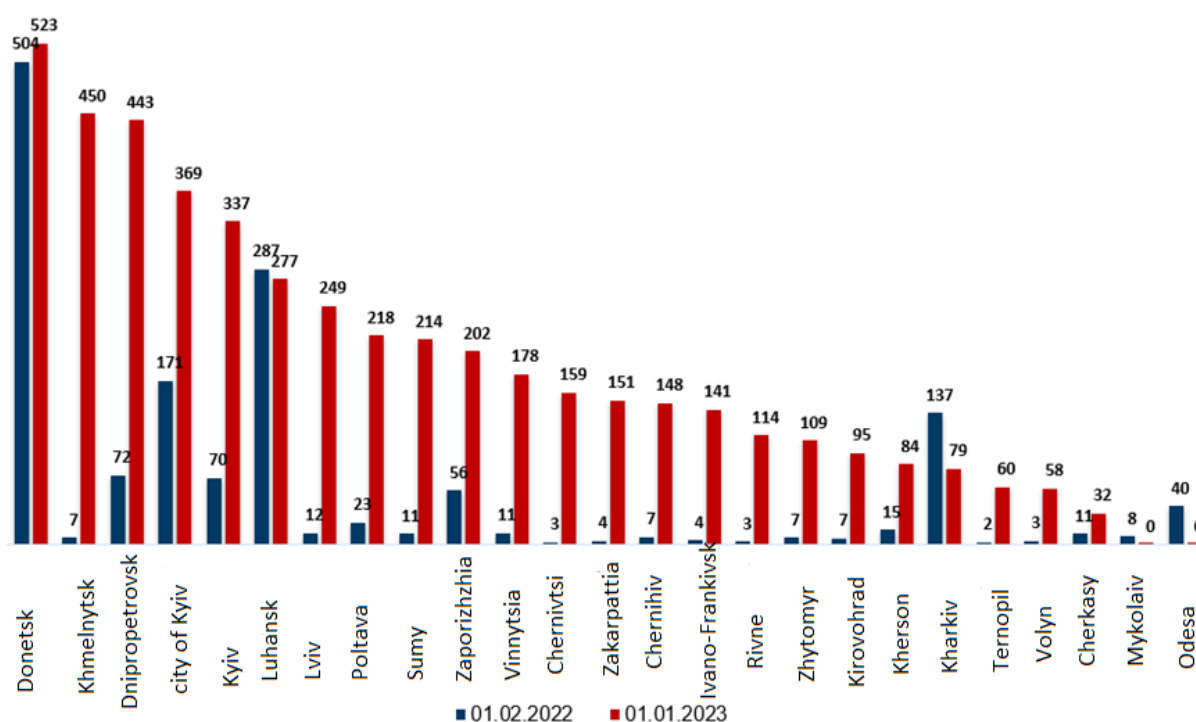
Kharkiv region - 461.9 thousand people, Dnipro region - 448.3 thousand people, Kyiv region - 334 thousand people and Kyiv city - 374.1 thousand people.

In March 2022, more than 500 thousand people moved within the country at once. In April 2022, the number of registered IDPs increased to its highest level since the beginning of the full-scale war, reaching 4.02 million people. In the following months, the number of registered IDPs increased by 21%. As of 01.02.2023, the number of IDPs reached 4.86 million people.

The regional structure of IDPs registration has changed significantly. At the beginning of 2022, the largest number of IDPs was registered in Donetsk region – 504 thousand people, Luhansk region – 287 thousand people, Kyiv city – 171 thousand people, Kharkiv region – 137 thousand people, and Dnipro region – 72 thousand people.

At the beginning of 2023, the largest number of registered IDPs was in Donetsk region – 523 thousand people, Kharkiv region – 450 thousand people, Dnipro region – 443 thousand people, Kyiv city – 369 thousand people, Kyiv region – 337 thousand people.

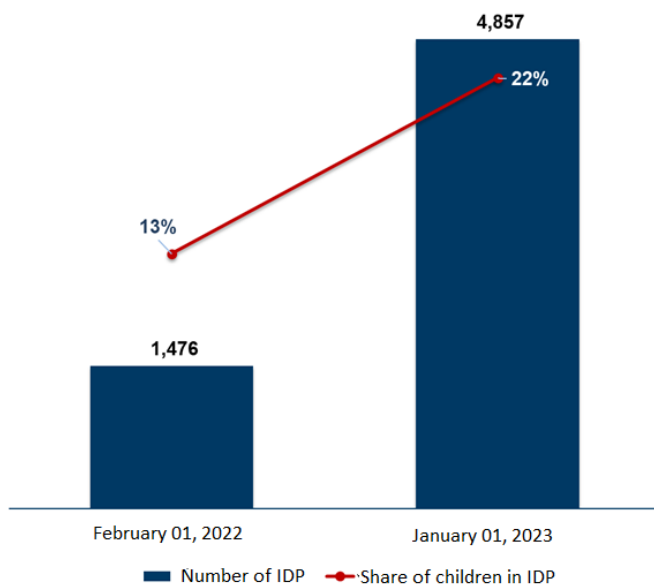
Number of IDP by regions, thousand people



Source: Ministry of Social Policy of Ukraine

In 2022, the gender structure among IDPs changed slightly, with fluctuations of 1%: displaced men account for 40% of the total number of IDPs, and women - 60%. The number of children in the IDPs structure increased significantly from 13% as of January 01, 2022 to 22% as of January 01, 2023.

Share of children in the total number of IDPs



Source: Ministry of Social Policy of Ukraine

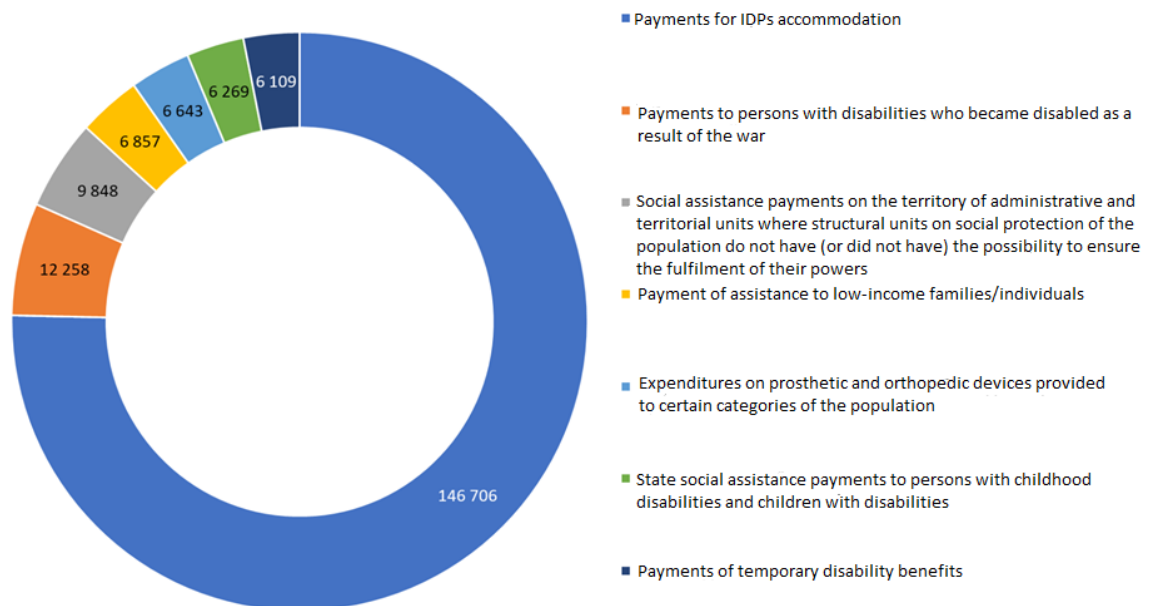
The estimate of social protection losses was \$7.1 billion, which consists of additional costs of Ukraine for social assistance payments to the population and for financing additional social services aimed at overcoming the consequences of the military aggression of the Russian Federation.

Social protection losses also include \$19.1 million allocated from the state budget reserve fund to pay one-time assistance to the population affected by the floods caused by the destruction of the Kakhovka hydroelectric power station.

Social protection losses of the population from the largest areas of funding that have emerged or are increasing as a result of the armed aggression of the Russian Federation include the following:

- accommodation allowance payments for IDPs - 71%;
- payments to persons with disabilities who became disabled as a result of the war - 6%;
- social assistance payments on the territory of administrative and territorial units where structural units on social protection of the population do not have (or did not have) the possibility to ensure the fulfilment of their powers - 5%
- state social assistance payments to persons with childhood disabilities and children with disabilities - 3%;
- payments of temporary disability benefits - 3%;
- expenditures on prosthetic and orthopedic devices provided to certain categories of the population - 3%;
- payment of assistance to low-income families/individuals - 3%.

TOP 7 areas of use of public funds for social protection, expenditures on which increased as a result of Russia's armed aggression, for 33 months, UAH million



Source: Ministry of Social Policy of Ukraine

Culture, sports, tourism

Since the beginning of the large-scale invasion, the cultural sphere has suffered the greatest historical losses in the history of independent Ukraine. For every country, culture is the basis of self-determination for every citizen, and the destruction of cultural facilities such as museums, historical buildings, monuments and artworks by prominent people is a very painful blow to Ukrainians, as with the destruction of each cultural facility, a part of the history of Ukraine and the Ukrainian people is lost.

Due to the high intensity of hostilities in eastern and southern Ukraine, as well as regular rocket attacks across the country, most cultural and sports institutions have ceased operations or significantly reduced their work. As a result, 12.5 million people in at least 6 regions of the country (Donetsk, Zaporizhzhia, Luhansk, Mykolaiv, Kharkiv, Kherson) have lost access to services, and another 13 million people in 7 regions have limited access to them.

According to the registers of national cultural heritage, there are about 15.5 thousand cultural heritage sites in Ukraine, of which about 1.2 thousand are sites of national importance and 14.3 thousand are local. These sites are categorized into eight types: historical, architectural, archaeological monuments, landscape, monumental art, urban planning/urban development sites, landscape gardening sites, and science and technology sites.

Among the most painful losses of this full-scale war on the cultural front are the Holy Dormition Sviatohirsk Lavra, which is included in the UNESCO World Heritage List, the museum of Hryhoriy Skovoroda, author of world-famous philosophical and artistic works, and even a collection of Scythian gold found by archaeologists in the 1950s. In addition, other important cultural and religious sites have suffered significant damage, including the Mykolaiv City Palace of Culture “Korabelnyi”, the Mariupol Drama Theatre, the Kharkiv National Academic Lysenko Opera and Ballet Theatre, the Museum of Antiquities in Chernihiv, the Kharkiv Slovo Building and many others. At present, the assessment of cultural heritage losses is based on an object-by-object list of damaged/destroyed facilities provided by witnesses and local administrations, which creates risks of incomplete data on the list of damaged facilities. Due to the lack of access to most of the damaged objects due to their location in the areas of hostilities, the list is incomplete and continues to increase.

Since the beginning of Russia's military aggression, 348 religious sites, 705 houses of culture/palaces of culture, 82 museums, 157 hotels/restaurants and 8 sports stadiums have been damaged in Ukraine according to documented losses, mostly located in 14 regions of the country: Dnipro, Donetsk, Zhytomyr, Zaporizhzhia, Kyiv, Luhansk, Lviv, Mykolaiv, Odesa, Sumy, Kharkiv, Kherson, Chernihiv and Kyiv city.

As of June, the share of **damages of the infrastructure of culture, religion and tourism totalled \$2.4 billion**. In total, at least 1,804 cultural facilities, 348 religious buildings, 343 sports facilities, and 164 tourism facilities have been damaged or destroyed since the start of the war.

An important methodological limitation of this calculation is that the financial value of cultural facilities is calculated without taking into account the actual value of the cultural value of these facilities, given the difficulties in calculating such value remotely, as well as the lack of a single and comprehensive register of cultural buildings that would contain detailed data on cultural heritage, art objects, and a list of museum artifacts in each of the facilities. Also, given this limitation, the current stage does not include the loss of libraries, museum collections, costs of relocation of museum collections, etc.

Projects for the restoration, conservation, and museumification of cultural heritage sites are developed individually for each site, taking into account the totality of survey data and best international practices, which requires the involvement of international experts; the cost estimation of such projects takes time and is based primarily on the results of a comprehensive survey and thorough documentation.

The valuation of damaged or destroyed cultural property is complicated by the difficulty of indirectly assessing the value and cost of the interior decoration of religious and other cultural institutions, art objects, decorations, exhibits, icons, frescoes, etc. contained in the buildings. Accordingly, the value of damaged objects of cultural value may be changed in accordance with the establishment of the possibility of restoration of these objects and its cost.

Total losses in culture, tourism and sports as of June amounted to \$10.8 billion, of which \$6.4 billion was for culture and sports, and \$4.4 billion for tourism.

The valuation of damaged or destroyed cultural property is complicated by the difficulty of indirectly assessing the value and cost of the interior decoration of religious and other cultural institutions, art objects, decorations, exhibits, icons, frescoes, etc. contained in the buildings. Accordingly, the value of damaged objects of cultural value may be changed in accordance with the establishment of the possibility of restoration of these objects and its cost.

The spheres of culture and tourism are interdependent. The accumulation of cultural heritage sites and cultural institutions that combine cognitive/educational and entertainment functions in their activities creates tourist attraction for such places, which leads to the formation of cultural and tourist areas.

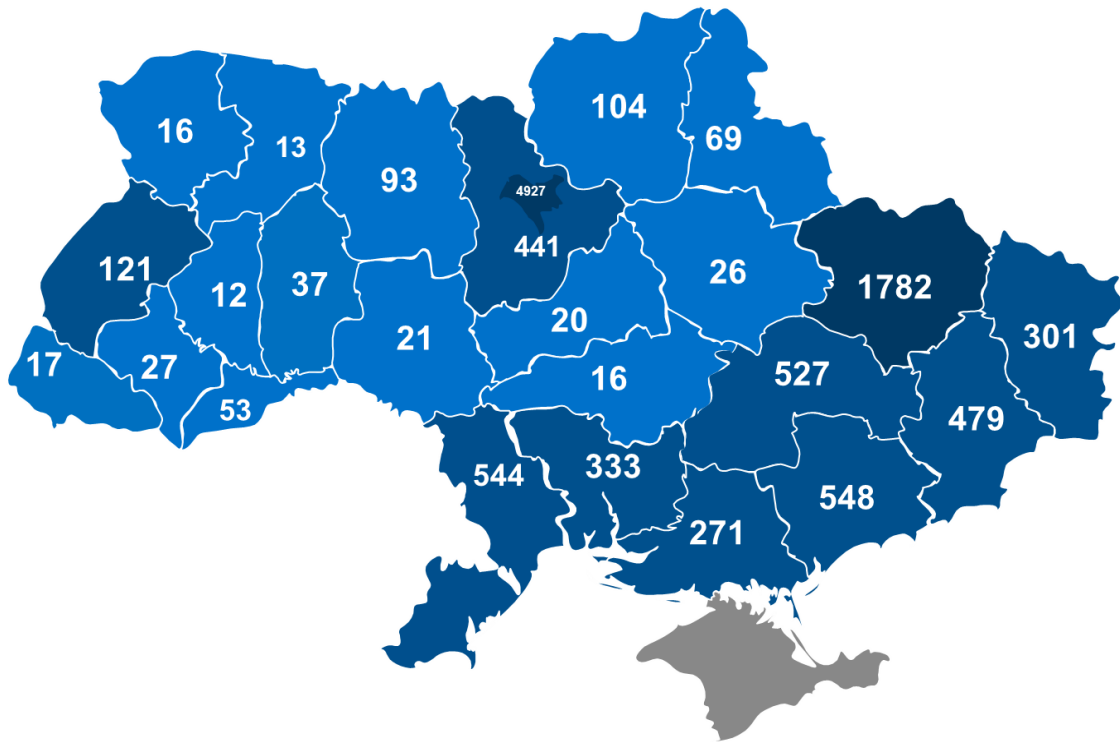
Such areas suffer the greatest losses, as the destruction and damage to cultural sites leads to major losses not only in the cultural sphere itself, but also in the tourism sector. This also works in the opposite direction. Accordingly, this affects indirect economic losses due to the destruction of the most attractive cultural and tourist sites, migration of the cultural community and the lack of domestic and foreign tourists.

The loss of cultural and tourist sites leads to a partial loss of the cultural and tourist value of certain regions of Ukraine, which may result in the loss of economic and financial support in the future. The migration of representatives of professional communities is also a very important factor in indirect losses, as culture is shaped by the people who work in it. The migration of a large number of troupes, choirs and ensembles, even within Ukraine, can contribute to an imbalance in the financial situation within the country towards more "safe" regions.

Tourism in Ukraine is currently losing a very significant amount of money. This is primarily due to a decrease in the total number of tourists. Ukraine is now completely without foreign tourists, who numbered about 4 million in 2020, almost 90 thousand of whom used the services of Ukrainian travel agencies. The situation with domestic tourism is quite similar. Due to active hostilities, the threat of missile attacks and mined tourist areas, 13 out of 24 regions were left without tourism in

full (100% of tourism businesses stopped operating) or in part (50% of tourism businesses stopped operating).

Losses in culture, tourism and sports as of June 2023 by regions, \$ million.



Source: Kyiv School of Economics

The estimated amount of damages and losses by type of loss is disclosed in Annexes.

PRODUCTIVE SECTOR

Industry and business services

The total damages of enterprises' assets is estimated at \$11.4 billion. In total, at least **426** large and medium-sized private enterprises, as well as state-owned enterprises, and tens of thousands of small private enterprises, have been damaged or destroyed since the start of the full-scale war. The true figure is likely to be higher, as not all enterprises are reported, especially those in the temporarily occupied territories.

Enterprises could be divided into two groups. The first was those destroyed by accident or “along” with shelling of military units and settlements. The second was destroyed intentionally as part of targeted strategic missile strikes. In addition to transport and energy infrastructure facilities described in the relevant sections, these are primarily military and dual-use production facilities. Unlike the first group, which is concentrated in the frontline regions, the second group is evenly distributed throughout Ukraine.

Damages include:

- Damage of fixed assets (the original valuation is used, since it is not possible to purchase an asset at its carrying amount in most cases);
- Damage of capital investments in progress;
- Damage of inventories of finished goods and intermediate materials (with the that in most cases the inventories were located close to the main production facilities).

Depending on the availability of data, losses are calculated in one of the following ways:

- This estimate is used for private enterprises for which the owner has reported its own estimate of damages, after verification.
- The financial statements as of the latest available date are used for large and medium-sized private enterprises for which the existence and level of damage is known. We distinguish between destruction (100%) and damage (40%).
- We use estimates provided by the ministries and agencies that manage the respective companies (if available, otherwise financial statements are used, as in the case of private companies) for public utility companies.
- The indirect calculation based on the level of damage to residential property in the regions is used for small private enterprises as an interim indicator.
- The value of assets (through ratios to revenue based on the financial statements of legal entities) was first estimated for individual entrepreneurs, and then damages were calculated similarly to small private enterprises.

The main conclusions regarding the damages of enterprises are as follows:

1. Business assets are the third largest item of infrastructure damage. It accounts for almost 8% of total losses.
2. In terms of industries, metallurgy suffered the most. In particular, two of the largest enterprises on the list of damaged/destroyed were destroyed - Azovstal and Illich Iron and Steel Works (both in Mariupol, see the list in Annex 7).
3. In terms of regions, Donetsk region suffered the most, accounting for almost half of the total damages incurred by the enterprises. There were also significant damages in Kharkiv, Luhansk and Kyiv regions.

The total losses to enterprises' assets are estimated at \$51.5 billion, the highest amount of the losses among all sectors, or almost 23% of the total amount of losses. Losses include the loss of income of destroyed or damaged businesses, as well as losses at the national level of certain sectors which operations have been significantly hampered.

Retail

The information on damages of **retailers** was obtained by analyzing data from two waves of a study conducted by the Ukrainian Council of Shopping Centers (the first wave was conducted jointly with the Association of retailers of Ukraine).

The study was conducted through a standardized online survey (CAWI) of top managers of retail companies. Representatives of 271 companies took part in the survey, including both chain and non-chain companies. A number of respondents were interviewed twice - during each of the study waves.

According to the study, at least 2.9 thousand retail outlets sustained significant damage.

The retail outlets include the following:

- Shops;
- Pharmacies;
- Kiosks;
- Petrol stations.

However, retailers' damages are not limited to the damages at their retail outlets. Thus, the issue of damages included the following items:

- Damage to the building/premises of the company-owned outlets, engineering networks and finishing/repair;
- Damage to equipment;
- Damage to inventories in retail outlets (at purchase prices);
- Damage to warehouses, production, office buildings/premises owned by the company and equipment therein;
- Damage to inventories in warehouses (at purchase prices);
- Other damages.

The amount of **damages** incurred by retailers reached **\$2.19 billion**. It did not include the damages of individual entrepreneurs.

Another source of damages in the retail sector is damages of **shopping centres (SCs)**. Shopping centres are not participants in the retail market, but provide space for retailers to carry out their professional activities.

According to the ICSC definition, a shopping centre is a retail property that is planned, built and managed as a single entity, comprising units and "communal" areas, with a minimum gross leasable area (GLA) of 5,000 square metres.

According to the Ukrainian Council of Shopping Centers (UCSC), which maintains a register of shopping centres and provided data on their damages, there are 329 shopping centres in Ukraine, of which 8 were destroyed and 19 damaged.

The amount of damages incurred by the shopping centres as a result of the hostilities is **\$407 million**.

The expert assessment of the damage took into account the area and nature of the damage, based on the construction cost of \$800-1100 per 1 sq. m, depending on the type of facility. The calculation of direct losses of the shopping centre does not include tenants' losses (equipment and goods), as they are already included in the losses of retailers.

Thus, the **total amount** of the industry damages since the beginning of the full-scale war in Ukraine is **\$2.60 billion**.

The industry's **losses** consist of lost retail revenue and lost shopping centre revenue.

The lost retail revenue for 10 months of 2022 was calculated as the difference between the turnover expected in 2022, taking into account the average annual growth of the industry over the last 5 pre-war years, and the actual turnover in 2022 according to statistics. Since the beginning of Russia's full-scale war of Ukraine, it has amounted to **\$31.41 billion**.

The Ukrainian Council of Shopping Centres calculated the **lost revenue of shopping centres** according to its own model, which includes not only the current monthly decrease in the revenue of shopping centres, but also the loss of revenue due to the destruction/damage of shopping centres, loss of control over shopping centres in the temporarily occupied territories and delays in commissioning of shopping centres under construction/design, thus, the lost revenue of shopping centres is **\$2.44 billion**.

In total, losses of the industry amounted to \$33.85 billion, which ranks this sector third in terms of indirect losses with a share of 15.1%. An estimate of the amount of direct and indirect losses by type of loss is provided in Annex 8.

Agriculture, land resources and forestry

As of June 2023, the amount of damages incurred by the Ukrainian agricultural sector amounted to \$8.7 billion.

Estimates of **damages** to the agricultural sector and agricultural infrastructure include the following main components: damage to agricultural machinery; damage to elevators and other grain storage facilities; livestock damages from animal deaths and forced slaughter due to the inability to keep animals; damage to perennial crops plantations; damages to beehives and other beekeeping assets; and damages to inputs and finished products due to the destruction and theft.

The abovementioned damages are estimated using indirect methods, a combination of relevant state and regional statistics, as well as data from surveys of agricultural producers conducted in 2022.

The largest share of damages was due to the destruction and damage to agricultural machinery, resulting in estimated damages of over **\$4.66 billion**. The second largest category was losses due to the destruction and theft of finished products, with the total value of destroyed and stolen products estimated at \$1.9 billion.

The infrastructure for storing agricultural products has suffered significant losses. The total capacity of the destroyed granaries reaches 8.2 million tonnes of output, and the capacity of the damaged granaries reaches 3.2 million tonnes of simultaneous storage capacity. The cost of restoring the damaged facilities is estimated at \$1.32 billion.

According to the Zoï Environment Network, the total area of forest fires in the areas where active hostilities took place is almost 298 thousand hectares. This area of forest fires in 2023 exceeds the average annual area of forest resources destroyed by fires throughout Ukraine by more than 50 times. According to the KSE's calculations based on the State Statistics Service of Ukraine, the average annual area of forest plantations lost due to forest fires is 5270 hectares. During the available 11 years of observations of the volume of forest resources lost due to fires (2010-2020), the highest value was recorded in 2020. At that time, the area of forest plantations destroyed reached 28 thousand hectares. One of the key factors behind this volume of forest fires is the difficulty in extinguishing forest fires in areas where active hostilities are or have been taking place. Even in the liberated territories, fighting forest fires is significantly complicated by the threat of mine contamination.

Forest damages due to forest fires are estimated at more than 82.9 million cubic metres of timber with an estimated value of \$4.5 billion.

As of June 2023, losses of the agricultural sector were estimated at \$40.3 billion.

Losses include losses in crop production, livestock production, losses to producers due to disruption of exports, as well as losses due to increased production costs and losses due to the need for recultivation.

These losses were estimated using indirect methods by combining state and regional statistics and data from a survey of agricultural producers conducted in 2022.

The largest share of indirect losses was caused by a decline in crop production. The decline in crop production was driven by a reduction in planted areas and changes in production technology, which resulted in lower yields of major crops. The total indirect losses due to the decline in crop production amounted to \$23.0 billion and correspond to the decline in production over two annual crop cycles - a decline in production in 2022 and 2023 calendar years.

The second largest category of losses was losses due to export disruption. The naval blockade imposed by Russia at the beginning of the invasion and the subsequent limited functioning of the so-called grain corridor led to higher logistics costs, which caused a decline in domestic prices for the main export-oriented products of the agricultural sector. Losses due to export disruptions were estimated at \$14.5 billion.

Indirect losses due to reduced livestock production amounted to \$1.7 billion, losses due to higher prices for inputs (fuel and mineral fertilizers) amounted to \$0.8 billion, and losses due to the need for land recultivation were estimated at \$0.2 billion.

The estimated amount of damages and losses by type of loss is disclosed in Annex 9.

INFRASTRUCTURE

Transport infrastructure

Infrastructure facilities became one of the key areas that suffered the greatest attacks by the aggressor with the unfolding of a full-scale war against Ukraine. In particular, in the first weeks of the full-scale war, Russian troops carried out massive shelling of aviation infrastructure, primarily airfields not only for military but also for civilian and military-civilian (dual) purposes. Subsequently, railway infrastructure, including power substations, became the targets of active attacks.

Thus, road infrastructure facilities suffered the greatest damage, both in absolute and value terms. Firstly, because they are naturally targeted during artillery attacks, and secondly, because Russian tanks have been actively moving along Ukrainian roads throughout the entire period of military aggression. In particular, motorways were used as communication lines between Russian troops in Ukraine and their rear in Russia and Belarus.

Since the beginning of the hostilities in Ukraine, 19 airports and civilian airfields have been damaged; at least 126 railway stations and stations have been damaged.

According to preliminary estimates, **the total amount of damages to transport infrastructure in Ukraine was \$36.6 billion.**

At the same time, the amount of **losses** amounted to **\$23.2 billion**. This amount includes the loss of income by enterprises in the sector, the cost of dismantling the destroyed facilities, economic costs, reduced spending on road construction, economic costs associated with civilian and military tasks, etc.

Road infrastructure

A detailed analysis of the condition of the roads damaged by shelling and tank traffic is possible only with a specialised technical inspection, which is not possible in a situation where active hostilities are still ongoing in a large part of Ukraine, and some roads and bridges are located on the temporarily occupied (after 24.02.2022) territory.

However, analysing the map of hostilities and comparing it with the road network allows us to make preliminary calculations of the approximate length of roads damaged by the full-scale war, both as a result of rocket attacks and tank movements. According to a study (Damaging Effect of Moving Tank Loads on Flexible Pavement, Journal of Engineering, 2010), the damaging effect of a tank can reach 2.36 times the damaging effect of a standard axle load from civilian vehicles. In this study, T-72 tanks were used, which is a good approximation in the case of the full-scale war in Ukraine, as most tanks are similar in physical characteristics or even heavier. The surface layer of the roads is severely damaged by metal tracks. Also, the destructive effect of tank braking is 2.38 times greater than the destructive effect of the tank's weight on the road's stretching. Finally, the destructive effect of tank manoeuvres is 1.22 times greater than the effect of the destructive effect of the tank's weight on the road's tension. What is important is that the effect of the tank's stress is not only horizontal but also vertical, and the maximum stress, according to study, is at a depth of up to 3 metres, which affects the degree of destruction not only of the surface layer of the road.

The peculiarity of road assessment is also that the average cost of damage and restoration of one kilometre of road in a city is usually significantly more expensive (the difference can be one third or more) compared to the cost of roads outside the city, since road construction in cities, in addition to the construction of the roadbed, also involves the construction of communication networks, sidewalks, lighting, etc.

According to preliminary estimates, a total of **25,400 km of roads and 344 bridges and bridge crossings of state, local or municipal importance** were damaged as a result of the hostilities (for bridges and roads, see the Ministry of Infrastructure). According to the Ministry, a preliminary review of the condition of roads in the de-occupied regions (Chernihiv, Kyiv, Sumy, and Kharkiv regions) confirms the information on preliminary estimates of significant damage to the road structure due to the passage of tanks and other heavy military equipment, which will require the reconstruction of a significant part of the damaged roads. Preliminary estimates show that the

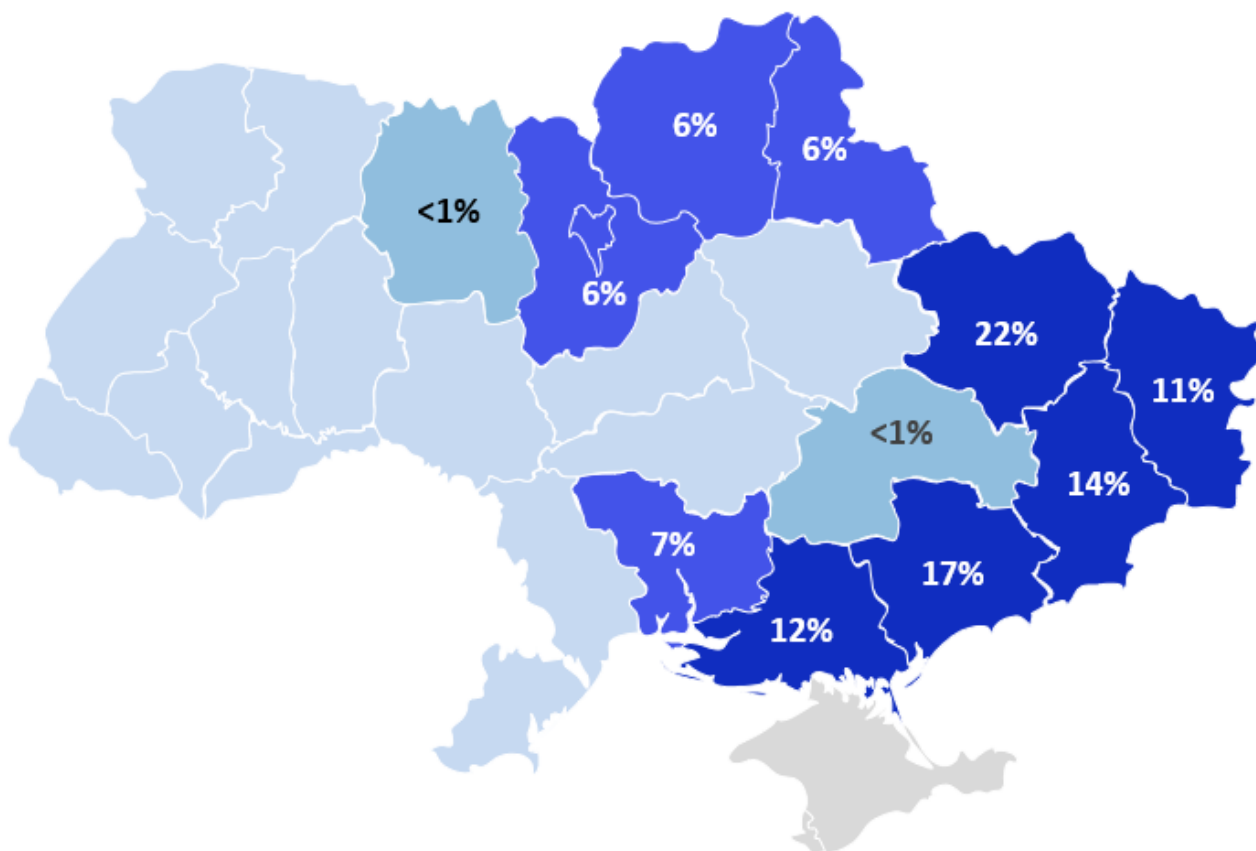
level of damaged roads (state and local roads, as well as municipal roads) varies from 0% to 95% and averaged approximately 10% of the total number of roads in the areas occupied by Russian troops or where hostilities took place (are taking place).

According to Ukravtodor, the weighted average cost of road reconstruction in 2021 (taking into account different categories of roads) was about UAH 29 million per 1 km of road (excluding the cost of restoring bridge crossings). With this in mind, a preliminary estimate of the total damages due to direct road destruction could be around **\$26.7 billion** in equivalent, at prices as of the end of 2021.

We also conducted a study that found that 290.3 km of roads were flooded as a result of the destruction of the Kakhovka hydroelectric power station, which increases the estimate of total losses by \$0.3 billion, bringing the total damages to **\$27.0 billion**. Damage and destruction of bridges and bridge crossings adds another **\$2.6 billion** in infrastructure damages.

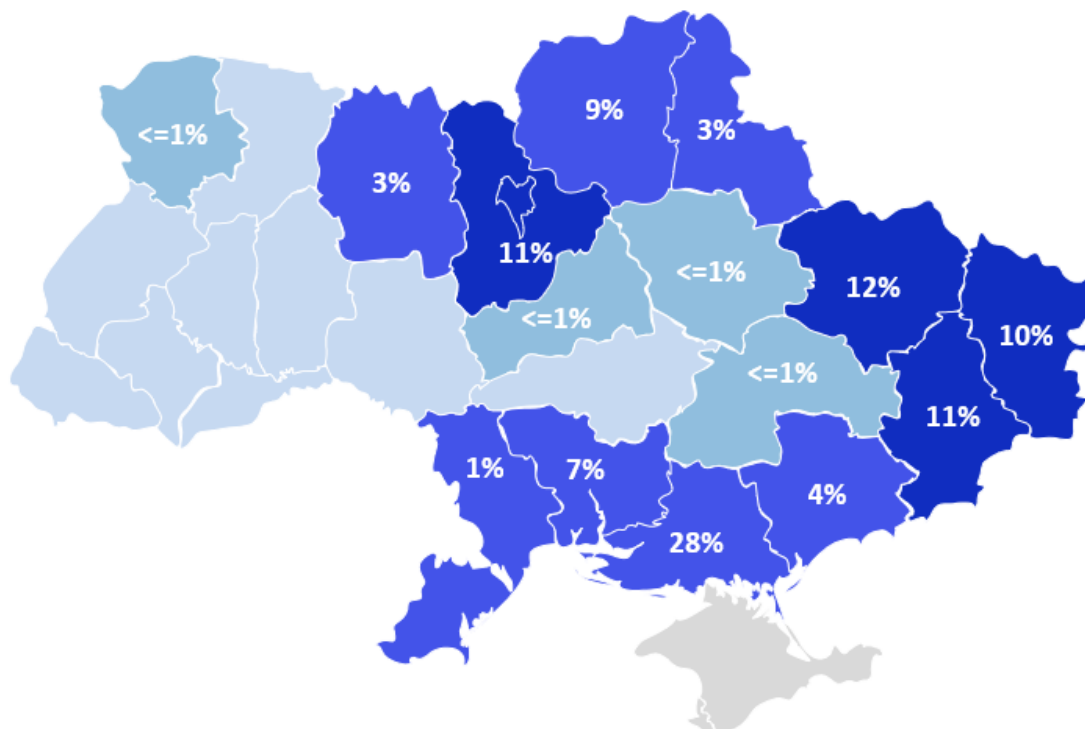
Since the beginning of the full-scale war, some work has been done to restore roads and bridges. In particular, 78 artificial structures on roads of national importance were reopened in 2022 (most of them in Kyiv (20), Chernihiv (20) and Kharkiv (17) regions), and 2 since the beginning of 2023 (3 more bridges are in the works). In addition, 2200 km of state and municipal roads were cleaned in 2022 (including about 612 km in Kharkiv, 588 km in Mykolaiv and 516 km in Kyiv regions).

Distribution of direct monetary damages to roads by regions



Source: Kyiv School of Economics

Distribution of direct monetary damages to bridges and bridge crossings by regions



Source: Kyiv School of Economics

Losses in the road sector due to reduced spending on road construction, bridge and bridge crossings, dismantling and removal of destroyed facilities amounted to **\$8.6 billion**, including \$7.8 billion for roads and \$0.8 billion for bridges.

Railway infrastructure

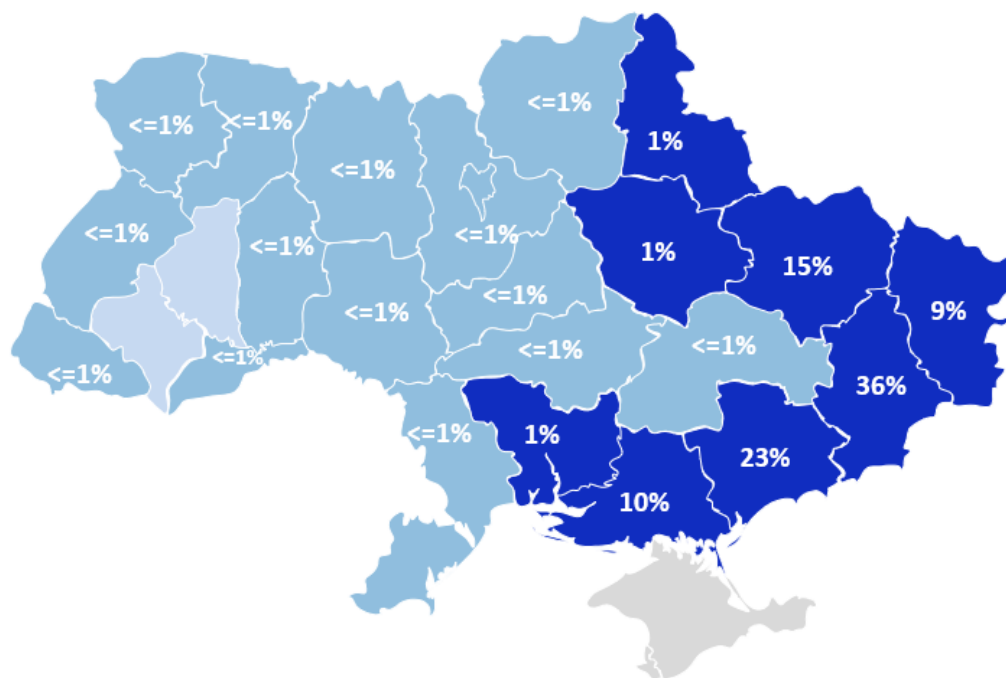
Since the outbreak of the full-scale war, the Ukrainian railway has tangibly demonstrated its role as a critical infrastructure facility, taking the brunt of the free of charge evacuation of millions of Ukrainian citizens (as well as a large number of businesses) who were stranded in the war zone; as well as the delivery of critical materials and equipment to these regions. In response, the Ukrainian railway has become an active target for Russian shelling and attacks.

According to preliminary estimates, the total length of the damaged railway track is up to 507 km; the number of damaged railway stations and yards is 126, of which more than 53 were damaged or destroyed in government-controlled areas and the rest in non-government-controlled areas. In addition, more than 700 km of railway tracks are located on the temporarily occupied territory (after 24.02). The total number of damaged, destroyed and lost buildings belonging to Ukrzaliznytsia is estimated at 5,500 and about 4,000 structures. At the same time, there is reason to believe that all movable property of Ukrzaliznytsia that was not removed from such territories in time can be considered completely lost (destroyed or stolen by the troops of the aggressor country).

Thus, the total direct damages in this sector are estimated at **\$4.3 billion**.

In turn, the indirect losses of the railway infrastructure amount to about **\$5.7 billion** and mainly consist of lost revenue of Ukrzaliznytsia.

Distribution of direct monetary damages to the railway infrastructure by regions



Source: Kyiv School of Economics

Aviation sector

The aviation sector began to suffer losses from the military aggression even before it actually began. On February 12, global insurance companies notified Ukrainian carriers that they would stop insuring their aircraft due to the high threat of an invasion by Russia. This led to the risk of cancellation of international carriers' flights to Ukraine, and following a working meeting with the leadership of the Office of the President of Ukraine, the State Aviation Administration of Ukraine, SE "UkrAerorukh", Boryspil International Airport and Ukrainian airlines, the government expressed its readiness to support air carriers by providing additional financial guarantees to support the aviation market.

With the outbreak of hostilities, the airspace over Ukraine was immediately closed and air traffic was suspended. At the same time, Russian troops began active rocket attacks on all key airfields in Ukraine, trying to deprive the country of its air defence capabilities. As a result, 19 out of 35 airfields were damaged, including 12 civilian and 7 dual-purpose airfields (excluding military airfields). Some of the airfields were hit several times.

Similar to the situation with roads, detailed information on the state of damage/opportunities for repair of airfields at most airports can only be established after detailed technical surveys, which, in turn, are possible only after the end of active hostilities at/in the area of airports (for those located in central, southern, eastern, and northern parts of Ukraine). However, according to preliminary estimates, the total amount of damages to the aviation sector (airports, airfields, aircraft, air navigation equipment) was about **\$2.0 billion**.

The full-scale war has completely shut down Ukrainian civil aviation: since the first hours of the Russian invasion, the sky over Ukraine has been closed. All Ukrainian airlines have lost the opportunity to earn money from flights, airports, handling and other companies in the industry have shut down. Only one airline, SkyUp, has reoriented itself to the European market, and in May 2023, Windrose Airlines began flights with one aircraft. All the others either landed their aircraft till our victory in the full-scale war or got rid of all aircraft altogether. Also, some European airlines' planes are "stuck" at Ukrainian airports.

According to our estimates, **the cost of losses to the aviation sector was estimated at \$6.8 billion**.

Ports and shipping sector

The total **damages** to port infrastructure and related businesses was estimated at **\$0.6 billion**. This estimate included both seaport infrastructure and inland waterway transport facilities that were damaged as a result of the full-scale war. The total losses also included damage to port infrastructure caused by the accident at the Kakhovka hydroelectric power station.

In total, property in at least four ports has been destroyed or damaged since the start of the full-scale war. For example, a grain terminal in Mykolaiv's Nika-Tera port was destroyed and river ports of Nibulon were damaged significantly due to the destruction of the Kakhovka hydroelectric power station.

The moderate damage to ports is due to two factors. Firstly, a port is a rather complex and spatially distributed facility consisting of many large parts. Therefore, it is impossible to completely destroy such a facility with a few precise missile strikes. Secondly, the aggressor captured or used its own and friendly cargo ships to export stocks of grain, ferrous metals, etc., and needed working ports for this purpose. For example, the Metinvest Group reported that the occupiers planned to export 200,000 tonnes of products worth \$170 million from Mariupol's factories. In turn, as for grain, 400-500,000 tonnes (also worth hundreds of millions of dollars) were reported stolen from four occupied southern regions, which is more than a third of local stocks.

Status of Ukrainian ports

PORTS OF UKRAINE DURING WAR

TOP LEAD

Ukrainian ports almost do not work due to occupation, blockade, mine danger and piracy from Russia's side



Source: UA War Infographics

After Russia's full-scale war of Ukraine, all of Ukraine's sea trade routes were inaccessible for any export and import operations. This led to significant losses for the Ukrainian economy. In [March 2022](#) alone, Ukraine's exports fell by 50%.

However, in August 2022, as a result of an agreement reached between Ukraine, Turkey, the UN and Russia, it was possible to unblock the operation of three Ukrainian ports for the export of domestic agricultural products - Odesa, Pivdennyi and Chornomorsk, which accounted for [70% of Ukraine's trade in 2021](#).

As part of the so-called Grain Initiative, [19 million tonnes](#) of agricultural products were exported through seaports (August 2022 - June 2023). Even with this initiative in place for the period analyzed (and blocked again by Russia from end-June 2023), the capacity of maritime trade remains limited even when unblocked again. Most Ukrainian ports in the Black and Azov Seas remain blocked - the port of Kherson, the port of Mykolaiv, and the port of Olviya - or temporarily

occupied - the ports of Mariupol, Berdiansk, and Skadovsk. There is still no traffic on the Dnipro River due to the blockade of the lower part of the river.

And the agreement itself faces constant obstacles from Russia. According to the [press service](#) of the Ministry of Infrastructure, in April 2023, only 65 vessels exported agricultural products, while in August 2022 (the first month of the agreement) there were 69, and the average indice for the entire period was 102 vessels. In fact, the potential of the agreements reached is only 50%.

Restrictions on ports' operations have affected the activities of companies operating in ports, the so-called stevedores. According to estimates, the **cost of losses incurred by seaport and inland waterway transport companies is estimated at \$2.1 billion**. The losses were calculated based on the following assumptions: 1) losses of all ports of Ukraine since the full-scale war started (24.02.2022) and until Grain Initiative was launched (August 2022), 2) losses of occupied and blocked ports and losses from lower capacity utilization of ports participating in Grain Initiative, 3) losses of all Ukrainian ports for 17 months starting from end-June (when Russian exited the accord for Ukrainian grain export).

Postal operators

The total **damages of postal operators** were estimated at **\$13 million**. This amount is based on data from Ukrposhta and Nova Poshta, which have the lion's share of the market. In total, since the beginning of the full-scale war, several hundred post offices, dozens of terminals/depots and vehicles, as well as a large number of parcels for which the operators are financially responsible, have been destroyed or damaged.

vehicles

In the territories and cities where the most fierce fighting took place, public transport infrastructure was destroyed, and people were left without private vehicles that were damaged or destroyed as a result of rocket and artillery fire.

According to analytical calculations, the damages incurred by utilities and private carriers, including destroyed vehicles, amounted to \$0.83 billion, including trolleybuses, trams and buses. **Damages of private passenger vehicles amounted to approximately \$1.9 billion, or 212,000 cars. In addition, 1,629 fire fighting vehicles worth \$89 million were lost.** The estimate of private passenger car losses was based on available data on the officially registered number of passenger cars and does not take into account possible losses of passenger cars not registered in Ukraine (in particular, the so-called "Euro cars").

Damages of municipal transport were calculated using both indirect methods, taking into account a number of assumptions; and using accurate data on damaged/destroyed municipal property provided by the military administrations.

The greatest damages to municipal property, which includes municipal (public) transport, were incurred in Luhansk and Donetsk regions, as well as in the city of Kharkiv. This was due to the fact that the Russian Federation mercilessly used heavy weapons to strike at civilian infrastructure. This resulted in the loss of an estimated 60% of public transport in Donetsk region and over 70% in Luhansk region. The industry in these two regions had been actually completely destroyed providing urban and suburban passenger transport services.

Most private cars were also lost in these two eastern regions of Ukraine.

Significant damages were caused to citizens as a result of the explosion of the Kakhovka hydroelectric power station. In particular, the damages were estimated at **\$37 million or 4,000 cars**.

In addition, the damages of vehicles included the destroyed Mriya aircraft worth \$300 million. Indeed the cost of building a new aircraft of the model may be higher. At the same time, the damages of air passenger transport are likely to be higher due to the possible destruction of other

civilian/cargo aircraft during the shelling of Ukrainian airfields; however, in the absence of detailed information on the location of such aircraft at civilian airfields, this assessment will be made at a later stage.

Losses in passenger transportation caused by Russia's aggression against Ukraine amount to **\$300 million**. The largest losses are in Donetsk region - \$130.8 million, Kherson region - \$42.5 million, and Luhansk region - \$13.6 million.

Digital infrastructure

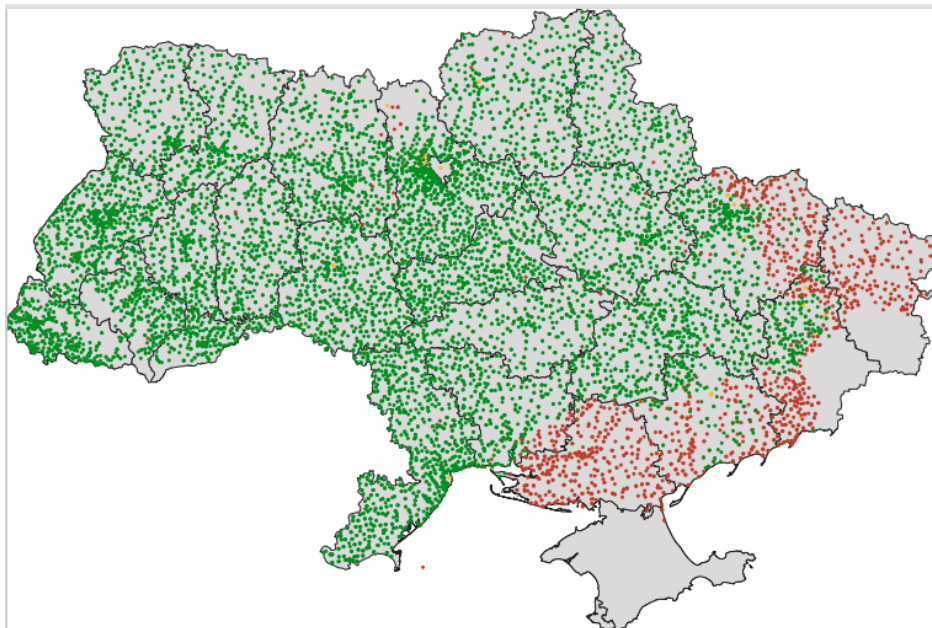
The total **damages** of telecoms operators are estimated at **\$510 million**.⁴ The digital infrastructure sector includes:

- Internet networks of fixed-line operators;
- Radio networks of mobile operators;
- Backbone networks;
- Technical and related means of electronic communications.

At least 726 operators of electronic communications with fixed access to the Internet suffered damages and losses as a result of the hostilities. After the de-occupation of settlements, the destruction of networks reaches 100%. Across the country, the quality of data transmission via fixed-line Internet access networks has decreased by an average of 13% (as of 01.05.2022).

There is no access to mobile communications in 12.2% of settlements, and in 3.1% - partially available. There are 3,534 mobile operator base stations out of service, which is almost 11% of the total. Over the past month, the total number of out-of-service base stations increased by 700. The quality of data transmission via mobile Internet access networks across the country has decreased by an average of 26% (as of 01.05.2022).

Distribution of non-operational mobile base stations as of May 2022



Source: Kyiv School of Economics

⁴ The estimates have not been updated from the previous report due to the lack of new comprehensive data.

The determination of the value of losses for owners of digital infrastructure or its components (including construction in progress) differs in different categories. The following classification was used for these purposes:

- National companies, electronic communications operators that provide electronic communications services to citizens of Ukraine throughout its territory;
- Medium-sized companies providing electronic communications services in several regions;
- Small companies providing electronic communications services within a region.

The damages of the national companies were determined based on the results of an inspection/survey of the destroyed or damaged electronic communications network infrastructure facilities, if they were accessible (even if possible in the officially uncontrolled territories). The amount of damage was determined in physical units (km, units, etc.) and was also estimated in monetary terms based on an approximate estimate of the cost of restoration work.

The damages of medium and small companies are calculated through the estimated cost of restoring/reconstructing networks or through the average monthly fee for 24 months.

There were also a number of other issues. Operators whose networks were fully or mostly under occupation or in the combat zone maintained their networks whenever possible so that Ukrainian citizens could continue to use Internet access from the free territory. In this case, revenues were close to zero, but expenses remained.

At the same time, some of these operators had loans from banks. They could pay for the use of the loan and repay the principal. At the same time, banks charged penalties for late payments and reported them to credit bureaus as bad borrowers.

According to an estimate, **losses** in the digital infrastructure sector were **\$1.4 billion**.

Energy sector

As of June 2023, direct damage to the Ukrainian energy infrastructure was estimated at \$8.8 billion.

Both direct and indirect methods of calculating the cost of lost and damaged facilities were used to assess the damage in the energy sector.

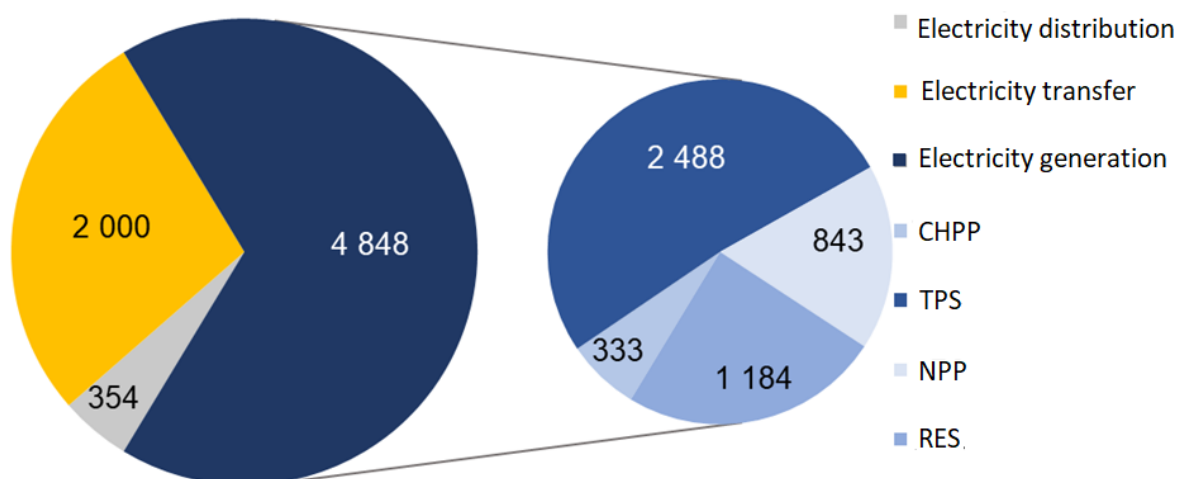
The cost of damaged facilities is based on the original book value of fixed assets, the cost of current repairs, the cost of restoration (the market value of replacing the destroyed facilities).

Basic information on losses in the energy sector is provided by the Ministry of Energy of Ukraine. To assess losses at certain large facilities, an individual approach is used based on information from open sources, owners and managers of enterprises. Data on damage to power generation facilities was collected on an aggregate basis, as well as from open sources, due to the high risk of dissemination of information on detailed damage to critical infrastructure facilities in a time of war.

The current assessment is currently complicated by the lack of detailed information on damage to facilities that are currently under occupation or to which access is physically impossible due to constant shelling and/or significant mine risks.

The **electricity generation and transmission sector** has suffered the most from Russian aggression in the energy sector. The Russian Federation continues to carry out targeted and large-scale attacks on facilities that ensure the production, transmission and distribution of electricity. **The preliminary estimate of the total amount of damage** to these facilities is **over \$7.2 billion**. According to public statements by the Prime Minister of Ukraine, the Ministry of Infrastructure and the Ministry of Community and Territorial Development (now the Ministry of Reconstruction), all thermal power stations (TPSs) and hydroelectric power plants (HPPs) under the control of Ukraine, as well as 13 combined heat and power plants (CHPPs) have been affected since the beginning of the full-scale invasion.

Direct infrastructure damage to electricity facilities, \$ million



Source: Kyiv School of Economics based on data from the Ministry of Energy of Ukraine, energy companies, open data

Large power generation facilities suffered a significant amount of damage. One of the most recent massive shelling incidents, according to the Prime Minister of Ukraine, damaged 9 units of thermal power stations, and at least one of them was completely destroyed by a direct missile hit. Overall, the Project team **estimates the damages to thermal power generation at \$2.5 billion for TPSs and \$333 million for CHPPs. Damages to hydroelectric power plants and pumped storage power plants (PSPPs) are currently estimated at \$965 million.** At the same time, the cost of restoring the lost capacity of such power plants may significantly exceed the damage assessment due to significant physical wear and tear and technological obsolescence of the damaged and destroyed equipment.

In early June, Russians blew up and completely **destroyed the Kakhovka hydroelectric power station. The damages caused by its destruction were estimated at \$586 million**, while the annual economic losses incurred by the state-owned Ukrhydroenergo were more than \$100 million. The cost of **building a new hydroelectric power plant of similar capacity will be about \$1 billion.**

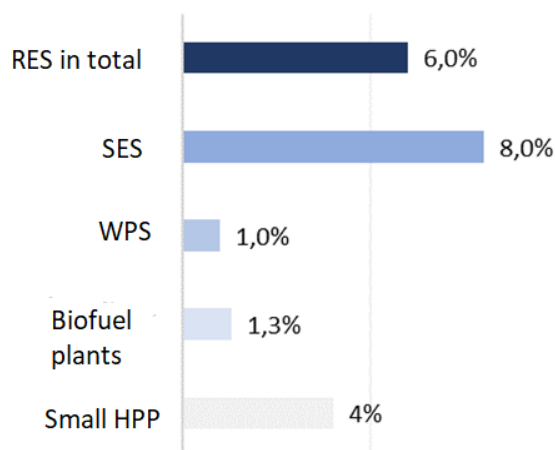
In addition, the largest nuclear power plant in Europe, Zaporizhzhia NPP (ZNPP capacity was more than 10% of the total capacity of the Ukrainian power system before the Russian full-scale invasion), remains occupied by the Russian military and is still under limited control of the SE NNEC Energoatom. The occupied nuclear power plant does not supply electricity and meets its internal needs from the Ukrainian power grid, as well as from diesel generators in emergency cases. The IAEA and the Ministry of Energy call the nuclear safety situation threatening.

In addition, the territories occupied by the Russian Federation after February 24, 2022 include Vuhlehirsk, Zaporizhzhia and Luhansk TPSs, and fierce fighting is taking place around Kurakhivska TPS.

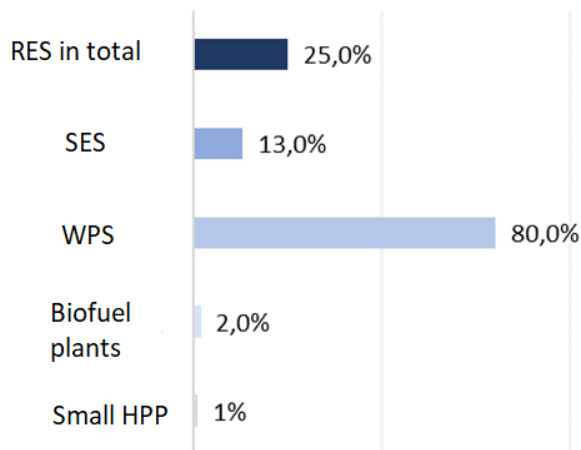
Renewable energy producers are also suffering significant losses. According to the Energy Charter Secretariat, 13% of solar generation capacity is located in the occupied territories, and 8% has been damaged or destroyed; about 80% of wind generation is occupied and some of it has been damaged by shelling; 2% of bioenergy capacity is under occupation, and at least 4 biogas plants are known to have been destroyed.

The KSE team estimated the **damages of renewable electricity producers** (excluding large hydropower plants and pumped storage plants) at \$220 million. This business also suffered significant financial losses. The occupied facilities have not been generating electricity for a year, generating no revenue. Such losses are multiplied by the impossibility of commissioning new unfinished facilities in which resources, including loans, have been invested. According to industry associations, by the end of last year, only wind farms with a total installed capacity of about 800 MW should have been completed and commissioned.

Destroyed or damaged WPS facilities



Occupied WPS facilities

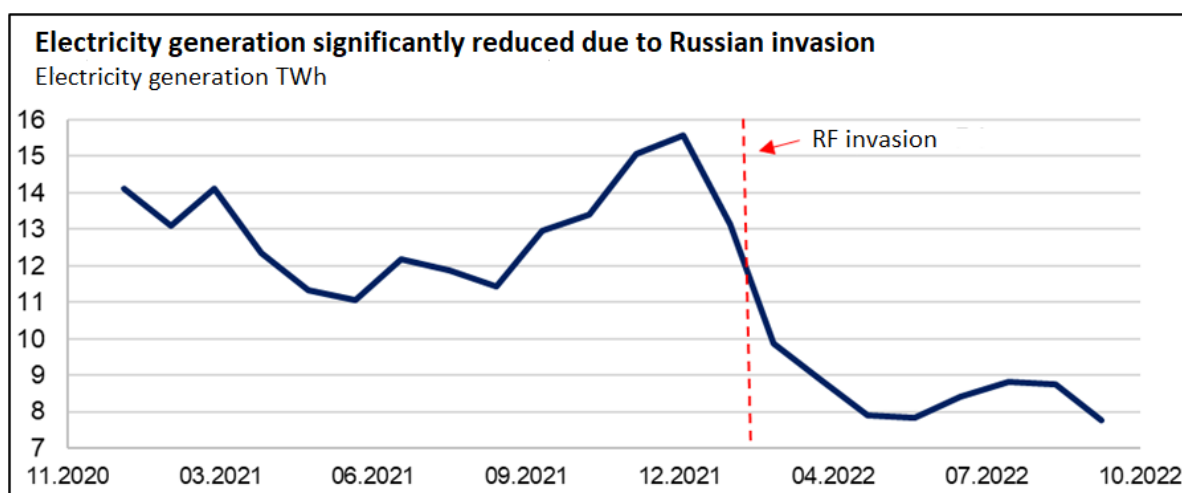


Source: Energy Charter International based on public data

The continuation of active hostilities in a large part of Ukraine, as well as targeted massive shelling by the RF, also led to damage and destruction of electricity transmission and distribution facilities. **According to preliminary estimates, the amount of damages caused by the full-scale war to the Transmission System Operator was estimated to be \$2 billion, and to the distribution system operators to be over \$350 million.**

In the first months of the full-scale invasion, Russian Federation targeted oil and oil product processing and storage facilities. Since February 24, 2022, 30 oil depots of various sizes and levels of modernisation, as well as the fuel stored there, have been damaged or completely destroyed. According to estimates, the **damages caused to the fuel storage sector** were almost **\$260 million**. In addition, the aggressor repeatedly shelled the facilities of the only major oil refineries that were active - Shebelynka (Kharkiv region) and Kremenchuk (Poltava region).

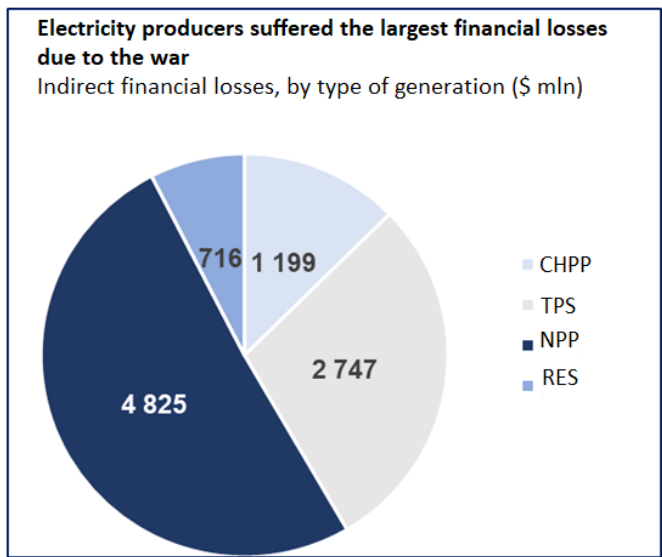
Due to massive migration of the population and a decline in business activity as a result of the full-scale war, demand for energy has fallen significantly. According to the statements of Ukrenergo's management and available data on the hourly balance of capacities of the IPS of Ukraine, electricity consumption and production have fallen by more than 30% since the beginning of the invasion.



Source: Kyiv School of Economics based on data from NPC Ukrenergo and open data

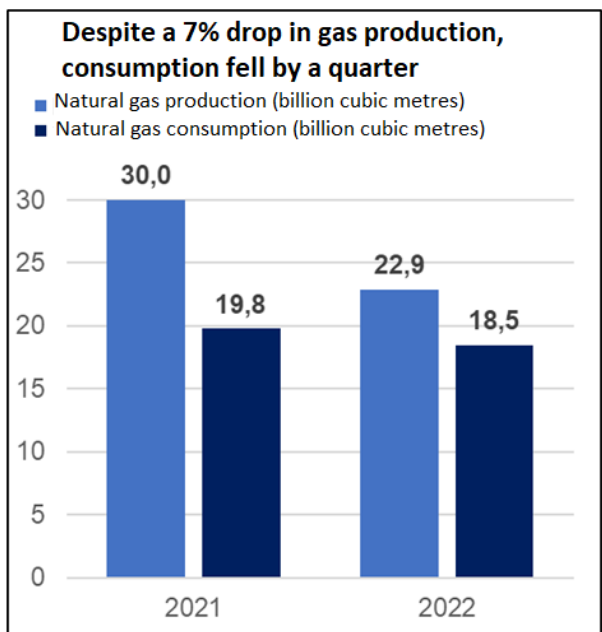
In addition, the destruction of the electricity infrastructure has made it impossible to supply and transport pre-war volumes of electricity. In addition, the weighted average wholesale electricity price over the past 14 months has not exceeded pre-war levels. This leads to significant losses for

electricity producers and transmission companies. **According to preliminary estimates, losses for the electricity sector amounted to more than \$13.7 billion**, of which more than two-thirds were incurred by electricity producers (\$9.9 billion).



Source: Kyiv School of Economics

The fall in energy demand due to the full-scale war also affected the natural gas sector. In 2022, despite a drop in natural gas production of almost 7%, domestic consumption decreased by 24% (~7 billion m³), and exports were banned in June 2022 to ensure that the country had enough resources to get through the heating season. As a result, due to the saturation of the domestic commercial market and the impossibility of exports, the gap between the market price of natural gas in the country and quotations on the largest European exchanges, from which Ukraine also imports the resource, has widened. For example, in March-December 2022, the average price of natural gas on the Ukrainian Energy Exchange was about \$900 per thousand cubic metres, and on the Dutch hub TTF - \$1400 per thousand cubic metres. This resulted in a drop in revenues for extractive companies. The decline in consumption has a negative impact on the revenues of gas transmission and distribution companies. **The total losses of gas sector companies amounted to almost \$4 billion**, including \$2.7 billion in losses among natural gas producers.



Source: Kyiv School of Economics, based on data from the Ministry of Energy of Ukraine, energy companies, energy associations, open data

Communal services and utilities

The housing and utilities infrastructure (communal services and utilities), which is an important part of the life support systems of settlements, has become one of the targets of Russian missile and artillery strikes. Constant shelling and hostilities have made it impossible or significantly complicated to carry out repairs, resulting in prolonged shutdowns of heating and water supply systems. In some towns, residents still do not receive utility services and do not have adequate access to drinking water.

For example, due to the damage to the water supply system, most districts of Mykolaiv were left without centralised water supply for a long time. The water supply system was restored only after the liberation of Kherson in November 2022, and until then, the city had only technical water, with drinking water delivered from other cities as bottled water through the retail network. In addition, the housing and utilities sector of the cities under heavy artillery shelling suffered significant damage. The heating and water supply sectors experienced constant interruptions in the cities due to forced power outages and a drop in voltage on equipment, which led to the need to install generators and accelerated the deterioration of assets.

According to preliminary estimates, as of June 2023, damages to heat supply facilities (excluding CHP plants), water supply and sewage, and municipal waste management facilities were \$2.7 billion.

During the full-scale invasion, **9 combined heat and power plants were completely destroyed** and another **14 damaged** in the areas where hostilities are taking place. For example, the destroyed Kremenchuk CHP plant (Poltava region) covered about 70% of the city's needs, i.e. about 180,000 residents, who could have been left without heat and hot water for the entire heating season if not for timely repairs. The value of direct losses caused by the destruction or damage to the CHPP is included in the Energy section.

In addition, according to preliminary data from regional military administrations, 5 boiler houses were partially damaged or completely destroyed as a result of the hostilities, most of them in Kharkiv, Kyiv, Chernihiv, Donetsk and Mykolaiv regions. 134 district heating stations were partially damaged or completely destroyed, and more than 178.6 kilometres of heating networks were completely destroyed.

According to preliminary estimates, more than 1,047 linear kilometres of water supply networks were destroyed, and 18 water treatment plants were partially damaged or completely destroyed. In addition, 119 water pumping stations were destroyed or damaged. Of these, 52 were in Kharkiv region, 13 in Luhansk region, and 11 in Donetsk region. In addition, 61 wells have been destroyed or damaged, most of them in Kharkiv region.

Laboratories that analysed the state of water supply in the region were also destroyed or damaged. Thus, preliminary estimates indicate that about 3 such facilities were destroyed/damaged.

According to preliminary estimates, more than 31 linear kilometres of sewerage networks were damaged, and 131 sewage pumping stations were partially damaged or completely destroyed, most of which are located in Kharkiv region. A total of 32 sewage treatment plants are also believed to be destroyed or damaged.

According to preliminary estimates, 21 landfills for household waste have been destroyed/damaged as a result of Russia's invasion of Ukraine. Three waste sorting lines were also completely destroyed. The vehicles used for waste removal, more than 200 garbage trucks, were also destroyed.

Losses communal services and utilities sector were estimated at around **\$3.5 billion**, including the dismantling of destroyed facilities and the removal of waste from the destruction (\$0.33 billion), government spending to rebuild and maintain utilities (\$0.05 billion), economic losses from the difference between actual costs and approved service tariffs (\$0.77 billion), and a reduction in industry revenue (\$2.34 billion).

FINANCIAL SECTOR

The full-scale war has had a major impact on the financial sector, especially on its main component - banks. They were affected both directly and through problems with the business of their clients (especially borrowers). **Damages** to the financial sector, including damage to real estate, amounted to **\$44 million**.

Initially, banks were forced to reduce the number of branches in areas where there was a threat to staff safety. At the beginning of March, only 21% of branches of systemically important banks were operating in or near the war zone, and 60% in Ukraine as a whole. However, due to the de-occupation of the northern regions, as of mid-June 2022, 85% of branches were already operating. After the de-occupation of certain territories in the East and South, banks began to reopen branches there as well.

In any case, due to the fall in demand for services, banks were forced to optimise their branch networks. According to the National Bank of Ukraine (NBU), which published its Financial [Stability](#) Report for June 2023, since the beginning of the invasion, banks have closed about 1,500 branches, or 20% of the total number (in regions where active hostilities are taking place, this share reaches two-thirds). In the autumn and winter, banks suffered from power outages, but over time, the institutions managed to establish autonomous operation of 45% of their branches.

Bank property came under fire. According to the NBU's surveys of banks, as of December 2022, the residual value of bank property that was lost, destroyed, or over which control was lost was **\$26 million** (compared to June, the estimate was reduced due to the liberation of the territories). Approximately half of this is real estate, and the other half is other property (ATMs, furniture, computers, etc.). Financial institutions do not have accurate information about the destruction or loss of the remaining property. It will only be possible to make a final assessment of the damage after the full-scale war is over or at least after the territories are liberated. No new destruction has been reported in the last six months.

Russians have been robbing banks in the occupied territories. By the beginning of May 2022, the amount of banknotes lost due to robberies or seizures of branches was **UAH 470 million**. Banks destroyed another **UAH 60 million** of national currency banknotes and took them to the NBU for further exchange.

The **losses** incurred by banks are much higher, **\$4.271 billion**. First and foremost, it is about credit risks. According to the NBU's estimates as of June 2023, loan portfolio losses due to damaged collateral and deteriorating borrowers' financial standing could amount to up to 20% of the net loan portfolio as of February 2022, or **\$3.861 billion** (the previous estimate in June was more pessimistic at 30%). Operational risk (expenses and lost income) is estimated at UAH 15 billion (**\$410 million**). Its growth has slowed; over the past six months, these losses have increased by UAH 3 billion, while over the previous six months, the growth was UAH 6 billion.

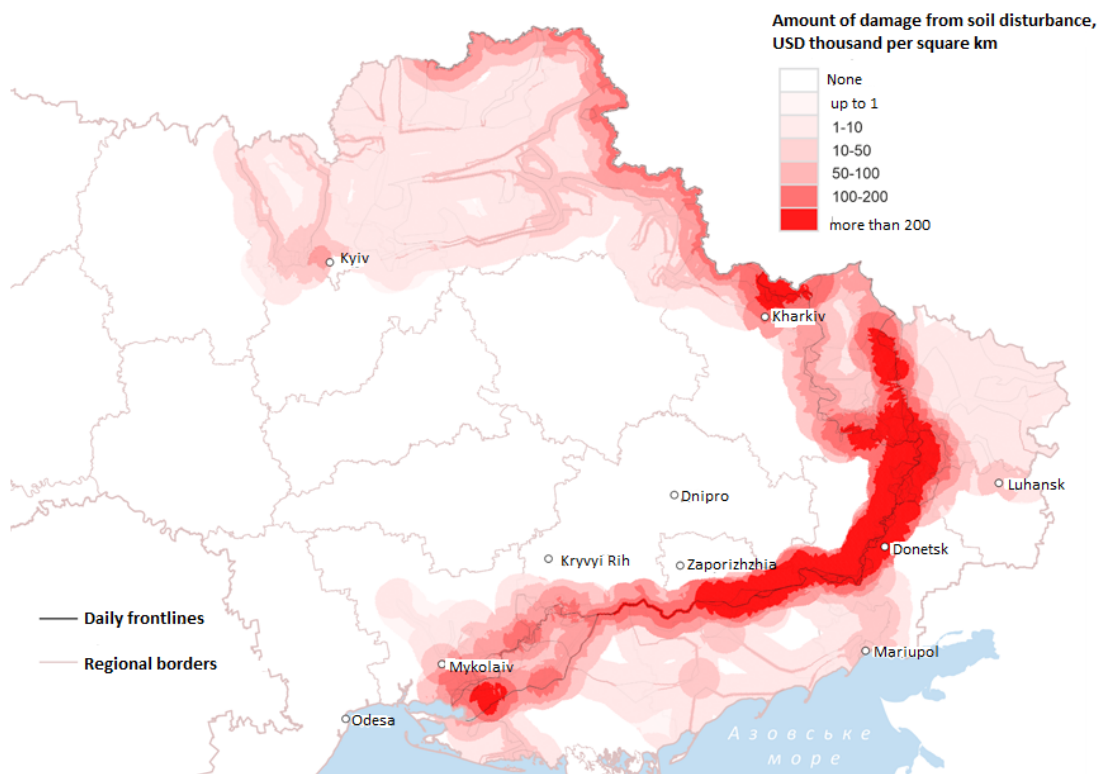
ENVIRONMENT

Russia's military aggression has resulted in a number of hazardous impacts on all components of the environment, including air, soil and landscapes, surface and groundwater, vegetation, and wildlife.

The main danger to the environment in the context of hostilities is associated with the risk of pollution due to damage to industrial enterprises and infrastructure facilities caused by munitions or emergency disruption of their operation due to the interruption of electricity, water, gas supply, disruption of technological processes, etc. The hostilities in the industrialised areas of eastern and southern Ukraine pose a particular threat.

Among the many industrial enterprises that suffered damage or disruption as a result of the hostilities were the most environmentally hazardous ones, such as the Chornobyl, Zaporizhzhia, Khmelnytskyi, Rivne and South Ukrainian NPPs, Kyiv, Dnipro, Kremenchuk, Dniester and Kakhovka hydroelectric power plants, numerous thermal power plants and combined heat and power plants, chemical and metallurgical enterprises, mines, oil refineries, oil product storage facilities, etc.

During the full-scale war, there were numerous cases of infrastructure damage and power outages at coal mining enterprises. This led to the shutdown of mine water drainage systems and, in some cases, to the complete flooding of mines, which inevitably resulted in surface water pollution, flooding and contamination of surrounding areas and subsidence of the surface.



Source: Kyiv School of Economics, Zoï Environment Network (Geneva)

Amount of damage caused by soil disturbance in the combat zones

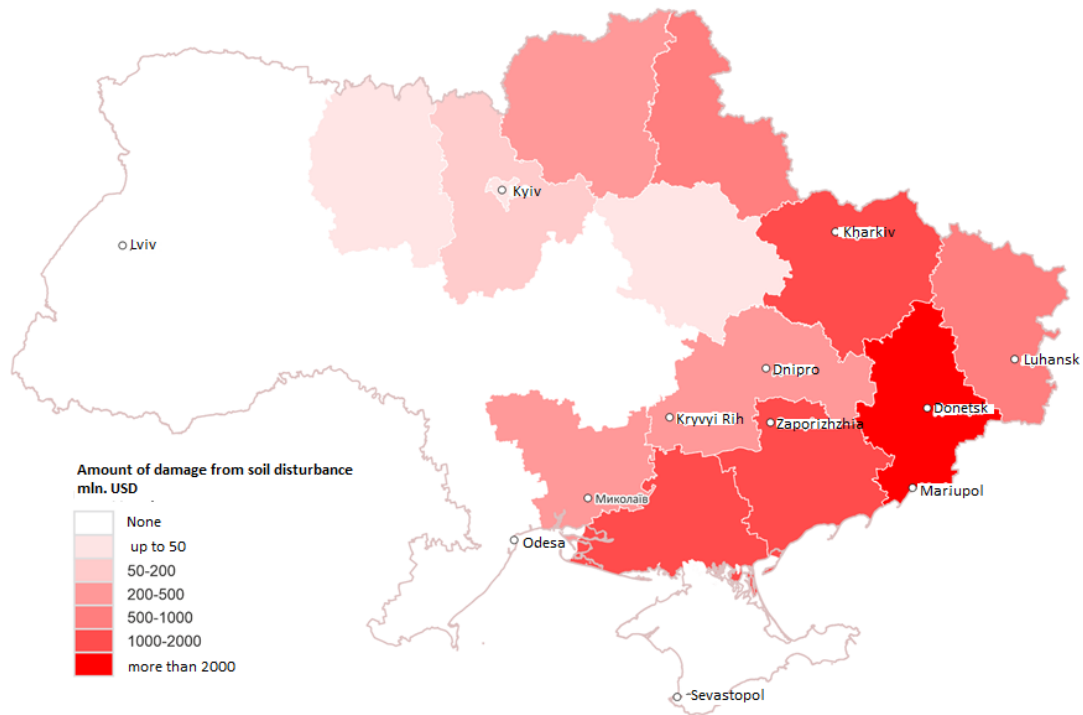
Since February 24, 2022, there have been repeated disruptions to the operation of hydraulic structures, water supply and wastewater facilities, including those accompanied by accidental discharges of pollutants into water bodies.

According to Ecodozor.org, as of June 2023, the hostilities caused 2049 cases of disruption and damage to at least 1093 enterprises and critical infrastructure facilities that could have led to environmental pollution.

The hostilities have complicated solid waste management, especially in settlements along the frontline. In addition to traditional household waste, there are remnants of military equipment, buildings, structures and infrastructure elements, the disposal of which requires additional capacity and is impossible without first clearing the area of mines and ammunition.

As a result of military manoeuvres, construction of fortifications, explosions and combustion of ammunition, the surface layer of soil is disturbed.

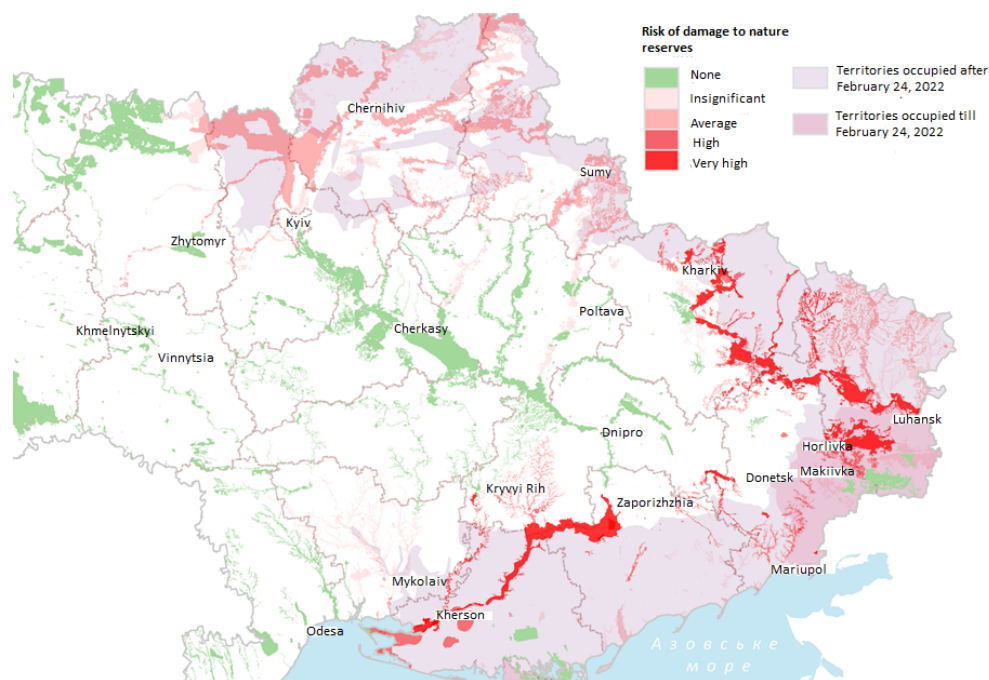
According to the KSE and Zoï Environment Network, 188,000 square kilometres of soil are at risk of damage and contamination. Damage from soil disturbance as a result of the hostilities is estimated at USD 9.8 billion.



Source: Kyiv School of Economics, Zoï Environment Network (Geneva)

Amount of damage from soil disturbance by regions of Ukraine

The use of land damaged as a result of hostilities will be complicated by the need for reclamation, demining and unexploded ordnance disposal.



Source: Kyiv School of Economics, Zoï Environment Network (Geneva)

Risks of damage to nature reserves

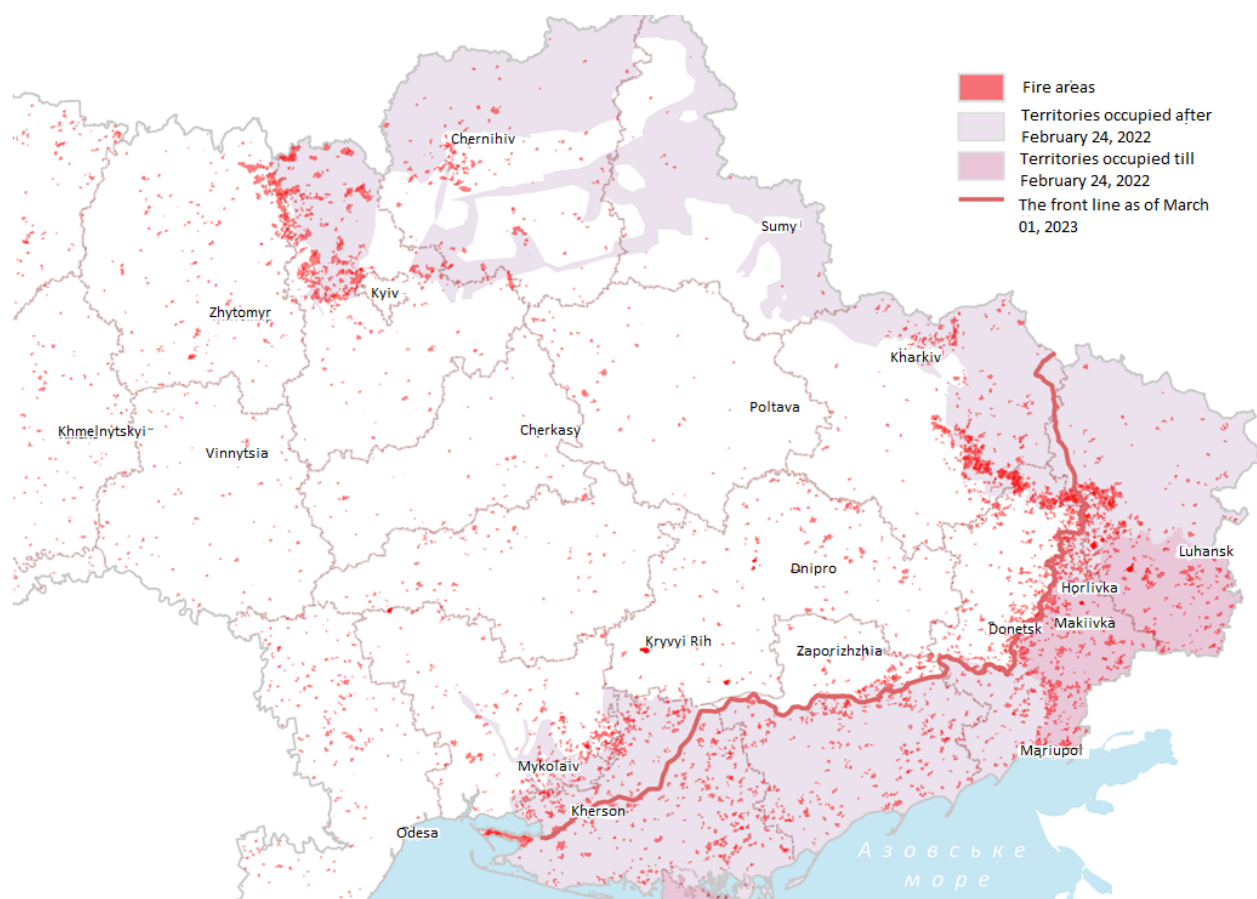
The hostilities on the territory of Ukraine have led to significant land pollution and damage to the landscapes of the nature reserve fund. Within the combat zone, 393 nature reserves and sites of the Emerald Network were located, which is more than a third of the total nature reserve fund of Ukraine. 347 sites were under occupation, and 257 sites were located up to 5 km from the frontline.

In total, about 46,000 square kilometres of the nature reserve fund and the Emerald Network are at risk of damage and pollution as a result of the aggression, which is 43% of the total area of these sites in Ukraine.

The disruption of nature reserves also occurs due to the lack of protection and lack of funding, which leads to an increase in illegal logging, mining, forest and grass fires.

Currently, the KSE and Zoï Environment Network are developing a methodology for assessing damage to soils, including soils of nature reserves.

As a result of the hostilities, forests and forest protection plantations have suffered significant damage. The greatest risks to forest plantations are associated with forest fires caused by ammunition explosions or deliberate arson related to the tactics of warfare. In addition, large areas of forest have suffered from mechanical damage caused by military manoeuvres and ammunition explosions, which leads to the weakening or death of forest stands.



Source: Kyiv School of Economics, Zoï Environment Network (Geneva), 2023

Estimation of forest and grass fires in the combat zone

As firefighting and forestry activities along the front lines are dangerous until the hostilities cease and the forests are cleared of mines, the decline in forest cover in Ukraine remains a serious problem.

According to the Zoï Environment Network, 48,960 thousand hectares of forest and 489,666 thousand hectares of grass fires were recorded due to the hostilities, which, together with the burning of oil and oil products, caused significant air pollution.

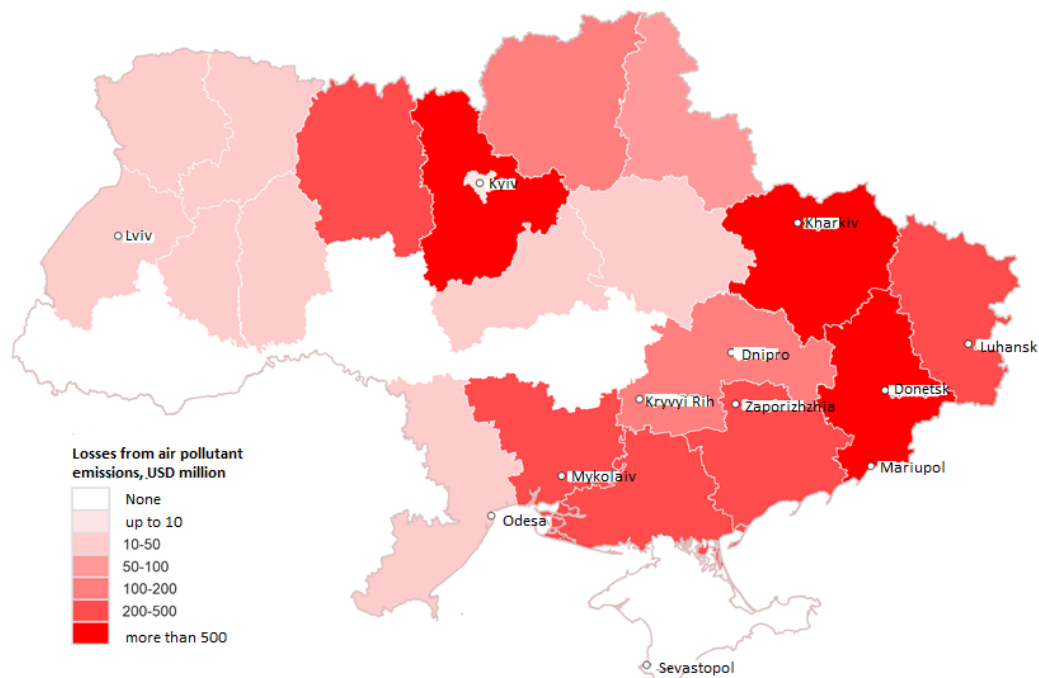
According to KSE estimates, the hostilities in Ukraine have released 1.24 million tonnes of pollutants into the air.

Emissions of pollutants into the air

Pollutants	Emissions, t	Damage, \$ million
Nitrogen oxides	17 296,02	417,34
Carbon monoxide	448 820,77	251,59
Non-methane volatile organic compounds	41 212,19	34,57
Sulphur oxides	3 877,28	96,24
Dust	336 476,68	259,10
Substances in the form of suspended solid particles larger than 2.5 microns and smaller than 10 microns	217 740,74	167,69
Substances in the form of suspended solid particles of 2.5 microns and less	178 162,09	2 428,11
Lead	0,47	1,41
Cadmium	0,02	0,01
Mercury	2,36	7,05
Arsenic	0,05	0,00
Chromium	7,85	14,88
Copper	5,18	0,48
Nickel	0,20	0,47
Selenium	0,05	0,02
Zinc	16,49	0,17
Polychlorinated dibenzo-para-dioxins and dibenzofurans	4,89	440,14
Benz(a)pyrene	2,13	191,91
Total	1 243,63	4 311,18

The damage caused by air pollutant emissions amounts to \$4.3 billion, of which \$1.85 billion is damage from forest fires, \$1.71 billion is damage from grass fires, and \$752 million is damage from the burning of oil and oil products. In addition, to restore damaged housing, utilities and transport infrastructure, additional emissions of pollutants into the air will be required in the amount of \$1.13 billion.

Damage from air emissions should be compensated in amounts that will allow for equivalent environmental clean-up measures, as well as measures to prevent and adapt to climate change.



Source: Kyiv School of Economics, Zoï Environment Network (Geneva)

Amount of damage from air pollutant emissions caused by military operations

The outbreak of the full-scale war has virtually paralysed many aspects of environmental protection activities. The destruction of the environmental protection system in the combat zones has led to the loss of information on the state of the environment, and in some areas there is no environmental monitoring, no provision of ecosystem services and no measures to improve the environment, reduce greenhouse gas emissions and adapt to climate change.

In order to reduce the negative environmental impact of hostilities, immediate measures should be taken to protect and restore ecosystems in the affected areas. Such measures may include land reclamation, reforestation, water purification, ammunition and mine clearance, and measures to prevent further pollution. It is important to maintain the attention of the international community and society to the problem of the environmental consequences of the full-scale war in Ukraine and to take all possible efforts to eliminate them.

DEMINING

Since the beginning of the full-scale war, **about 270,000 km² of Ukraine's territory have been affected by the war**, either through direct hostilities, mining of combat areas, or as a result of artillery shelling, strategic aviation, etc. The mines, other explosive ordnance (EO), and their remnants pose a direct threat to the lives and health of Ukrainian citizens, and impede normal economic activity in the affected areas.

According to the State Emergency Service of Ukraine (SESU), as of April 2023, **around 174,000 km², or approximately 30% of Ukraine's territory, is potentially contaminated by EO** and needs to be surveyed for the mine threat and cleared.

Since the beginning of the full-scale war, the **SES has already surveyed and cleared 907 km²** (134 km² since the beginning of 2023) and **defused about 406,000 EO** (95,000 EO since the beginning of 2023). Mine clearance is also carried out by units of the Ministry of Defence, the Armed Forces and non-governmental mine action operators (MAOs) - data on their scope of work is not publicly available.

Based on the current results of mine action, the density of defused EO is 448 explosive items per 1 km² of cleared territory. This figure may be significantly higher in areas of prolonged and active hostilities.

One of the priority areas of demining is the clearance of agricultural land to enhance both food and economic security of Ukraine. In total, the Government has identified 4,700 km² of priority land that needs to be surveyed and demined.

Russian terrorist attack on the Kakhovka hydroelectric power station

The areas that were flooded after the Russian attack on the Kakhovka hydroelectric power station became particularly dangerous, as the water washed away mines and other explosive devices and carried them away.

Due to the unpredictability of water flows, it is difficult to predict where mines may be located. Therefore, the cost of demining these areas is based on the entire area affected by the flooding. To determine the area of flooding, we used an [interactive map](#) created by the US Institute for the Study of War (ISW). Based on satellite imagery, it shows the difference between the areas as of June 05 (before the explosion) and June 09 (3 days after the explosion).

According to our estimates based on the map, a total of 530-540 km² in Kherson and Mykolaiv regions were flooded - all of which we consider potentially mined.

Therefore, humanitarian demining needs to be carried out in all areas, which consists of three main stages, after each of which the areas that are already considered unmined are released:

- [Non-technical survey](#) - collecting information about where the area is potentially mined without using technical means of detecting explosive objects, such as mine detectors (i.e. surveys of the population, local authorities, etc.).
- [Technical survey](#) - collecting direct evidence of the presence of EO using technical means.
- [Direct demining](#) - direct search and clearance of the area of EOs.

Although in general logic, NTS should free up areas for maintenance and demining, we will assume that both TS and NTS should be carried out over the entire flooded area due to unpredictable currents and the fact that information on areas where flooding has occurred and people have seen explosive ordnance still needs to be collected.

Therefore, based on interviews* with mine action operators (MAOs) working in Ukraine and World Bank data, the cost of the different stages can be estimated as:

Source of data	Cost of NTS	Cost of TS	The process of reducing the area during TS	Cost of demining
Interview with MAO	~593 \$/km ² * 540 km ² = \$0,32 mln	~305 th. \$/km ² * 540 km ² = \$165 mln	→ Reducing by 70%	~2,94 mln \$/km ² * 162 km ² = \$476 mln
World Bank	~1208 \$/km ² * 540 km ² = \$0,65 mln	~742 th. \$/km ² * 540 km ² = \$401 mln	→ Reducing by 30%	~3,00 mln \$/km ² * 378 km ² = \$1,13 bln

The **total cost of demining the flooded areas** could range from **\$0.64 billion to \$1.5 billion**.

To clear the entire allegedly mined territory of Ukraine, up to **\$41 billion** would be required (excluding demining of water bodies, as we do not yet have data on the cost of this process). The increase in the total cost of demining as a result of the terrorist attack on the Kakhovka hydroelectric power station can be estimated at up to **\$1 billion**.

* – The prices reported by the MAOs are averages, but the sample of prices from different MAOs was small, so the use of an average is not mathematically correct. However, we used it anyway due to the need to anonymise the tariffs of individual MA operators.

ANNEXES

Annex 1.

Assessment of damages and losses to residential buildings as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages to infrastructure				
Destroyed				
Multi-apartment buildings	pcs	178 921	5 367	23,59
Individual buildings	pcs	8 977 862	60 318	4,46
Dormitories	pcs	7 114	91	0,26
Damaged	pcs			
Multi-apartment buildings	pcs	178 921	13 729	23,55
Individual buildings	pcs	8 977 862	87 451	2,76
Dormitories	pcs	7 114	256	0,25
Damaged and destroyed as a result of the accident at Kakhovka HPP				1
Total damages to infrastructure	x	x	x	55,863
Losses				
Increased expenditures to support the industry	x	x	x	0,11
Additional costs for rental housing	x	x	x	11,40
Costs of dismantling and removing construction waste	x	x	x	4,90
Total losses in the sector	x	x	x	16,4

Source: data of the State Statistics Service, data of the Ministry of Development of Communities and Territories of Ukraine, Order of MinRegion No. 53 dated 17.02.2022, data of regional military administrations, official exchange rates of the NBU, market data; calculations of MinRegion together with KSE

Annex 2.

Assessment of damages and losses to the healthcare sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed				
Hospitals	pcs	1135	79	0,84
Polyclinics, dentistry, diagnostic centres	pcs	1131*	31	0,12
Outpatient clinics	pcs	1131*	77	0,06
Blood centres	pcs	28	3	0,01
Other (medical offices, laboratories, medical warehouses, dormitories, forensic bureaus)	pcs		87	0,11
Damaged				
Hospitals	pcs	1135	289	1,20
Polyclinics, dentistry, diagnostic centres	pcs	1138*	116	0,18
Outpatient clinics	pcs	1138*	273	0,08
Blood centres	pcs	28	6	0,01
Other (medical offices, laboratories, medical warehouses, dormitories, forensic bureaus)	pcs		242	0,15
Total damages to infrastructure			1203	2,8
Losses				
Decrease in private sector revenues as a result of business closures and a decline in demand	x	x	x	2,6
Decrease in planned budget expenditures	x	x	x	0,0
Total losses in the sector	x	x	x	2,7

Source: Data on the number of damaged public healthcare facilities - MoH; Data on the number of damaged private healthcare facilities - public sources; Data on the cost of replacing one healthcare facility is calculated using several methods: (1) For facilities for which the number of square metres and/or beds is known, the data of the Ministry of Regional Development on the average cost of construction of 1 square metre of healthcare facilities is used; (2) For facilities for which the number of square metres and/or beds is unknown, the following is used

*total of outpatient clinics and polyclinics

Annex 3.

Assessment of damages and losses to the social protection sector as a result of the full-scale war

Types of costs	Measurement unit	Number of damaged facilities	Damage assessment, \$ bln.
Damages			
Damaged and destroyed			
Children's homes	pcs	6	0,003
Residential institutions	pcs	31	0,055
Geriatric facilities	pcs	14	0,009
Social centres	pcs	48	0,044
Homeless shelters	pcs	1	0,000
Health resorts	pcs	46	0,079
Children's camps	pcs	13	0,016
Institutions for people released from prison	pcs	0	0,000
Total damages to infrastructure	pcs	159	0,207
Economic losses			
The need for social payments based on the number of IDPs and other categories of citizens in additional need of social support as of March 01, 2023	x	x	7,1
Total losses in the sector	x	x	7,1

Source: number and cost of damaged facilities - Ministry of Reconstruction; amount of additional social protection expenditures required - Ministry of Social Policy; KSE calculations

* Number of damaged facilities and their estimated cost according to the Ministry of Reconstruction

Annex 4.

Assessment of damages and losses to education and science as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed				
Secondary education institutions	pcs	13991	500	1,95
Institutions of pre-school education	pcs	15335	237	0,51
Vocational education institutions	pcs		23	0,25
Higher education institutions	pcs	515	209	2,43
Institutions of professional higher education	pcs	129	3	0,02
Out-of-school education institutions	pcs		11	0,06
Specialised education institutions	pcs		12	0,06
Damaged				
Secondary education institutions	pcs	13991	1182	1,83
Institutions of pre-school education	pcs	15335	723	0,62
Vocational education institutions	pcs		39	0,17
Higher education institutions	pcs	515	375	1,74
Institutions of professional higher education	pcs	129	17	0,03
Out-of-school education institutions	pcs		16	0,01
Specialised education institutions	pcs		28	0,05
Scientific institutions	pcs	6306*	90**	0,01
Total damages to infrastructure	x		x	9,73
Losses				
Decrease in private sector revenues due to business interruption and demand downturn	x	x	x	0,49
Decrease in revenues of scientific institutions due to decrease in rental income**	x	x	x	0,01
Decrease in planned budget expenditures	x	x	x	1,59
Total losses in the sector	x	x	x	2,08

Source: Ministry of Education and Science; Ministry of Reconstruction; National Academy of Sciences; KSE calculations

* number according to the State Register of Scientific Institutions Supported by the State; the list is not exhaustive. <http://rnib.rit.org.ua/rni?page=4>

** currently includes an assessment of damaged NAS institutions only; the assessment of losses of other scientific institutions will be carried out at the following stages

Annex 5.

Assessment of damages and losses to culture, sports and tourism as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed				
Religious institutions	pcs	n.d.	58	0,1
Sports culture	pcs	16199	59	0,4
Cultural sphere	pcs	34340	215	1,0
Tourism sector	pcs	n.d.	50	0,0
Damaged				
Religious institutions	pcs	n.d.	290	0,0
Sports culture	pcs	16199	284	0,3
Cultural sphere	pcs	34340	1589	0,4
Tourism sector	pcs	n.d.	114	0,1
Damaged as a result of an accident at Kakhovka HPP				0,05
Total damages to infrastructure		x	2659	2,4
Losses				
Decrease in revenues of the culture and sports sector	x	x	x	6,4
Decrease in revenues of the tourism industry	x	x	x	4,4
Total losses in the sector	x	x	x	10,8

Source: Ministry of Reconstruction data on the number and value of damaged facilities, State Statistics Service data on the initial number of facilities; other - KSE calculations

Annex 6.

Largest affected industrial assets (according to available information on damaged assets)

No	Enterprise	Sector	Status	Damage assessment, \$ mln.
1	Illich Iron and Steel Works of Mariupol	Metallurgy	Destroyed	2 385
2	Azovstal	Metallurgy	Destroyed	1 777
3	Motor Sich	Mechanical engineering	Damaged	450
4	Ukratnafta	Oil refining	Destroyed	405
5	Zorya - Mashproekt	Mechanical engineering	Destroyed	264
6	Ukrainian power machines	Mechanical engineering	Damaged	181
7	Avdiivka Coke Plant	Coke and chemicals	Damaged	166
8	Philip Morris Ukraine	Cigarette production	Destroyed	154
9	Antonov	Aircraft construction	Damaged	151
10	LYNIK	Oil refining	Destroyed	126
11	Organic Systems	Food industry	Destroyed	121
12	Novokramatorsk Machine-Building Plant	Mechanical engineering	Damaged	113
13	Rubizhne Cardboard and Packaging Plant	Paper production		98
14	Mykolaiv Alumina Plant	Metallurgy	Damaged	97
15	Dniprospetsstal	Metallurgy	Damaged	87
16	Sandora	Food industry	Damaged	82
17	Energomashpetsstal	Mechanical engineering	Damaged	78
18	Odesa Port Plant	Chemical industry	Damaged	77
19	Coca-Cola Beverages Ukraine	Food industry	Damaged	75
20	Odesa Oil Refinery	Oil refining	Damaged	74
21	Severodonetsk Azot Association	Chemical industry	Damaged	70

No	Enterprise	Sector	Status	Damage assessment, \$ mln.
22	Zaporizhzhya Iron Ore Plant	Mining and quarrying	Inventory only	51
23	Altcom road construction company	Construction	Damaged	55
24	Farmak (products warehouse)	Pharmaceuticals	Damaged	54
25	Kub-Gas	Gas production	Destroyed	50

Source: KSE calculations, reports of destruction of individual facilities, open data

Annex 7.

Assessment of damages and losses to the industrial sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed				
Large and medium-sized private enterprises	pcs	5270	14	5,1
Small private enterprises and individual entrepreneurs	pcs	78060	n.d.	2,2
State-owned enterprises	pcs	1665	18	1,0
Damaged				
Large and medium-sized private enterprises	pcs	5270	64	1,7
Small private enterprises and individual entrepreneurs	pcs	78060	n.d.	0,8
State-owned enterprises	pcs	1665	330	0,6
Total damages to assets	x	x	x	11,4
Losses to sector				
Decrease in revenue of large and medium-sized private enterprises	x	x	x	34,6
Decrease in revenue of small private enterprises and individual entrepreneurs	x	x	x	5,3
Decrease in revenue of state-owned enterprises	x	x	x	4,0
Decrease in revenues of certain sectors	x	x	x	7,6
Total losses to sector	x	x	x	51,5

Sources: reports on the destruction of individual facilities, municipalities (level of destruction in cities), State Statistics Service; KSE calculations

Annex 8.

Assessment of damages and losses to retail as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages to sector				
Destroyed				
Retail facilities	pcs	40277	n.d.	1,5
Shopping centres	pcs	329	8	0,3
Damaged				
Retail facilities	pcs	40277	n.d.	0,7
Shopping centres	pcs	329	19	0,2
Total direct damage to sector				2,60
Losses to sector				
Unreceived retail revenue	x	x	x	31,41
Unearned revenue from shopping centres	x	x	x	2,44
Total losses to sector	x	x	x	33,85

Source: State Statistics Service, Ukrainian Council of Shopping Centers, Association of retailers of Ukraine

Annex 9.

Assessment of damages and losses to the agro-industrial complex and land resources as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed				
Agricultural machinery	pcs	764323	109 601	4,25
Grain storage facilities	capacity, th.t.	75084	8 198	1,2
Dead animals (including poultry and fisheries)	th.heads	203292	2 230	0,1
Destroyed apiaries	bee colonies	2272740	86 902	0,0
Perennial crops	ha	197100	20 104	0,5
Destroyed and stolen inputs	t.	962951	135 993	0,1
Destroyed and stolen finished agricultural products	t.	25486613	4 037 542	1,9
Damaged				
Slaughter of animals due to the impossibility of keeping them	th.heads	203292	14 072	0,1
Dead and missing bees	bee colonies	2272740	192 526	0,0
Agricultural machinery	pcs	764323	50 749	0,4
Grain storage facilities	capacity, th.t.	75084	3 249	0,1
Total damages to infrastructure	x	x	x	8,7
Losses				
Reduced income due to lower production - crop production	x	x	x	23,0
Reduced revenue due to lower production - livestock, beekeeping, fisheries and aquaculture	x	x	x	0,3
Reduced revenue due to logistics disruptions and lower domestic prices for major export crops	x	x	x	14,5
Reduced profits for producers due to higher prices for key inputs	x	x	x	0,8
Additional costs due to the need for reclamation	x	x	x	0,2
Total losses to sector	x	x	x	40,3

Source: calculations of the KSE Agrocentre (Centre for Food and Land Use Study)

Annex 10.

Assessment of damages and losses to the transport sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed/damaged				
trolleybuses	pcs	2980	344	0,03
trams	pcs	1922	152	0,2
buses	pcs	241426	13 812	0,6
passenger cars*	mln.pcs	10,10	207 457	1,9
fire trucks	pcs	4216	1 629	0,09
Mriya aircraft	pcs	1	1	0,3
Total damages to infrastructure**	<i>pcs</i>		223 395	3,13
Losses				
Reduced revenues in the municipal, suburban and intercity passenger transport industry in the affected regions		x	x	0,3
Total losses to sector		x	x	0,3

Sources:

Number of cars registered in Ukraine https://dostup.pravda.com.ua/request/statistika_kilkosti_zarieiestrov;

Data on losses of municipal transport - for four regions (Kharkiv, Donetsk, Luhansk, Dnipro) – information from military civilian administrations; for other regions - KSE assumptions

data on trolleybus and tram fleet:

http://www.ukrstat.gov.ua/druk/publicat/kat_u/2021/zb/10/zb_Transpot.pdf

data on the bus fleet: https://dostup.pravda.com.ua/request/statistika_kilkosti_zarieiestrov

Data on the cost of restoring the Mriya aircraft - Ukroboronprom

*only officially registered private cars are taken into account, excluding cars imported without customs clearance into the territory of Ukraine

**at the current stage, the following are not taken into account: (1) loss of trucks; (2) loss of other vehicles, including those owned by the authorities; (3) loss of aircraft (except for the Mriya aircraft, the loss of which is publicly available)

The assumption for the calculation is that the average replacement cost of one unit of public transport is 1/3 of the replacement cost (the cost of purchasing similar objects at ProZorro tenders in 2021, at the exchange rate at the end of 2021). For buses: we take the average between the cost of a bus and a minibus, since the exact structure of the bus fleet is not known (the distribution between large buses and minibuses).

Annex 11.

Assessment of damage and losses to infrastructure as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Destroyed				
Airports	pcs	34	9	1,5
Property of postal operators	x	x	x	0,002
Damaged				
Roads of national importance	km	47 th.km	8 855	9,4
Roads of local importance	km	120 th.km	8 625	9,2
Municipal roads (cities and other settlements)	km	270 th.km	7 883	8,4
Bridges and bridge crossings	pcs	11 076	344	2,6
Assets of UZ	other	n/d	-	4,3
Infrastructure of seaports and inland waterway transport (ports; berths; warehouses; terminals; movable property)	other	n/d	-	0,6
Airports	pcs	34	9	0,3
Air bases	pcs	1	1	0,04
Ukraerorukh	pcs	n/d	1	0,2
Property of postal operators	x	x	x	0,01
Total damages to infrastructure				36,6
Losses				
Decrease in industry revenue (Aviation)	bln.UAH	x	x	6,8
Decrease in industry revenue (Railway)	bln.UAH	x	x	4,8
Expenditures on (re)evacuation of the population, transportation of humanitarian aid, assistance to employees/families involved in the full-scale war (Railway)	bln.UAH	x	x	0,9
Reduced spending on road construction (18-month forecast starting from June 2023)	bln.UAH	x	x	7,8
Decrease in spending on bridges and bridge crossings	bln.UAH	x	x	0,8
Decrease in revenues of ports and other inland waterway transport entities	bln.UAH	x	x	1,8
Decrease in revenues of postal operators	bln.UAH	x	x	0,3
Total losses to sector	bln.UAH	x	x	23,2

Source: Roads - KSE calculations; Railways - UZ data and calculations, KSE calculations; Aviation - official statistics, public data, KSE calculations; Seaports and inland waterway transport infrastructure - MIU data; Postal operators - Nova Poshta, Ukrposhta; KSE calculations.

Annex 12.

Assessment of damages and losses to digital infrastructure as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages				
Damaged				
Fixed line operators	pcs	4162	726	0,3
Mobile operators	x	x	x	0,2
Total damages to sector				0,51
Losses				
Decrease in revenues of fixed line operators	bln.UAH	x	x	0,3
Decrease in revenues of mobile operators	bln.UAH	x	x	0,8
Additional expenses of mobile operators	bln.UAH	x	x	0,3
Total losses to sector	bln.UAH	x	x	1,4

Source: Ministry of Digital Transformation, NCCIR, telecom operators

Annex 13.

Assessment of damages and losses to banks as a result of the full-scale war

Types of costs	Damage assessment, \$ bln.
Diamages	
Destroyed/damaged*	
Property of banks	0,026
Cash in bank branches	0,018
Total damages to assets	0,044
Losses	
Losses from realisation of credit risks due to the full-scale war	3,861
Losses from operational risks as a result of the full-scale war	0,41
Total losses to sector	4,271

Source: National Bank of Ukraine; Financial Stability Report, December 2022
https://bank.gov.ua/admin_uploads/article/FSR_2022-H2.pdf?v=4

* at the current stage, the section includes only data on bank losses; excludes direct losses and indirect losses of other financial institutions

Annex 14.

Assessment of damages and losses to the housing and utilities sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damages to infrastructure				
Destroyed				
CHPP and TPS	pcs	87	9	Included to other section
Boiler houses	pcs	19 025	312	0,152
Heating networks	linear m.	18 987 083	1708 602	0,389
Central heating stations	pcs	5 523	114	0,048
Water treatment plants	pcs	400	3	0,075
Sewage treatment plants	pcs	967	13	0,390
Water pumping stations	pcs	5 646	49	0,086
Sewage pumping stations	pcs	2 908	34	0,102
Water supply networks	linear m.	98 076 470	1 047 635	0,288
Sewerage networks	linear m.	37 053 200	314 635	0,404
Wells	pcs	22 134	14	0,002
Laboratories	pcs	n.d.	3	0,001
Clean water tanks	pcs	2 129	2	0,002
Water towers	pcs	6 947	9	0,002
Containers for household waste collection	pcs	n.d.	19 371	0,012
Garbage trucks	pcs	3 669	211	0,043
Landfills for household waste disposal	pcs	5 969	11	0,033
Waste sorting lines	pcs	34	3	0,005
Container sites	pcs	n.d.	309	0,000
Biogas plants	pcs	21	3	0,005
Damaged				
CHPP and TPS	pcs	87	14	Included to other section
Boiler houses	pcs	19 025	247	0,048
Heating networks	linear m.	18 987 083	0	0,000
Central heating stations	pcs	5 523	20	0,003
Water treatment plants	pcs	400	15	0,150
Sewage treatment plants	pcs	967	20	0,240
Water pumping stations	pcs	5 646	70	0,049
Sewage pumping stations	pcs	2 908	97	0,116
Water supply networks	linear m.	98 076 470	-	0,000
Sewerage networks	linear m.	37 053 200	-	0,000
Wells	pcs	22 134	47	0,002
Laboratories	pcs	n.d.	2	0,000
Clean water tanks	pcs	2 129	2	0,001
Water towers	pcs	6 947	35	0,003
Containers for household waste collection	pcs	n.d.		0,000

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Garbage trucks	pcs	3 669		0,000
Landfills for household waste disposal	pcs	5 969	10	0,012
Waste sorting lines	pcs	34	0	0,000
Container sites	pcs	n.d.	151	0,000
Biogas plants	pcs	21	0	0,000
Damaged as a result of an accident at Kakhovka HPP				0,050
Total damages to infrastructure				2,714
Losses				
Dismantling of destroyed facilities and removal of demolition waste	x	x	x	0,333
Additional government expenditures to rebuild and maintain the facilities	x	x	x	0,049
Economic losses from the difference between actual costs and approved service tariffs	x	x	x	0,766
Reduction of sector income	x	x	x	2,344
Total losses to sector	x	x	x	3,492

Source: State Statistics Service, Ministry of Reconstruction, regional military administrations, official NBU exchange rates, market data, expert assumptions, etc.

Annex 15.

Assessment of damages and losses to energy sector as a result of the full-scale war

Sub-sector	Damage assessment, \$ bln.
Damages	
Electricity generation, including:	7,20
Electricity generation, incl:	4,85
TPS	2,49
CHPP	0,33
NPP	0,84
RES	1,18
Electricity transmission	2,00
Electricity distribution	0,35
Oil and gas sector, including:	1,19
Gas transmission	0,78
Gas distribution	0,15
Storage of oil and oil products	0,26
Coal mining industry	0,41
Total damages to infrastructure	8,8
Losses	
Loss of revenues in the electricity sector	13,7
Loss of revenues from gas production and gas supply	4,0
Loss of revenues from oil production and refining	9,5
Total losses to sector	27,2

Source: data from the Ministry of Energy of Ukraine, data from regional military administrations, Energy Charter Secretariat, official NBU exchange rates, market data, expert assumptions, etc.