CONFLICT OBSERVATORY

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Destruction of the Oskil Dam in Ukraine, March–September 2022

A remote assessment of environmental impacts

A Conflict Observatory Report

Compiled by: CURIA Lab

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The Conflict Observatory Ukraine is an independent consortium of research organizations who capture, analyze, and make widely available evidence of war crimes and atrocities in Ukraine. The Cultural Resilience Informatics and Analysis (CURIA) Lab at the University of Virginia supports the Conflict Observatory's mission by documenting impacts of the war on Ukraine's cultural heritage.

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Executive Summary

This report investigates the March and September 2022 breaches of the Oskil Dam, the second of which rendered the dam inoperable for 22 months. The Oskil River and its dam are part of a complex water supply system in southeast Ukraine. A tributary of the Siverskyi Donets River, the Oskil River supplies water to the entire Donetsk region up to Mariupol through the Siverskyi Donets-Donbas canal. Before Russia's full-scale invasion of Ukraine, the dam was a critical regulator of drinking and agricultural water in one of Ukraine's driest regions. In the first part of the report, we analyze the environmental impacts caused by downriver flooding after the breaches. Using remote sensing methods, we document significantly degraded vegetation health and a marked decrease in soil moisture content. The second part of the report investigates what caused the breaches. Using open source information in Ukrainian and Russian, we document the strategic importance of the Oskil Dam as both a civilian infrastructure and an operational defensive boundary. We document Ukrainian and Russian armed forces' fight for territorial control in the vicinity of the Oskil Dam in March through September 2022. The military activities in this period included high-impact weapons capable of causing significant structural damage to the dam. The information analyzed here does not support a definitive attribution of blame to either side. It does definitively attribute the dam's failure to kinetic fighting. Although further investigations are needed, this report offers a step toward environmental legal accountability.

Introduction

Russia's invasion of Ukraine has caused widespread collateral and intentional damage to the environment.[1] Military activities, such as the use of munitions and the construction of military infrastructure, initiate a cascade of environmental degradation with significant consequences for communities. These activities directly damage soils, forests, grasslands, wetlands, agricultural land, and sensitive wildlife habitats. This initial damage then triggers secondary effects, such as the release of pollutants and contaminants, further disrupting the composition and morphology of these ecosystems. This destabilization of ecosystems can directly impact the communities that rely on them for resources, livelihoods, and well-being. Water systems are particularly vulnerable. For example, damage to hydrological infrastructure, such as dams, can lead to floods or the draining of reservoirs, which in turn destroys crops, alters soil moisture, reduces

[1] Anthes, E. (2022, April 13). A 'Silent Victim': How Nature Becomes a Casualty of War. *The New York Times*. https://www.nytimes.com/2022/04/13/science/war-environmental-impact-ukraine.html

electricity production, and contaminates or disrupts the supply of drinking water, directly impacting community access to essential resources.[2,3]

This report focuses on the environmental and societal impacts resulting from the destruction of the Oskil Dam between its initial breach in late March 2022 and its subsequent reconstruction in July 2024. The Oskil case highlights some of the environmental consequences resulting from Russia's invasion, while also illustrating the challenges in identifying and analyzing the causes, intentions, and effects of such damage. The environmental assessment presented in this report utilizes remote sensing methodologies, which, while seeing broader application, remain underutilized for evaluating environmental damage in active armed conflicts. We use satellite imagery to examine changes in vegetation health and soil moisture in the forested and agricultural areas surrounding the reservoir, a technique not commonly applied in the academic literature on conflict-related damage in Ukraine. This approach not only fills a critical gap in existing methods for documenting the environmental consequences of war, but also demonstrates its potential to overcome the logistical and safety barriers that prevent conventional field research. The report provides a precedent for analysis and investigation of environmental destruction with application for Ukrainian domestic legal prosecution as well as broader international initiatives, including the Register of Damage for Ukraine. The Register aims to provide a comprehensive record for future reparations, encompassing the destruction of infrastructure and natural resources.[4]

The destruction of the environment stems from both collateral impacts and deliberate decisions, many of which may violate international and national laws. According to the European Parliamentary Research Service, these environmental impacts include air, soil, and water contamination, forest fires and deforestation, and damage to ecosystems.[5, 6, 7] A number of provisions under the Geneva Conventions and customary international law set out legal

[2] Shumilova, O., Tockner, K., Sukhodolov, A., & others. (2023). Impact of the Russia–Ukraine armed conflict on water resources and water infrastructure. Nature Sustainability, 6(7), 578–586. https://doi.org/10.1038/s41893-023-01068-x
[3] Snizhko, S., Didovets, I., & Bronstert, A. (2024). Ukraine's water security under pressure: Climate change and wartime. Water Security, 23, 100182. https://doi.org/10.1016/j.wasec.2024.100182
[4] Council of Europe. (n.d.). Register of Damage Caused by the Aggression of the Russian Federation against Ukraine. https://rd4u.coe.int/en/
[5] Gabija Leclerc. (2023). Environmental impacts of the war in Ukraine: Implications for EU policy. *European Parliament*. https://www.europarl.europa.eu/RegData/etudes/ATAG/2023/751427/EPRS_ATA(2023)751427_EN.pdf
[6] EcoZagroza. (n.d.). EcoZagroza: Environmental consequences of war. https://ecozagroza.gov.ua/en
[7] WWF Central and Eastern Europe. (2023, July 14). Assessing the environmental impacts of the war in Ukraine. https://wwfcee.org/our-offices/ukraine/assessing-the-environmental-impacts-of-the-war-in-ukraine

obligations regarding the treatment of the environment. These include specific provisions in treaty law, such as Articles 35, 54, 55, and 56 of the Protocol Additional to the Geneva Conventions of 12 August 1949[8] (Protocol I), as well as the Rome Statute. Article 8 (2)(b)(iv) of the Rome Statute of the International Criminal Court[9] states: "Under certain circumstances, environmental destruction can constitute a war crime, such as when an intentional attack will cause widespread, long-term, and severe damage that is clearly excessive in relation to the anticipated military advantage." Protocol I, Article 35(3) states, “[i]t is prohibited to employ methods or means of warfare which are intended, or may be expected, to cause widespread, long-term, and severe damage to the natural environment.” Protocol I, Article 55(1) further specifies that “Care shall be taken in warfare to protect the natural environment against widespread, long-term and severe damage. This protection includes a prohibition of the use of methods or means of warfare which are intended or may be expected to cause such damage to the natural environment and thereby to prejudice the health or survival of the population.”

Provisions in international customary law apply specifically to the protection of water resources during armed conflict. Article 52 of the 2004 Berlin Rules on Water Resources[10] (the International Law Association’s authoritative summary of customary international law on water resources) states that, “Combatants shall not, for military purposes or as reprisals, destroy or divert waters, or destroy water installations, when such acts would cause widespread, long-term, and severe ecological damage prejudicial to the health or survival of the population or if such acts would fundamentally impair the ecological integrity of waters.” Furthermore, Article 53 of the Berlin Rules specifies that, “...combatants shall not make dams and dikes the objects of attack, even where these are military objectives, if such an attack may cause the release of dangerous forces and consequent severe losses among the civilian population.” Russia and Ukraine are also parties to the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques that requires state parties to adhere to specific obligations,[11] which establishes a framework for accountability in cases of environmental harm

[8] International Committee of the Red Cross. (1977) Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts https://www.icrc.org/sites/default/files/external/doc/en/assets/files/other/icrc_002_0321.pdf
[9] International Criminal Court. (2024). Rome Statute of the International Criminal Court (2nd ed.). https://www.icc-cpi.int/sites/default/files/2024-05/Rome-Statute-eng.pdf
[10] International Law Association. (2004). Berlin Rules on Water Resources. http://www.cawater-info.net/library/eng/l/berlin_rules.pdf
[11] Gabija Leclerc. (2023). Environmental impacts of the war in Ukraine: Implications for EU policy. European Parliament. https://www.europarl.europa.eu/RegData/etudes/ATAG/2023/751427/EPRS_ATA(2023)751427_EN.pdf

during armed conflict.[12] Moreover, elements of customary international law, such as military manuals, may also provide important guidance regarding the protection of the environment in conflict zones. The 2001 Ukraine Criminal Code includes provisions on Ecocide and Violations of Rules of Warfare that can be applied to certain types of environmental destruction.[13]

Background: Oskil Dam and Reservoir

The Oskil Dam, located in the Kharkiv oblast of Ukraine (Figure 1), was planned and constructed in 1957 by Soviet authorities as a critical component of regional water management. Prior to its destruction, the reservoir created by the dam covered an area of approximately 130 km². It had a maximum length of 125 km, a width of 4 km, and an average depth of 4 meters. The reservoir stored around 474 million cubic meters of water, making it the largest reservoir in Ukraine's Left Bank (Figure 2).[14] The Oskil Dam and Reservoir was designed to serve multiple purposes. The dam and reservoir were built to regulate the water levels of the Siverskyi Donets-Donbas canal, which provides drinking and industrial water to the Donets and Luhansk regions.[15, 16] Additionally, the Oskil Hydroelectric Power Plant (HPP) served as a buffer station and had the capacity to generate 80-90 MW per day when both turbines were operational, enough to cover the needs for half of the city of Izyum.[17] Beyond its practical functions, the dam and reservoir provided recreational opportunities. The forested area immediately downstream of the dam forms part of the Holy Mountains National Nature Park (Sviati Hory), a protected area that is an important ecological and recreational resource for the region.[18]

[12]Russian Federation, Instructions on the Application of the Rules of International Humanitarian Law by the Armed Forces of the USSR, Appendix to Order of the USSR Defence Minister No. 75, 1990, § 6(g) cited in ICRC Practice relating to Rule 45 Causing Serious Damage to the Natural Environment Section A. Widespread, long-term and severe damage https://ihl-databases.icrc.org/en/customary-ihl/v2/rule45.

[13] Rekrut, Iryna, "Environmental Damage is a War Crime: Analyzing the Legal Implications of the Russian Armed Invasion's Environmental Impact on Ukraine" (2024). *JCLC Online*. 30. https://scholarlycommons.law.northwestern.edu/jclc_online/30

[14] Measurements are taken from the Ukrainian Nature Conservation Group (uncg.org.ua) and the Water Monitoring Laboratory of the Eastern Region of the Siversk-Donetsk Basin Management of Water Resources (sdbuvr.org.ua).

[15] Sheldon, M. (2022, June 24). How Russia's offensive damaged critical Donbas water infrastructure. Bellingcat. https://www.bellingcat.com/news/2022/06/24/how-russias-offensive-damaged-critical-donbas-water-infrastructure/

[16] Ukrainian National Environmental Group (UNCG). (2022, May 31). Should the Oskil Reservoir be rebuilt after the war? https://uncg.org.ua/en/should-the-oskil-reservoir-be-rebuilt-after-the-war/

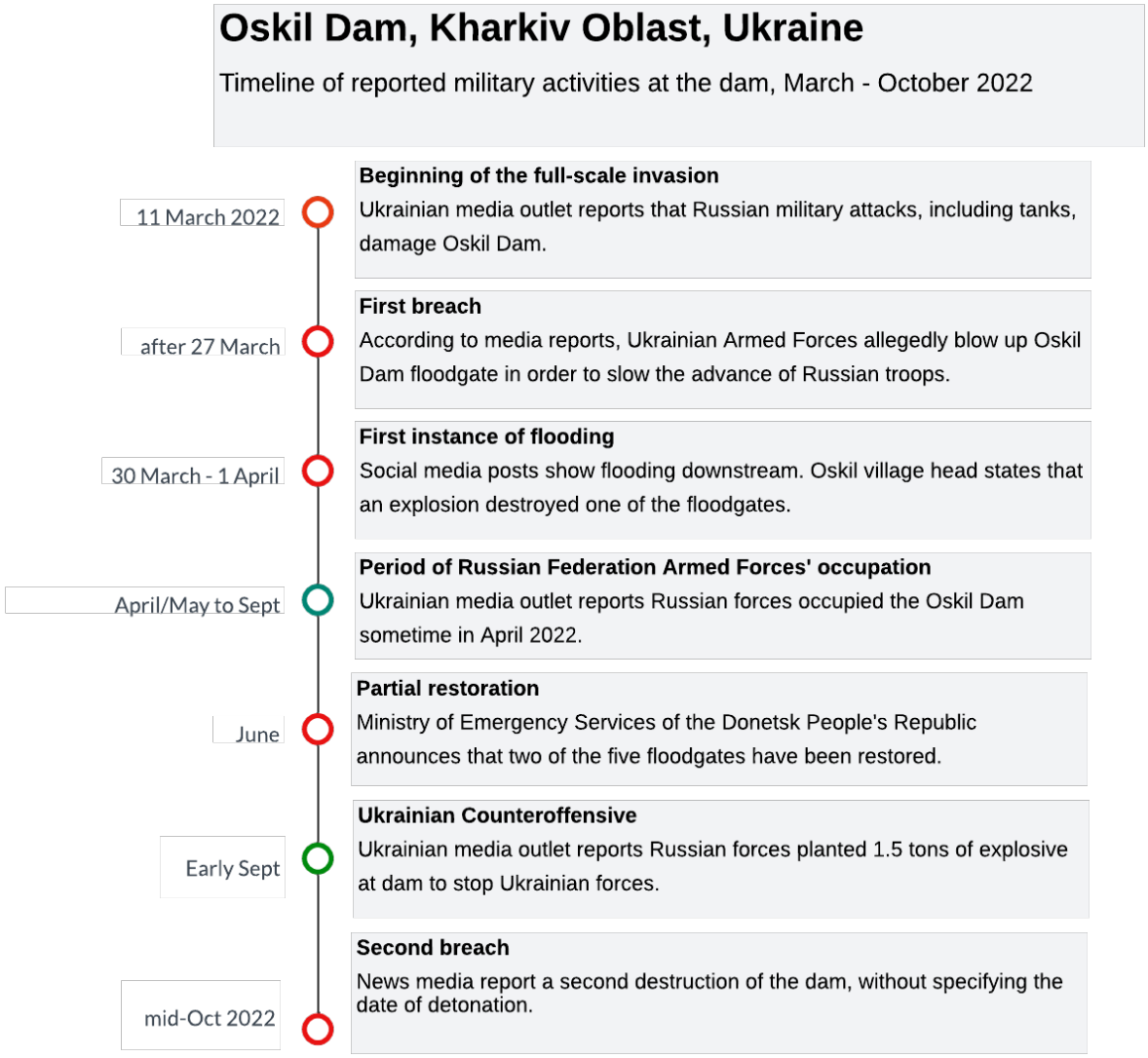
[17] Larin, Y. (September 15, 2023) "Destruction of the Oskol Reservoir: How the Kremlin takes water from Donbas residents." Dumka. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa

[18] Загальна: святі гори. Загальна| Святі гори. (n.d.). https://npp-svyatygory.com.ua/basic.html

Figure 1: Map of Ukraine, highlighting study area of the Oskil Dam and Reservoir.

Condensed Timeline of Oskil Dam Destruction

Multiple, sometimes contradictory, reports about damage to the Oskil Dam proliferated in traditional and social media beginning in early March 2022. The following graphical timeline provides an overview of the reports, condensed by CURIA analysts for sequential clarity. The textual timeline that follows provides more detail and original references.



- March 11, 2022 – Oskil Dam workers state in an interview with a Ukrainian media outlet that Russian military units, including tanks, started attacks resulting in damage to the portions of the Oskil Dam on March 11, 2022.[19]

[19] Ursa Media. (2024, March 4). Подвійний злочин: Чи понесе Росія відповідальність за екоцид на Харківщині? [Double crime: Will Russia be held accountable for ecocide in Kharkiv region?]. https://ursamedia.com.ua/history/podvijnyj-zlochyn-chy-ponese-rosiyja-vidpovidalnist-za-ecozid-na-kharkivshuni/

- After March 27, 2022 – A Ukrainian regional outlet claimed that an unspecified Ukrainian military unit blew up the Oskil Dam floodgate to halt the enemy along Ukrainian defensive lines sometime after March 27, 2022.[20]
- March 30 to 31, 2022 – Social media posts uploaded to Facebook and Telegram on March 30 and 31, 2022, depicted higher water levels in the Oskil River immediately downstream of the Oskil Dam and flooding occurring in villages adjacent to the river.[21]
- April 1, 2022 – The head of the Oskil community tells the Ukrainian media outlet Suspilne Kharkiv that an explosion destroyed one of the floodgates of Oskil Dam. He also states that water levels in the Oskil River have risen to "the average flood level."[22]
- Sometime in April 2022 – Oskil Dam workers state in an interview with a Ukrainian media outlet that Russian forces occupied the Oskil Dam sometime in April 2022.[23]
- June 7, 2022 – The press accounts on Telegram of the Ministry of Emergency Services of the Donetsk People's Republic announced a completed restoration of two of the five floodgates at Oskil Dam.[24]
- Early September 2022 – Oskil Dam workers state in an interview with a Ukrainian media outlet that Russian forces allegedly planted 1.5 tons of explosives near the first shutter gate mechanism at Oskil Dam in early September 2022 in anticipation of advancing Ukrainian forces.[25]

[20] SLK. (2023, August 30). Кожен патій залишився без житла: як живе деокупований Студенок [Each household left without housing: Life in the de-occupied Studenok]. https://www.slk.kh.ua/spec-proekti/podih-zitta/kozen-patij-zalisivsa-bez-zitla-ak-zive-deokupovanij-studenok.html
[21] https://novosti.dn.ua/ru/news/322412-v-svyatogorske-iz-za-podryva-damby-na-harkovshhine-severskij-donets-vyhodit-iz-beregov; https://www.facebook.com/100010465777519/videos/396607705243842/; https://t.me/truexanewsua/38055; https://www.facebook.com/watch/?v=1130730051081795
[22] Suspilne Media. (2022, April 2). В Осколі на Харківщині внаслідок підриву дамби підтопило вулиці [In Oskil, Kharkiv region, streets were flooded as a result of the dam explosion]. https://suspilne.media/kharkiv/224440-v-oskoli-na-harkivsini-vnaslidok-pidrivu-dambi-pidtopilo-vulici
[23] Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa
[24] https://t.me/mchs_dnr/7108
[25] Ursa Media. (2024, March 4). Подвійний злочин: Чи понесе Росія відповідальність за екоцид на Харківщині? [Double crime: Will Russia be held accountable for ecocide in Kharkiv region?]. https://ursamedia.com.ua/history/podvijnyj-zlochyn-chy-ponese-rosiyja-vidpovidalnist-za-ecozid-na-kharkivshuni/

- Mid-October 2022 – News media publish reports starting in mid-October 2022 referencing a 2nd destruction of the Oskil Dam, without specifying the date of the detonation.[26]

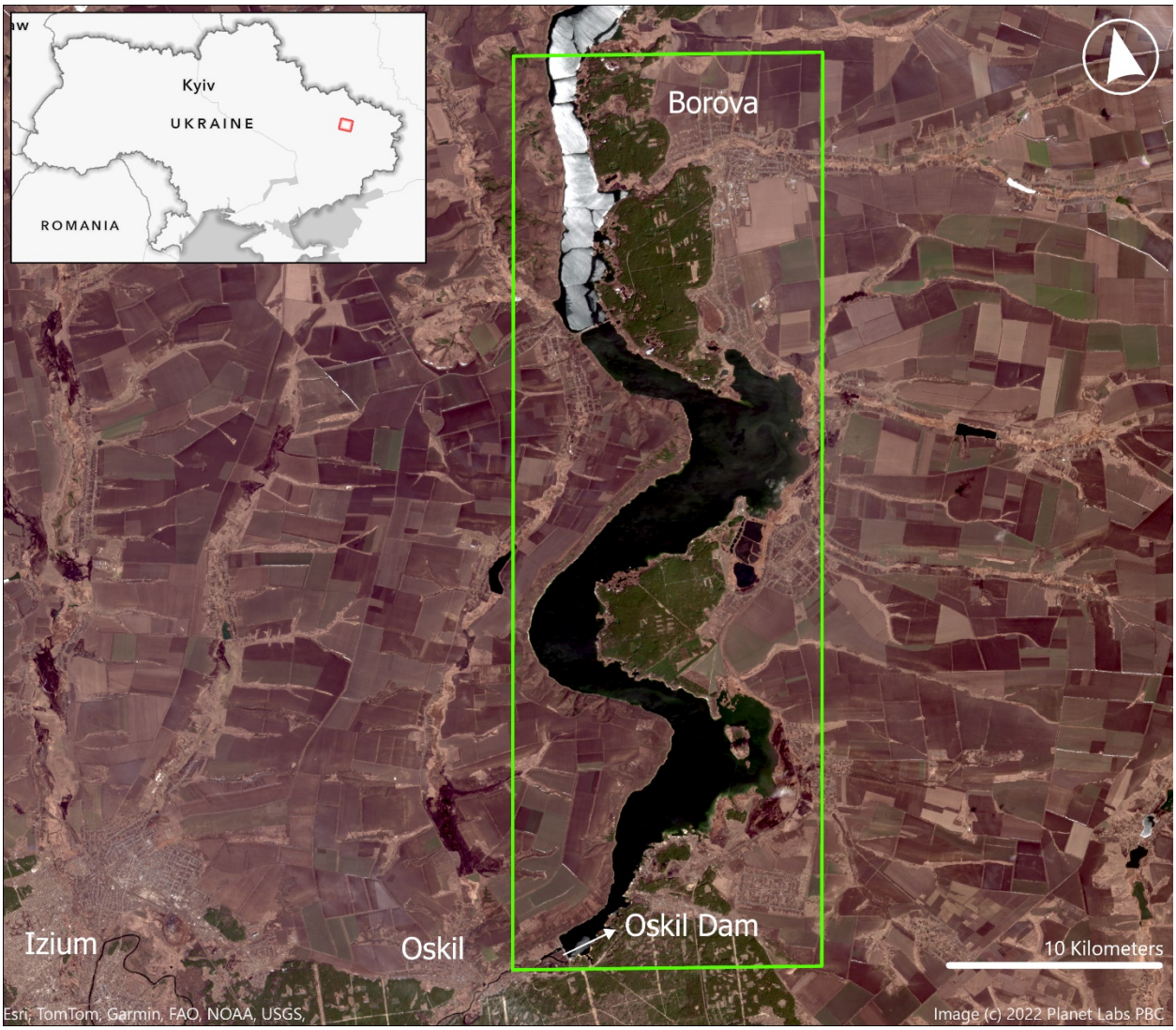


Figure 2: Map of Oskil Reservoir, Kharkiv Oblast. March 28, 2022.

[26] Tribun. (2024, May 1). Оскільський гідровузол: показуємо, як виглядає екологічний злочин на водосховищі на Харківщині [Oskil Hydroelectric Complex: Showing what environmental crime looks like at the reservoir in the Kharkiv region]. https://tribun.com.ua/uk/110486-oskilskij-gidrovuzol-pokazuemo-jak-vigljadae-ekotsid-vodosxovischa-na-xarkivschini; https://www.objectiv.tv/objectively/2022/10/27/okolo-9-tys-ga-dna-obmeleli-kak-vyglyadit-oskolskoe-vodohranilishhe-video/

Research Questions

1. How quickly did the water drain from the reservoir following the first breach in spring 2022, and what were the immediate impacts on local communities?
2. How do changes in vegetation health and soil moisture in the surrounding agricultural and forested areas in the two years following the dam breaches serve as indicators of impacts on local communities and their reliance on ecosystems?
3. How was the dam breached in spring 2022? What structural damage did the dam sustain, and what caused that damage? Who had authority over the dam at the time of this set of changes?
4. How was the dam breached in autumn 2022? What structural damage did the dam sustain, and what caused that damage? Who had authority over the dam at the time of this set of changes?

Environmental Impact Assessment

Methodology: Remote Sensing Analysis

Tracking Changes in Water Surface Area

We analyzed satellite imagery to reveal spatiotemporal variation in the extent of water within the reservoir, relying solely on remote sensing data in the absence of ground-based measurements. We employed a multi-sensor approach combining the strengths of Sentinel-2 and PlanetScope imagery. This approach allowed us to capture both long-term trends and the rapid changes immediately following the dam breach.

A five-year baseline (2017–2021) of normal seasonal variation in water surface area was established using Sentinel-2 data. This broader temporal context was crucial for interpreting the changes observed in 2022. While a single pre-damage image from this period is presented in the main figures for illustrative purposes, the full five-year dataset was used for the baseline analysis.

For the period encompassing the dam breaches and the most significant water level fluctuations (March 28, 2022, to October 19, 2022), we used high-resolution PlanetScope imagery. This timeframe was chosen specifically to capture the immediate and rapid changes in water surface

area, particularly the initial draining of the reservoir. March 28 was selected because it provided the closest available imagery showing stable reservoir conditions before any noticeable water level changes, serving as our primary pre-damage reference for the 2022 analysis. October 19 was selected because it marked a time when military activity had likely subsided, and no further significant changes in water levels were anticipated in the short term.

PlanetScope's high temporal resolution was essential for accurately quantifying these rapid changes. While Landsat and Sentinel-2 offer valuable data and were used for the broader temporal context, their revisit times (16 days for Landsat, 5–10 days for Sentinel-2), combined with frequent cloud cover in the region, especially during the spring and summer months, would have significantly limited our ability to document the rapid drawdown of the reservoir in 2022. The higher spatial resolution of PlanetScope was a beneficial side effect, allowing for more precise measurements of the changing water extent during this period of rapid change. Using Planet imagery for the entire multi-year period (including pre- and post-breach) would have been prohibitively time-consuming given the data volume and processing requirements.
To assess longer-term post-breach trends, we extended our analysis using Sentinel-2 data for the two years following the dam breach (2023–2024). This allowed us to contextualize the rapid changes of 2022 within a broader temporal framework and to assess longer-term trends in water surface area recovery or further changes.

It is important to note that our analysis reflects changes in the water surface area. Without bathymetric data or ground-based measurements for the reservoir, we are unable to calculate changes in water volume. For all imagery, we selected cloud-free scenes to maximize reservoir coverage and generated composite images for selected dates.

Due to extensive cloud cover in the region between March 28 and April 9, 2022, we cannot determine the precise timing of the initial water decline. However, we can determine that water levels began to decline during this period. We established the study area by identifying the maximum overlapping extent of the 26 composite images to ensure consistent measurements across all dates. We then clipped all images to match this defined area (Figure 2). We calculated the Normalized Difference Water Index (NDWI) for each composite image to quantify the extent of the water body. NDWI, derived from the green and near-infrared (NIR) spectral bands, effectively differentiates water pixels from other land cover types using the formula: NDWI = (Green − NIR) / (Green + NIR). Typically, NDWI values exceeding 0.2 indicate the

presence of water bodies. However, because of the ice present in the initial March 28 image, we applied a modified threshold of –0.01 to accurately classify both water and ice pixels as part of the water body. We consistently applied this –0.01 threshold to all images without overestimating water extent (Figure 3a), establishing a reliable baseline for subsequent comparisons.

We used the water pixels from the initial image of March 28, 2022, to create a water mask, representing the maximum extent of the water surface area in the reservoir before the dam was damaged (Figure 3b). To define the final study area for all images and account for potential fluctuations in water levels following the dam breach, we applied a 500-meter buffer around the initial water mask. This buffer was designed as a conservative measure to ensure that our analysis captured all relevant changes in water extent, even if they extended beyond the initial boundary defined by the March 28, 2022, image. Given the dynamic nature of the event and the potential for rapid and unpredictable changes in water extent, particularly during the initial drainage phase, a precautionary approach was deemed necessary. While the 500-meter distance was chosen empirically, it represents a substantial area surrounding the initial water extent. Subsequent analysis of imagery throughout the study period confirmed that no significant changes in water extent occurred outside of this buffered area. We further adjusted this buffer to exclude the area immediately downstream of the dam, as well as nearby lakes and retention ponds, ensuring that the final study area remained focused solely on the reservoir (Figure 3c).

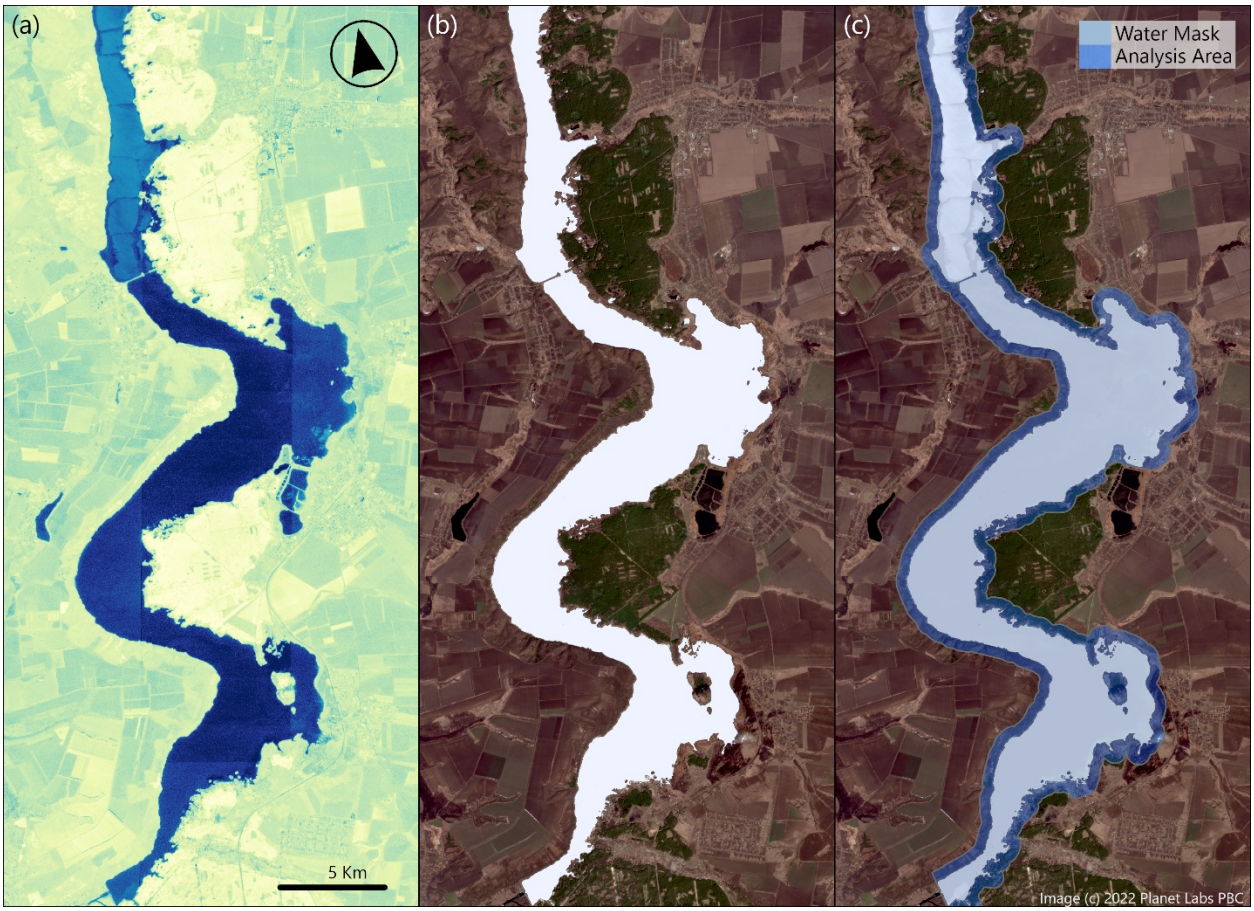


Figure 3: Remote sensing analysis from March 28, 2022. (a) NDWI Analysis. (b) Initial water mask. (c) Buffered study area.

Once we established the initial water mask and defined the extent of the study area, we reclassified all NDWI rasters using the previously mentioned –0.01 threshold. This process produced binary rasters with water and non-water pixels for each date. We then converted the binary rasters to polygons, allowing us to derive and visualize water masks as well as calculate the total water surface area for each date (Figure 4).

Figure 4: Water masks for the first five dates (March 28–May 5, 2022) in time-series analysis demonstrate changes in reservoir water levels following damage to the dam in late March 2022.

We generated water masks for imagery acquired between March 28 and October 19, 2022. We also processed Sentinel-2 imagery to compare our 2022 water masks with those from the five years prior to destruction of the dam and the two years following it. As shown in Figure 5, the data from the baseline period (2017–2021) reveal consistently high water levels comparable to those observed on March 28, 2022, when the reservoir measured 143.1 km^2. In contrast, the water levels during the two years following the dam damage (2023–2024) remain significantly

lower, indicating severe or permanent structural damage to the dam, which has prevented the reservoir from returning to its previous capacity. Figure 4, which provides a zoomed-in view of an area with significant changes in water extent, illustrates the rapid drainage of the reservoir, which was reduced to 8.7 km^2 by May 5, a decrease of ~94%. The substantial reduction in the reservoir's water area following March 28 cannot be attributed to natural variability. Water levels between 2017 and 2021 were consistently high, indicating no unusual fluctuations. Furthermore, it is important to note that Ukraine is not currently experiencing a drought. Precipitation levels since 2017 have remained consistent with long-term averages, further highlighting that the marked shrinkage of the reservoir cannot be explained by changes in precipitation.[27]

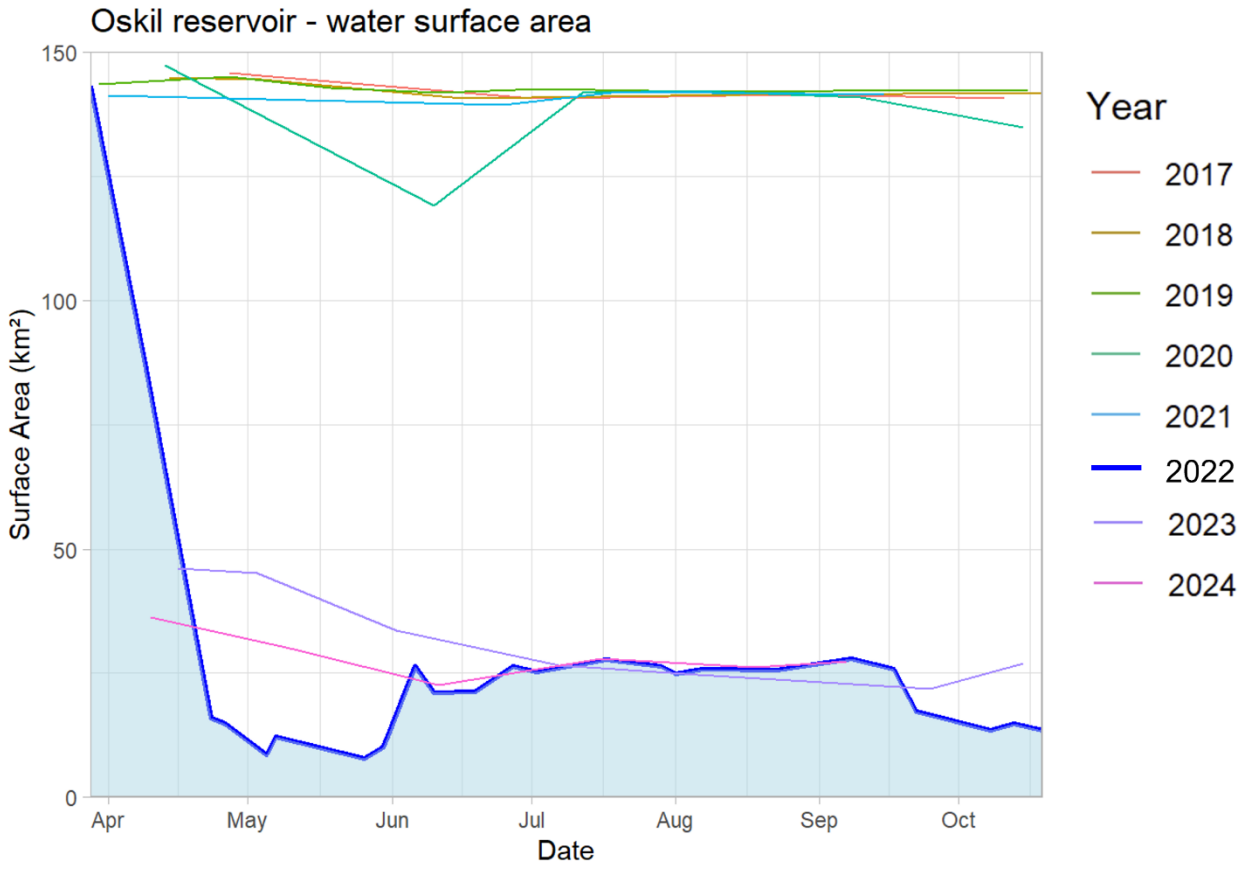


Figure 5: Annual changes in water surface area of the Oskil Reservoir, highlighting the decline in water levels post-dam damage.

[27] World Bank Climate Change Knowledge Portal. Climatology | Climate Change Knowledge Portal. (n.d.). https://climateknowledgeportal.worldbank.org/country/ukraine/climate-data-historical#:~:text=Precipitation%20falls%20predominately%20in%20summer,highest%20rainfall%20(67%20mm)

Assessing the Broader Environmental Impact

Following our quantification of changes in water levels within the Oskil Reservoir, we extended our analysis to assess the environmental impacts of the dam's destruction, specifically regarding vegetation health and soil moisture content in the surrounding areas. To achieve this, we conducted a remote sensing analysis using Sentinel-2 imagery. We calculated the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Moisture Index (NDMI) to evaluate potential changes in vegetation and soil moisture following the dam breaches[28, 29]. The NDVI, calculated as (NIR – RED) / (NIR + RED), is a widely recognized indicator of vegetation health, with values ranging from –1 to 1. Values closer to 1 correspond to more robust and healthy plant growth, while values closer to 0 or negative values generally represent non-vegetated surfaces or stressed vegetation. NDVI is based on the principle that healthy vegetation strongly reflects near-infrared light (NIR) while absorbing much of the red (RED) light for photosynthesis. This difference in reflectance results in higher NDVI values for healthy vegetation. Meanwhile, the NDMI is calculated as (NIR – SWIR) / (NIR + SWIR) and is utilized to monitor soil moisture, providing insights into changes in water content within vegetation and the surrounding land. NDMI is based on the principle that liquid water absorbs shortwave infrared (SWIR) radiation. Healthy, well-hydrated vegetation has a higher water content, leading to less SWIR reflectance and therefore higher NDMI values. We used imagery from 2017 to 2021 as a baseline to establish pre-damage trends for both NDVI and NDMI indices. This baseline data allows us to discern any deviations in NDVI and NDMI during the post-damage period (2023 and 2024). By calculating the NDVI and NDMI indices for the pre-damage years, we can characterize typical vegetation health and soil moisture patterns prior to the dam breach. This five-year baseline helps us understand seasonal variations in vegetation and soil moisture within the study area. We then compared these baseline indices with data from the two years following the dam damage.

To further investigate the environmental impacts of the dam's destruction, we conducted a more focused analysis on the forested areas within the study area. While agricultural land is dominant in the region, these areas are subject to ongoing management practices, including irrigation and potential water diversions, which could mask or alter the natural environmental response to changes in water availability. In contrast, the three identified forested zones are unmanaged,

[28] EOS Data Analytics. NDVI mapping in agriculture, index formula, and uses. Retrieved December 14, 2024, from https://eos.com/make-an-analysis/ndvi/
[29] EOS Data Analytics. NDMI: Vegetation index equation and values interpretation. Retrieved December 14, 2024, from https://eos.com/make-an-analysis/ndmi/

providing a more direct and unconfounded measure of the ecological impacts of the dam breach. For these areas, we extracted NDVI and NDMI values and compared them against those from the rest of the study area to assess how vegetation health and soil moisture in these regions were affected.

Limitations of Remote Sensing Data

While remote sensing technologies have been instrumental in documenting observable changes in the environment following the destruction of the Oskil Dam, they have inherent limitations that prevent them from providing a complete picture of the situation. The long-term environmental impacts of the dam's destruction are still unfolding and may take years to fully materialize. The remote sensing analyses employed in this report, including assessments of water surface area, vegetation health (NDVI), and moisture content (NDMI), can identify important patterns and trends. For example, observed changes in NDVI and NDMI can suggest potential impacts on agricultural productivity and forest health, which could in turn affect local livelihoods and access to resources. However, these indices are proxies and cannot directly measure underlying biophysical processes. Specifically, remote sensing cannot directly measure underlying issues such as sediment deposition, nutrient loading, and contamination, all of which can have significant consequences for both the environment and local communities. For instance, increased sediment deposition could impact water quality and aquatic habitats, potentially affecting local fishing activities. Similarly, changes in nutrient loading could lead to algal blooms, impacting water quality for drinking and irrigation. These complex environmental factors require ground-based data for thorough assessment. Given the relatively short time since the dam's breach, sustained ground-based monitoring of water quality, sediment transport, and aquatic ecosystems is essential. This comprehensive approach is necessary to understand fully the environmental impacts and inform effective recovery efforts. Without these on-the-ground measurements, remote sensing analyses risk oversimplifying complex ecological dynamics. It is crucial for remote sensing efforts to be complemented by robust field data collection to provide a holistic view of the unfolding ecological changes and their implications for both the environment and local communities.

Findings: Environmental Assessment of Dam's Destruction

Vegetation and Soil Health Analysis Using NDVI and NDMI

Initial results indicate a notable deviation from baseline conditions in both vegetation health and soil moisture levels in the post-damage years. Areas that had previously supported dense vegetation showed significant declines in NDVI, suggesting a potential disruption in plant growth due to reduced water availability. Similarly, the NDMI values for the surrounding land exhibited a marked decrease, highlighting diminished soil moisture content. Figures 6 and 7 show a direct comparison between the July values of 2021 (pre-damage) and the July values of 2024 (post-damage). July was selected for both years because it represents the period of peak NDVI and NDMI values. The difference was calculated by subtracting the July 2024 value from the July 2021 value. These patterns point to broader ecological consequences stemming from the sustained low water levels in the reservoir. Further analysis of these indices over a longer timeframe will provide critical insights into the longer-term ecological effects of the dam damage on both vegetation and soil moisture dynamics in the region.

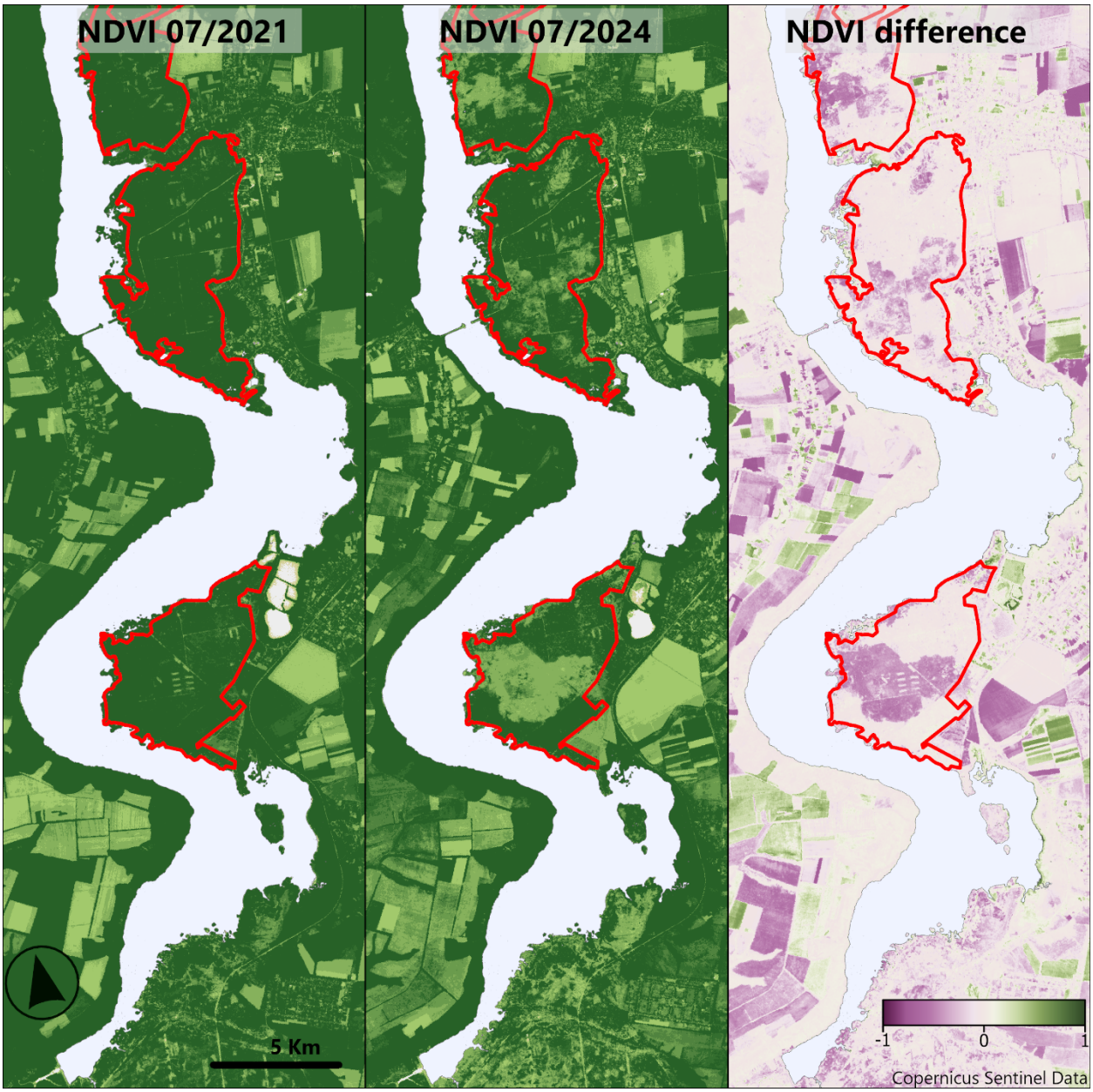


Figure 6. NDVI Analysis for July 2021 (left), July 2024 (middle), and the change in NDVI (right) between the two years. Declines in NDVI indicated by shades of purple and increases by shades of green, with forested areas highlighted by red boundaries.

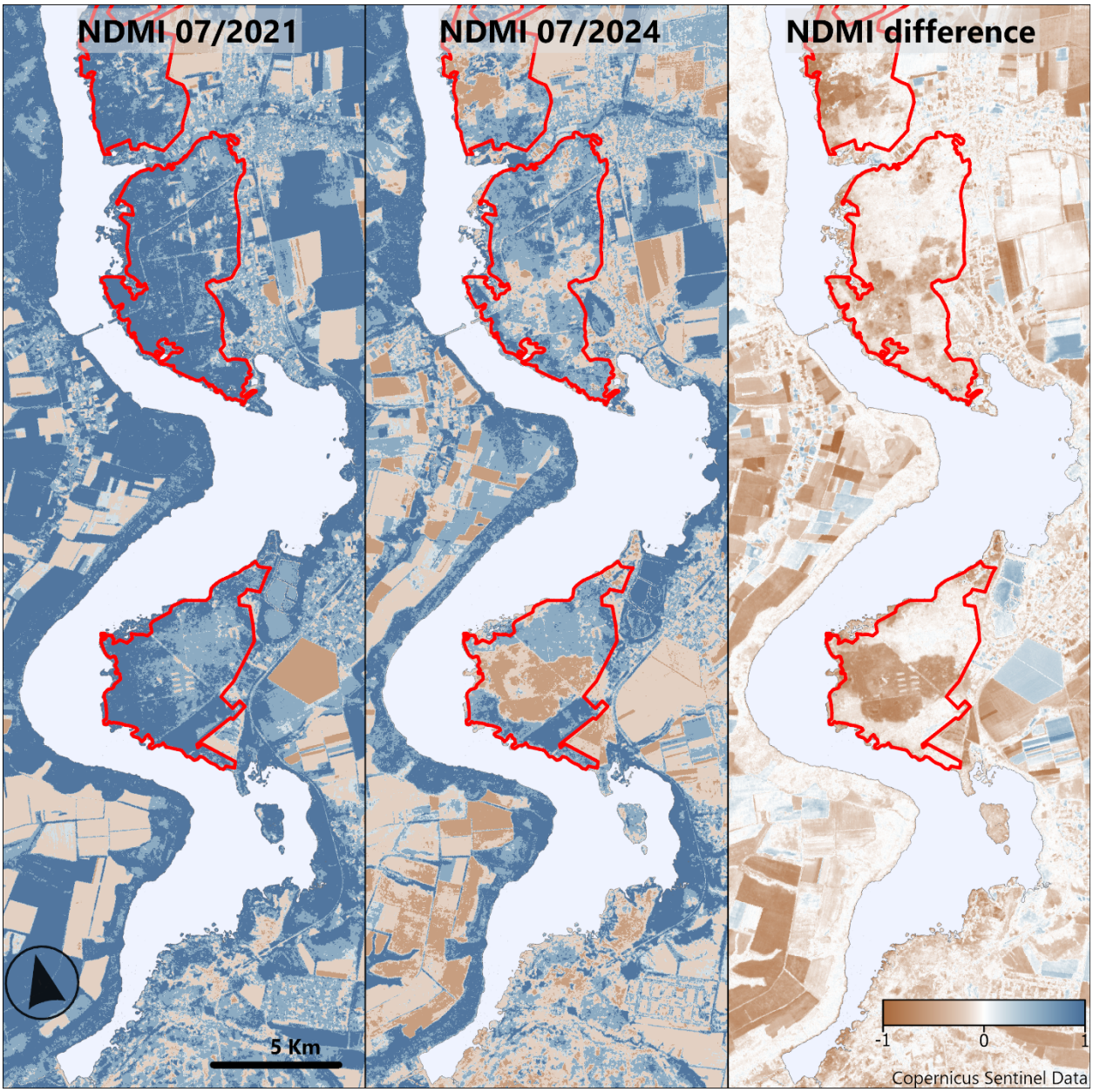


Figure 7. NDMI Analysis for July 2021 (left), July 2024 (middle), and the change in NDMI (right) between the two years. Declines in NDMI indicated by shades of red and increases by shades of blue, with forested areas highlighted by red boundaries.

Having established a broad overview of vegetation changes across the entire study area adjacent to the reservoir, we now focus specifically on the forested areas. To assess the impact of the dam breach on these forested ecosystems, we analyzed changes in NDVI and NDMI within these distinct zones. The results reveal a concerning trend: NDVI and NDMI within these forested areas are declining at a quicker rate than in the surrounding agricultural lands. This

accelerated decrease suggests that the vegetation in these forested regions is experiencing more severe stress, possibly due to reduced water availability following damage to the dam. A Welch Two Sample t-test comparing NDVI in the pre- and post-damage years within the forested area (Figure 6) yielded a t-statistic of 5.2 with a p-value of $4.1e^{-05}$, indicating a statistically significant decline in NDVI ($p < 0.001$). The mean NDVI in pre-damage years was 0.68, while it decreased to 0.59 in post-damage years. Similarly, a Welch Two Sample t-test comparing NDMI in the pre- and post-damage years revealed a t-statistic of 7.8 with a p-value of $9.1e^{-08}$, providing strong evidence of a statistically significant reduction in NDMI ($p < 0.001$). The mean NDMI for the pre-damage years was 0.23 and decreased to 0.11 in the post-damage years (Figure 7). These statistically significant declines in both NDVI and NDMI suggest changes in vegetation vigor and moisture content within the forested areas following the dam breach. However, without ground-based data, we cannot definitively determine the ecological significance of these changes or their specific impacts on forest health and sustainability. Despite this limitation, these findings offer a spatially extensive and efficient means of identifying areas of potential ecological concern following the dam breach. This broad-scale perspective is important for informing future monitoring efforts and prioritizing areas for more detailed ground-based studies and potential restoration interventions.

In addition to the original study area, we expanded our analysis to include a large, forested region immediately downstream of the Oskil Dam. This inclusion sheds light on the broader ecological impacts of the dam's destruction. Throughout the year, we observed peak NDVI and NDMI values in the lands adjacent to the reservoir during August. As a result, we focused our analysis of the downstream forest on August imagery from both the pre-damage period (2017–2021) and the post-damage period (2023–2024). This approach enabled a direct comparison of peak vegetation health and soil moisture between the pre-damage and post-damage periods.

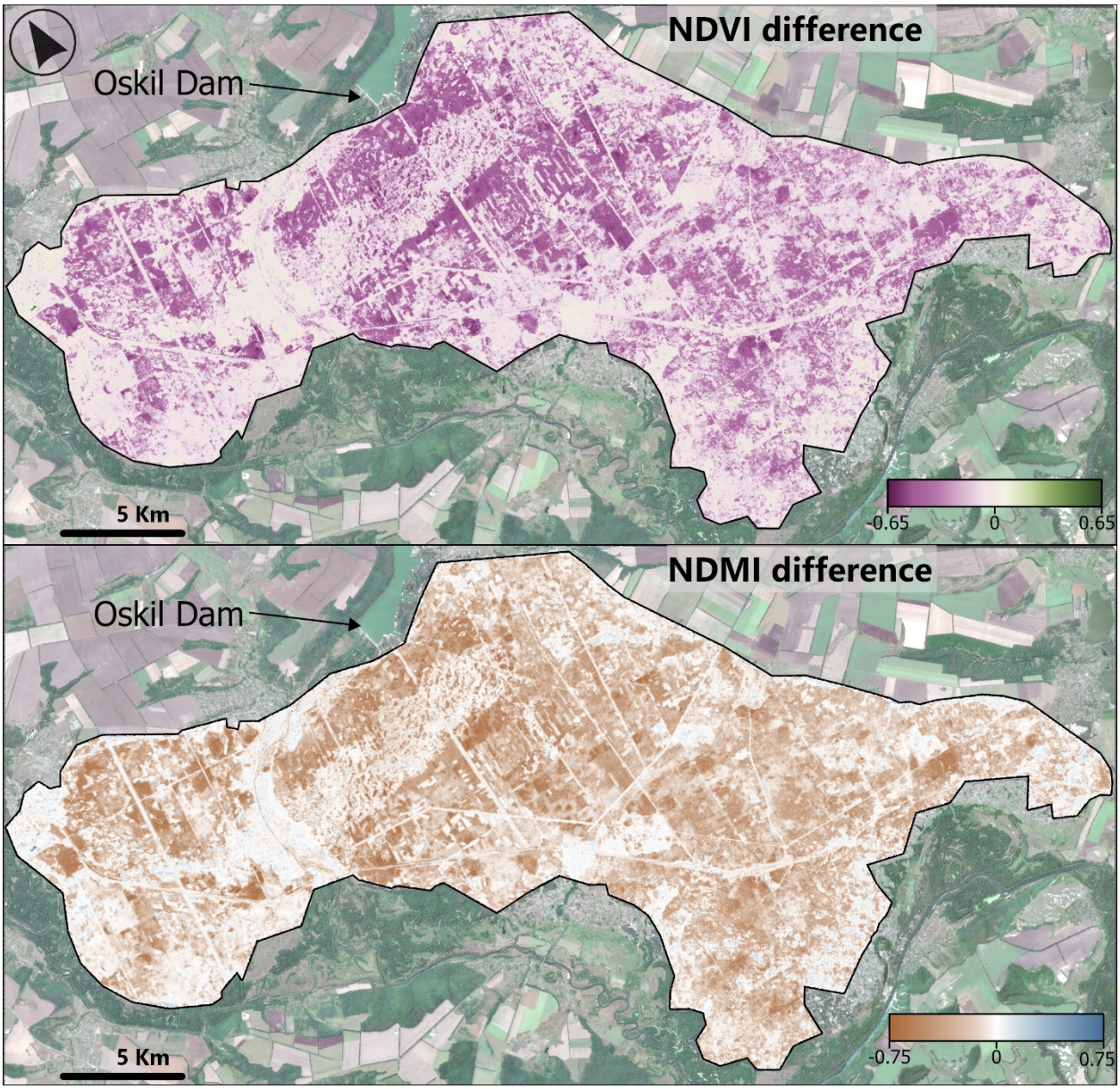


Figure 8. Changes in NDVI (top) and NDMI (bottom) between August of 2021 and 2024 for the forested area downstream of the Oskil Dam.

Our analysis of the downstream forested area revealed a pronounced decline in both NDVI and NDMI values during the post-damage years, a trend more severe than observed in the forested areas adjacent to the reservoir, with no areas showing an increase (Figure 8). This region includes parts of the Holy Mountains National Park, a protected area known for its rich biodiversity and cultural significance. The park is home to a variety of plant and animal species,

including several that are rare or endangered.[30] The lower NDVI values indicate reduced vegetation vigor, which could affect the ability of the forest to support its diverse wildlife. Meanwhile, the drop in NDMI points to decreased soil moisture, likely due to the reduced water flow following the dam's destruction. The observed drying trend poses a threat to the park's ecosystems. Studies have demonstrated a strong connection between reservoir water levels and surrounding groundwater levels.[31, 32] This connection is particularly relevant as many ecosystems, especially those in riparian zones and near surface water bodies, can be groundwater-dependent ecosystems, relying on groundwater for water, nutrients, and temperature regulation.[33] Our findings suggest that the park's vegetation is likely dependent on groundwater influenced by the reservoir, making it vulnerable to the altered hydrological conditions. Moreover, the Holy Mountains National Park holds cultural importance as a site of historical significance and natural beauty, attracting visitors for recreation, education, and spiritual retreats. The environmental degradation in this area could thus have broader implications for both ecological integrity and civilian needs. These findings further emphasize the extensive consequences of the dam's breaching, extending beyond the immediate reservoir area and impacting downstream ecosystems. Our targeted analysis, comparing forested and agricultural areas within and downstream of the original study area, provides new insight into how these two land cover types have been differentially impacted by the dam's destruction.

Local and Regional Hydrological Services

In addition to the environmental losses, the destruction of the Oskil Dam caused severe disruptions to the water supply in the Donetsk and Luhansk regions by impacting the Siverskyi Donets-Donbas canal, which connects to the Siverskyi Donets-Donbas River. The dam's reservoir had previously served as a vital source of water for the canal, especially during periods of low flow in the Siverskyi Donets River.[34] With most of the water drained from the reservoir, the canal has faced significant water shortages, exacerbating concerns about access to clean drinking water for millions of residents in the region. These shortages are the result of

[30] Patoka, M. Reserves under occupation: how Russian dig up virgin steppes and steal rare animals. *UAnimals Media*. https://uanimals.org/media/en/reportaj-en/zapovidnyky-v-okupatsii/
[31] Seeboonruang, U. (2012). Impacts of reservoir on groundwater level and quality in a saline area, Nakhon Panom Province, Thailand. APCBEE Procedia, 4, 16–21. https://doi.org/10.1016/j.apcbee.2012.11.004
[32] H Sulistiyono, Agustawijaya, D. S., & B W R Wardani. (2021). Impacts of dams on surrounding groundwater levels. 847(1), 012001–012001. https://doi.org/10.1088/1755-1315/847/1/012001
[33] Groundwater dependent ecosystems. Part I: Hydroecological status and trends. (2011). Environmental Science & Policy, 14(7), 770–781. https://doi.org/10.1016/j.envsci.2011.04.002
[34] Ukrainian National Environmental Group (UNCG). (2022, May 31). Should the Oskil Reservoir be rebuilt after the war? https://uncg.org.ua/en/should-the-oskil-reservoir-be-rebuilt-after-the-war/

the full-scale invasion, as Russian forces have repeatedly targeted and destroyed critical water infrastructure. This has dramatically deteriorated water security in a country already facing limited internal water resources, with only 26.8% originating within its own borders.[35]

The Siverskyi Donets-Donbas canal was integral to mitigating seasonal water variability, storing water during periods of high flow and releasing it during dry spells. Without the reservoir's ability to regulate these flows, downstream regions are more vulnerable to both drought and potential flooding. This instability poses a significant threat to the local water management system and increases the likelihood of further hydrological disruptions. The reservoir's strategic importance extended beyond the immediate area, as it supported the water supply for industrial operations in the Donetsk and Luhansk regions. The canal's water, essential for industrial activities and municipal use, has now been drastically reduced, intensifying the already strained water resources. This reduction has impacted not only drinking water availability but also agricultural irrigation systems that depended on the reservoir's consistent water levels for crop production. The dam also played a role in generating hydroelectric power for the Kharkiv regional grid.[36]

In many surrounding villages, groundwater levels dropped, and residents reported hydrogen sulfide odors in their well water.[37] The broader disruption to regional hydrology has made water shortages more acute, leaving local communities increasingly vulnerable to the lack of clean, reliable water supplies.[38] As the region continues to face difficulties in restoring the reservoir and clearing mines from the surrounding area, the full extent of the damage and its implications for both the local population and regional water security remain uncertain.

Environmental Impacts of Dam Breach

This section focuses on the potential environmental impacts commonly associated with dam breaches and significant changes in water flow and sediment transport. Ideally, this analysis

[35] Snizhko, S., Didovets, I., & Bronstert, A. (2024). Ukraine's water security under pressure: Climate change and wartime. *Water Security, 23*, Article 100182. https://doi.org/10.1016/j.wasec.2024.100182
[36] Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa
[37] Larin, Y. (September 15, 2023) "Destruction of the Oskol Reservoir: How the Kremlin takes water from Donbas residents." Dumka. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa
[38] Snizhko, S., Didovets, I., & Bronstert, A. (2024). Ukraine's water security under pressure: Climate change and wartime. *Water Security, 23*, Article 100182. https://doi.org/10.1016/j.wasec.2024.100182

would be further strengthened by detailed socio-economic data on how local communities interact with and depend on the surrounding ecosystems (e.g., specific fishing practices, reliance on river water for irrigation or domestic use, proximity of settlements to the riverbanks); however, such data was not readily available within the scope of this study. This highlights the need for future research to investigate the specific socio-economic impacts of the dam breach on local communities and to assess the vulnerability of local livelihoods to these changes.

While our analysis focuses on documenting the timing and rate of drainage using surface area calculations, it has been estimated that the initial breach of the dam in March 2022 resulted in the rapid draining of 355 million cubic meters of water, about 76% of its total capacity.[39] This water flowed into the Siverskyi Donets River, causing it to overflow and flood the nearby communities of Studenok, Yaremivka, and Pasika. This event has the potential to trigger a range of environmental changes, impacting both the reservoir area and the downstream river system. The sudden drop in water levels exposed approximately 9,000 hectares of its silted bed, which swept fish populations downstream, impacting both the aquatic ecosystem and local communities reliant on these sources.[40] The sudden release of large amounts of water from a breached dam can lead to environmental issues, especially concerning sediment transport and deposition. As water is discharged, it can carry substantial amounts of sediment that accumulated behind the dam.[41] While this scenario has not been directly observed, it is understood that such a surge of sediment downstream could have a major impact on river systems, water quality, and the surrounding areas.[42] The potential consequences of these changes will be discussed further.

The initial release of water from a breached dam typically carries a large volume of coarse sediment, leading to physical changes in the riverbed and banks. Over time, finer sediments may remain suspended in the water column, gradually spreading further downstream. This sediment transport can significantly alter river morphology, potentially increasing the erosion, destabilizing riverbanks, which may become more prone to collapse, leading to further erosion

[39] Ukrainian National Environmental Group (UNCG). (2022, May 31). Should the Oskil Reservoir be rebuilt after the war? https://uncg.org.ua/en/should-the-oskil-reservoir-be-rebuilt-after-the-war/
[40] Ukrainian National Environmental Group (UNCG). (2022, May 31). Should the Oskil Reservoir be rebuilt after the war? https://uncg.org.ua/en/should-the-oskil-reservoir-be-rebuilt-after-the-war/
[41] Graf, W. L. (2006). Downstream hydrologic and geomorphic effects of large dams on American rivers. Geomorphology, 79(3-4), 336–360. https://doi.org/10.1016/j.geomorph.2006.06.022
[42] Ritchie, Andrew C., et al. "Morphodynamic Evolution Following Sediment Release from the World's Largest Dam Removal." Scientific Reports, vol. 8, no. 1, 5 Sept. 2018, www.nature.com/articles/s41598-018-30817-8, https://doi.org/10.1038/s41598-018-30817-8.

in the river channel.[43, 44] Rapid sediment deposition can also change river topography and drastically change fluvial habitats.[45] This accumulation of sediment on riverbeds can smother crucial habitats, such as spawning beds for fish and benthic habitats for invertebrates.[46] Increased sedimentation reduces water clarity, which in turn can inhibit photosynthesis in aquatic plants and disrupt the food chain. The influx of fine sediments may also alter nutrient availability, affecting both the health of aquatic organisms and the broader ecosystem dynamics. Excess nutrients like phosphorus and nitrogen introduced into the water column can stimulate algal blooms, leading to eutrophication and oxygen depletion. This coupled with pollutants such as heavy metals and organic contaminants that may have been stored behind the dam can degrade water quality and pose risks to aquatic life and human health.

While the removal of dams can sometimes offer long-term environmental benefits, such as the restoration of natural river flow and enhanced ecosystem health, the destruction of the Oskil Dam was not planned or controlled. This act resulted in the sudden and uncontrolled release of water, causing immediate and severe disruptions. Essential services like water supply for irrigation and domestic use were compromised, significantly impacting agriculture, fishing, and other livelihoods. This highlights an important distinction between planned dam removals, which can be carefully managed, and the devastating consequences of unplanned and uncontrolled destruction.

Open Source Intelligence Analysis

Methodology: Open Source Intelligence

Data Collection Approach

To address the research questions (3) and (4), we used open source intelligence and third-party military analysis, following the guidelines outlined in the Berkeley Protocol on Digital Open

[43] Asahi, K., Shimizu, Y., Nelson, J., & Parker, G. (2013). Numerical simulation of river meandering with self-evolving banks. *Journal of Geophysical Research: Earth Surface, 118*(4), 2208–2229. https://doi.org/10.1002/jgrf.20150
[44] Nones, M. (2019). Dealing with sediment transport in flood risk management. *Acta Geophysica, 67*(3), 677–685. https://doi.org/10.1007/s11600-019-00273-7
[45] Van Rooijen, E., Siviglia, A., Vetsch, D. F., Boes, R. M., & Vanzo, D. (2024). Quantifying fluvial habitat changes due to multiple subsequent floods in a braided alpine reach. *Journal of Ecohydraulics, 9*(1), 1–21. https://doi.org/10.1080/24705357.2022.2105755
[46] Duan, X., Wang, Z., Xu, M., & Zhang, K. (2009). Effect of streambed sediment on benthic ecology. *International Journal of Sediment Research, 24*(3), 325–338. https://doi.org/10.1016/S1001-6279(10)60007-8

Source Investigations.[47] Specifically, we used multiple search engines to introduce algorithmic plurality in the assessment and collection steps (Google, Yandex, Bing, and Dzen, a Russian news aggregator). We assessed online information in Ukrainian, Russian, and English, concentrating on six common social media sites used by both Ukrainian and Russian communities: Facebook, YouTube, Instagram, Twitter/X, VK, and Telegram. Facebook, Telegram and YouTube have the highest share of users among all social media users in Ukraine, as of June 2024.[48] VK is a popular Russian social media platform; however, in recent years it has become a secondary platform of choice, often for reposting content from Telegram. Platforms such as Instagram and Twitter/X were used to discover potentially relevant content, some of which was reposted from the aforementioned platforms. We recorded our search terms and hits in a structured spreadsheet. Most key terms were simultaneously utilized in Ukrainian, Russian, English, with respect to variations in each respective language's declensions and conjugation, and historical and renaming conventions relevant to Russification, Ukrainianization, and Sovietization policies. To optimize our search for relevant terms in Telegram, we used TGStat. This tool allows users to perform advanced keyword searches across nearly all public Telegram group chats and channels more efficiently without a requirement to follow or join the accounts first. This tool bypasses the inefficient search tools built natively into Telegram and allows for greater channel discoverability and analytics.

To understand more about troop movements in the vicinity of the dam at the time of each breach, we relied on data from Janes, a commercial military intelligence and analysis firm. Their research methodology includes open source and imagery intelligence in combination with proprietary data and the analysis of military subject matter experts. Janes starts by identifying and locating units on the ground and linking these military assets to orders of battle, and then observes the effects delivered in a given area to reverse engineer the most likely delivery platforms, artillery maneuver areas, and priorities of fire. Janes combines open source research and analysis techniques with a reverse engineering process based on military doctrines to identify the scheme of maneuver, fire support, targeting, and sustainment. Their reports provide insight into the strategic and operational movements of higher order Russian military formations

[47] Office of the High Commissioner for Human Rights. (2020). *The Berkeley Protocol on Digital Open-Source Investigations*. United Nations. https://www.ohchr.org/en/publications/policy-and-methodological-publications/berkeley-protocol-digital-open-source
[48] OPORA. (2024, July 10). Media consumption of Ukrainians: The third year of full-scale war. https://www.oporaua.org/en/viyna/media-consumption-of-ukrainians-the-third-year-of-a-full-scale-war-25292

involved in the campaigns against the important population centers in Izyum and Kup'yans'k, cities adjacent both to the Siverskyi Donets River and the Oskil Dam.

In order to understand historical trends, daily updates, and double check military developments of particular regions or military units in the Russia-Ukraine War, we relied on multiple open source aggregation and analysis publications. We assessed reports published by the US-based, non-partisan Institute for the Study of War; DeepStateUA, an independent, Ukraine-based monitoring group; and Rybar, a pro-Kremlin analytical unit linked to the Russian Ministry of Defense.

Open Source Intelligence Limitations

Information visibility during the period of Oskil's occupation was significantly limited due to both military and demographic factors. Russian occupying forces imposed direct and indirect information restrictions on the civilian population and on occupational administrative units involved in the dam's operations. These restrictions probably reduced public posting of user generated content which could assist in determining actor responsibility for the dam's destruction. Furthermore, the Oskil dam region is a mostly rural, low-population density area.[49] The dam's central place in high-intensity fighting would have made it difficult for civilians to observe directly during the key time points. In addition, mandatory civilian evacuations at the onset of the Russian advance reduced the number of potential eyewitnesses. During the period of RFAF control of the dam and reservoir, information about the condition of the dam and causes of damage to it are limited. We have less than a dozen public statements from occupation authorities and private individuals with known pro-Kremlin leanings, such as WarGonzo, a popular Russian mil blogger. In this setting, there is a risk that mis- and dis-information narratives proliferated without counter narratives that would support thorough verification. These demographic and locational features are likely to have affected the volume and variety of user-generated social media posts and witness statements.

[49] Oskil Village Council. (n.d.). Structure. https://oskilskasilrada.gov.ua/structure/

Chronology of Military Activity Around the Oskil Dam

Initial Full-Scale Invasion and First Dam Breach (February 2022 to April/May 2022)

Narratives of the events surrounding the initial destructive activities relating to Oskil Dam come from local Ukrainian civil servants and employees of the Oskil Dam. It is impossible to establish the veracity of their statements from open sources alone, but the statements have value for documenting what was said about the damage in the immediate aftermath of the first breach. In interviews with regional Ukrainian media outlets, two employees of the Oskil Dam claimed that shelling and bombing of the Oskil Dam first occurred on March 11, 2022 (at around 12:00, according to one employee) as Russian forces approached from the northeastern (right bank) settlement of Komarivka with tanks, firing on both the Oskil Dam's road surface and the Oskil Dam itself. The same employees were both reportedly the last to operate the facility amid staff evacuations and left shortly afterwards after making the decision to "stop the unit and put everything on the stoppers, disconnect and leave."[50]

Information regarding massive damage to the Oskil Dam first emerged from March 30 to April 1, 2022. On March 30 to 31, 2022, the first videos of massive decreases in water levels of the Oskil Reservoir[51] and flooding just downstream of the Oskil Dam, including near the Svyatohirs'k Monastery,[52] circulated on Ukrainian social media spaces.[53] On April 1, 2022, the head of the village of Oskil confirmed to a Ukrainian national outlet an explosion at one of the gates of Oskil Dam.[54] No information in open sources was uploaded in this temporal scope of time to provide a confident attribution for the perpetration of this attack to either Ukrainian or Russian military units.

Janes' analysis of open source information indicates that numerous Russian Ground Forces formations took part in the campaign to take Izyum and the surrounding area from early March

[50] Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa

[51] https://t.me/truexanewsua/38055; https://www.facebook.com/watch/?v=1130730051081795

[52] Novosti Donbassa. (2022, April 2). В Святогорске из-за подрыва дамбы на Харьковщине Северский Донец выходит из берегов [In Svyatohirsk, due to the dam explosion in Kharkiv region, the Seversky Donets river overflows]. https://novosti.dn.ua/ru/news/322412-v-svyatogorske-iz-za-podryva-damby-na-harkovshhine-severskij-donets-vyhodit-iz-beregov; https://www.facebook.com/100010465777519/videos/396607705243842/

[53] https://www.facebook.com/watch/?v=493110772416818&extid=CL-UNK-UNK-UNK-AN_GK0T-GK1C&ref=sharing

[54] Suspilne Media. (2022, April 2). В Осколі на Харківщині внаслідок підриву дамби підтопило вулиці [In Oskil, Kharkiv region, streets were flooded as a result of the dam explosion]. https://suspilne.media/kharkiv/224440-v-oskoli-na-harkivsini-vnaslidok-pidrivu-dambi-pidtopilo-vulici

to May 2022, likely including elements of the 1st Guards Tank Army and the 20th Combined Arms Army.[55] Janes collection of various Tank Divisions and Motor Rifle Divisions operating in the broader area is consistent with Ukrainian social media posts documenting a number of Russian T-72,[56] T-80,[57] and other tank and armored personnel carrier variants that were spotted near the settlements around Oskil Dam in both the spring and fall of 2022.[58] Additionally, open source information indicates that a number of Russian military fixed-wing aircraft were operating in the areas of in the Izyum and Oskil administrative boundaries, including a Su-35S fighter jet from the 159th Fighter Aviation Regiment of the Russian Aerospace Forces sometime during the period of February 24 to April 3, 2022, [59] and other aircraft capable of delivering aerial bombs around the Oskil River area.[60]

Due to operational security, limited information exists on which Ukrainian units were stationed to defend (or possibly sabotage) the Oskil Dam in the spring. Two units have been public about their activities. The Special Purpose Battalion named after the Hero of Ukraine, Major General Serhii Kulchytskyi of the Ukrainian National Guard[61] and the 113th Separate Brigade of the Territorial Defense Forces took part in the defense of Oskil Dam at the start of the full-scale invasion.[62] In an interview with a Ukrainian military publication, one fighter of the Kulchytskyi

[55] Janes. (2024). *Assessment provided to CURIA Lab*.
[56] Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa
[57] https://www.facebook.com/photo/?fbid=660556928747962&set=g.142215299746724
[58] https://www.facebook.com/photo/?fbid=660554525414869&set=g.142215299746724; https://www.facebook.com/izyumlive/posts/pfbid0D7E8EU4rJwsrceqzS57dKtFKDtx2WZUuEr2hvBuRkFrPVPtSVo4oSEc8Ugcw1E6Rl
[59] Censor.net. (2022, April 4). Ukrainian soldiers detained Russian pilot Yermalova, who bombed peaceful cities in Ukraine and Syria and killed many people. https://censor.net/ru/v3331177; https://www.facebook.com/pgo.gov.ua/posts/344494287713411
[60] https://www.facebook.com/DSNSKHARKIV/posts/pfbid02MqbqBQKo9t426GfC7LUToxRQbPmj9YQGXZqdfSLrbVuEfm8k9FPCYbH4CMqTNURZl
[61] Fakty. (2022, October 2). Залишився без пальця, але знову хоче повернутися на фронт: історія захисника Дмитра Фінашина [Lost a finger, but wants to return to the front: The story of defender Dmitry Finashyn]. https://fakty.com.ua/ua/ukraine/suspilstvo/20221002-zalyshyvsya-bez-palczya-ale-znovu-hoche-povernutysya-na-front-istoriya-zahysnyka-dmytra-finashyna/; https://www.facebook.com/BatalionGeneralaKulchitskogo/posts/pfbid019k3RXVyAQK9N3Dwn4W1NTCL7tSM8AabLi6qK7LRapv1V9YrbmPqZGtXCYJotSwbl; https://www.facebook.com/BatalionGeneralaKulchitskogo/posts/762158785957785; https://dpu.edu.ua/novyny/student-volonter-voin-shliakh-do-peremohy-vidvertyi-dialoh-z-tymy-khto-bachyv-viinu-zseredyny
[62] Ukrainian Ministry of Defense. (2022, October 22). Треба вижигати Москву: як група селян була росіянами в Ізюмі [We must burn Moscow: How a group of villagers were Russians in Izium]. https://tro.mil.gov.ua/treba-vyzhygaty-moskvu-yak-grupa-selyukiv-byla-rosiyan-v-izyumi

Battalion spoke of the placement of two giant concrete slabs across the Oskil Dam and anti-tank mining in the area, done to impede the movement of the Russian forces.[63] In the same interview, the veteran described how the SP Battalion used mortars and artillery against advancing Russian forces, who responded with anti-aircraft weaponry and air raids.[64] The SP Battalion took part in engagements in a number of settlements around the Oskil Reservoir area in the spring of 2022, including Sviatohirsk, Studenok, Rubtsi, Oskil, and Pisky-Radkivski, all locations that were later flooded when the Dam was breached.[65] Another unit that participated in the fighting near Oskil Dam in the spring 2022 had self-reportedly engaged in the destruction of tactical Ukrainian assets, immediately prior to the Oskil Dam's destruction in March 2022, in order to prevent them from falling into Russian possession following the latter's advance. Members of the 113th Separate Brigade of the Territorial Defense Forces were transferred to fight near Oskil village after completing an order to destroy the "Nadia" oil depot on March 7, 2022, outside of Izyum, which they previously protected since late February 2022, so as not to allow it to enter into Russian control once Izyum was occupied.[66] A single Ukrainian regional outlet claimed that an unspecified Ukrainian military unit intentionally blew up the Oskil Dam gate to halt the enemy along Ukrainian defensive lines that were breached at the nearby villages of Yaremivka and Pasika on March 27, 2022, just south of the dam.[67] An unverifiable competing narrative alleges that Russian forces attacked the dam with the intention blocking the flow of water resulting from an initial Ukrainian raising of the floodgates earlier in March 2022, appears to be supported by the testimony of an Oskil Dam employee who speculated that an alleged Russian airstrike was conducted "to force down the [dam gate] shutters and block the descent of water [in order to] give the Russians an opportunity to arrange a crossing for their

[63] ArmyInform. (2023, March 14). Марив та пив воду з калюжі: герой України Дмитро Фінашин про поранення та шлях до своїх [I was delirious and drank water from a puddle: Hero of Ukraine Dmytro Finashyn on his injuries and the path back to his people]. https://armyinform.com.ua/2023/03/14/maryv-ta-pyv-vodu-z-kalyuzhi-geroj-ukrayiny-dmytro-finashyn-pro-poranennya-ta-shlyah-do-svoyih/

[64] Fakty. (2022, October 2). Залишився без пальця, але знову хоче повернутися на фронт: історія захисника Дмитра Фінашина [Lost a finger, but wants to return to the front: The story of defender Dmitry Finashyn]. https://fakty.com.ua/ua/ukraine/suspilstvo/20221002-zalyshyvsya-bez-palczya-ale-znovu-hoche-povernutysya-na-front-istoriya-zahysnyka-dmytra-finashyna/

[65] https://www.instagram.com/p/C_0kBTFoWKr/

[66] Ukrainian Ministry of Defense. (2022, October 22). Треба вижигати Москву: як група селян була росіянами в Ізюмі [We must burn Moscow: How a group of villagers were Russians in Izium]. https://tro.mil.gov.ua/treba-vyzhygaty-moskvu-yak-grupa-selyukiv-byla-rosiyan-v-izyumi

[67] SLK. (2023, August 30). Кожен п'ятий залишився без житла: як живе деокупований Студенок [One in five was left without housing: Life in de-occupied Studenok]. https://www.slk.kh.ua/spec-proekti/podih-zitta/kozen-patij-zalisivsa-bez-zitla-ak-zive-deokupovanij-studenok.html

equipment [downstream]," which occurred after that same engineer alleged that station opened the floodgates to lower the water level as Russian forces initially approached.[68]

Period of Russian Occupation and Partial Restoration (April/May 2022 to September 2022)

Due to the Oskil River's geography dividing the administrative boundary of the surrounding village of Oskil and the adjacent Oskil Dam, it is difficult to determine the exact end dates for combat between the right bank of Oskil village and the Oskil Dam, occupied by Russian forces since early March 6, 2022, and the more resilient Ukrainian defended left bank portion.[69, 70] According to an interview with Oskil Dam employees, the structure was captured sometime in April 2022.[71] In one criminal investigation, Ukrainian prosecutors list April 12, 2022, as the date that the full administrative boundaries of Oskil Village Council were occupied.[72] The Ukrainian Open Source Intelligence project DeepStateUA mapped Oskil Dam and the nearby village of Oskil as fully occupied by Russian forces between May 2 and May 4, 2022.[73] Janes' data and analysis suggest that the combat situation may have remained fluid around the dam as late as May 8 to May 26, 2022.[74] The Institute for the Study of War also assessed that the village of Oskil was fully captured by Russian forces later on May 21, 2022.[75]

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[68] Ursa Media. (2024, March 4). Подвійний злочин: Чи понесе Росія відповідальність за екоцид на Харківщині? [Double crime: Will Russia be held accountable for ecocide in Kharkiv region?]. https://ursamedia.com.ua/history/podvijnyj-zlochyn-chy-ponese-rosiyja-vidpovidalnist-za-ecozid-na-kharkivshuni/; Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa

[69] Suspilne Kharkiv. (2022, October 27). В п'ятеро менше води: як під час війни обміліло Оскільське водосховище на Харківщині [Five times less water: How the Oskil Reservoir in Kharkiv region dried up during the war]. https://suspilne.media/kharkiv/302934-vpatero-mense-vodi-ak-pid-cas-vijni-obmililo-oskilske-vodoshovise-na-harkivsini/

[70] Fakty. (2022, November 25). Перетворилося на пустелю: як війна знищила Оскільське водосховище на Харківщині [Turned into a desert: How the war destroyed the Oskil Reservoir in Kharkiv region]. https://fakty.com.ua/ua/ukraine/20221125-peretvorylosya-na-pustelyu-yak-vijna-znyshhyla-oskilske-vodoshovyshhe-na-harkivshhyni/

[71] Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa

[72] Ukrainian Court Register. (n.d.). Case no. 185/10692/22. https://reyestr.court.gov.ua/Review/118211461

[73] https://deepstatemap.live/en#12/49.1781126/37.4499893

[74] https://dos.sharepoint.us/sites/CURIALab/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FCURIALab%2FShared%20Documents%2FEcological%20Destruction%2FOskil%20Dam%2FJane%27s%20RFI%2FRFI%2DCuria%2D24%2D002%2Epdf&viewid=11ac347a%2D5e49%2D4ad3%2Daf9a%2D5804933e7e64&parent=%2Fsites%2FCURIALab%2FShared%20Documents%2FEcological%20Destruction%2FOskil%20Dam%2FJane%27s%20RFI

[75] Institute for the Study of War. (2022, May 21). Russian offensive campaign assessment: May 21. https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-may-21

Immediately following the cessation of active fighting in the area, Russian state media broadcast segments about water access in the Oskil Dam featured an entourage of the Donetsk People's Republic (DPR) and the Russian Armed Forces officials, many of whom are not identified by name, during broadcasts despite their close proximity to the main protagonists. On May 21, 2022, Russian war propagandist Semyon Pegov, also known by his alias WarGonzo, published a video in which Major General Evgeny Poplavsky,[76] the deputy commander of the Central Military District of the Russian Armed Forces and whose identification patch is absent in the video,[77] travels with the head of the DPR's Ministry of Emergency Services Alexey Kostrubitsky to the Oskil Dam.[78] In a longer edit of the video, Poplavsky makes a comment regarding the inevitable restoration of the Oskil Dam.[79] A few days later on May 24, 2022, DPR Head Denis Pushilin published photographs of himself visiting the Oskil Dam alongside Major General Poplavsky (only identified as "callsign Pythagoras"), Deputy Minister for Civil Defense, Emergencies and Elimination of ConsequencePRhe DPR, Andrey Agarkov,[80] Head of the Central Executive Committee of the "Donetsk Republic" Movement Alexey Muratov,[81] the Chief Engineer of the Branch "Regional Department for Canal Operation" of the DPR-controlled water utility "Voda Donbassa" Vadim Grabar,[82] and one other unidentified DPR-controlled "Voda Donbassa" associate.[83]

[76] https://russian-torturers.com/ru/profile/1781
[77] https://ria.ru/20181113/1532690117.html
[78] https://t.me/wargonzo/7030
[79] https://dzen.ru/video/watch/628a3659f5a7bd7b13404a85
[80] https://80.mchs.gov.ru/glavnoe-upravlenie/rukovodstvo/1369
[81] https://myrotvorets.center/criminal/muratov-aleksej-valentinovich/; https://orenburg.er.ru/person/e245bbe4-5873-4fd0-b9ff-cffa7aacac09
[82] https://m.vk.com/wall-212478216_65; https://archive.ph/DqrEN
[83] Glava DNR. (2022, May 24). Денис Пушилин рассказал о начале восстановления Краснооскольского гидроузла, поврежденного ВСУ [Denis Pushilin talks about the beginning of the restoration of the Krasnooskol hydroelectric complex, damaged by the Ukrainian Armed Forces]. https://glavadnr.ru/news/denis-pushilin-rasskazal-o-nachale-vosstanovleniya-krasnooskolskogo-gidrouzla-povrezhdennogo-vfu/; https://t.me/PushilinDenis/2261

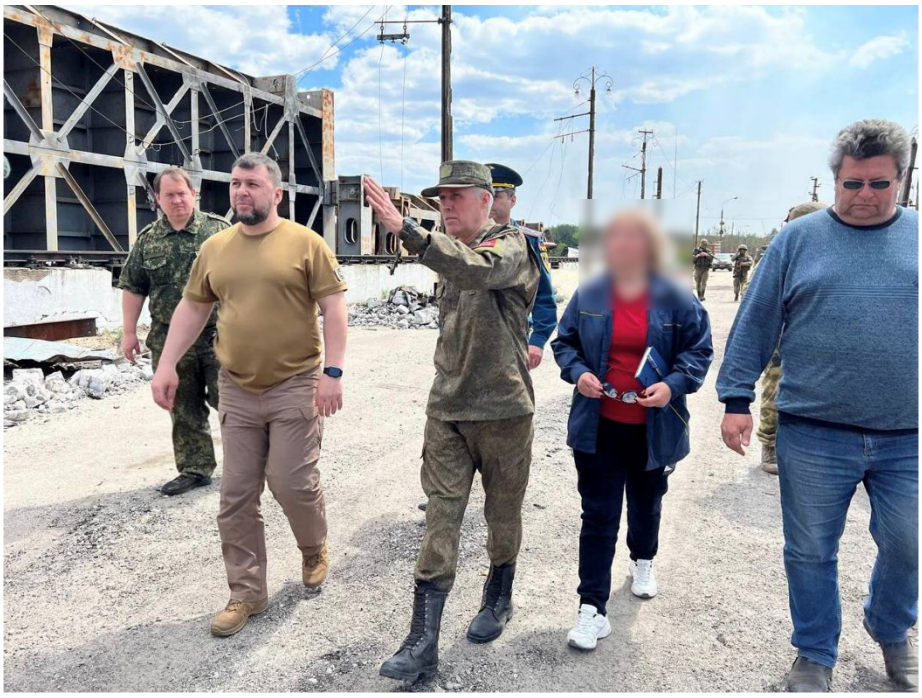

Figure 9: Press release photograph of a site visit to Oskil Dam from the Office of the Head of the DPR Denis Pushilin. From left to right: Alexey Muratov, Denis Pushilin, Evgeny Poplavsky (standing behind and partially obscured by Pushilin), an unknown Voda Donbassa employee, and Vadim Grabar. Image published on May 24, 2022.

On May 25, 2022, in broadcasts of the Pushilin visit, DPR commentators provided exposition noting that the intention of these repairs was to ensure proper reserves and distribution of water supplies to previously occupied or soon to be occupied settlements, including Sloviansk, Horlivka, Makiivka, and Donetsk.[84] Pushilin likewise stated that specialists were sent to help fix the gateways to start restoring water reserves in the Oskil Reservoir.[85]

Regarding structural information, the DPR press broadcast provides the first concrete media documenting the damage that Oskil Dam sustained in late March 2022 and attempts to repair the damage. During the separate broadcasts of Pushilin's visit and the visit by DPR's Ministry of Emergency Services, Kostrubitsky and Major General Poplavsky, the individuals, remarked that

[84] https://t.me/TK_Union/15591
[85] Glava DNR. (2022, May 24). Денис Пушилин рассказал о начале восстановления Краснооскольского гидроузла, поврежденного ВСУ [Denis Pushilin talks about the beginning of the restoration of the Krasnooskol hydroelectric complex, damaged by the Ukrainian Armed Forces]. https://glavadnr.ru/news/denis-pushilin-rasskazal-o-nachale-vosstanovleniya-krasnooskolskogo-gidrouzla-povrezhdennogo-vfu/

one gateway in particular was blown up.[86] Pushilin also specified during his visit that “all the cables were cut out”.[87]

Figure 10 Left: Screenshot of the destroyed Oskil Dam gate broadcast on the DPR television station UNION. Image published on May 25, 2022. Right: Photograph of an alleged repaired Oskil Dam gate published by the DPR Ministry of Emergency Services. Published on June 7, 2022.

A few weeks later on June 7, 2022, the Ministry of Emergency Services of the DPR announced that it completed restoring the two dam gates destroyed in late March 2022.[88] The entity’s social media account provided three images to accompany the claim, seemingly showing a functional gate with calmer water flowing through the Dam.[89] While it is not possible to verify from the provided imagery whether the replacement gate was that of the broken gate or an existing one, anecdotal reports from settlements near the Oskil Dam between mid-August and early September 2022 suggest a moderate rise in water levels in the Oskil Reservoir. This could

[86] Glava DNR. (2022, May 24). Денис Пушилин рассказал о начале восстановления Краснооскольского гидроузла, поврежденного ВСУ [Denis Pushilin talks about the beginning of the restoration of the Krasnooskol hydroelectric complex, damaged by the Ukrainian Armed Forces]. https://glavadnr.ru/news/denis-pushilin-rasskazal-o-nachale-vosstanovleniya-krasnooskolskogo-gidrouzla-povrezhdennogo-vfu/
[87] Glava DNR. (2022, July 15). Денис Пушилин принял участие в запуске резервного водовода [Denis Pushilin took part in the launch of the backup water pipeline]. https://glavadnr.ru/news/denis-pushilin-prinyal-uchastie-v-zapuske-rezervnogo-vodovoda/
[88] https://t.me/mchs_dnr/7108
[89] https://t.me/mchs_dnr/7108

indicate a successful restoration and closure of all floodgates at the Oskil Dam.[90] This observation is consistent with the slightly higher surface water levels recorded between June 6 to September 17 (Figure 5).

Ukrainian Counteroffensive (September to October 2022)

Following the start of the Ukrainian military's counteroffensive in Kharkiv Oblast, Ukrainian forces succeeded in making rapid progress by mid-September 2022 with the liberation of Izyum on September 11, 2022.[91] According to intelligence from the United Kingdom's Ministry of Defence published on the day of Izyum's recapture, the Russian Armed Forces likely ordered a withdrawal of its forces past the Oskil River,[92] resulting in both orderly and panicked withdrawals of Russian troops from the left bank of Oskil.[93] On September 11, 2022, Ukrainian unmanned aerial vehicle footage emerged online of a large column of Russian forces crossing a makeshift dirt bridge to leave the left bank of Oskil village, away from Izyum.[94]

[90] https://www.instagram.com/p/CwPrhjRNvxh/; https://obrii.com.ua/vijna/45440-oskilske-vodoshovishhe-postupovo-napovnyuyetsya.html; https://t.me/Obriilzyum/2858
[91] https://x.com/AFP/status/1569053593327620096
[92] https://x.com/DefenceHQ/status/1569188879860637700
[93] https://x.com/DefenceHQ/status/1570279562008829952
[94] https://x.com/KyivPost/status/1568915445184401408 https://x.com/Arvelleg1/status/1568913157074350081

Figure 11: Oskil Dam facing the Oskil Reservoir in various stages of damage. From top to bottom: 2017; May 21, 2022; August 31, 2023.

According to an Oskil Dam employee, Russian forces planted 1.5 tons of explosives near the first shutter gate mechanism sometime in September 2022, in advance of the arrival of

Ukrainian forces in the town,[95] the explosion of which resulted in both the gate and the dam road span above it being completely destroyed.[96] Videos dated to and published on Facebook on December 12, 2022, by a Ukrainian National Guard member and deputy of Izyum City Council, confirm that the dam had four closed dam gates and one destroyed dam gate.[97]

Figure 12: Oskil Dam road span above the first gate in various stages of destruction. From top to bottom: Published on May 23, 2022; published on August 31, 2023.

While open sources do not provide any additional indications on specific attribution for the September 2022 dam breach, there are several specific Russian military entities capable of planning the dam's destruction worth considering on theoretical grounds, based on previously reports of these entities engaging with or maintaining an awareness of the destruction of similar

[95] Ursa Media. (2024, March 4). Подвійний злочин: Чи понесе Росія відповідальність за екоцид на Харківщині? [Double crime: Will Russia be held accountable for ecocide in Kharkiv region?]. https://ursamedia.com.ua/history/podvijnyj-zlochyn-chy-ponese-rosiyja-vidpovidalnist-za-ecozid-na-kharkivshuni/

[96] Dumka Media. (2023, September 15). Уничтожение Оскольского водохранилища: Как Кремль забирает воду у жителей Донбасса [Destruction of the Oskil Reservoir: How the Kremlin takes water from the residents of Donbas]. https://dumka.media/rus/war/1694600851-unichtozhenie-oskolskogo-vodohranilishcha-kak-kreml-zabiraet-vodu-u-zhiteley-donbassa

[97] https://www.facebook.com/watch/?v=1199184984031208; https://www.facebook.com/watch/?v=906422897405541

infrastructure in the period following the full-scale invasion of 22 February 2022. The awareness by the Russian National Defense Control Center head Mikhail Mizintsev of the previous Oskil breach and its critical infrastructure role for the population could indicate that higher level strategic directorates in the Main Operations Directorate (GOU) of the Russian General Staff were involved. An alternative entity lower on the chain of command of the Russian Armed Forces was possibly tied to the September 2022 attack. On July 15, 2024, the head of Kharkiv Region Prosecutor's Office, Oleksandr Filchakov, told a Ukrainian media outlet that a notice of suspicion was being prepared against this individual, Russian General Oleg Makovetsky,[98] commander of the 6th Air Force and Air Defence Army of the Russian Aerospace Forces.[99] Filchakov alleged that Makovetsky ordered the bombing and destruction of the Oskil Dam. This notice does not specify whether Makovetsky's involvement was in the March dam breach or the September breach.[100] Engineering and sapper units of the RFAF 11th Separate Guards Engineering Brigade destroyed two dam gates in the North Crimean Canal, demonstrating the capacity of lower-level units to engage in hydrological infrastructure attacks.[101]

Russian Information Narrative

The following section of the report outlines Russian state and Russian-proxy talking points regarding the importance and impact of destruction of Oskil Dam to the life-sustaining qualities of the local region. Following the first massive destruction of the dam in early March 2022, pro-Kremlin talking points regarding water access, disproportionate military tactics, and other harm to the local population were circulated throughout prominent Russian media spaces. However, there is a notable total absence of these narratives, or any discussion of Oskil Dam, in pro-Kremlin media and social media spaces during the period of September/October 2022 onwards, following the second destruction of the dam. While not an admission of culpability, the statements issued by Russian occupational entities regarding the importance of the dam following its initial destruction may illustrate their awareness of the possible impact of the

[98] https://russian-torturers.com/profile/543
[99] https://www.youtube.com/watch?v=aGxyT_8EHMg
[100] Dumka Media. (2024, July 15). Руководитель прокуратуры Харьковщины Александр Филчаков: прокуратура подготовила подозрения российским генералам за бомбардировку Харькова [Head of the Kharkiv Prosecutor's Office, Alexander Filchakov: The prosecutor's office has prepared charges against Russian generals for the bombing of Kharkiv]. https://dumka.media/rus/interview/1721018966-rukovoditel-prokuratury-harkovshchiny-aleksandr-filchakov-prokuratura-podgotovila-podozreniya-rossiyskim-generalam-za-bombardirovku-harkova
[101] https://t.me/zvezdanews/73221

destructive aftermath in the case that Russian forces were responsible for its destruction in the fall of 2022.

Following the Russian occupation of Izyum in early April 2022 and the settlements surrounding the Oskil Reservoir, Russia and their Donetsk People's Republic/Lugansk People's Republic-controlled government and media entities began an information campaign to portray the capture of Oskil Dam as a strategic victory of liberation of the local population from alleged inhumane military tactics of the Armed Forces of Ukraine and for renewed accessibility of water access for the new Russian territories.

These narratives were first established prior to the complete occupation of the area, following the initial dam explosion sometime at the end of March 2022 and subsequent flooding. On April 4, 2022, then-head of the National Defense Control Center of the Russian Federation, Colonel General Mikhail Mizintsev, announced that "units of the Ukrainian Armed Forces blew up the dam of the Oskil Reservoir," resulting in "more than seven settlements located along the Severskiy Donets River coming under threat of flooding" with more than 4,000 residents in Svyatohirs'k already being flooded.[102] Shortly following the first Oskil Dam attack, on April 8, 2022, Russian state-controlled outlets accused the Ukrainian government of purposefully perpetrating the attack to limit the water supply of the Donbas region.[103] On May 1, 2022, before the occupation of the entire administrative Oskil Region, the Russian Ministry of Defense-linked Open Source Intelligence think tank Rybar[104] accused the Ukrainian Armed Forces of again mining the "critically important infrastructure object" (Oskil Dam) in an attempt to prevent the movement of Russian forces through villages adjacent to the Oskil River.[105]

[102] NTV. (2022, April 4). Russian MoD: Ukrainian troops blew up the Oskol reservoir dam. https://www.ntv.ru/novosti/2700369/; https://t.me/mod_russia/13986; https://telegra.ph/Zayavlenie-Mezhvedomstvennogo-koordinacionnogo-shtaba-Rossijskoj-Federacii-po-gumanitarnomu-reagirovaniyu-na-Ukraine-ot-4-aprely-04-04
[103] https://t.me/ukraina_ru/65496
[104] The Bell. (2022, November 22). Unmasking Russia's influential pro-war Rybar Telegram channel. https://thebell.io/unmasking-russia-s-influential-pro-war-rybar-telegram-channel
[105] https://t.me/rybar/31995

In the following weeks on May 21, 2022, DPR-controlled media outlets broadcasted the visit by Pushilin to the dam, where he reiterated Ukrainian involvement in the destruction of the Oskil Dam as a standard practice of "the enemy acting in his style to cause harm."[106]

Media segments of alleged Ukrainian responsibility extended past the high-profile visits as well. On May 23, 2022, Russian-state broadcaster RIA Novosti published a video segment of one of its correspondents stating that Ukrainian forces destroyed the dam to "ruin the hydrology of the river," for the sake of causing "terror," and might have resulted in the disruption of crossing points such as bridges Russian force planned to maneuver across during their offensive. The correspondent also alleged that the Ukrainians intended to destroy the entire dam but were unsuccessful.[107]

Discussion: Potential Legal Implications

The information collected and assessed in this investigation does not support definitive attribution of damage to the Oskil Dam. One thing is certain, however: without Russia's war on Ukraine, the kinetic activity that caused the breaches would not have occurred. Photographs and satellite imagery taken before and after the breaches document physical damage that cannot be explained by normal use patterns, and that show classic markers of explosive impacts. Kinetic fighting caused the dam's failure. As such, we need to consider several laws and articles to construct the relevant legal framework.

Various articles of the Criminal Code of Ukraine (CCU) may be relevant to the Oskil activities documented in this report. Article 242, "Violation of Rules Related to Water Protection**,"** stipulates that "Violation of rules related to the protection of water (water reservoirs), where it resulted in contamination of surface or underground water and water-bearing horizons, potable or curative water springs, or caused changes in their natural characteristics, or caused exhaustion of water springs and exposed human life and health or environment to danger." Further, CCU Article 441 criminalizes Ecocide ("ecocide" is the word in the Ukrainian text: Екоцид), which is defined as: "Mass destruction of flora and fauna, poisoning of air or water

[106] Glava DNR. (2022, May 24). Денис Пушилин рассказал о начале восстановления Краснооскольского гидроузла, поврежденного ВСУ [Denis Pushilin talks about the beginning of the restoration of the Krasnooskol hydroelectric complex, damaged by the Ukrainian Armed Forces]. https://glavadnr.ru/news/denis-pushilin-rasskazal-o-nachale-vosstanovleniya-krasnooskolskogo-gidrouzla-povrezhdennogo-vfu/
[107] https://t.me/rian_ru/164327

resources, and also any other actions that may cause an environmental disaster." Finally, CCU Article 438, Violations of the Rules of Warfare, criminalizes "use of methods of the warfare prohibited by international instruments, or any other violations of rules of the warfare recognized by international instruments consented to by binding by the Verkhovna Rada (Parliament) of Ukraine, and also giving an order to commit any such actions."

International Humanitarian Law (IHL) provides critical protections related to the natural environment during armed conflict. The Principle of Distinction mandates that attacks must be limited to military objectives, ensuring that civilian objects—including vital infrastructure and the natural environment—may not be the object of attacks or reprisals. Article 8(2)(b)(iv) of the Rome Statute further stipulates that attacks causing excessive incidental death, injury, or damage to civilian objects or the environment are considered war crimes if such harm is clearly excessive compared to the anticipated environmental advantage. Additionally, the Principle of Precaution stipulates that in the conduct of military operations, care shall be taken to spare the civilian population and civilian objects, including the natural environment.

One of the implications of attribution uncertainty is the lack of a clear path for legal remedies. In the case of conflict zone environmental damage, the question of legal remedies is further complicated by the lack of case precedent. Ukraine is unique among European nations in criminalizing ecocide, and there is, as of this writing, no legal precedent that establishes a threshold of evidence for environmental damage culpability and remedy in war. While this investigation is not a substitution for legal precedent, it offers a step toward legal accountability by applying a tested scientific method to detect and document environmental change in the theater of conflict. To this end, findings from this investigation can support accountability through the Council of Europe's Register of Damage for Ukraine. The Register accepts claims of damage caused by Russia's war of aggression against Ukraine. Articles B.3.1 and B.3.2 offer provision for the State of Ukraine to make claims for environmental damage (B.3.1) or the loss or depletion of natural resources (B.3.2). The consequences of the war for Ukraine's ecosystems are significant and widespread and are likely to have effects for many years. Registering damage and seeking compensation constitute a remedy with potential to mitigate these effects and help recover Ukraine's environment.

References

The table below provides a list of all images used for the change in water area analysis. The table contains sensor type and original image IDs from Planet Labs.

Table 1. List of PlanetScope imagery used for analysis.

Date	Image ID	Sensor	Notes
March 28, 2022	20220328_080229_06_247e	PSB.SD	Orthorectified, 4 bands
March 28, 2022	20220328_080226_74_247e	PSB.SD	Orthorectified, 4 bands
March 28, 2022	20220328_080224_42_247e	PSB.SD	Orthorectified, 4 bands
April 09, 2022	20220409_073434_60_2442	PSB.SD	Orthorectified, 4 bands
April 09, 2022	20220409_073432_30_2442	PSB.SD	Orthorectified, 4 bands
April 09, 2022	20220409_073430_01_2442	PSB.SD	Orthorectified, 4 bands
April 23, 2022	20220423_073645_11_242d	PSB.SD	Orthorectified, 4 bands
April 23, 2022	20220423_073642_81_242d	PSB.SD	Orthorectified, 4 bands
April 26, 2022	20220426_081826_50_2274	PSB.SD	Orthorectified, 4 bands
April 23, 2022	20220423_073640_51_242d	PSB.SD	Orthorectified, 4 bands
April 26, 2022	20220426_081824_02_2274	PSB.SD	Orthorectified, 4 bands
May 05, 2022	20220505_073438_97_245c	PSB.SD	Orthorectified, 4 bands
May 05, 2022	20220505_073436_68_245c	PSB.SD	Orthorectified, 4 bands
May 05, 2022	20220505_073434_40_245c	PSB.SD	Orthorectified, 4 bands
May 07, 2022	20220507_082057_47_240a	PSB.SD	Orthorectified, 4 bands
May 07, 2022	20220507_082055_12_240a	PSB.SD	Orthorectified, 4 bands
May 07, 2022	20220507_082052_77_240a	PSB.SD	Orthorectified, 4 bands
May 26, 2022	20220526_073131_44_241f	PSB.SD	Orthorectified, 4 bands
May 26, 2022	20220526_073129_14_241f	PSB.SD	Orthorectified, 4 bands
May 30, 2022	20220530_080713_27_2475	PSB.SD	Orthorectified, 4 bands
May 30, 2022	20220530_080710_96_2475	PSB.SD	Orthorectified, 4 bands
May 31, 2022	20220531_080319_04_248f	PSB.SD	Orthorectified, 4 bands
May 31, 2022	20220531_080316_73_248f	PSB.SD	Orthorectified, 4 bands
May 31, 2022	20220531_080314_42_248f	PSB.SD	Orthorectified, 4 bands
June 06, 2022	20220606_073306_55_2458	PSB.SD	Orthorectified, 4 bands
June 06, 2022	20220606_073304_08_2458	PSB.SD	Orthorectified, 4 bands
June 06, 2022	20220606_073301_62_2458	PSB.SD	Orthorectified, 4 bands
June 10, 2022	20220610_080212_34_249a	PSB.SD	Orthorectified, 4 bands

June 10, 2022	20220610_080210_05_249a	PSB.SD	Orthorectified, 4 bands
June 10, 2022	20220610_080207_77_249a	PSB.SD	Orthorectified, 4 bands
June 19, 2022	20220619_080422_42_249b	PSB.SD	Orthorectified, 4 bands
June 19, 2022	20220619_080420_11_249b	PSB.SD	Orthorectified, 4 bands
June 19, 2022	20220619_080417_80_249b	PSB.SD	Orthorectified, 4 bands
June 27, 2022	20220627_080602_69_2475	PSB.SD	Orthorectified, 4 bands
June 27, 2022	20220627_080600_40_2475	PSB.SD	Orthorectified, 4 bands
June 27, 2022	20220627_080558_11_2475	PSB.SD	Orthorectified, 4 bands
July 02, 2022	20220702_073252_52_242b	PSB.SD	Orthorectified, 4 bands
July 02, 2022	20220702_073250_23_242b	PSB.SD	Orthorectified, 4 bands
July 09, 2022	20220709_080045_15_2461	PSB.SD	Orthorectified, 4 bands
July 09, 2022	20220709_080042_86_2461	PSB.SD	Orthorectified, 4 bands
July 09, 2022	20220709_080040_57_2461	PSB.SD	Orthorectified, 4 bands
July 17, 2022	20220717_080521_92_248e	PSB.SD	Orthorectified, 4 bands
July 17, 2022	20220717_080519_62_248e	PSB.SD	Orthorectified, 4 bands
July 29, 2022	20220729_080334_67_2446	PSB.SD	Orthorectified, 4 bands
July 29, 2022	20220729_080332_21_2446	PSB.SD	Orthorectified, 4 bands
July 29, 2022	20220729_080329_75_2446	PSB.SD	Orthorectified, 4 bands
August 01, 2022	20220801_080210_75_2486	PSB.SD	Orthorectified, 4 bands
August 01, 2022	20220801_080208_25_2486	PSB.SD	Orthorectified, 4 bands
August 01, 2022	20220801_080205_76_2486	PSB.SD	Orthorectified, 4 bands
August 07, 2022	20220807_080346_53_248b	PSB.SD	Orthorectified, 4 bands
August 07, 2022	20220807_080344_26_248b	PSB.SD	Orthorectified, 4 bands
August 07, 2022	20220807_080341_98_248b	PSB.SD	Orthorectified, 4 bands
August 23, 2022	20220823_081509_59_241c	PSB.SD	Orthorectified, 4 bands
August 23, 2022	20220823_081507_29_241c	PSB.SD	Orthorectified, 4 bands
August 23, 2022	20220823_081504_99_241c	PSB.SD	Orthorectified, 4 bands
September 08, 2022	20220908_080219_13_24a5	PSB.SD	Orthorectified, 4 bands
September 08, 2022	20220908_080216_83_24a5	PSB.SD	Orthorectified, 4 bands
September 08, 2022	20220908_080214_54_24a5	PSB.SD	Orthorectified, 4 bands
September 17, 2022	20220917_072926_65_2455	PSB.SD	Orthorectified, 4 bands
September 17, 2022	20220917_072924_35_2455	PSB.SD	Orthorectified, 4 bands
September 17, 2022	20220917_072922_06_2455	PSB.SD	Orthorectified, 4 bands
September 22, 2022	20220922_080531_25_247a	PSB.SD	Orthorectified, 4 bands
September 22, 2022	20220922_080528_96_247a	PSB.SD	Orthorectified, 4 bands

September 22, 2022	20220922_080526_67_247a	PSB.SD	Orthorectified, 4 bands
October 08, 2022	20221008_080358_81_2438	PSB.SD	Orthorectified, 4 bands
October 08, 2022	20221008_080356_44_2438	PSB.SD	Orthorectified, 4 bands
October 08, 2022	20221008_080354_07_2438	PSB.SD	Orthorectified, 4 bands
October 13, 2022	20221013_080608_50_247f	PSB.SD	Orthorectified, 4 bands
October 13, 2022	20221013_080606_14_247f	PSB.SD	Orthorectified, 4 bands
October 13, 2022	20221013_080603_77_247f	PSB.SD	Orthorectified, 4 bands
October 19, 2022	20221019_072838_64_2447	PSB.SD	Orthorectified, 4 bands
October 19, 2022	20221019_072836_31_2447	PSB.SD	Orthorectified, 4 bands
October 19, 2022	20221019_072833_97_2447	PSB.SD	Orthorectified, 4 bands

Table 2. List of Sentinel-2 imagery used for analysis.

Date	Image ID	Sensor
April 27, 2017	https://sentinelshare.page.link/dRZM	Sentinel-2
May 4, 2017	https://sentinelshare.page.link/AAaM	Sentinel-2
July 1, 2017	https://link.dataspace.copernicus.eu/z5mf	Sentinel-2
July 18, 2017	https://link.dataspace.copernicus.eu/67q4	Sentinel-2
August 12, 2017	https://link.dataspace.copernicus.eu/c3un	Sentinel-2
September 9, 2017	https://link.dataspace.copernicus.eu/ambl	Sentinel-2
October 11, 2017	https://link.dataspace.copernicus.eu/lixn	Sentinel-2
April 14, 2018	https://sentinelshare.page.link/C5zv	Sentinel-2
May 4, 2018	https://sentinelshare.page.link/x79f	Sentinel-2
June 16, 2018	https://sentinelshare.page.link/9H9h	Sentinel-2
July 31, 2018	https://sentinelshare.page.link/Hkiu	Sentinel-2
August 15, 2018	https://sentinelshare.page.link/2j3r	Sentinel-2
September 19, 2018	https://sentinelshare.page.link/MjHU	Sentinel-2
October 19, 2018	https://sentinelshare.page.link/31f3	Sentinel-2
March 30, 2019	https://sentinelshare.page.link/tr3X	Sentinel-2
April 27, 2019	https://sentinelshare.page.link/HaKQ	Sentinel-2
May 19, 2019	https://sentinelshare.page.link/q746	Sentinel-2
June 11, 2019	https://sentinelshare.page.link/sFbb	Sentinel-2
July 3, 2019	https://sentinelshare.page.link/V6U6	Sentinel-2
August 7, 2019	https://sentinelshare.page.link/QfLf	Sentinel-2
September 4, 2019	https://sentinelshare.page.link/PdPa	Sentinel-2
October 16, 2019	https://sentinelshare.page.link/kViw	Sentinel-2

March 19, 2020	https://sentinelshare.page.link/DbEL	Sentinel-2
April 13, 2020	https://sentinelshare.page.link/BwSS	Sentinel-2
June 10, 2020	https://sentinelshare.page.link/gmnG	Sentinel-2
July 12, 2020	https://sentinelshare.page.link/iEg3	Sentinel-2
August 6, 2020	https://sentinelshare.page.link/gxz4	Sentinel-2
September 10, 2020	https://sentinelshare.page.link/NVmf	Sentinel-2
October 15, 2020	https://sentinelshare.page.link/ckq4	Sentinel-2
March 4, 2021	https://sentinelshare.page.link/jBX3	Sentinel-2
April 1, 2021	https://sentinelshare.page.link/bVPP	Sentinel-2
June 25, 2021	https://sentinelshare.page.link/534f	Sentinel-2
July 20, 2021	https://sentinelshare.page.link/6MVY	Sentinel-2
August 29, 2021	https://sentinelshare.page.link/6MVY	Sentinel-2
September 15, 2021	https://sentinelshare.page.link/Wtz3	Sentinel-2
October 30, 2021	https://sentinelshare.page.link/2FfU	Sentinel-2
April 16, 2023	https://link.dataspace.copernicus.eu/4vb6	Sentinel-2
May 3, 2023	https://link.dataspace.copernicus.eu/j3ag	Sentinel-2
June 2, 2023	https://link.dataspace.copernicus.eu/b9e3	Sentinel-2
July 7, 2023	https://link.dataspace.copernicus.eu/ek4n	Sentinel-2
August 6, 2023	https://link.dataspace.copernicus.eu/oayo	Sentinel-2
September 25, 2023	https://link.dataspace.copernicus.eu/pe6d	Sentinel-2
October 15, 2023	https://link.dataspace.copernicus.eu/sau1	Sentinel-2
March 11, 2024	https://link.dataspace.copernicus.eu/v78f	Sentinel-2
April 10, 2024	https://link.dataspace.copernicus.eu/mvlh	Sentinel-2
May 10, 2024	https://link.dataspace.copernicus.eu/gez1	Sentinel-2
June 11, 2024	https://link.dataspace.copernicus.eu/rirk	Sentinel-2
July 16, 2024	https://link.dataspace.copernicus.eu/xgpf	Sentinel-2
August 18, 2024	https://link.dataspace.copernicus.eu/6te7	Sentinel-2
September 7, 2024	https://link.dataspace.copernicus.eu/qb9v	Sentinel-2