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THE GREAT MEADOW VS. THE KAKHOVKA RESERVOIR:
A MODERN PERSPECTIVE

The Great Meadow vs. the Kakhovka Reservoir: A Modern Perspective

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Abstract

The document examines the consequences of the construction and destruction of the Kakhovka Reservoir, focusing on ecological, historical, cultural, and economic aspects. The Great Meadow (Velykyi Lug), which was flooded during the creation of the reservoir, was a unique natural and cultural hub of Ukraine, playing a key role in biodiversity conservation and the formation of national identity. After the dam's destruction in 2023, the restoration of natural ecosystems began, opening opportunities to create a modern model of sustainable regional development.

The text explores future scenarios for the territory of the former reservoir: rebuilding the reservoir, preserving natural ecosystems, and developing alternative energy sources. The authors emphasize the feasibility of abandoning the Soviet model in favor of solutions adapted to current climate challenges. The restoration of the Great Meadow is proposed as a promising ecological project that could become a symbol of Ukraine's recovery after the war.

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Published with the support of the Fondation de France as part of a project «Advocating for the environment and local communities of the future for the former Kakhovka Reservoir and Kakhovka HPP».

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ꟽNTRODUCTION

The construction of the Kakhovka Hydroelectric Power Plant (HPP) and the subsequent filling of the Kakhovka Reservoir in the mid-20th century marked one of Ukraine's most significant infrastructural transformations, leaving an ambiguous legacy. This project fundamentally transformed the country's southern region, destroying local ecosystems and creating a radically new economic order and way of life for hundreds of thousands of people across the territory.

Before the reservoir flooded the area, the floodplain of the Dnipro River was known as the «Great Meadow.» The Great Meadow (in Ukrainian, Velykyi Lug) was a vast wetland ecosystem crucial to the Cossack Hetmanate. This region was a mosaic of wetlands, floodplain forests, meadows, and waterlogged areas, serving as a habitat for numerous plant and animal species. Moreover, this territory was significant as a historical and cultural landscape closely associated with the Cossack history of Ukraine. Here, the Zaporozhian Sichs existed, and the Great Meadow (Velykyi Lug) was considered the cradle of Cossack culture.

The decision to create the reservoir and HPP was part of the ambitious Stalinist «plan for the transformation of nature» of the Soviet era. Its goal was to ensure the production of gunpowder (based on raw cotton materials) for the Soviet army, which was exhausted by the world war. Upon completion of the hydroelectric complex and filling of the reservoir, Joseph Stalin died, and priorities in the USSR changed. Thereafter, the role of the hydroelectric complex was positioned as new opportunities for irrigating arid lands, generating electricity, developing industry, and water transport. However, this large-scale transformation of the region came at a significant cost: the flooding of hundreds of thousands of hectares of land, the destruction of natural and cultural landscapes, the displacement of thousands of people, and the disruption of the familiar economic order of the entire transformed region.

The flooding of the Great Meadow (Velykyi Lug) led to the loss of biodiversity and the destruction of natural habitats, triggering widespread ploughing of the southern Ukrainian steppes. The Great Meadow (Velykyi Lug) was a vast wetland ecosystem crucial to the Cossack Hetmanate. This region was a mosaic of wetlands, floodplain forests, meadows, and waterlogged areas, serving as a habitat for numerous plant and animal species. Since the construction of the HPP, it began to be used for agricultural purposes rather than grazing livestock. Due to the regulation of the Dnipro River's water flow, the hydrological regime of the region changed, and erosion processes of the banks, siltation, and eutrophication began; irrigation led to soil salinisation. Intensive water evaporation from a large shallow body of water caused an increase in water deficit and water mineralisation in the Lower Dnipro basin.

The social aspects of creating the reservoir were also traumatic. Dozens of villages and hamlets that preserved the memory of the Zaporozhian era disappeared underwater, and their inhabitants were forcibly resettled to new places. This resettlement resulted in the loss of their familiar way of life, cultural identity, and economic stability. Meanwhile, residents from other regions with nothing in common with the Cossack past were resettled to the newly created irrigation systems of Kherson, Zaporizhzhia, and Dnipropetrovsk regions. Consequently, the traditionally pastoral region of southern Ukraine became the most extensively cultivated region in Europe within a few years, a condition that persists to this day, primarily due to the destruction of the old economic order rather than the creation of new opportunities. As a result of the construction of the reservoir, logistical links between the right and left banks of the Dnipro significantly deteriorated, as did the conditions for navigation.

After the launch of the North Crimean Canal in the 1960s, the USSR created conditions for the resettlement of people from agricultural regions to northern Crimea to the places freed up as a result of the deportation of the Crimean Tatar population by the Soviet authorities. The ploughing of the steppes of the Crimea and Kherson region led to the actual loss of specific ecosystems and endemic species of living organisms. For example, in the Kherson region, several plant species were on the verge of extinction – the Scythian tulip (*Tulipa scythica*), the Scythian sage (*Phlomis scythica*), and Regel's onion (*Allium regelianum*). Such species as the small fritillary (*Fritillaria meleagroides*) and the narrow-leaved peony (*Paeonia tenuifolia*) completely disappeared from this region.

Over time, the reservoir became integral to the regional economy, providing water supply, fisheries, recreation, and energy. However, its existence was always accompanied by discussions about the feasibility of such a large-scale change, as the negative consequences significantly outweighed the expected benefits.

Today, after the destruction of the Kakhovka HPP dam, an opportunity has arisen for expert discussion about the region's future. The question of whether to rebuild a new reservoir after its destruction is now more open to debate than previous attempts to drain the existing reservoirs. The revival of natural ecosystems and historical memory, the search for new ways of economic development – in the modern world, these are sufficiently weighty arguments in favour of refusing to build, no less important than economic indicators. This publication attempts to assess the full range of problems and visions related to the former Kakhovka Reservoir, from the history of its creation and impact on nature to modern views on future scenarios.

THE GREAT MEADOW: NATURAL AND HISTORICAL-CULTURAL SIGNIFICANCE

The Great Meadow (Velykyi Lug), where the Soviet authorities constructed the Kakhovka Reservoir, was the most prominent natural forest in the Steppe Zone of Ukraine [18], a crucial territory for preserving biodiversity and global seasonal bird migrations.

The territory of the Great Meadow – a floodplain complex south of Khortytsia Island on the Dnipro River – was historically a centre of state formation and Ukrainian national identity. Before the development of the Zaporizhzhia Sich, the Great Meadow (Velykyi Lug) was sparsely populated due to constant threats of raids. The local population consisted primarily of semi-settled Slavic tribes: hunters, fishermen, and nomads. The founding of the Sich stimulated the active colonisation of the region. Runaways from various parts of the Polish-Lithuanian Commonwealth, Muscovy, and the Ottoman Empire settled here, forming a new social stratum – the Zaporozhian Cossacks. The opportunities provided by various natural industries and grazing for most of the year offered settlers much more favourable conditions than in the surrounding steppe territories, where only a nomadic way of life was possible. By 1774, the population of the Great Meadow (Velykyi Lug) exceeded 100,000 Cossacks [7].

The Zaporizhzhia Sich played a key role in shaping Ukrainian identity. The Sich operated on democratic principles: all critical issues were decided at the Cossack Rada, and atamans were elected by vote [23]. Over time, the Sich became a symbol of the struggle for democracy and freedom for Ukrainians, and its legacy influenced the development of Ukrainian culture, literature, and politics. This significance of the Zaporizhzhia Sich for Ukrainians has not been lost to this day. However, in 1775, the Zaporizhzhia Sich was destroyed by the order of Catherine II, and the Great Meadow (Velykyi Lug) was gradually integrated into the Russian Empire [45].

In the mid-1920s, Ukrainian scientists advocated creating a nature reserve here [37]. Still, after World War II, a decision was made at the highest level to create a reservoir and hydroelectric power plant here.

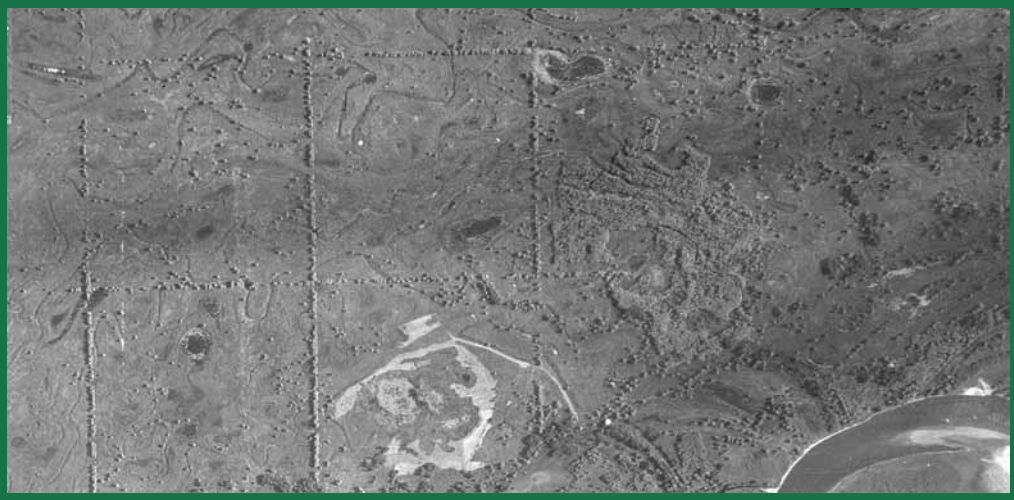
Origin of the name “Great Meadow” in Ukrainian, the word “lug” (“луг”) traditionally referred to a floodplain forest moistened by river overflows. The toponym “Velykyi Lug” (“Великий Луг”) thus signifies an ancient floodplain forest that surrounded the Cossack capital. This definition is supported by explanatory dictionaries [25], and the phrase is found in folk songs, Taras Shevchenko’s poems, and other sources.

In 1957, all the villages where the descendants of the Zaporozhian Cossacks lived and which preserved the memory of the formation of the Ukrainian state disappeared under the waters of the reservoir, and their inhabitants were forcibly resettled. The Soviet authorities created the reservoir hastily, without proper archaeological research. Thus, it is likely that the construction of the Kakhovka HPP and reservoir (at least indirectly) served another purpose for J. Stalin – the destruction of the historical landscape, which is a symbol of the struggle against the enslavement of Ukrainians by the Russian Empire and the assimilation of the descendants of the Zaporozhian Cossacks [29]. From an economic standpoint, the territory of the Great Meadow (Velykyi Lug) was used for logging, hunting, fishing, and beekeeping [45], as well as pastures and hayfields. The main economic activity in the region was livestock farming (primarily raising fine-fleeced and coarse-wool sheep and cattle for milk and meat). During the Soviet period, the economic role of the territory changed: logging sites became grazing and haymaking areas for collective farms. As a result, the area of forests decreased significantly, and meadow ecosystems were formed in their place. Therefore, at the time of the creation of the reservoir, only 20% of the area of the Great Meadow (Velykyi Lug) was occupied by forest vegetation. This explains why modern Ukrainians perceive the Great Meadow (Velykyi Lug) more as a meadow landscape than a forest one. With the flooding of the Great Meadow, lands were lost that were the only suitable place for grazing in dry years [39, pp. 71-95; 39, p. 84; cited in 35].

CONSTRUCTION OF THE KAKHOVKA RESERVOIR

The Kakhovka Reservoir was part of an ambitious project to create the Dnipro cascade, which would regulate the flow of the Dnipro River for energy, agriculture, and transportation [13]. Construction began in the post-World War II period when the Soviet Union was rebuilding its economy and seeking to solidify its leadership in large-scale infrastructure projects. The choice of location was determined by both geographical conditions and the presence of a large floodplain territory — the Great Meadow, which had a unique ecosystem and historical significance for Ukraine [15].

Map of the Great Meadow (Velykyi Lug) before the reservoir construction. The Great Meadow's hayfields were divided into sections for collective farms through the creation of forest belts, as depicted in the map [10] and the 1943 aerial photograph [9].



The project also reflected the ideological concept of the «great construction projects of communism,» designed to demonstrate the power and ability of the Soviet government to transform nature [22, pp. 24, 60-66; cited in 35]. The primary goal of creating the Kakhovka hydroelectric complex was to provide conditions for growing cotton in southern Ukraine. This crop was used in the production of gunpowder, which was of strategic importance for the Soviet army [27]. However, even during the reservoir construction, this goal lost its relevance due to changes in economic priorities and agreements on cotton supplies from other countries [27, 44]. Despite this, the project continued to be implemented, with a new focus on solving other tasks, such as generating electricity, irrigating arid lands, and developing transportation [14].

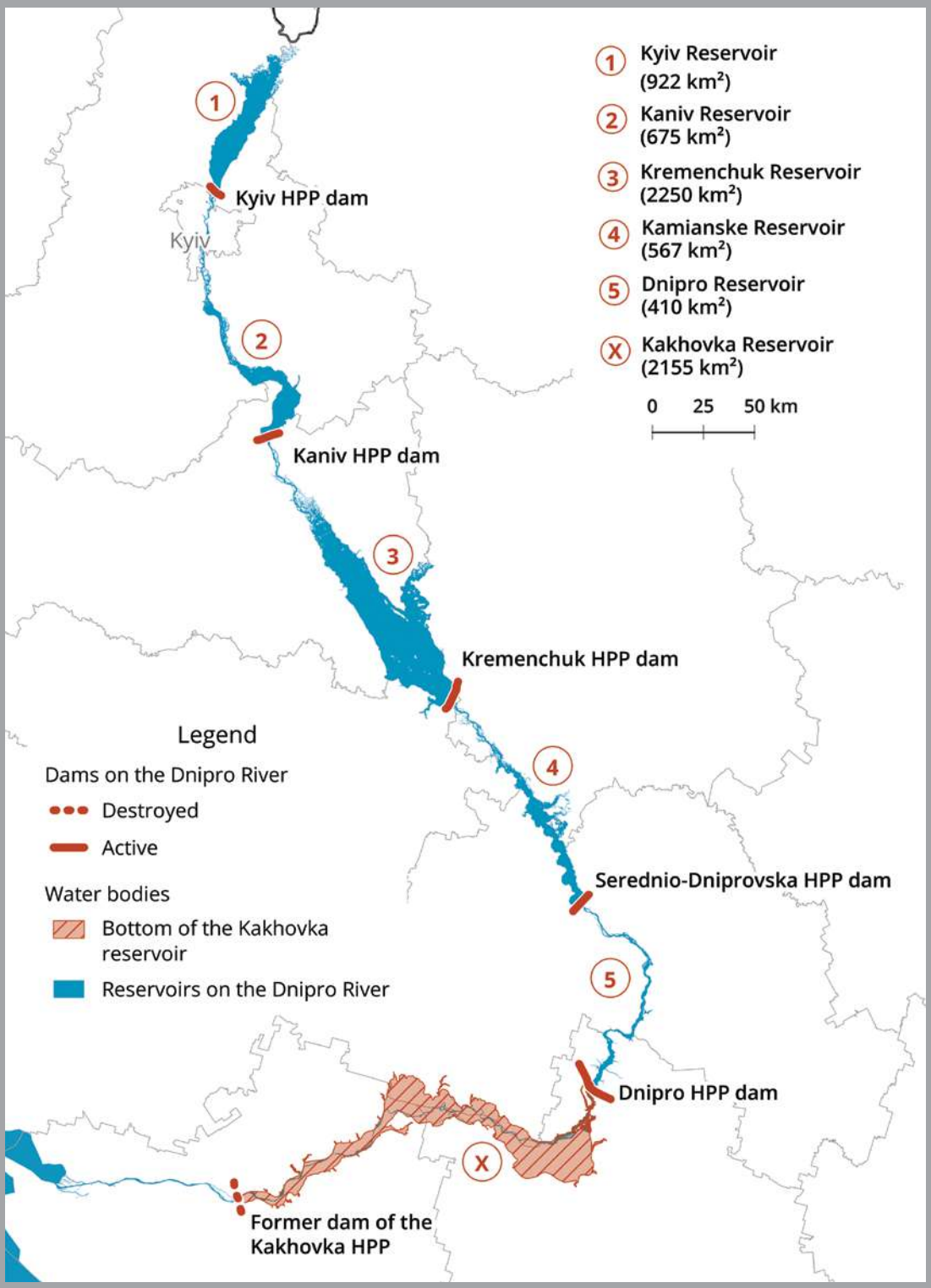
Construction of the Kakhovka HPP began in 1950, and just five years later, the reservoir was put into operation [20]. The construction involved significant human and technical resources. Approximately 15,000 workers from over 300 cities of the USSR worked on the site daily. The project involved the use of advanced technologies for that time, including 1,100 vehicles, 30 excavators, 75 cranes, and 14 steam locomotives [4].

During construction, a new city, Nova Kakhovka, was also built, which became an important transport and logistics centre of the region [20]. Engineers created a complex infrastructure system that included a concrete dam, an earth dam, a spillway, and a navigable lock. The dam, 193 meters long, could pass up to 4962 cubic meters of water per second, and the turbine system generated 1489 million kWh of electricity per year [20].

The Kakhovka Reservoir became the southernmost in the Dnipro cascade. Its area reached 2155 km^2, and the volume of water was 18.2 km^3, with a useful capacity of 6.8 km^3 [20]. The depth of the reservoir in some areas reached 24 meters, which created conditions for navigation, irrigation, and water supply [34].

The reservoir became a key element in the irrigation system of southern Ukraine, including the Kherson, Crimea, and Mykolaiv regions. With its help, large-scale projects were implemented, including the launch of the North Crimean Canal [34]. Despite its significant potential, the reservoir's use was not without problems, including siltation, soil salinisation, and deterioration of water quality, which became evident in its first years of operation [16].

Dnipro cascade of reservoirs



ECOLOGICAL CONSEQUENCES OF THE KAKHOVKA RESERVOIR CONSTRUCTION

The ecological consequences of constructing the reservoir became apparent in the first few years after its filling, and studies began as early as 1957.

LOSS OF BIODIVERSITY

The construction of the Kakhovka Reservoir led to the flooding of the unique natural ecosystems of the Great Meadow. This territory served as a habitat for many endemic and rare species of flora and fauna [15]. Ancient forests, floodplain meadows, and wetlands, which were crucial for migratory birds, disappeared. This disrupted the region's ecological balance, as the Great Meadow (Velykyi Lug) played a key role in preserving the biodiversity of the Steppe zone of Ukraine [22, pp. 24, 60-66; cited in 35]. As a result of the flooding, several plant species, including the Scythian tulip (*Tulipa scythica*), Scythian sage (*Phlomis scythica*), and Regel's onion (*Allium regelianum*), were on the verge of extinction. The narrow-leaved peony (*Paeonia tenuifolia*) and the small fritillary (*Fritillaria meleagroides*) completely disappeared from the region [27].

The destruction of wetlands affected the animal world, particularly species dependent on these ecosystems. Rare birds, fish, and amphibians lost their natural habitats [15, 24]. These ecosystems were essential for maintaining ecological processes such as water purification, microclimate regulation, and soil retention. The loss of the Great Meadow (Velykyi Lug) also reduced the region's attractiveness for ecotourism, which could have provided alternative economic development.

EROSION AND ABRASION PROCESSES

Changes in the hydrological regime caused by the reservoir construction led to active erosion of the banks. The long shoreline, water level fluctuations, and artificial regulation caused the formation of abrasion cliffs [20]. These processes destroyed the banks and led to the loss of significant areas of fertile soil. In the area of influence of the Kakhovka Reservoir, unstable coastal sections formed, requiring constant technical interventions [21].

Abrasion processes of reservoir banks (Photo by O. Vasyliuk)

Bank erosion negatively affected local infrastructure and transportation routes. The lack of natural bank stability increased the risk of flooding settlements near the reservoir. Abrasion processes also changed the region's natural appearance, which had ecological and cultural consequences [24].

SILTATION AND EUTROPHICATION

Large areas of shallow water in the Kakhovka Reservoir contributed to the intensive accumulation of organic residues and silt, which led to eutrophication—

The consequences of eutrophication (Photo by M. Maksymenko)

the enrichment of water with nutrients such as nitrogen and phosphorus [38]. Such conditions stimulated the excessive growth of blue-green algae, causing water «blooms.» This not only reduced oxygen levels but also killed aquatic organisms.

Siltation also changed the bottom topography of the reservoir, increasing the area of shallow-water zones. By the time the dam was destroyed, 82% of the reservoir's bottom was covered with silt [24].

SOIL SALINIZATION

Intensive irrigation of lands using water from the Kakhovka Reservoir led to the rise of groundwater levels. This caused the salinisation of large areas of fertile land, especially in the arid regions of Kherson and Zaporizhzhia [28]. The high mineralisation of water made effective farming impossible in many areas. Soil salinisation reduced their productivity and required the implementation of costly drainage systems. Many saline lands remain unsuitable for agriculture [16].

SPREAD OF INVASIVE SPECIES

The creation of an artificial water body contributed to the settlement of the territory by alien plant and animal species, which displaced the local flora and fauna. Such species included the bluegill sunfish (*Lepomis gibbosus*) and the common carp (*Carassius gibelio*), which adapted to low-oxygen conditions [42].

This changed the ecological balance of the region and made it difficult to restore natural ecosystems even after the destruction of the dam.

THE KAKHOVKA RESERVOIR: ECONOMIC AND REGIONAL DEVELOPMENT SIGNIFICANCE

POWER GENERATION

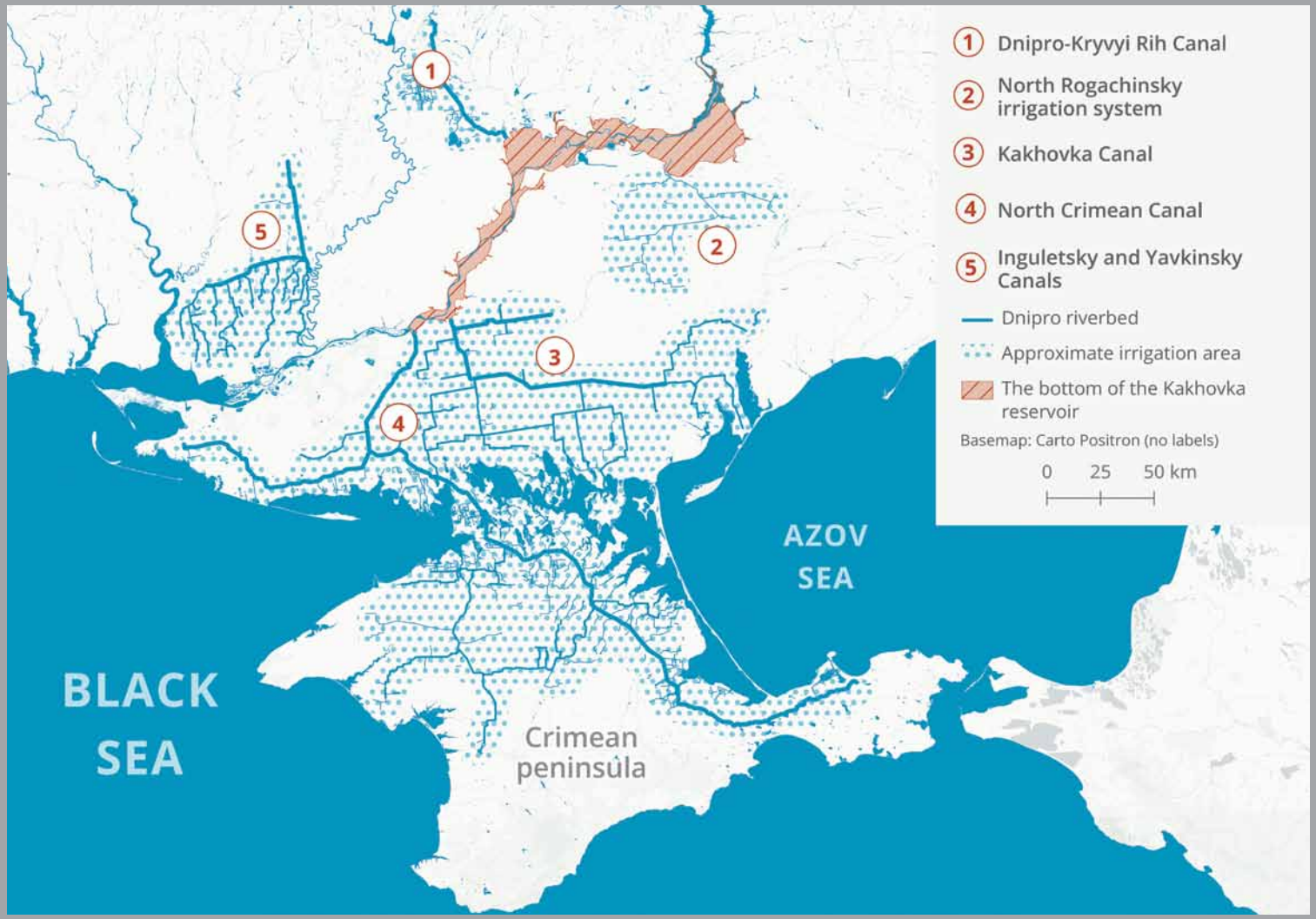
The Kakhovka Reservoir was a crucial component of Ukraine's energy system, providing an average annual generation of 1489 million kWh. The station's total capacity was 334 MW, with each of its six turbines generating 55.6 MW [34]. The HPP gave the region a stable power supply for industrial enterprises, residential buildings, and infrastructure. The Kakhovka HPP also contributed to the energy independence of the southern region, reducing the need for centralised energy sources. Its efficiency provided electricity for about 2.5 million consumers.

In addition to domestic consumption, the surplus of generated energy was supplied to other regions through the national power grid. The HPP also played an important role in regulating the frequency in the network, which increased the stability of the power supply. The station's infrastructure was technologically advanced but required periodic repairs and modernisation. Despite its potential, the facility had limitations in increasing capacity due to the natural characteristics of the Dnipro River.

WATER SUPPLY

The Kakhovka Reservoir supplied water to three main irrigation canals: the North Crimean Canal, the Kakhovka Canal, and the Dnipro-Kryvyi Rih Canal. The total water supply through these canals exceeded 21 cubic kilometres per year [34]. This water irrigated about 750,000 hectares of land in Kherson, Zaporizhzhia, Mykolaiv regions, and Crimea. The reservoir also supplied water for the technical needs of enterprises, such as thermal power plants and chemical plants. The resource was critically important for the development of the region's agriculture, providing irrigation for arid areas. Drinking water, supplied from the reservoir system, was provided to the population of nearby cities and towns. In addition, water was used to fill small reservoirs and artificial lakes, which served as reservoirs for regulating flow. Problems with water quality, particularly its mineralisation, became a challenge for some regions. The reservoir played the role of a buffer during floods, protecting coastal areas from flooding.

Map of irrigation systems connected to the Kakhovka Reservoir



FISHERIES

The Kakhovka Reservoir was a source of stable fisheries, providing an average annual catch of over 20,000 tons of fish [42]. The main species were silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), and silver crucian carp (*Carassius gibelio*). The reservoir also contributed to aquaculture development, as commercial fish species were artificially bred. The fishing industry supported thousands of fishermen and employees of the fish processing industry. This activity met the region's food needs and provided for product export. However, intensive fishing and water pollution posed a challenge to maintaining stable fish populations. Eutrophication reduced the oxygen balance of the water, negatively affecting spawning grounds. Biomelioration measures were implemented to preserve fish resources in the reservoir, including water purification and restoration of spawning grounds. Fisheries remained an important element of the region's economy but required effective management.

RECREATION AND TOURISM

The large size of the Kakhovka Reservoir (2155 km^2) attracted tourists, especially during summer [15]. The reservoir's shores became a place for recreation, including water sports, fishing, and boating. The tourist infrastructure included recreation centres, campsites, and beaches, providing local residents with jobs. Up to 500,000 tourists visit the reservoir annually. This stimulated the development of the local economy and increased incomes for communities. The popularity of the reservoir also contributed to cultural events, such as regattas and festivals, held on its shores. However, problems with water quality and bank erosion created risks for recreational use. Restoring natural landscapes and improving infrastructure could further increase the region's tourism potential.

LOGISTICS AND TRANSPORTATION

The Kakhovka Reservoir facilitated navigation on the Dnipro River. The depth of the reservoir reached 3.65 m, allowing for the movement of large-tonnage vessels [34]. Over 5 million tons of cargo pass through the Kakhovka HPP lock annually. The main types of cargo were grain, metals, fertilisers, and industrial goods. Shipping significantly reduced transportation costs for regional enterprises. In addition to economic benefits, the reservoir provided access to remote areas, contributing to their integration into the national economy. The lock was also an important engineering solution that allowed for controlling the water level between different parts of the cascade. Despite the efficiency of shipping, siltation of the reservoir gradually reduced its capacity.

SCENARIOS FOR THE FUTURE

The development of agriculture, industry, and the population of southern Ukraine depended heavily on the Kakhovka Reservoir, built in the 1950s. Today, the return of the population to this region is possible only under the conditions of de-occupation, restoration of the previous or creation of a new infrastructure model.

The decision on the scenario for the development of southern Ukraine after the destruction of the Kakhovka HPP requires the involvement of specialists from many fields of science, transparent public discussion, and independent environmental impact assessment. However, despite significant public resonance, in 2023-2024, the state neither organised an expert platform nor held an open discussion on this topic (although the state-financed research to study the consequences of the destruction of the Kakhovka HPP) [32]. Ukraine's public position after the destruction of the Kakhovka HPP was the calculation of damages [31] caused to the state as a result of the terrorist act, its recognition as a war crime [36], and the determination of the amount of funds [12] required to restore the HPP dam.

At the same time, a transparent discussion of the fate of the former reservoir is part of Ukraine's public commitments, including to partner countries. Thus, in February 2024, the Environmental Treaty for Ukraine, developed by the "High-Level Working Group on Environmental Consequences of War," functioning under the Office of the President of Ukraine, included a special recommendation: *"Consideration of the issue of enabling some reclaimed territories to return to their natural state, as well as conducting broad consultations and involving experts in making such decisions"* with a special comment: *"Engage independent experts for a thorough analysis of options and related environmental consequences, given the significant scale of this project and its long-term and multifaceted impacts"*.

Thus, Ukraine publicly committed to conducting a transparent evaluation of plans for the possible restoration of the Kakhovka HPP. However, despite this public promise, the Action Plan developed by the Ministry of Environmental Protection to the international treaty directly contradicts the recommendations of the Environmental Treaty [41].

Discrepancies Between the Environmental Treaty Recommendations and the Action Plan for Their Implementation

Recommendation 42 of the Environmental Treaty specifies the obligation for environmental impact assessment and strategic environmental assessment for all projects, plans, and programmes. It also clearly states that an example of a project requiring transparent evaluation involving independent experts is precisely the possible restoration of the Kakhovka HPP (the Treaty provides only this one ex-

ample). However, in the Ministry's Action Plan, it is stated that these procedures should be cancelled for the project of the possible restoration of the Kakhovka HPP.

Suggestions and comments from the public on the *"Concept Note Defining the Scope of Deviations from Environmental Impact Assessment and Strategic Environmental Assessment Rules"* [30] were not taken into account. The protocol of the public discussion [33] did not even mention the remarks submitted to the ministry. Therefore, if the "concept note" leads to changes in legislation, these changes will be adopted without considering public opinion on managing the territory of the former Kakhovka Reservoir.

Several Publicly Discussed Scenarios for the Territory of the Former Reservoir

Among them are:

1. Creation of new HPPs and reservoirs.
2. Restoration of natural ecosystems with simultaneous solving of regional economic tasks (without involving the reservoir resource).
3. Some original options (from creating a cascade of low-pressure small HPPs to building a "narrowed" reservoir, bioenergy fields, wind farms, etc.).

The first scenario (creation of new HPPs and reservoirs) involves lengthy preparatory work, particularly demining. Only after this can the key issues be addressed: analysis of the safety of soils contaminated due to military actions and flooding, restoration of settlements, and economic evaluation of the restoration of the hydronode infrastructure. Undoubtedly, these processes will be prolonged, so the total economic cost of the region's restoration will be much higher than the possible construction of a new HPP [5]. With a high probability, that only part of the residents will be able to return to their former places of residence in the coming years. Thus, the scenario of creating a new reservoir is quite realistic. However, it is important to assess whether such a decision will be justified from both an environmental and economic perspective. It should be taken into account that the full-scale war has limited the possibilities for economic activity. Therefore, post-war recovery is likely not to envisage a return to the previous infrastructure but will require the implementation of new solutions.

Currently, there are already signs that recovery is developing according to the second scenario, which involves the restoration of natural ecosystems. The bottom of the Kakhovka Reservoir is gradually turning into a natural willow-poplar forest adapted to the specific conditions of the Steppe climatic zone. The process of nature restoration is spontaneous, without planning and human intervention, which saves human and financial resources. At the same time, the funding for the reconstruction of the southern region is mainly directed at adapting the affected territories to new conditions rather than restoring the reservoir, that is, creating an economic system that does not depend on its existence.

CREATION OF A NEW RESERVOIR

The restoration of the Kakhovka Reservoir through the construction of a new dam is proposed as one of the key scenarios for stabilising the economic and ecological situation of the region. The plan involves creating a reservoir with an area of 1200–1500 km², which is 30–40% smaller than the original size (2155 km²) [2]. The capacity of the updated hydroelectric power plant (HPP) is projected to be 300–350 MW, with an average annual output exceeding 1500 million kWh, which will provide electricity for up to 2.5 million consumers [1]. However, the significant investments required to implement the project are estimated at $1.2–1.5 billion, including the costs of modernising irrigation infrastructure and cleaning the reservoir's bottom. In the long term, financial risks and high operational costs cast doubt on the feasibility of implementing this scenario.

Siltation, which was previously one of the main problems of the reservoir, will remain a serious challenge. Every year, up to 2–3 million tons of silt accumulate in the water body, reducing its useful volume and complicating its use for irrigation, water supply, and navigation [24]. Restoring the reservoir will recreate these problems, requiring constant expenses for cleaning the bottom. Additionally, siltation will contribute to eutrophication, causing the «blooming» of water, which significantly worsens its quality. As a result, the water will become less suitable for agriculture and drinking, reducing the efficiency and practicality of maintaining a large water body.

Another significant challenge is the evaporation of water. In a region with a forecasted increase in the average annual temperature by 2.7–3°C by the end of the century, water losses due to evaporation may reach up to 15% of the total reservoir volume annually [26]. Considering the already decreased water flow of the Dnipro River (by 20% over the last three decades), the creation of a large reservoir is irrational. Evaporation reduces the useful volume of water for irrigation and other needs, making the operation of the reservoir economically unviable in the long term.

The ecological impact of flooding territories that formed after the reservoir was drained is significant. Floodplain forests, meadows, and wetlands have recovered in the area of the former reservoir, performing important ecosystem functions, including water purification, microclimate regulation, and biodiversity support [1]. These areas have become home to rare species of flora and fauna, such as the white-tailed eagle (Haliaeetus albicilla). Flooding these ecosystems would destroy the habitats of many species that have been recovering since the dam was destroyed.

The social consequences of implementing this scenario also raise concerns. Relocating several thousand residents from the flooded areas will require compensation of $100–150 million [12]. This could lead to social tensions, as communities will lose their homes and lands that they adapted for farming and livelihood after the reservoir was drained. Considering the significant dependence of the population

on the natural resources formed after the dam's destruction, implementing this scenario would worsen the economic conditions of local communities. The loss of these resources would become an additional factor of social dissatisfaction.

Navigation, which is also mentioned among the advantages of restoring the reservoir, will not resolve all transportation problems in the region. Although the new dam will allow the restoration of a navigation lock, the issue of silting in the fairway will remain relevant. Maintaining stable navigation will require additional technical measures, significantly increasing the costs of operating the reservoir. Given the limited volume of cargo that can be transported along this route, the efficiency of navigation as an argument for restoration remains questionable.

The implementation of this scenario will require significant investments in the modernisation of irrigation systems that depend on the reservoir. Channels supplying water to 750,000 hectares of arable land require capital repairs and the introduction of modern technologies [34]. However, the high cost of these measures, combined with challenges in maintaining a stable water level, complicates the economic feasibility of the project. Given the trend of declining water flow in the Dnipro River, the efficiency of these systems in the future remains uncertain.

After the destruction of the Kakhovka HPP, one of the key tasks became ensuring water supply for settlements and the agricultural sector that depended on the reservoir. The Ukrainian government organised the drilling of over 150 artesian wells in the affected regions to restore access to water [34]. The wells were equipped in rural communities in the Kherson, Zaporizhzhia, and Mykolaiv regions, where water supply was most critical. This solution served as a temporary alternative to the centralised water supply that was previously provided through the reservoir. Thanks to this, a humanitarian crisis was avoided, and tens of thousands of residents were supplied with drinking water.

For the agricultural sector, a large-scale reconstruction of the water supply system was organised. Specifically, irrigation canals that previously depended on the reservoir were re-equipped to use artesian water and pump remaining water resources from the Dnipro River. Additionally, the government decided to construct temporary water pipelines, which allowed water to be transported over significant distances to the most affected regions [34]. This made it possible to partially restore irrigation on over 250,000 hectares of agricultural land that were in critical water deficit zones.

One of the largest projects involved constructing a water pipeline to supply drinking water to cities such as Kryvyi Rih, Nikopol, and Marhanets, which faced significant difficulties due to the disappearance of the reservoir. The water pipeline, over 30 km long, was built in record time, allowing the uninterrupted operation of enterprises and the supply of water to apartment buildings. Engineering solutions included the use of modern materials to reduce water losses during transportation. Thanks to these measures, the water supply in the region was stabilised, preventing severe social consequences.

The impracticality of restoring the Kakhovka Reservoir is confirmed by a combination of economic, environmental, and social challenges. Siltation, evaporation, destruction of natural territories, and high costs make this project inefficient. Decisions regarding the implementation of the scenario must consider the long-term consequences, which significantly outweigh the potential benefits. Building a new reservoir will not ensure the sustainable development of the region and may create more problems than it solves.

THE RESTORATION OF NATURAL ECOSYSTEMS

The restoration of natural ecosystems within the territory of the former Kakhovka Reservoir is one of the most environmentally sustainable scenarios. Following the dam's destruction in 2023, unique natural landscapes quickly replaced the flooded zones. Floodplain forests, meadows, and wetlands now span over 60,000 hectares, performing key ecosystem functions such as water purification, microclimate regulation, and carbon sequestration [1]. These natural formations can retain up to 50 million cubic meters of water annually, significantly reducing the risk of floods. Given global environmental challenges, preserving these areas is critical for environmental stability and for Ukraine's compliance with international obligations.

Natural ecosystems have become home to more than 200 bird species, including rare ones like the white-tailed eagle (*Haliaeetus albicilla*), whose population in the region has increased by 25% since the reservoir was drained. Habitats for plant species such as narrow-leaved peony (*Paeonia tenuifolia*), Scythian tulip (*Tulipa scythica*), and Regel's onion (*Allium regelianum*), which were previously on the brink of extinction, have also been restored [1]. Additionally, an increase in the population of the Eurasian otter (*Lutra lutra*), an indicator of ecological health, has been observed. These developments highlight the high potential of these ecosystems to sustain biodiversity.

a

b

Photo of floodplain forests and meadows formed after the reservoir drained a) photo by Vincent Mundi, 2024; b) photo by Alessio Mamo [3].

The ecosystems also serve as powerful reservoirs for soil retention. Estimates suggest they prevent erosion across approximately 30,000 hectares, significantly reducing the risk of losing fertile lands. Unlike the reservoir, which previously caused bank abrasion of 1.5–2 meters annually, the natural zones ensure long-term soil stability [24]. This underscores the importance of these areas in the context of climate change adaptation.

The economic feasibility of this scenario is also evident. Total rehabilitation costs for floodplains are estimated at $80–100 million, which is 15 times less than the cost of constructing a new reservoir ($1.2–1.5 billion) [5]. Furthermore, natural ecosystems do not require annual maintenance, which, in the case of reservoir restoration, would cost $10–15 million. Thus, this scenario is significantly cheaper and imposes no additional financial burden on the state budget.

The development of ecotourism can substantially boost the region's economic activity. Preliminary estimates suggest that the floodplains of the Great Meadow could attract up to 300,000 tourists annually, generating additional income of $8–10 million [1]. Creating tourist routes, eco-friendly resorts, and protected parks will increase employment in the region. For example, developing ecotourism infrastructure could create up to 5,000 new jobs in the service and conservation sectors. Integrating natural areas into international programs like the Emerald Network opens up new funding opportunities. According to EU programs, including these territories in the network could secure up to €20 million in biodiversity conservation grants [19]. Additionally, the Ramsar Convention could support sustainable development projects for wetlands. This would enhance Ukraine's international reputation as a country committed to environmental care and fulfilling its global obligations.

Floodplains are crucial for combating climate change. Each year, these areas can sequester up to 1.5 million tons of CO_2, significantly contributing to reducing Ukraine's carbon footprint [1]. Compared to reservoirs, which release methane (a greenhouse gas) due to organic decomposition, floodplains have the opposite environmental effect. Preserving such areas aligns with the goals of the Paris Agreement and promotes sustainable regional development.

The social aspect of this scenario is also positive. Local communities will not require relocation, which would be necessary if territories were flooded to create a new reservoir. Additionally, access to natural resources that emerged after the reservoir drained will support the development of local enterprises, particularly in fishing and agriculture. Preserving natural zones will help avoid social tensions and ensure regional stability.

The conclusions indicate that the restoration of natural ecosystems is the most advantageous scenario from both environmental and economic perspectives. It preserves unique nature, supports biodiversity, and stabilises the region's climatic conditions. In the long term, this approach ensures the sustainable development of the region without significant financial, environmental, or social risks.

COMPROMISE AND ORIGINAL SCENARIOS FOR DEVELOPMENT

Creation of a smaller reservoir

The scenario of creating a smaller reservoir is a compromise solution that considers the needs for water supply, irrigation, and energy while minimising environmental and social impact. The area of the new reservoir could be reduced to 600–800 km², which is approximately 30–40% of the original size of the Kakhovka Reservoir (2,155 km²) [2]. This scenario proposes the construction of a 35 km-long dam to form a water body with a limited volume to meet the region's needs. The reduced size of the reservoir is expected to avoid significant maintenance costs and reduce risks associated with evaporation and silting. The total cost of the project is estimated at $600–800 million, which is almost half the cost of restoring the large reservoir.

The main advantage of a smaller reservoir is the preservation of key functions for the region's irrigation systems. Specifically, the North Crimean, Kakhovka, and Dnipro-Kryvyi Rih canals will be able to continue providing irrigation for 400–500 thousand hectares of arable land, which constitutes over 50% of the initial irrigated area [34]. In the agricultural sector, preserving irrigation systems will prevent a decline in grain yields, which account for up to 20% of Ukraine's exports. The reduced size of the reservoir allows for better water level control and decreases evaporation losses by 30–40% compared to larger water bodies.

The energy function of the smaller reservoir will also be preserved, though the capacity of the new hydropower plant will decrease to 150–200 MW. This level will generate approximately 700–900 million kWh of electricity annually, meeting the region's basic energy needs [1]. Thanks to the modernisation of hydro units, energy production efficiency may be increased. A smaller reservoir will require lower construction and maintenance costs for energy infrastructure, contributing to long-term financial savings.

Reducing the size of the reservoir significantly lowers the environmental impact associated with flooding natural areas. The construction of the smaller reservoir will save approximately 40,000 hectares of floodplain forests, meadows, and wetlands, which perform important ecosystem functions [1]. Such areas provide habitats for many rare animal and plant species, promoting biodiversity conservation. For instance, the white-tailed eagle (*Haliaeetus albicilla*) and the Eurasian otter (*Lutra lutra*) will remain in their natural habitats. Additionally, ecosystems that remain unflooded help retain soil and reduce erosion risks.

The social impact of this scenario is also significantly smaller compared to the restoration of the large reservoir. The reduced volume of the water body will avoid displacing a large number of residents from flood zones. An estimated 1–2 thousand people will need to be relocated, whereas creating a large reservoir could displace over 10 thousand [12]. Compensation costs for affected communities are estimated at $20–30 million, which is acceptable within the overall project budget. This will help reduce social tensions and ensure support among the local population.

A smaller reservoir also addresses the issue of silting, which is characteristic of large water bodies. By reducing the size of the water body, the annual accumulation of silt will decrease by 50–60% compared to the previous reservoir [24]. This will significantly reduce the costs of dredging and maintaining the functionality of the water body. Controlling silting will also help preserve water quality, which is important for meeting the needs of the population and agriculture. An important aspect is the reduction of water losses through evaporation. Reducing the area of the reservoir will decrease these losses by 40%, equivalent to saving approximately 120 million cubic metres of water annually [26]. This is particularly important in the context of climate change, where the Dnipro River's water flow has already decreased by 20% over the past three decades [20]. More efficient use of water resources will ensure the stability of the water supply for the region.

The scenario of creating a smaller reservoir also preserves the potential for navigation on the Dnipro River. Although the volume of cargo transportation will be slightly lower, the ability to transport up to 3 million tonnes of cargo annually will ensure the region's integration into the national logistics network [43]. Combined with reduced costs for maintaining the fairway, this makes navigation economically viable within this scenario.

Conclusions suggest that creating a smaller reservoir is a feasible solution that preserves the region's essential functions while minimising environmental and social impact. Reduced costs, smaller flooded areas, and more efficient use of water resources make this scenario more acceptable compared to restoring the large reservoir.

Scenario of developing alternative energy sources

The development of alternative energy sources in the area of the former Kakhovka Reservoir offers an economically advantageous and environmentally sustainable approach to addressing the region's energy and conservation challenges. The core idea of this scenario is the construction of solar power plants (SPPs) and the development of wind energy. According to experts, just 1% of the former reservoir's area (approximately 20 km²) could generate 300–350 MW of electricity annually, which corresponds to the capacity of the Kakhovka Hydropower Plant [6]. The project cost is estimated at $300–400 million, almost half the cost of restoring the reservoir. The payback period for such power plants is 7–10 years, making them attractive for domestic and international investors.

Floating solar power plants can not only generate electricity but also reduce water evaporation losses by 40% [26]. In a region where the Dnipro River's water flow has decreased by 20% over the last 30 years, this is a significant factor in conserving water resources [20]. Additionally, the development of wind energy in areas with wind speeds of 5.5–6 m/s will provide another 100 MW of capacity, increasing the region's overall energy potential. Combined, the total electricity generation from SPPs and wind farms could meet the needs of up to 500,000 households annually, significantly contributing to the stability of Ukraine's energy system.

A major advantage of this scenario is the minimisation of environmental impact. Unlike reservoirs, which cause silting problems (up to 2–3 million tonnes of silt annually) and eutrophication, SPPs do not pose such risks [24]. The absence of flooding preserves over 60,000 hectares of natural ecosystems, including floodplain forests, meadows, and wetlands, which play a crucial role in biodiversity conservation. These areas are habitats for over 200 bird species, including the rare white-tailed eagle (*Haliaeetus albicilla*) and the Eurasian otter (*Lutra lutra*) [1]. Preserving such zones also helps combat climate change, as they sequester up to 1.5 million tonnes of CO_2 annually, significantly reducing Ukraine's carbon footprint.

The economic potential of alternative energy includes creating up to 10,000 jobs during the construction, maintenance, and management of the plants [1]. Local communities will receive substantial revenues through taxes related to the energy facilities' operations, enabling the development of regional infrastructure. Preliminary estimates suggest that the annual economic effect of SPPs and wind farms could amount to up to $50 million. This will ensure the region's sustainable funding without significant risks to the natural environment.

Implementing this scenario also supports the region's integration into international conservation programmes. Floodplain areas could be included in the Emerald Network, providing access to funding within EU programmes. Additionally, participation in the Ramsar Convention could attract up to €20 million for the conservation of wetlands [19]. This would enhance Ukraine's international reputation as a country adopting modern approaches to sustainable development.

The risks of implementation include high initial investments and dependence on state policies regarding «green» tariffs. It is essential to conduct detailed studies to identify the most effective locations for the stations. At the same time, international support in the form of grants and concessional loans could offset part of the costs, reducing the financial burden on the state budget.

The conclusion indicates that the development of alternative energy sources is the most environmentally and economically justified solution. It avoids significant environmental losses, preserves natural ecosystems, and ensures a stable energy supply. Implementing this scenario will be an important step towards the region's sustainable development and strengthening Ukraine's energy independence.

FEATURES OF SCENARIO IMPLEMENTATION FOR LOCAL COMMUNITIES

Residents of all settlements located along the reservoir's banks (primarily villages) were heavily dependent on the reservoir. During its creation, many settlements were relocated a short distance, often ending up on the reservoir's very edge. The new environmental conditions of the 1950s established a dependence of local life on the reservoir, such as adjusting to higher groundwater levels, which facilitated

easy access to water for irrigating gardens. Additionally, a large portion of local residents was involved in fishing.

With the reservoir's loss, most villages are now located far from the Dnipro River or its branches. Along with this, traditional natural resource use for the local population has disappeared. This explains why many local residents view the destruction of the Kakhovka Hydroelectric Power Plant as the destruction of their entire way of life.

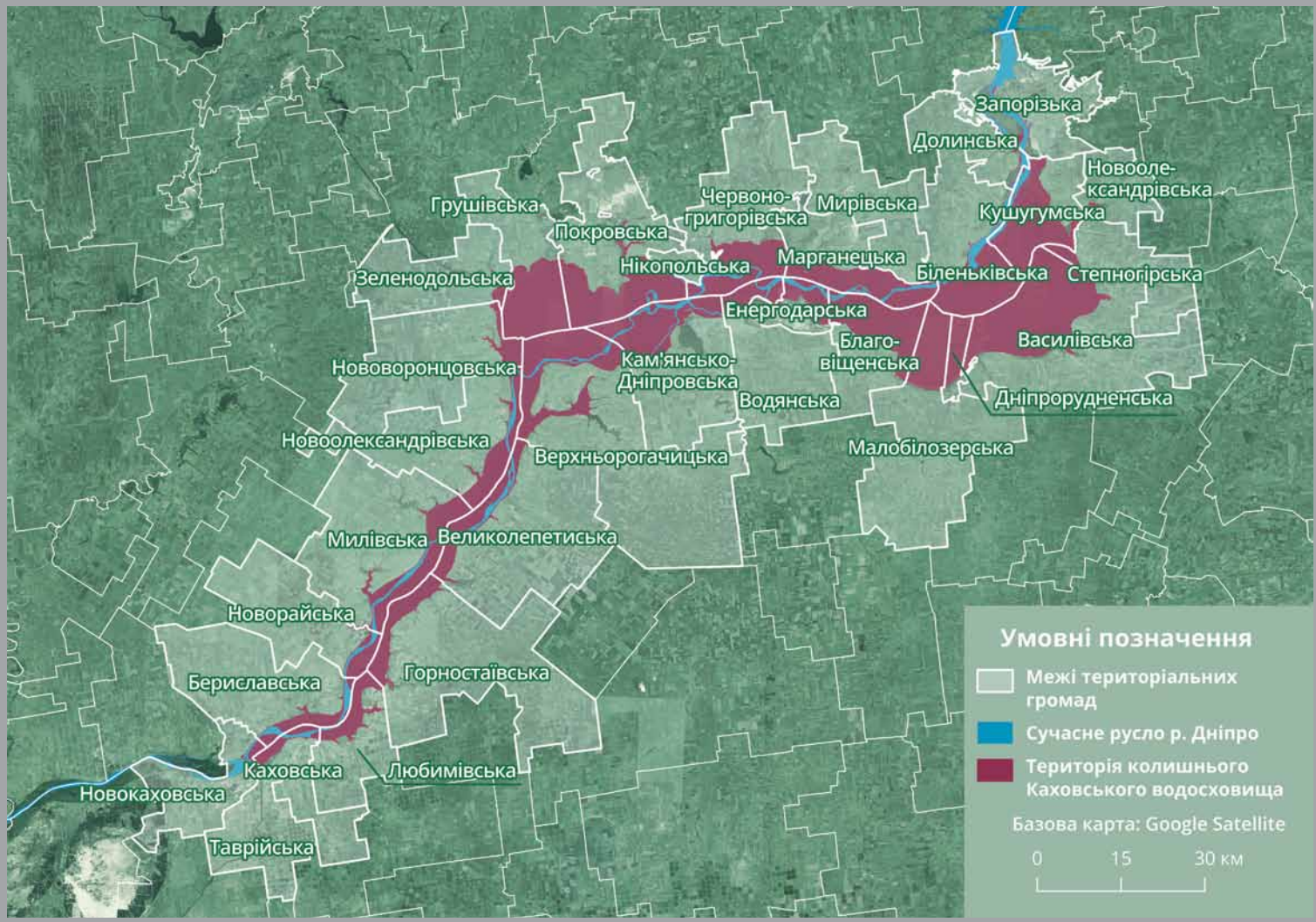
At the same time, memories from elders who recall life before the reservoir highlight a broad range of resource uses in the Great Meadow. These include timber harvesting, reed gathering, fishing, hunting, livestock grazing, and beekeeping [40]. Preserving the natural ecosystems of the Great Meadow would allow for the revival of the former coexistence of people and the Dnipro Valley's ecosystem (except for grazing and beekeeping, which currently pose significant environmental risks due to the potential migration of heavy metals and other toxins into products).

Moreover, the widespread growth of willows on the former reservoir bed offers economic opportunities for developing wickerwork. This includes the production of furniture, packaging, woven reinforcements for camouflage structures, and fortifications. Thinning willow thickets could promote forest biotope formation while providing high-quality raw materials in significant quantities. Wickerwork could become a viable small business with local markets in Zaporizhzhia, Kryvyi Rih, and Kherson, supporting resource preservation and promoting employment.

Abandoning the reservoir might lead to water resource shortages for monocultural agriculture. Instead, small family farms could take precedence. Currently, such farms are more likely to establish themselves in the market than large agricultural holdings due to their mobility and flexibility. Furthermore, during wartime, small family farms have demonstrated resilience and adaptability to new conditions [8]. They play a significant role in supporting local communities by providing substantial employment opportunities. European Union policies, particularly the «Green Deal,» also tend to support small agricultural enterprises as more environmentally friendly and adaptive.

It is challenging to identify a single scenario most beneficial to local residents from those known today. This is primarily because they are designed for different implementation periods. For example, restoring the Great Meadow offers short-term benefits but requires changes to economic practices to fully utilise them. Building a reservoir would not demand such changes but would take a long time to complete. The waiting period for such a scenario is too lengthy for most families, as it could span generations and exceed acceptable waiting periods.

Boundaries of local communities, parts of which are located within the former Kakhovka Reservoir



CONCLUSIONS

The construction of the Kakhovka Reservoir in the 1950s was driven by both military and economic objectives, which overshadowed the assessment of the environmental risks associated with its construction. As a result, the natural conditions of southern Ukraine underwent a colossal transformation: a vast area of valuable floodplain ecosystems was flooded, the flow of the Dnieper River was disrupted over a distance of approximately 250 km, and consequently, its importance for the spawning of many valuable fish species, as well as the migration and breeding of birds, was lost. At the same time, the largest irrigation system in the region was created in large areas around the reservoir, leading to a fundamental transformation of the region's economy and a significant increase in population. In addition, the creation of the reservoir led to the restructuring of the entire transport logistics of the region, the water supply of cities, and the operation of the energy sector. Most modern Ukrainians cannot imagine life without the Kakhovka Reservoir, as their ancestors arrived in this region after its construction.

In 2023, Russian forces committed an act of terrorism that was unprecedented in terms of the environmental consequences of the full-scale invasion. The reservoir ceased to exist, the territory downstream suffered destruction as a result of catastrophic flooding, and the marine environment experienced unprecedented pollution and desalination. The mass destruction of infrastructure, the flooding of entire cities, and the loss of human life caused a resonance that led to a discussion of the terrorist act at all levels, including UN meetings. After June 6, 2023, the concept of «ecocide» ceased to be a play on words and became a universally accepted term applied to the «Kakhovka» terrorist act [17].

In the first days after the disaster, biologists began studying the consequences of the terrorist act. Within a few months, they discovered the rapid restoration of floodplain forests and other vegetation in the territory of the former reservoir. Such forests are climatically stable, and their existence indicates the possibility of returning the territory of the former reservoir to its natural state.

This fact sparked a public discussion about the future of the destroyed Kakhovka hydroelectric complex. Society was divided mainly into supporters of the scenario of restoring the former reservoir or reviving the floodplain complex of the Lower Dnieper and the Great Lugo, as well as several compromise scenarios that require the adoption of fundamentally new technical solutions.

The occupation of almost the entire region that depended on the Kakhovka hydroelectric complex in 2022 and, subsequently, the destruction of the Kakhovka HPP created conditions for a paradigm shift. Making any hasty decisions without studying international experience, weighing the advantages and disadvantages of each scenario, and conducting a strategic environmental assessment could be an unacceptable mistake [18].

Most «compromise» or «original» projects meet the interests of only certain sectors of the economy, so they are likely to divert precious resources from the comprehensive restoration of the region. The consideration of any scenario should be based on whether the proposed model can meet the needs of the environment, the population, and the main sectors of the economy (while methods of agriculture, economic priorities, etc., may change).

Time is playing against the scenario of restoring the hydroelectric complex. With each month of war and the occupation of the left bank of the Dnieper, the area of the young forest is growing, and support for the restoration of the Great Lugo is increasing. Meanwhile, the economic infrastructure, which is critically dependent on the operation of the reservoir, does not have the resilience to wait for restoration while idle [18]. The volume of expenditures required to restore the entire complex (including the water supply and irrigation system) seems disproportionate compared to the needs that can be met exclusively at the expense of the reservoir. It is more efficient to compensate for its loss through modern technologies and adaptation of the economic system than to restore a system that loses half of its water during transportation.

Summarising the analysed information, the scenario of preserving the young ecosystem of the new Great Lugo while simultaneously solving the economic needs of the region in ways alternative to the reservoir has the greatest potential. This means not looking for alternative sources of water for irrigation but creating a new economic model for the region that will be better adapted to modern conditions.

From the very first day of the terrorist attack, Ukraine has been investing huge funds in restoring the capacity of the affected region, in particular, building new water pipelines and adapting all sectors of the economy and the lives of local residents to new conditions. In fact, this means creating a new economic system. This system is more resilient both in conditions of geopolitical turbulence and in conditions of ongoing climate change. If, in the future, the creation of a new reservoir is started, this will lead to the destruction of the largest floodplain willow-poplar forest in Europe and the largest forest massif in southern Ukraine, the loss of the opportunity to build a sustainable economic model in the region, and, finally, to colossal waste, since funds are already being invested in another restoration scenario. Equivalent investments in more sustainable alternative energy sources and increasing energy efficiency are more justified in today's realities [11] than restoring a hydroelectric power station. Modern agricultural technologies are able to provide for the cultivation of a variety of agricultural products without outdated irrigation technologies and subsequent large-scale salinisation of soils.

Studies have shown that even if the reservoir is preserved, global climate change in the coming decades would lead to the final salinisation of irrigated lands, as well as a water deficit for irrigation, water supply, and power generation. Thus, the rejection of the Soviet model, which provided for the creation of a new reservoir and the further development of irrigated agriculture in southern Ukraine, opens up prospects

for the formation of a more sustainable and modern economy in the region than the «Stalinist plan for the transformation of nature» envisaged.

The unexpected restoration of the Great Lugo, the memory of whose existence Soviet ideologists tried to erase for so long, can become a symbol of Ukraine's recovery after the war. The study of the archaeological heritage of this territory can open up new pages in the history of Ukrainian statehood and the pre-Cossack period. The unique experience of the «Kakhovka» terrorist act can enter the history of the Russian-Ukrainian war as a turning point after which Ukraine recovered stronger than before [18]. In addition, the restoration of the Great Lugo will most likely be the largest environmental project ever implemented in Europe.

REFERENCES

1. **Docudays UA.** Будівництво Каховської ГЕС-2: катастрофа неминуча? [Internet]. Docudays UA; 2021 [cited 2024 Jan 9]. Available from: https://docudays.ua/2021/events/rights-now/budivnytstvo-kakhovskoi-hes-2-katastrofa-nemynucha
2. **Elevatorist.** Філіал Кам'янка-Дніпровська Нібулона [Internet]. 2024 [cited 2024 груд 14]. Available from: https://elevatorist.com/karta-elevatorov-ukrainy/elevator/298-filial-kamenka-dneprovskaya-nibulona
3. **Harding, L.** Life returns to Ukrainian reservoir drained by Russian strike on dam. [Internet]. The Guardian; 2024 Jul 20 [cited 2024 Jul 25]. Available from: https://www.theguardian.com/world/article/2024/jul/20/life-returns-to-ukrainian-reservoir-drained-by-russian-strike-on-dam
4. **Herson.depo.ua.** Архіви КДБ: як у бруді та злиднях будували Каховську ГЕС [Інтернет]. Herson.depo.ua; 2021 серп 15 [цитовано 2024 лют 20]. Доступно: https://herson.depo.ua/ukr/herson/arkhivi-kdb-yak-u-brudi-ta-zlidnyakh-buduvali-kakhovsku-ges-202108151355165
5. **Honcharuk V., Pidlisnyi Y., Dekarchuk M., Podzerei R., Zadorozhna O., Datsenko A., Borovyk P., Blahopoluchna A., Parakhnenko V., Liakhovska N.** Environmental and economic damage to agriculture as a result of the explosion of the Kahovska hydroelectrical station. Management Theory and Studies for Rural Business and Infrastructure Development. 2024. № 46
6. **International Renewable Energy Agency (IRENA).** Renewable capacity statistics 2024. [Internet]. IRENA; 2024 Mar [cited 2024 Dec 22]. Available from: https://www.irena.org/Publications/2024/Mar/Renewable-capacity-statistics-2024
7. **kafk** [YouTube]. С.О. № 6 «Козаки. Запорізька Січ» [Internet]. kafk; 2014 Sep 15 [cited 2025 Jan 11]. Available from: https://www.youtube.com/watch?v=SUrPgqlu5jo&t=1053s
8. **Mamonova N., Borodina O., Kuns B.** Ukrainian agriculture in wartime. [Internet]. Transnational Institute; 2023 Nov 9 [cited 2024 Jul 5]. Available from: https://www.tni.org/en/article/ukrainian-agriculture-in-wartime
9. **OldMaps.dp.ua.** Карта Великого Лугу Дніпровського [Internet]. OldMaps; 2024 [cited 2024 груд 11]. Available from: https://oldmaps.dp.ua/greatlug/?leftmap=91943&rightmap=1943&double=0#14/47.4490/34.0938
10. **OldMaps.dp.ua.** Порівняння мап Великого Лугу: 1914 та 1943 роки. [Інтернет]. OldMaps; 2024; [цитовано 2024 груд 1]. Доступно: https://oldmaps.dp.ua/greatlug/?leftmap=91943&rightmap=1943#12/47.4898/34.0951
11. **Ro3kvit Coalition.** Інтегрована Візія річки Дніпро. [Internet]. Ro3kvit; 2024 [cited 2024 Dec 11]. Available from: https://ro3kvit.com/ua/projects/dnipro-river-integrated-vision
12. **United Nations Ukraine** [Звіт]. The Post Disaster Needs Assessment report of the Kakhovka Dam Disaster [Інтернет]. United Nations Ukraine; 2023 жов 17; [цитовано 2024 лист 2]. Доступно: https://ukraine.un.org/sites/default/files/2023-10/PDNA%20Final%20and%20Cleared%20-%2016Oct.pdf
13. **Wikipedia**. [Інтернет]. Річка Дніпро. Wikipedia; 2024 [цитовано 2024 лип 15]. Доступно: https://uk.wikipedia.org/w/index.php?curid=3154
14. **Анцишкін І.** Плани 1952 року і побудова Каховського водосховища. Свята Справа. 2009. № 1-2 (5). С. 20-21.
15. **Апанович О.М.** Запорозька Січ у боротьбі проти турецько-татарської агресії: 50–70-ті роки XVII ст. Київ: Вид-во АН УРСР, 1961. 299 с.
16. **Безсонний В.Л., Пляцук Л.Д., Третьяков О.В.** Аналіз екологічного стану Каховського водосховища на підставі ентропійного індексу. Збірник наукових праць НУК. Миколаїв, 2023. № 1 (490). С. 198–208. https://doi.org/10.15589/znp2023.1(490).24
17. **Василюк О.В., Колодежна В.В., Демченко В.О., Куземко А.А., Марущак О.Ю., Мойсієнко І.І., Некрасова О.Д., Пархоменко В.В., Русін М.Ю., Сон М.О., Сплодитель А.О., Темченко Є.А., Філюта К.О., Ходосовцев О.Є., Шевченко І.В.** Знищення Каховського водосховища: наслідки для довкілля / упор. В.В. Колодежна, О.В. Василюк. Чернівці: Друк Арт, 2025. 112 с. (Серія: «Метаморфози Великого Лугу». – вип. 1).

18. **Василюк О.В., Пархоменко В.В., Мойсієнко І.І., Шаповал В.В., Панченко С.М., Спрягайло О.В.** До питання відродження Великого Лугу – історичної території Запорізької Січі. Традиції заповідної справи, сучасні проблеми збереження та повоєнного відновлення територій природно-заповідного фонду (Серія: «Conservation Biology in Ukraine». Вип. 32). Чернівці: Друк Арт, 2023. С. 25-41.
19. **Верховна Рада України**. Постанова Кабінету Міністрів України № 695 від 2020 р. Про затвердження Державної стратегії регіонального розвитку на 2021-2027 роки [Internet]. Верховна Рада України; 2020 [cited 2024 Nov 21]. Available from: https://zakon.rada.gov.ua/laws/show/695-2020-%D0%BF#Text
20. **Вишневський В.І., Сташук В.А., Сакевич А.М.** Водогосподарський комплекс у басейні Дніпра: монографія. Київ: Інтерпрес ЛТД, 2011. 188 с.
21. **Вороніна Д.А., Міськевич С.В.** Причини та наслідки заболочення екосистем навколо Каховського водосховища. Проблеми відтворення та охорони біорізноманіття україни в світлі вчення про ноосферу. Полтава: Астрая, 2009. С. 159-160.
22. **ГАРФ.** Ф. Р 5587. Оп. 27. Д. 124. Протокол и стенограмма общегородской конференции научных и инженерно-технических организаций города Одессы, посвященной помощи строительству Каховской гидроэлектростанции и Южно-Украинского канала. 22-23 ноября 1950. Л. 24, 60-66
23. **Грушевський М.С.** Історія України-Руси: В 11 т. Т. 7: Козацькі часи – до року 1625. Київ: Наук. думка, 1995 [Репринтне видання]. 628 с.
24. **ДНУ «Український інститут науково-технічної експертизи та інформації» (УкрІНТЕІ).** Науковий звіт «Розробка рекомендацій щодо доцільності відбудови Каховського гідровузла та наповнення Каховського водосховища для забезпечення надійної експлуатації водозаборів комунального та промислового водопостачання, та відновлення екологічного стану і біорізноманіття Нижнього Дніпра» 1 Етап. Інститут гідробіології Національної академії наук України. Київ, 2023. 108 с. № держреєстрації 0123U105277 Доступно: https://nddkr.ukrintei.ua/view/rk/1dd12d4ce0b8eb8f0a30beb280d2ec3f
25. **Жайворонок В.В.** Знаки української етнокультури: словник-довідник. Київ: Довіра; 2006. С. 70-71.
26. **Іванюта С.П., Коломієць О.О., Малиновська О.А., Якушенко Л.М.** Зміна клімату: наслідки та заходи адаптації: аналіт. доповідь / за ред. С.П. Іванюти. Київ: НІСД, 2020. 110 с. Available from: https://niss.gov.ua/sites/default/files/2020-10/dop-climate-final-5_sait.pdf
27. **Каштанов К.** Єгипет у близькосхідній політиці СРСР (1957–1961 рр.). Схід. 2018. № 4 (156). С. 41-47.
28. **Мельник І.Л.** Особливості формування, стан Каховського водосховища [Електронний ресурс]. Всіосвіта; 2019 лист 9 [цитовано 2024 бер 28]. Доступно: https://vseosvita.ua/library/embed/01007b4x-4d3e.doc.html#
29. **Ми – Україна.** [YouTube]. Параграф: таємна історія Каховського водосховища. Козацька Атлантида. Як Сталін знищив Великий Луг. [Інтернет]. Ми – Україна; 22 черв 2023; [цитовано 2024 груд 2]. Доступно: https://www.youtube.com/watch?v=aA06uLrE59Q&t=1474s
30. **Міністерство захисту довкілля та природних ресурсів України.** Концептуальна записка, що визначає сферу відступів/від правил оцінки впливу на довкілля (ОВД) та стратегічної екологічної оцінки (СЕО) [Internet]. Міністерство захисту довкілля та природних ресурсів України; 2024 Sep 18 [cited 2024 Dec 8]. Available from: https://mepr.gov.ua/kontseptualna-zapyska-shho-vyznachaye-sferu-vidstupivvid-pravyl-otsinky-vplyvu-na-dovkillya-ovd-ta-strategichnoyi-ekologichnoyi-otsinky-seo/
31. **Міністерство захисту довкілля та природних ресурсів України.** Рік після теракту рф на греблі Каховської ГЕС: Екокомітет провів виїзне засідання на Херсонщині [Internet]. Міністерство захисту довкілля та природних ресурсів України; 2024 січень 3 [цитовано 2024 грудень 18]. Available from: https://mepr.gov.ua/rik-pislya-teraktu-rf-na-grebli-kahovskoyi-ges-ekokomitet-proviv-vyyizne-zasidannya-na-hersonshhyni/
32. **Міністерство освіти і науки України.** Наказ про оголошення конкурсу на виконання наукових досліджень і розробок [Internet]. МОН України; 2024 [cited 2025 січ 13]. Available from: https://nauka.gov.ua/docs/41/Наказ_МОН_Про_огол_конкурсу_ДЗ_2024.PDF
33. **Міністерство охорони довкілля та природних ресурсів України.** Протокол громадського обговорення концептуальної записки [Internet]. Київ: Міністерство охорони довкілля та природних ресурсів України; 2024 Sep. [cited 2024 Jan 9]. Available from: https://mepr.gov.ua/wp-content/uploads/2024/09/Protokol-gromadskogo-obgovorennya-Kontseptualnoyi-zapysky.pdf

34. **Обухов Є.В., Корягіна О., Малацковська С.В.** Оцінка випаровування з Каховського водосховища: заключний звіт. Одеса: Одеський державний екологічний університет; 2014. 45 с. Доступно за: http://eprints.library.odeku.edu.ua/id/eprint/1937/1/Zvit_K_Obukhov_0113U005798_2014.pdf
35. **Олененко А.** «Новое наше море – новое наше горе»: конфликт между украинским и советским в борьбе за конструирование ландшафта Нижнего Поднепровья. Ab Imperio. 2019. № 1. С. 125-152.
36. **Офіс Генерального прокурора.** [Повідомлення в Telegram] [Інтернет]. Андрій Костін підписав документ, яким МКС надається вся необхідна інформація стосовно підриву окупантами дамби Каховської ГЕС. Telegram; 2023 черв 6 [цитовано 2024 черв 8]. Available from: https://t.me/pgo_gov_ua/12962
37. **Охороняймо пам'ятки природи. Матеріали до охорони природи Середньої Наддніпрянщини** / під ред. М. Акімова; Видання Дніпропетровської краєвої інспектури охорони пам'яток природи. Дніпропетровськ, 1930. 66 с.
38. **План управління річковим басейном Дніпра на 2025-2030 роки.** Київ, 2024. 1344 с. Доступно за: https://davr.gov.ua/fls18/u8/PURBDnipro.DOCX
39. **РГАЭ**. Ф. 339. Оп. 1. Д. 632. Заключения и переписка о рассмотрении проектного задания на строительство Каховской ГЭС на р. Днепре.
40. **Сушко К.** Повернення Дніпра. Звідкіль родом Каховська ГЕС? 2-ге вид., доп. й розшир. Чернівці: Друк Арт, 2024. 88 с.
41. **Українська природоохоронна група.** Чому Україну чекає невиконання екологічного договору? [Internet]. 2024 May 28 [cited 2024 May 28]. Available from: https://uncg.org.ua/ekologichnyj-dogovir-dlya-ukrayiny/
42. **Христенко Д.С., Рудик-Леуська Н.Я., Котовська Г.О.** Атлас адвентивної іхтіофауни басейну р. Дніпро. Київ: Фітосоціоцентр, 2011. 124 с.
43. **ЦДАВО України.** Ф. 2. Оп. 13. Спр. 1382.
44. **Шама О.** Вибухові врожаї. Навіщо ЦРУ збирало дані про вирощування бавовника в Україні в 1950-х роках і тримало їх засекреченими [Internet]. NV.ua. 2023 Oct 21 [cited 2023 JOct 23]. Available from: https://nv.ua/ukr/ukraine/events/bavovna-dlya-porohu-yak-rodyuchi-ukrajinski-zemli-u-1940-50-h-rokah-namagalisya-vikoristati-dlya-bavovni-50459843.html
45. **Яворницький Д.І.** Історія запорізьких козаків: в 3-х томах. Т. 1. Київ: Наукова думка, 1990. 592 с.