



Figure 1. In the 17th and 18th centuries, Zaporizhian Cossack naval units repeatedly took part in the wars of great empires, and their raids struck terror along the Turkish coast. Attack of the Zaporizhians on a Turkish ship in the Black Sea, a map detail from *Le cours du Danube*, 1703, by Placide de Sainte-Helene and Pierre Du Val. Courtesy David Rumsey Map Collection, David Rumsey Map Center, Stanford Libraries

# Submerged Cultural Heritage of Ukraine and the Russian Aggression

**Dmytro Kobaliia**, PhD, Head of the Archaeology Department of National Reserve Khortytsia, kobalia@i.ua

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Since the beginning of Russia's full-scale invasion of Ukrainian territory, dramatic changes have occurred in the sphere of Ukraine's underwater cultural heritage. The destruction of the Kakhovka dam in the summer of 2023 has impacted thousands of archaeological sites and objects in southern Ukraine and these processes are irreversible. Many heritage sites were previously submerged but have now surfaced. In the long term, the disappearance of Ukraine's largest reservoir, the Kakhovka, opens up opportunities to restore the legendary Great Meadow, a sacred territory closely tied to the origins of the Cossacks and the Ukrainian state itself. In the twentieth century, the Great Meadow was flooded by the Soviet communist government under the pretext of developing irrigation, electrification, and navigation. As a result, a vast number of national sites became inaccessible for scientific research. The preservation of this historical landscape would allow systematic exploration of both underwater and terrestrial sites.

Ukraine is one of the largest countries in Europe and naturally possesses a large number of underwater cultural heritage monuments. It should be noted that the degree of their study remains extremely low. The Sea of Azov water area is practically unexplored. There is much we do not know about many issues, even about events of popular interest, such as the sea voyages of the Zaporizhian Cossacks who lived in this region from the sixteenth to the nineteenth centuries, when it was a frontier territory between the Christian and Muslim worlds.





Figure 2. One of the monuments of the Mennonite cemetery at the bottom of the Dnipro river. Photograph courtesy Y. Bataev

Conventionally, Ukraine's underwater heritage sites are distributed in four geographical zones. These include the Northern Black Sea coast; the vast river system of the Dnipro river with its tributaries; smaller river systems such as the Dniester, Ingulets, and Seversky Donets; and the steppe rivers of the southeast. The underwater heritage sites are quite diverse. They include shipwreck sites from antiquity to the present day, ancient submerged settlements, crossing points, fords, port facilities, anchorages, dugouts, and many others.

### The Dnipro River

A specific feature of Ukraine is the relatively large number of submerged land sites: cemeteries, burial sites, and settlements. This is due to the creation of a cascade of hydroelectric power plants on the

Dnipro river in the twentieth century. Now they may well be classified as underwater sites, which is sometimes strange. An example is the Einlage Mennonite cemetery of the eighteenth century on the Dnipro. Before the construction of the cascade of hydroelectric power plants in the twentieth century, the cemetery was located on the bank near the settlement of the same name, founded by German–Dutch colonists who had settled in southern Ukraine at the end of the eighteenth century. In the southeastern part of the country, numerous Bronze Age and Scythian settlements were submerged as a result of the construction of the Soviet irrigation system on small steppe rivers.

Ukraine has been home to diverse populations, and portions of the country changed hands many times, so the cultural palette of the sites is diverse.



Figure 3. A sharp drop in the water level of the Dnipro river has led to the formation of extensive shallows. Photograph courtesy A. Kuzemko

Underwater sites of Ukraine may be equally interesting for specialists from Turkey, Hungary, Lithuania, Austria, Bulgaria, Romania, Greece, Poland, and so on. However, they may also be of interest to many others, as our territory is characterized by the processes of mixing different traditions, both cultural and purely technological. Shipwrecks in Ukraine can be particularly interesting because they show the influence of various shipbuilding traditions.

After the start of a full-scale Russian invasion in early 2022, the situation with underwater sites in the lower reaches of the Dnipro river is changing dramatically. It seemed that nothing could happen to underwater sites that have safely survived all previous wars, including two world wars. Turns out it could. On the morning of June 6, 2023, Rus-

sian troops blew up the Kakhovka hydroelectric power plant.

This operation, aiming to prevent a flanking strike by the Armed Forces of Ukraine (AFU), set off the largest hydrological disaster ever in the Southern Podniprovia. As a result of the dam explosion in the Kherson region, at least twenty-eight settlements with a population of around 38,000 people were flooded. It is known that at least fifty-two people and a vast number of animals died due to the flooding.

Kakhovka HPP is the lowest and southernmost of the eight Dnipro dams built between 1928 and 1980. The Dnipro dam cascade is the foundation of Ukraine's hydroelectric power system. The serious hydrological changes that followed the collapse of the dam affected a section of the river





Figure 4. Numerous missile strikes on the Dnipro dam have resulted in a forced water discharge, which previously flowed through the turbines. Photograph courtesy P. Petrenko

over 300 km long. By midsummer, the water level in the Dnipro upstream of the dam had fallen to its natural, pre-dam level. In the upper reaches of the river, it dropped by an average of six meters, while to the south the drop was sixteen meters. The Kakhovka reservoir, with an area of 482 thousand square kilometers, disappeared. Within a year, the area of the reservoir decreased by 91 percent and the volume of water by 96 percent. These dramatic events caused a whole complex of hydrological processes that have impacted hydrobiology, geology, and, of course, cultural heritage sites.

At the moment, the changes in the hydrological regime in this zone make it possible to trace two processes overlapping each other and intensifying in opposite directions. Undoubtedly, they will have their consequences both in the short and long term. On the one hand, we see extensive shallowing and drying of the previously flooded areas,

primarily the area of Kakhovka, and on the other hand, there is a sharp increase in the river flow below the Zaporizhzhia and, to a lesser extent, Kakhovka dams.

Both of these processes have significant implications for underwater archaeological heritage. The shallowing and draining of the vast area between Kakhovka and the southern suburbs of Zaporizhzhia has converted many archaeological sites from underwater to terrestrial ones. These include hundreds of settlements and burial sites from the Stone Age to the early twentieth century. It should be noted that most ancient sites have never been fully investigated. This would have required massive archaeological surveys, which, by the time of the construction of the hydropower plant, were not a priority for the Soviet authorities. Therefore, the systematic study of all these sites, now newly accessible, will have the potential to completely rewrite



Figure 5. Gold plaque from a Scythian *gorytos*, or bow case, 350–320 BC, excavated in Melitopol in southeastern Ukraine. The decoration represents scenes from the story of Achilles. Courtesy National Museum of the History of Ukraine

the ancient history of Ukraine. Among the most significant of these sites are six Zaporozhian Sichs or Cossack capitals of the sixteenth to eighteenth centuries, the headquarters of Mamai Khan, the city of Shahr-Al-Jedid, which existed from 1360 to 1374, and the capital of the Scythian Kingdom in the sixth to ninth centuries BC. Being underwater, all of them were in a state of natural conservation, but now their status will change.

We should mention that, even before the flooding, this vast territory was of great importance in the cultural memory of Ukraine. Until the middle of the twentieth century, the Great Meadow of Zaporizhzhia was located between the Dniipro and Konka rivers, an area abounding with forests, small channels, lakes, and islands. This is where the legendary Scythian Gilea of Herodotus was located, and this is where the Cossack historical phenomenon was born. All of this was destroyed

by the Soviets. The unexpected emergence of all these sites on the surface definitely opens up new prospects for the postwar period. After all, excavations on the surface are significantly easier than those underwater.

The fall of the river level did not lead to the emergence of a desert. Not at all. We are witnessing intensive restoration of ecological systems, which means there is an opportunity for detailed underwater survey. The last time these beds were so accessible was before the invention of scuba diving. Of course, theoretically, such research could have been done before, but standing water and siltation impeded it. In the early 2000s, the Department of Archaeology of National Reserve “Khortytsia” conducted a series of underwater expeditions in the areas of the Zaporizhian Sichs that were flooded in the twentieth century. The goal was to assess the scientific potential of these sites. As a result of





Figure 6. The washing away of sand causes the erosion and subsequent destruction of the wooden hulls of 18th-century ships. Photograph courtesy A. Hoopovka

this work, we discovered a large number of artifacts related to the daily life of the Zaporizhians and the Ukrainian population of these lands in the nineteenth century. As our research showed, the flooded beds of old rivers in general preserved their relief, but they were covered with a significant layer of silt, and water visibility barely reached one meter (and, in summertime, dropped to zero). Now everything has changed. The flowing water is quite clear, and the silt accumulations have started to be gradually washed away by floods. A gradual fading of *Dreissena* mussel colonies, which had grown due to warm standing water, is also expected. Their strata reached up to two meters in some places, and it was extremely difficult to conduct an archaeological investigation in such conditions.

The second process is associated with the strengthening of the Dnipro river flow, primarily in the ten-kilometer area below Zaporizhzhia and Kakhovka HPPs. This is related to uncontrolled water discharge, as the Kakhovka dam today is a natural waterfall on the dam debris. Zaporizhzhia dam, while still standing, is forced to release water after multiple missile attacks in 2023 and 2024. As of fall 2024, the forty-meter dam has withstood fourteen strikes by ballistic and cruise missiles. Most of them were directed at the two turbine compartments that generate electricity.

Before the war began, the current was not as strong. The water level of the Dnipro was significantly higher, and the interaction of the dam system allowed for the regulation of seasonal water inflow. Today the northern dam covers the water area of

Zaporizhzhia, where the river course bifurcates around Khortytsia, the largest island of the Dnipro. Uncontrolled water discharge has increased the speed of the water flow by a factor of ten. Peak values now occur in April–May, the time of snow-melt and precipitation in the upper reaches of the river. In 2024, the floodwater level downstream of the dam rose to almost the nominal values of prewar times. At the same time, the reservoir rose to 40 percent of its pre-bombing area. In early fall, by contrast, it drops, making many sections non-navigable. It is difficult to imagine what is happening on the bottom of the river in the Zaporizhzhia area now, but we can speculate. We may judge how significant the changes in the underwater relief downstream of the dam can be based on the floods of 1998. At that time, heavy floods forced the release of excess water directly through one of forty spillways of the dam. In normal operation all the water went into the turbine compartments. In the spring of 1998, in just a few hours, the water flow washed away a large part of Khortytsia's bank, about four thousand square meters.

The changes underwater were even more dramatic. To a large extent, they led to a significant increase in underwater archaeological research, which was primarily of a rescue nature. This work was carried out by archaeologists from the National Reserve "Khortytsia," as well as by our colleagues from Odesa, Kyiv, and Kharkiv. The coastal areas of Khortytsia along the western channel of the Dnipro increased their depth to eight meters. Huge masses of sand were shifted southward. These masses were able to carry large and heavy objects weighing more than three hundred kilograms, such as the oak rudder blade of a brigantine wreck. This happened due to the powerful turbulent flows occurring in places where the river passed through a narrow area and then sharply widened. In such areas, water flows began to move at a steep angle to the shore, quickly eroding its sandy strata. As a result, the hulls of ships of the

Dnipro flotilla of 1736–39 (from the Russo-Turkish War) were revealed under the shore. Some of them were raised. Shipwrecks including brigan-tines, galleys, prams, and Cossack boats had been found before, but not in such quantity or such good condition.

We know that in 1739 the main part of this flotilla was located along the shore of Khortytsia, and most of the ships were dragged to the shore, where they were abandoned after the war. Then the hulls were covered by sand and silt. From time to time, after floods, German colonists who settled on the island in the late eighteenth century stumbled upon them. Archaeological excavations of some of the ships and analysis of the stratigraphy indicate that all of them were destroyed during periods of high floods, when masses of sand exposed the wood. As a rule, the hulls of the ships have not been preserved in their entirety. The areas of damage point not only to natural erosion of the surface elements but also to fractures caused by the impact of water and sand. Often, the chronological layers are heavily mixed together. The solid structures were preserved as a result of the silt and sand that filled their voids. When the sediments were washed away in flooding events, the hulls began to deteriorate under the impact of the current. Wet wood retained its morphology but became softer. Fasteners, mostly nails, no longer held. Under their own weight combined with the impact of the waters, the wrecks disintegrated first into large fragments and then into smaller ones. Some of the parts floated and were carried away by the current. The stern of the brigantine of 1738 was found eight kilometers downstream.

The peculiarity of this exceptionally interesting ship complex is the wide use of pine wood, which is uncommon in southern Ukraine. Quite quickly covered with silt, it retained most of its physical properties for three hundred years. By contrast, the wood exposed above the ground became soft and loose, lost its shape, and acquired negative buoy-





Figure 7. Strong currents and shoreline collapse are causing the rapid destruction of shipwrecks. Photograph courtesy A. Holovko

ancy. We often observed a situation where opposite ends of the same piece, half covered by sediment, had completely different physical properties such as weight, density, buoyancy, color, and preservation state. This example from twenty-five years ago has direct relevance to what is happening today.

In 2024, the processes described above were several times stronger and, unlike the temporary flooding situation, they do not have a predictable end. Obviously, bottom erosion continued in spring 2024 with great intensity. With the end of the flood, by summer, they slowed down, but did not stop completely. Much of the wooden wreckage has drifted downstream, thereby increasing the extent of the wreck sites dramatically. In riverine conditions with a strong current there is a direct correlation between the mass and size of objects and the distance they drift, whether they are ship parts or

ships' contents. In such conditions the objects least likely to drift are iron objects such as cannonballs, small shot, buckles, buttons, chest straps, etc. The most frequently found material, the nails, cannot be an accurate marker as they often continue to fall out of ship parts as they drift.

One way or another, the spatial relationships of the known eighteenth-century complexes have changed. The hulls protruding from the ground, especially those in the turbulence zone, may be largely exposed, which accelerates their destruction or damage. At the same time, new objects, previously hidden in the sediments, emerge.

It should also be noted that the construction of the forty-meter-high hydroelectric power station at the beginning of the last century triggered another process—the gradual washout of sand below the dam and, consequently, its accumulation above it.





Figure 8. Many objects that were previously underwater have ended up in the “dry” zone, which poses a threat to their condition. Photograph courtesy D. Smolenko

Vast sand dunes no longer move downstream. As a result, the riverbed is steadily deepening in this zone. It is clearly visible if we compare modern indicators with the pilot charts of the eighteenth and nineteenth centuries. This means that heavy objects are shifted lower to the granite base of the channel, and lighter wooden ones are carried away. Downstream of Zaporizhzhia city, where the channel flows into the valley of the Great Meadow, the sand settles and the reverse process of its accumulation takes place. Similar phenomena, but of smaller scale, occur downstream of Kakhovka HPP.

In such conditions, the search for dugouts, usually submerged in the coastal zone of the old channel, becomes one of the promising directions of research. Now we can see the old riverbed! The vast Dnipro system must contain hundreds, if not thousands, of such boats. For thousands of years,

the local population used such boats throughout the large and intricate river system of the Dnipro. At the moment, such searches are severely complicated by the prohibition of underwater work and the proximity of the front line, but in the future they have great potential. By comparison, thirty-one boats have been raised in Ukraine, of which only six have been dated. According to some sources, certain examples—such as the dugout from Khotyanivka—may date back to the second millennium BC. In neighboring Poland at least 333 boats were known by 2010 and, of these, 154 have been dated.

The exposed coastal zone of the “old” Dnipro here and downstream should be of particular interest for underwater research as the concentration of finds there is significantly higher. Let me remind you once again that, by the time scuba and the



underwater archaeological boom appeared in the USSR in the late sixties, these banks had already been flooded and stabilized by the weakening of the current. I am absolutely sure that the number of identified underwater sites in this situation will increase severalfold. However, a considerable number of sites such as settlements, burial grounds, Cossack wintering grounds, etc. have again moved to the above-water position and, accordingly, have fallen out of the scope of underwater archaeology. Some of the Soviet-era vessels have also unexpectedly joined them.

Among the problems that will inevitably arise with the study of this territory after the war, and which are the direct consequence of it, we should note the following. Archaeological work will be significantly complicated by the mining of coastal areas. We should not forget that the front line along the Dnipro river stretched for 360 km. The left occupied bank is low, and mine barriers are not uncommon here. In addition to the coastal zone, there are also mines in the water, for example, in the area of Zaporizhzhia Nuclear Power Plant and in the Kherson region. Obviously, it will take years to demine these areas.

Another problem may be the ratio of underwater archaeologists to sites in Ukraine. In the prewar years, the Institute of Archaeology issued only a few permits for underwater work. The abundance of washed-out objects, as well as the economic crisis, will inevitably lead to a surge of systematic looting, which was hardly blocked before the war. One of the main reasons for this phenomenon is the chronic crisis in the relationship between the Institute of Archaeology, the Ministry of Culture, and regional inspections. Unfortunately, these structures are poorly coordinated with one another, which often only complicates the conduct of regular archaeological research and leads to conflicts even at the preparation stage. Therefore, bureaucratization, an unbalanced legal framework, and lack of money will be a serious concern for historic

preservation, in addition to the mines rusting in the ground. In the summer of 2023 the Institute of Archaeology undertook a reconnaissance expedition along the right bank of the Dnipro with the participation of the military. Its goal was to record known sites and to search for previously unknown ones.

### Other Regions

Some dams of steppe rivers in the southeast of Ukraine were damaged or destroyed during the three years of war. Of course, the changes are smaller in scale than on the Dnipro, but in general we can talk about the same trends and problems. In Soviet times, a cascade of small dams and ponds was constructed here, primarily for irrigation. Their destruction during the war was dictated by the operational and tactical goals of the warring parties. Steppe rivers have served and continue to serve as natural water obstacles for military equipment, so they are always included in fortification systems. For obvious reasons, their coastal zones were also mined. As on the Dnipro, the destruction of small reservoirs has led to the exposure of previously flooded sites, primarily Bronze Age settlements. A number of medieval and post-medieval sites, such as Cossack wintering grounds, have also appeared.

In the Black Sea, most of the sites are located on the coastal shelf, at depths varying from thirty to forty meters. Unfortunately, many sites, primarily shipwrecks, were damaged back in Soviet times. This is connected with trawl fishing. As a rule, the preservation of wrecks is much better in closed areas near military bases, for example, near Zmiinyi Island. Not much has changed for them during the war, except that access to them is complicated by the minefields, as well as military installations on the shore. In the last couple of years, thanks to the efforts of the Armed Forces of Ukraine, the number of wrecks has even slightly increased.

### Prospects for the Future

As we have seen, the military actions, and above all the destruction of Kakhovka HPP, have had the most serious consequences for the underwater cultural heritage of Ukraine. The biggest concern is for sites located in the Dnipro river and its tributaries in the south of the country. These consequences, however, have both negative and positive sides. On the one hand, if the status quo is preserved, we can see prospects opening up for underwater archaeology and the possibility of surveying iconic sites of national importance and the entire old Dnipro riverbed; on the other hand, such work is connected with considerable economic difficulties and seems unsafe for the moment.

The key question mark is the feasibility of restoring the Kakhovka dam and reservoir. Many experts find this feasibility doubtful. Before the war, the dam produced only 0.9 percent of the country's electricity. There are even more questions about the reservoir, which flooded vast territories that are significant for the historical memory of Ukraine. The area of the reservoir is 40 percent of the area of all Ukrainian reservoirs. It is very large and very shallow. According to the calculations made by specialists from the Institute of Botany of the National Academy of Sciences of Ukraine, the annual income from the Kakhovka Lake is no more than 15 percent of the potential ecosystem income of the Great Meadow. It is estimated that the production of a similar amount of electricity using solar panels would require an area equal to just 1 percent of the reservoir area.

Initially, the construction of the dam was supposed to solve such issues as navigation, irrigation, and electrification. Since 1984, the reservoir has also been used for cooling the units of Zaporizhzhia Nuclear Power Plant. With the use of modern technologies, all these issues can be solved without rebuilding the dam. The Dnipro's navigation channel runs within the old Dnipro riverbed. It was navigable before the reservoir appeared. Naturally,

its deepening will require investments as well as a comprehensive archaeological survey. Irrigation, including the North Crimean Canal, can be restored by creating a system of pumping stations. Water would no longer flow on its own, but it could be pumped into the canal, as has been done all along with the Bazavlug River. Its level was below the level of the reservoir, and the water was pumped all these years. The cooling problem of Zaporizhzhia NPP can be solved in the same way, especially since the Konka riverbed comes through the cooler basin. The irrigation system of the Podni-provia steppe zone, as well as of the steppe river valleys, has long been in need of modernization.

These solutions will allow us to preserve not only archaeological sites but also natural heritage. Moreover, the irrigation of fields is no longer within a framework of centralized "socialist construction" directed by the government. Now it is the task of agro-industrial enterprises and lessees capable of introducing innovative methods and applying the experience of, for example, Israeli specialists. Unfortunately, the current government has already announced a decision to rebuild the dam, which will take at least seven years and cost \$1.2 billion. This decision was taken without any expert assessment, which is highly suspicious. In addition, it does not take into account the rate of self-recovery of the Great Meadow, which will have to be destroyed anew. According to specialists at the Institute of Hydrobiology of the National Academy of Sciences of Ukraine, this work will take at least ten years.

In any case, to solve all these issues, we need to stop the aggression and win this war.