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The war threatens marine ecosystems:

the impact of the Russia's aggression on the Black Sea

The authors of the research:

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Dr. Viktor Komorin, Acting Director of the Ukrainian Scientific Center of Ecology of the Sea (UkrSCES), emphasizes the importance of assessing the complex and far-reaching impacts of the war on the Black Sea marine environment. He highlights that not only direct combat, but also pollution, underwater noise, and destruction of coastal infrastructure have critically affected marine biodiversity. His contribution ensures that environmental damage becomes an integral part of post-war assessment and accountability.

The research was conducted at the request of the Mission of the President in the Autonomous Republic of Crimea/Office of the Crimea Platform and the NGO CrimeaSOS.

This brochure provides an overview of the situation. The comprehensive research is available here:

Due to the armed aggression of the Russian Federation, which began with the occupation of the Crimean Peninsula in 2014, damage to Ukraine and other Black Sea riparian countries is caused as a result of the impact of military actions on coastal ecosystems, marine ecosystems, and maritime economy. Although Ukraine has been primarily affected, Russian military operations may have adversely impacted all the Black Sea countries and, indirectly, Mediterranean and Danube regions to some degree. This impact is clearly not restricted to a single specific event or effect but includes all consequences resulting from warfare activities including marine pollution, eutrophication, increased risk of infections, increased risk of bioinvasions of alien (non-indigenous) species, and other effects. Also, war activities not directly related to combat are to be considered, such as construction works (especially those producing underwater noise or altering the seascape) or changes in shipping routes[1].

The Black Sea is the easternmost marginal sea of the Mediterranean basin, ca. **436 000 km²** large and **2,210 m** maximum deep, situated between Europe and Asia and connected to the global ocean through the Bosphorus Strait (Figure 1). It also includes a small epicontinental Azov Sea, connected through the Kerch Strait. Its huge river catchment basin includes the Danube River system, and several other major European rivers and makes the sea highly productive and even eutrophied, especially in the waters of the vast continental shelf. The Black Sea is unique by its stratified water column with a deep anoxic layer, and thus its ecosystem is fragile and vulnerable to threats. Historically impacted by overfishing, industries, bioinvasions and water pollution from multiple sources, the Black Sea ecosystem went through a major biotic crisis in the late 20th century and recently showed some signs of recovery until having been exposed to an emerging military threat posed by Russia's war and war related activities.

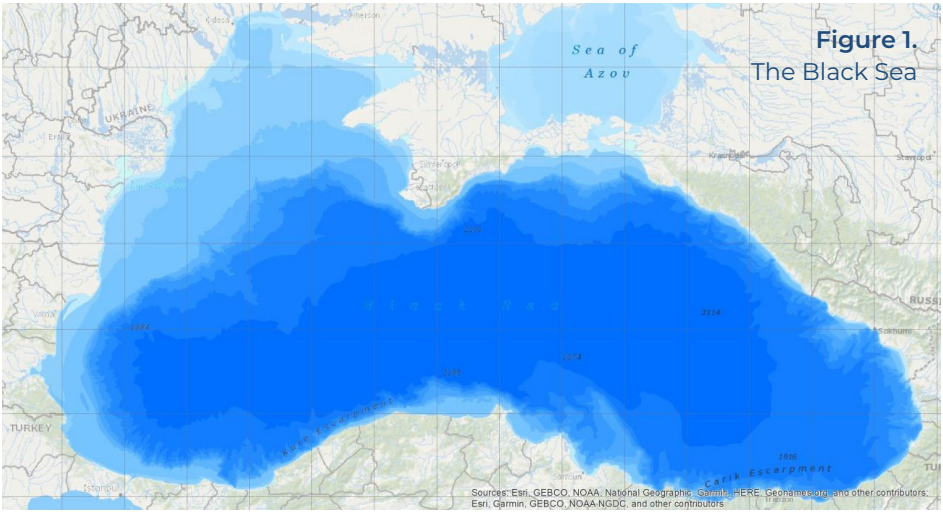


Figure 1.
The Black Sea

[1] **Recommendation 16.1 – Post-War Plan for the Black Sea Cetaceans.**
Report of the Sixteenth Meeting of the ACCOBAMS Scientific Committee
https://accobams.org/wp-content/uploads/2025/02/SC16.Doc27_Final-Report-of-the-SC16.pdf

The Russian aggression against Ukraine and further temporary occupation of parts of Ukrainian territory have created a transnational environmental crisis extending far beyond Ukraine's borders to affect the entire Black Sea region and waterways linking the Mediterranean and Danube basins and, indirectly, global ocean ecosystem and shipping routes. These impacts threaten globally recognized conservation areas, including habitats and migration corridors for the globally endangered and vulnerable species. Russia's war shows how regional warfare can trigger cascading ecological effects across international boundaries, compromising marine biodiversity, ecosystem services, and the environmental security of multiple nations through interconnected waterway systems. The observed incidents exemplify fragility of marginal sea ecosystems under war threat and the devastating effect of non-combat activities caused by war, such as habitat loss due to war-related construction and destruction.

Environmental impact of combat activities at sea and coastal areas

The direct impact of combat activities of Russia's navy, aviation and other troops on the Black Sea (Figure 2) was largely seen during the first years of Russia's full-scale invasion against Ukraine in 2022-2023 and first summarized by environmental researchers on site[2] who provided the primary evidence for the footprint of Russia's war. Moreover, after the occupation of Crimea in 2014, Russia began to militarize the peninsula and its shores to facilitate its full-scale invasion of mainland Ukraine in 2022.

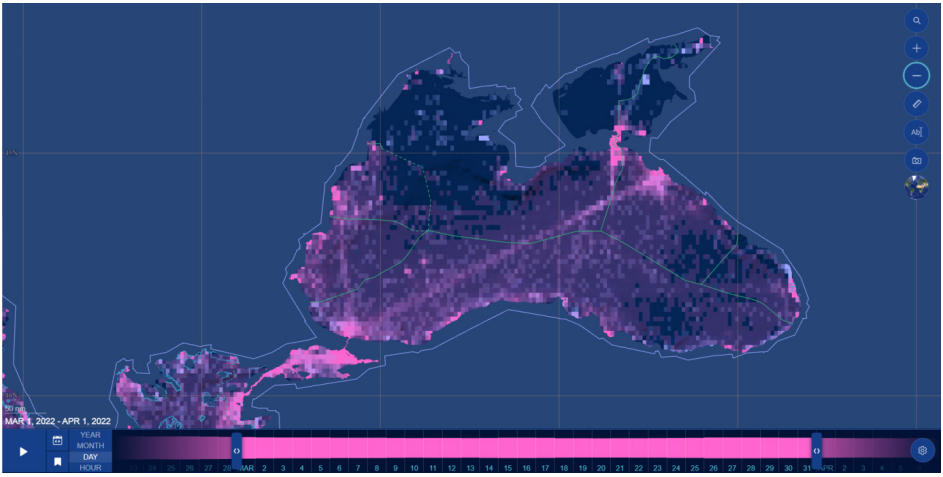


Figure 2.
Vessel activity in the Black Sea in March 2022, during the first month of Russia's full scale invasion. Coordinates of commercial (AIS bearing) vessels are shown in pink, while the Russian navy operations (radar detections without a corresponding AIS) dominating in the northern area are seen in light blue. Source: https://globalfishingwatch.org/

Impact on coastal territories is due to the following **activities**:

- Deployment and movement of military units and equipment in adjacent territories
- Construction of fortifications (anti-tank ditches, berms, bunkers, trenches, pits, etc.)
- Bombardment, shelling, explosions
- Mine placement
- Fires
- Placement and accumulation of waste (including remnants of military equipment), bodies of the deceased, bodies of dead animals, polluting and hazardous substances, ammunition
- Chemical and/or radiation contamination, including that arising from destruction and/or accidents at utilities, industrial, agricultural, and other facilities caused by military actions

Direct impact on marine ecosystems is due to the following **activities:**

- Maneuvering of military vessels
- Launching missiles from ships and submarines (discharge of fuel (gases), including failed missile launches that remained in the sea)
- Sinking of vessels as a result of military actions
- Sinking of ammunition with radioactive and/or chemically active components
- Contamination with debris from aircraft and missiles shot down over the sea surface
- Mining of water areas
- Gunfire, explosions
- Action of ship radars (particularly submarines)

Factors affecting the marine environment include but not limited to:

- Damage to individual marine organisms and destruction of marine habitats
- Spill of oil products and other toxic substances
- Spill of biogenic substances (including plant oil, sewage waters and grain) and following eutrophication
- Spill of radioactive substances
- Influx of marine debris
- Ambient underwater noise
- Impulse underwater and aerial noise
- Microbiological contamination from land
- Bioinvasions coming with ballast water

[2] Komorin V.M. (ed.). 2022. Analytical Report of the Working Subgroup on Generalization and Development of Methodology for Assessing Damage Caused to the Marine Environment and Determining Losses Inflicted on Ukraine as a Result of Armed Aggression by the Russian Federation. Odesa, Research Institution «Ukrainian Scientific Center of Ecology of the Sea».

Affected endangered and vulnerable marine species living or migrating in the area include, among others, the red algae (seaweed) *Phyllophora* spp., foxtail stonewort *(Lamprothamnium papulosum)*, sea grasses *(Zostera spp.)*, bottlenose dolphin *(Tursiops truncatus)*, harbour porpoise *(Phocoena phocoena)*, short-beaked common dolphin *(Delphinus delphis)*, horned grebe *(Podiceps auritus)*, yelkouan shearwater *(Puffinus yelkouan)*, pygmy cormorant (Phalacrocorax pygmeus), white pelican (Pelecanus onocrotalus), Dalmatian pelican *(Pelecanus crispus)*, red breasted goose *(Branta ruficollis)*, common eider *(Somateria mollissima)*, white tailed eagle *(Haliacetus albicilla)*, oystercatcher *(Haematopus ostralegus)*, sea plover *(Charadrius alexandrinus)*, great black headed gull *(Ichthyaetus ichthyaetus)*, little tern *(Sterna albifrons)*, beluga sturgeon (*Huso huso)*, diamond sturgeon *(Acipenser gueldenstaedtii)*, starry sturgeon *(Acipenser stellatus)*, Black Sea salmon *(Salmo trutta labrax)*, long-snouted seahorse *(Hippocampus guttulatus)*, Dnieper barbel *(Barbus borysthenicus)*, Danube shad *(Alosa immaculata)*, Caspian shad *(Alosa tanaica)*[3], etc. This list does not include coastal terrestrial biota, rich in endemic species. Especially concerning is the situation of the sea zander *(Sander marinus)*, which is suspected to go to full extinction after the Kakhovka Dam destruction (see below).

Several spectacular examples of war induced impact are briefly outlined below, as they were seen or suspected at the Black Sea.

Chemical pollution. There is a list of approximately 70 different chemical substances that are used in weapon composition. However, a complete list does not exist, as the composition of materials is unknown in many cases[4]. It is believed that conventional ammunition represents the main portion of dumped material and consists primarily of nitroaromatic explosive substances, such as TNT (2,4,6-trinitrotoluene) and DNT (2,4-dinitrotoluene), and explosive substances such as RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine).

[3] https://www.cbd.int/doc/c/50f9/bd6d/21c043b0408fd80e5d2bbb96/ebsa-ws-2017-01-04-en.pdf
[4] Beddington, J., Kinloch, A. J., Kinloch, A. J., & Eng, F. R. (2005). Munitions dumped at sea: a literature review. Imperial College Consultants Ltd. London, UK.
[5] https://www.oryxspioenkop.com/2022/03/list-of-naval-losses-during-2022.html

Marine debris. War specific marine debris includes ship and aircraft wrecks, ammunition and mines. Multiple incidents of naval losses have been reported since 2022[5], and most of the targeted vessels remain on the seafloor. Wrecks are the sources of multiple persistent contaminants including fuel (especially, highly toxic missile fuel and radioactive fuel for nuclear power engines or nuclear weapons), conventional ammunition, details of mechanisms, etc. It can be only suggested which compounds the war related Black Sea wrecks contain. Ammunition itself is toxic, as it consists of metals, mainly copper, iron, nickel, tungsten, tin, lead, aluminum and zinc, and also contains oxides, plasticizers and stabilizers, such as nitrates, saltpeter, nitroglycerin and nitrocellulose. Especially concerning are the items located at the continental shelf which is the entire north-western Black Sea.

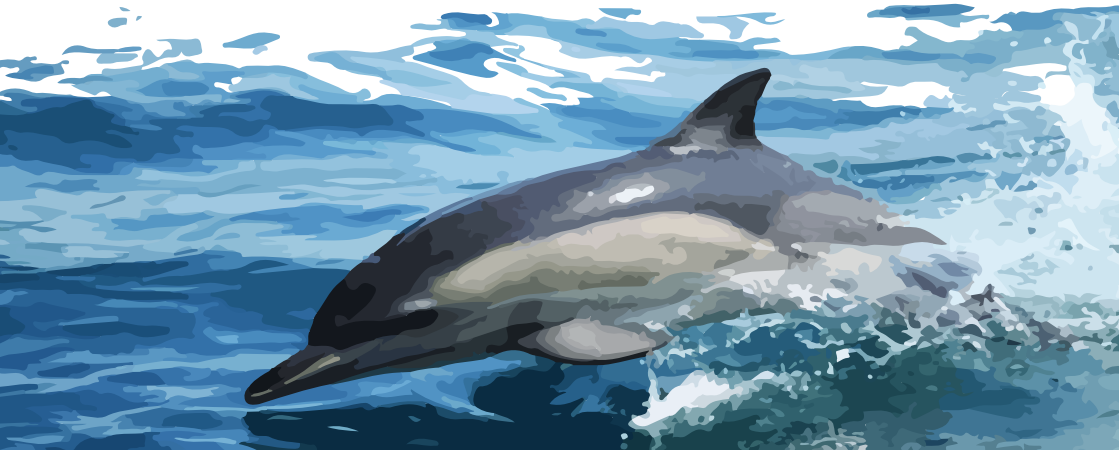
Sea mines. Both bottom and moored sea mines represent a unique and persistent form of marine debris with significant environmental implications. Moreover, moored mines tend to lose their anchors and drift with the current for a while, creating mobile underwater hazards. These weapons constitute dangerous long-term marine debris because they contain high explosives, primarily TNT and other nitroaromatic compounds, along with heavy metals including copper, iron, lead, and zinc. Unlike conventional marine debris, sea mines present both immediate physical hazards and chronic chemical contamination risks. Their metal casings corrode over time, releasing toxic substances into marine ecosystems while the explosive charges remain potentially active for decades. Blowing up sea mines is deadly for marine mammals, as underwater shock waves can kill or injure marine life. These explosions cause mortality and health deterioration in marine mammals, fish, and other sea life, while also destroying seafloor habitats. Legacy sea mines may be probably the greatest threat for marine life in the long run.

The mass mining of the western part of the Black Sea with naval mines was likely done by the Russian Navy in mid-March 2022[6]. Subsequently, the mining of Ukrainian waters by the Russian army occurred remotely, using aviation means. The total number of installed mines likely amounts to no less than a thousand, and their fate today is not tracked. However, it is known that at least one hundred mines have been neutralized, which were washed ashore by waves on the coasts of Ukraine, Romania, Bulgaria, Turkey, and Russia – eastward to Sochi, as well as cases of mines colliding with ships, particularly in the Bosphorus area.

[6] https://defence-ua.com/minds_and_ideas/morski_mini_rashistiv_vid_odesi_do_stambula_zahid_maje_vidkriti_more_dlja_ukrajini-6520.html

Noise Pollution. Marine explosions and sonar operations during active periods of war can interfere with the daily life of many aquatic species. The acoustic frequencies used by dolphins and whales overlap with frequencies used by naval sonars of vessels (including submarines), which can cause hemorrhaging in the inner ear and cause the animal to strand on shore. In addition, naval ordnance (for example, depth charges, torpedoes) create significant underwater explosions that can cause excessive pressure and shrapnel injuries to invertebrates, fish, birds, and marine mammals in close proximity to the explosion site. There may also be impacts on marine biota from some surface explosions – particularly missile launches from naval and aircraft vessels over the sea, as well as from aircraft engine noise at low altitudes. Aquatic organisms are particularly sensitive to the effects of explosions. For example, bony fishes have gas-filled swim bladders that easily rupture under the influence of large pressure differentials. Marine mammals are expected to also suffer from high mortality rates during powerful explosions.

Impact on Cetaceans. Combat operations of the Russian navy and aviation in 2022 (including ship-based missile launches) took place particularly in waters important for marine mammal conservation: in the Danube region, Karkinit Bay, Balaklava, and the Sea of Azov. An event of increased cetacean mortality in the Black Sea, which encompassed the entire western half of the sea, occurred in 2022 and coincided with the full-scale invasion – the armed aggression of the Russian Federation against Ukraine, which drew the attention of the public and researchers. Documented – information and illustrative materials were collected on **914 cases** of cetacean deaths on Black Sea shores, including **125 cases** on Ukraine's Black Sea coast and **118 cases** of cetacean strandings on Ukraine's Black Sea coast between February 24 and December 31, 2022 but mostly before October 2022 (Figure 3). Overall, the increase in mortality more than doubled (2.2 times) exceeding the average annual level in 2019-2021, though it was lower than in 2017 – the year of mass mortality. In species composition, **59%** consisted of harbor porpoise *Phocoena phocoena relicta*, **26%** – common dolphin *Delphinus delphis ponticus*, **10%** – bottlenose dolphin *Tursiops truncatus ponticus*, the remainder – species unknown. This differs from previous years by the high proportion of *Delphinus delphis ponticus* strandings.



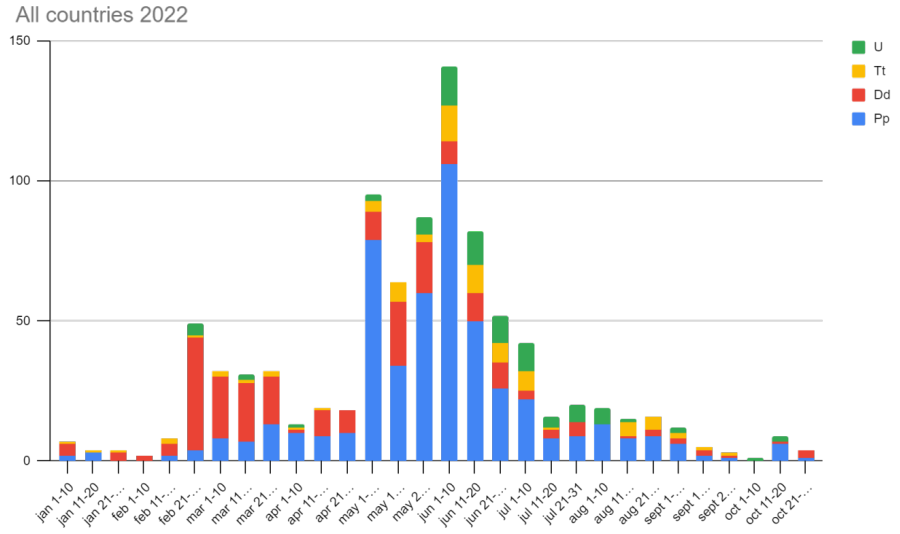


Figure 3.
Cetacean strandings at the Black Sea coast in 2022 (source: Vishnyakova et al, 2023[7]).

Meanwhile, direct and indirect consequences of other war-related activities, even if not a combat in the narrower sense or located far from the sea, had an even more devastating effect on the marine environment. Here we count three most important episodes: the Kakhovka Dam destruction by the Russian army (weaponizing the water-related disaster) in 2023, the oil spill in the Kerch Strait (irresponsible behaviour of the occupiers and the Russian shadow fleet) in 2024 and the construction of the bridge across the Kerch Strait (destruction of a biologically important habitat) in 2016-2017.

[7] Vishnyakova, K., Tonay, A., Popov, D., Meshkova, G., Paiu, M., Danyer, I., ... & Goldin, P. (2023). An unusually high number of cetacean strandings in the Black Sea, 2022-is it the consequence of war?. In 34th European Cetacean Society Conference: Abstract book (p. 256).

Consequences of the Kakhovka Dam Destruction for the Black Sea Ecosystem [8]

The explosion of the Kakhovka Hydropower Plant Dam by the Russian army on June 6, 2023, became an act which is sometimes designated as ecocide[9] that primarily affected the ecosystems of the lower Dnipro, Kakhovka Reservoir, and coastal plains[10]. To this day, Russia continues to shell industrial facilities located in the settlements around the former Kakhovka Dam. The constant shelling causes serious environmental challenges. At the same time, the Kakhovka HPP explosion had critical consequences for marine ecosystems as well, particularly causing a decrease in water salinity and restructuring of phytoplankton and zooplankton composition due to an increase in freshwater species. Blooming in Odesa Bay, caused by cyanobacteria, became significant, especially after the intensive water inflow from the Dnipro-Bug Estuary.

In autumn, the bay ecosystem was stabilized, with conditions returning to average multi-year indicators. A significant increase in chlorophyll-a concentration was recorded in Odesa Bay after the Kakhovka HPP dam explosion, but later the chlorophyll-a concentration decreased to levels typical for this period in previous years.

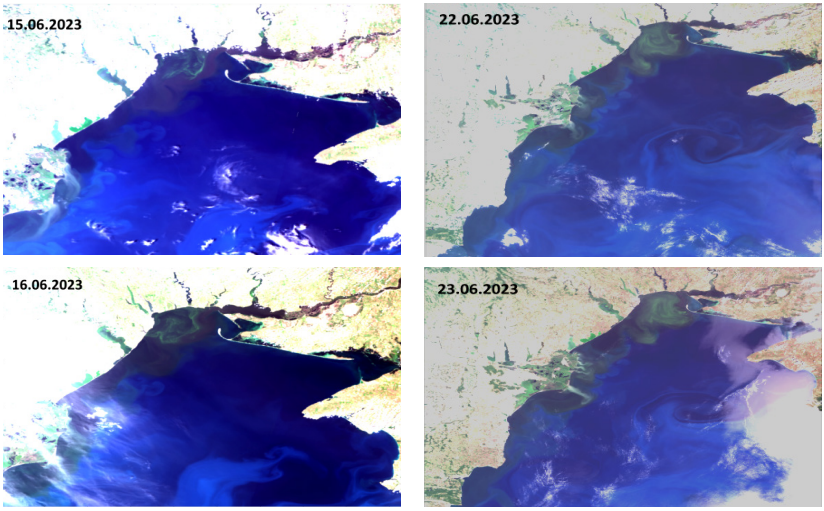


Figure 4.
The north-western Black Sea following the Kakhovka HPP Dam explosion and showing an algal bloom (Copernicus Open Access Hub, Sentinel-3[11])

[8] Primary source: Komorin V. 2023. Operational report of UkrNTSEM regarding the emergency situation that developed after the explosion of the Kakhovka HPP dam as of 17.10.2023. Odesa, Research Institution "Ukrainian Scientific Center of Ecology of the Sea"
[9] Tsymbalyuk, D. (2025). Ecocide in Ukraine: The Environmental Cost of Russia's War. John Wiley & Sons.
[10] Vyshnevskyi, V., Shevchuk, S., Komorin, V., Oleynik, Y., & Gleick, P. (2023). The destruction of the Kakhovka dam and its consequences. Water international, 48(5), 631-647.
[11] https://scihub.copernicus.eu/

Significant pollution levels were identified in seawater samples and biological objects (fish, mollusks, dolphins) in Odesa Bay, including toxic substances of industrial origin (naphthalene, phenanthrene, anthracene), agricultural toxicants (beta_HCH, Heptachlor), and heavy metals (copper, zinc, chromium, nickel). The levels of many toxic substances in fish (mullet) significantly exceed maximum permissible concentrations according to EU standards, making their consumption potentially dangerous for human health. Mollusks, in turn, were found to be particularly contaminated with toxic metals, with MPC exceedances from 3.8 to 19,280 times. Tissues from a dead porpoise also showed significant concentrations of copper and zinc.

Among the existing threats and current and potential risks from the consequences of the Kakhovka dam explosion that may affect marine ecosystems, the following can be identified:

Radiation threat. The main source of threat is the Zaporizhzhia Nuclear Power Plant, all power units of which are currently in a cold shutdown state. Various types of incidents with different consequences are not unlikely, which may primarily have psychological and informational effects. In case of an incident, the lower Dnipro, its estuary and adjoining sea are under serious threat of contamination.

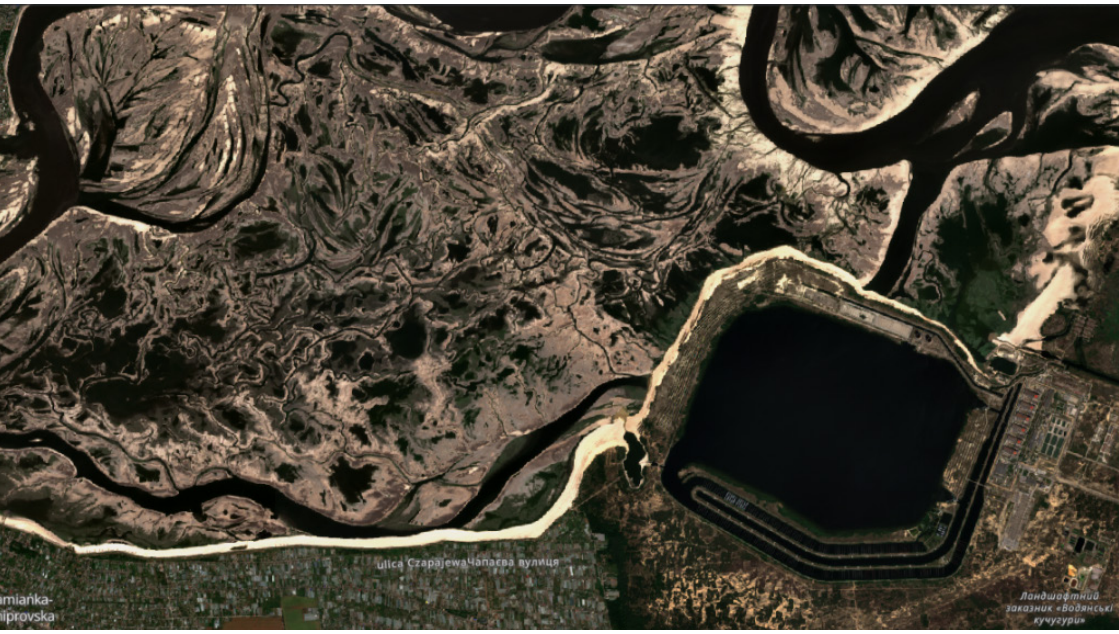


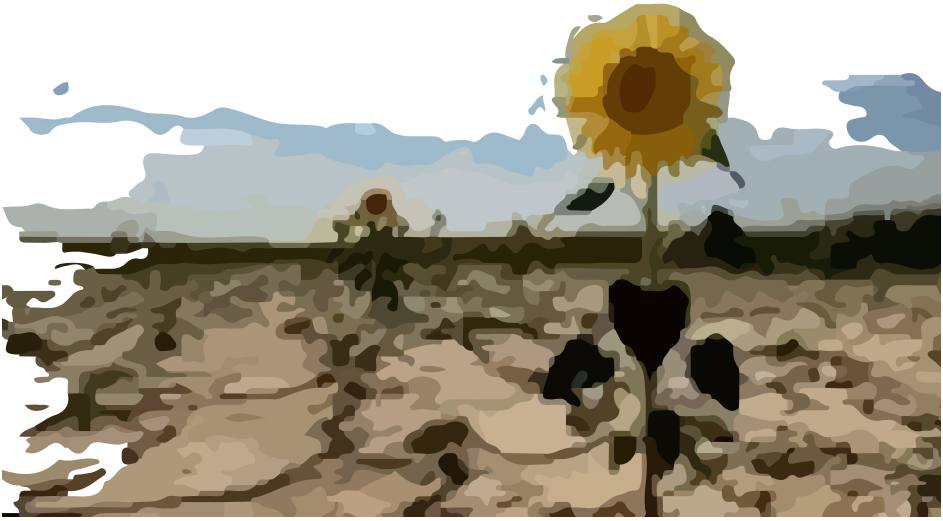
Figure 5.
The Zaporizhzhia Nuclear Power Plant soon after the Kakhovka HPP Dam explosion, June 20, 2023, exposed to the threat of water shortage Source: Copernicus Open Access Hub, Sentinel-2.

Mine threat. Dense mining by Russians of the line of contact as of the end of 2022/2023, particularly the left bank of the Dnipro, the Vasylivka area, Kamianske and territories east of it, led to the formation of an extremely large minefield, the demining of which is a long (up to one hundred years), expensive and economically unprofitable process.

Chemical pollution. This particularly concerns contamination with explosive substances, products of their combustion and decomposition, and metals from ammunition. This zone is probably also concentrated along the line of contact as of the end of 2022/2023, and it is poorly suited either for economic activities or for flooding. Another source of chemical pollution is the Titan plant, other factories and associated storage ponds[12]. In 2018, a man-made disaster occurred as a result of incorrect exploitation at the Crimean Titan plant (the city of Armiansk in the occupied Crimea). This led to chemical emissions of an unknown toxic substance. The occupation administration wanted to hide the consequences of the disaster.

Bioinvasions. Transformations of natural biotopes under conditions of long-term climate change lead to an increase and spread of invasive species, which due to biological characteristics will have advantages over native and primarily relict species. These processes are already being observed in aquatic ecosystems.

Desertification. A natural process due to regional long-term climate changes. Primarily threatens the Syvash region, as well as the lower Dnipro area.



[12] Other effects, such as the "toxic time-bomb": Shumilova, O., Sukhodolov, A., Osadcha, N., Oreshchenko, A., Constantinescu, G., Afanasyev, S., ... & Grossart, H. P. (2025). Environmental effects of the Kakhovka Dam destruction by warfare in Ukraine. Science, 387(6739), 1181-1186.

Oil spill in the Kerch Strait on December 15, 2024: The Scale of Environmental Disaster[13]

The tanker accident in the Kerch Strait is a recent example of the catastrophic consequences of the irresponsible occupation policy of the Russian government. As a result of the accident involving Russian tankers **«Volgoneft-212»** and **«Volgoneft-239»**, which occurred south of the Kerch Strait on December 15, 2024, a significant amount of heavy fuel oil (**Heavy fuel oil, HFO**), similar to mazut, entered the Black Sea and Kerch Strait. This led to pollution of the Black Sea waters and created a threat to marine ecosystems, coastal territories, and biodiversity. The scale of the oil product spill remains unassessed due to the absence of objective independent evaluation, but even conservative preliminary estimates (at least **4,000 tons**) indicate that this is the largest oil product spill in the history of the Black Sea region. Parts of both vessels still remain in Black Sea waters and continue to pose a threat of leakage.

A similar previous event already occurred on **November 11-12, 2007**, when four Russian vessels – «Volnogorsk», «Kovel», «Nakhichevan» and «Volganeft-139» – ignored navigation safety warnings, went to sea and suffered disaster in the Kerch Strait. Then, as a result of the tanker **«Volganeft-139»** accident, approximately **2,000 tons of oil products** entered the marine environment, causing large-scale environmental damage.

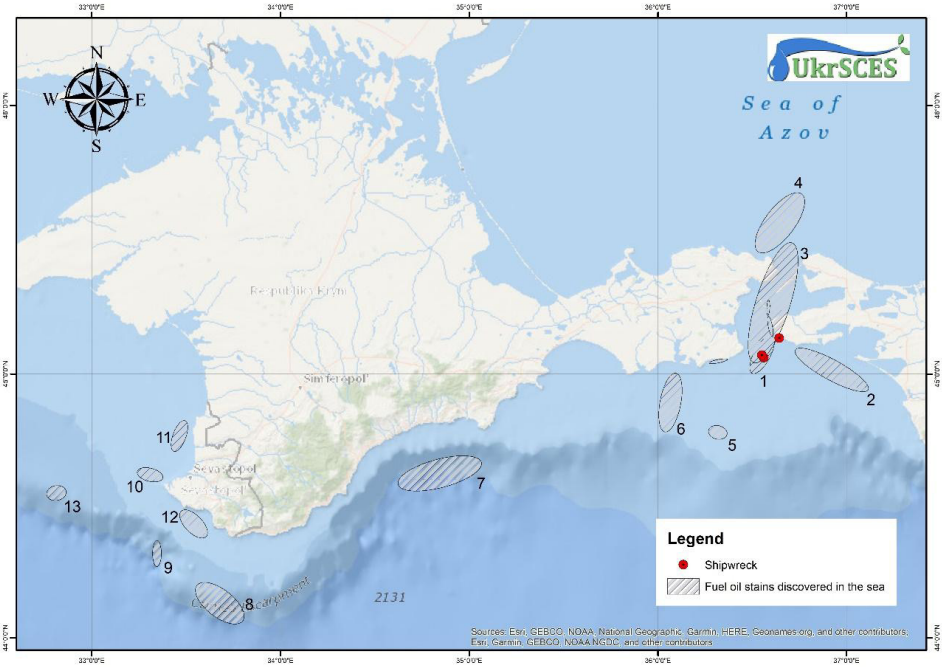


Figure 6.
Distribution of oil spill signs at sea after the satellite imagery data between December 15, 2024, and January 31, 2025

Results of satellite monitoring and mathematical modeling confirmed the connection between Crimean coastal pollution and the tanker accident in the Kerch Strait. There is a hypothesis that mazut could have entered the main Black Sea current and been transported thousands of kilometers along the entire Black Sea, posing a threat to all Black Sea countries. Detected clumps of mazut on the coast of the Odesa region, 400 km from the accident site, confirm the scale of pollution and the need for long-term environmental monitoring. The main environmental risks are seawater pollution, sedimentation of heavy oil product fractions on the seabed, toxic impact on marine biota, including birds, fish, and marine mammals, as well as threats to coastal protected areas.

[13] Komorin V.M., Lepyoshkin O.V., Tityapkin A.S., Dikhanov Yu.M. 2025. Scale and consequences of ecological catastrophe: tanker accident in the Kerch Strait on December 15, 2024. Odesa, Research Institution "Ukrainian Scientific Center of Ecology of the Sea"

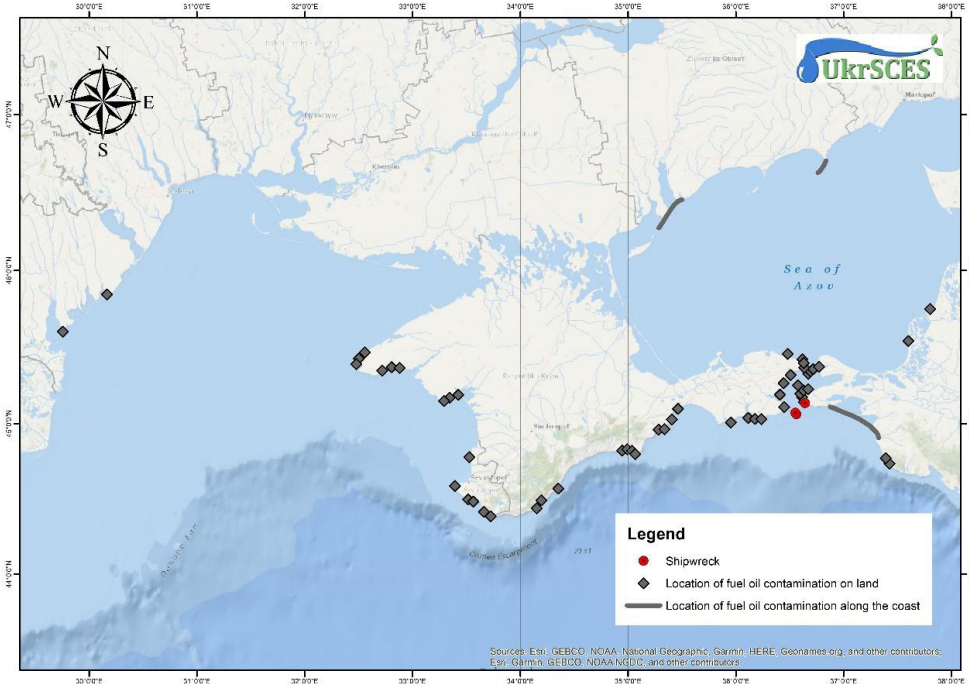


Figure 7.
Distribution of oil spill records ashore

There is an obvious lack of proper international coordination in responding to this disaster. Unlike the similar accident in 2007, the Russian Federation did not provide official information about the incident in accordance with the requirements of the Bucharest Convention. This significantly complicated the assessment of pollution scale and implementation of effective response measures. The 2024 catastrophe could have been prevented by drawing conclusions from the 2007 accident and removing outdated river tankers from being used at sea (in 2007, a similar accident with a fuel oil spill occurred). Today, Russia uses the same outdated tankers in the Baltic Sea to transport oil to circumvent sanctions. This so-called shadow fleet, which helps to wage the war against Ukraine, could cause an equally large-scale incident in the seas that surround the European continent[14].

[14] About the environmental disaster in Crimea caused by the spill of fuel oil from old Russian tankers https://www.greenpeace.org/ukraine/en/news/3230/about-the-environmental-disaster-in-crimea/

Environmental Impact of the Kerch Bridge[15]

The so-called Kerch Bridge was illegally constructed by the occupiers in 2018, to facilitate movement of Russian military equipment and soldiers. The main adverse environmental effects of the bridge construction across the Kerch Strait include:

Disruption of natural environmental state. Removal, displacement and disposal of bottom soils (dredging for vessels involved; construction of coastal reinforcement structures; arrangement of trenches for water outlets); erosion of sea floor from the operation of vessel propellers and destruction of the seabed by crane anchors; pile driving; construction of dams on the Taman and Kerch peninsula sides and thus disrupting the strait integrity as a water pathway and migration route for marine life. Installation of numerous piles at the intersection of the Kerch Strait reduces the cross-sectional area of the current for water exchange between the Azov and Black Seas.

Figure 8.
The bridge across the Kerch Strait and floating constructions near it block the major migration corridor for marine life. Source: Copernicus Open Access Hub, Sentinel-2

Physical pollution. Light and noise effects of construction work and intensification of shipping (floating cranes, barges, construction service vessels) and the transport movement by the bridge.

Chemical pollution. Toxic pollutants from floating vessels and other mobile equipment involved in construction.

[15] Primary source: Komorin, M. Pavlenko (2021) Information on the impact of construction and operation of the transport crossing through the Kerch Strait on the natural environment. Odesa, Research Institution "Ukrainian Scientific Center of Ecology of the Sea". 10 p.

Adverse Changes in Marine Ecosystem

- Destruction and silting of bottom habitats of benthic organisms and fish spawning grounds;
- Complete or partial death of benthos organisms in the work area (dredging, support installation) and in the dredged soil dumping area;
- Increased water turbidity and reduced transparency;
- Death of zooplankton due to clogging of gills and filtering apparatus by suspension raised from the sea floor;
- Reduction of fish food base and fish stocks;
- Contamination with toxic substances;
- Increasing eutrophication;
- Stress for marine vertebrates due to noise and light pollution;
- Changes in water currents that leads to erosion of the eastern and western shores of Tuzla Island;
- Bridge support piles installed in the strait will become centers of bottom sediment accumulation and a factor in intensifying the silting of the Kerch Strait, which will lead to increased dredging, which is one of the main factors of negative impact on the marine environment of the Kerch Strait. In winter, the piles will also become centers of ice formation and ice field formation from the Azov Sea side.

The adverse impact is more devastating for the area because the Kerch Strait and adjoining sea and lagoon areas is an Ecologically and Biologically Significant Area (EBSA) recognized by the Convention on Biological Diversity, and also an Important Marine Mammal Area recognized by the IUCN. Moreover, the Azov Sea, for which it serves as a single marine biogeographical corridor, also contains several habitats and species or populations designated as threatened at the worldwide level. Among them, there is a declining population of the Black Sea harbour porpoise (Phocoena phocoena relicta), one of the smallest whales in the world.

State Responsibility. The Russian Federation bears full responsibility for each incident as an occupier country. Additionally, in the case of the oil spill in the Kerch Strait, it is important to recall that the cleanup of the 2007 accident consequences was carried out in a coordinated manner, involving all available resources of all involved countries. Black Sea region states – parties to the Bucharest Convention on Protection of the Black Sea Against Pollution – were properly informed about the event, allowing prompt organization of monitoring measures, ensuring access to environmental data, and coordinating actions at the international level. Information about pollution scale, forecast results, and environmental monitoring data were open to all interested parties. Thus, the Russian Federation government was fully aware of the proper course of action in such a situation and had relevant experience. However, now the Russian Federation has not provided official information about the event in accordance with Bucharest Convention requirements.

The absence of timely notification makes operational response at the regional level impossible and endangers coordination of pollution response actions. Data on the accident scale, its environmental consequences, and forecast model results are being concealed, which contradicts international standards of environmental information openness and principles of cooperation in marine environment protection.

International Legal Framework for Assessment

From an international law perspective, the environmental damage described here engages multiple overlapping legal frameworks. The applicable regulations include:

International Humanitarian Law (IHL) The primary framework is Additional Protocol I to the Geneva Conventions (1977), which contains specific environmental protection provisions. Articles 35(3) and 55 prohibit methods and means of warfare that cause widespread, long-term, and severe environmental damage. The Geneva Conventions extensively define the basic rights of wartime prisoners, civilians, and military personnel; establish protections for the wounded and sick, and their Additional Protocols extend protection to the natural environment during armed conflict.

United Nations Convention on the Law of the Sea (UNCLOS) Part XII of UNCLOS addresses the protection and preservation of the marine environment. Article 192 of UNCLOS provides for the general obligation for States to protect and preserve the marine environment. This creates binding obligations for all coastal states, including those not directly involved in the conflict but affected by transboundary pollution.

Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) is technically applicable for the cases when the environment is modified in a hostile way, which is apparently the case for the Kakhovka Dam destruction and, possibly, the construction of the Kerch Bridge in the Kerch Strait, which is used to transport Russian military equipment and soldiers for the military operations against Ukraine. According to the Article 5, the Security Council may initiate an investigation on its violations.

Other regulations applicable to some of the incidents mentioned here include the **San Remo Manual on International Law Applicable to Armed Conflicts at Sea, International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78),** and the **Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention),** as well as agreements protecting certain species of groups of biota.

Measures to be taken

From the perspective of environmental scientists and researchers, two main pillars for recommended activities include **Assessment** and **Action (Response)**.

Assessing Impact on Marine Ecosystems

Obviously, the impacts of military actions on marine ecosystems are multifactorial, diverse, and they differ significantly in significance, strength, and duration, interaction with seasonal, interannual, and other cyclical natural processes, as well as stochastic effects. Following the IHL, it is important to assess if the damage is widespread, long-term and severe. Also, additional principles of short-term assessment priority determination may be suggested:

uniqueness: unique objects and events include:

- degradation, damage, size reduction and reduction in biological and landscape (habitat) diversity of unique (especially valuable, globally and regionally important) natural ecosystems, previously identified by internationally recognized expert assessments: these include, for example, biosphere reserves, Emerald Network territories, Important Bird and Biodiversity Areas, Important Marine Mammal Areas, etc.;
- disappearance of endemic, narrow-range, threatened, vulnerable species and populations (as defined by IUCN and international conventions);
- appearance of new (including in this region) diseases and causes of death (trauma, etc.), and invasive species;
- appearance of new (including in this region) toxins, pollutants;
- appearance of new (including in this region) sources and phenomena of underwater noise;

lethality: can be assessed from the perspective of probability of death (mortality), mass impact, and duration of influence; assessment priorities include:

- highly lethal toxins, oil spills;
- persistent pollutants;
- radioactive substances;
- especially dangerous infections and other diseases, trauma;
- powerful underwater noise, explosions, submarine radars;
- destruction of ecosystems, populations.

An assessment may include the development of an open-access platform that brings together data from satellite imagery, research vessels, biodiversity surveys, environmental monitoring, and citizen science.

Such a platform will integrate these inputs into an interoperable system fully aligned with EOSC standards and will contribute to the European Open Science Cloud and related infrastructures (e.g., EMODnet, SeaDataNet). Such an initiative will directly support the protection of biodiversity, restoration of ecosystem services, and the formulation of sustainable marine policies — not only in Ukraine, but also as a model for other post-conflict marine regions.

Some populations may need specific ways of assessment. For example, for cetaceans, the following recommendations were provided by the Scientific Committee of the ACCOBAMS Agreement[16]:

1. Comprehensive monitoring of underwater noise, chemical pollution, marine debris and biological indicators of stress in animals, as well as postmortem studies, studies of pathology, lifespan and population structure, are necessary for understanding and managing the war impact and other anthropogenic impacts (construction, seismic surveys), until it is secured that the post-war impacts have been decreased to pre-war levels.

2. Collecting and long-term archiving of organ and tissue samples for the purposes of multiple screening and identification of causes of death, including but not limited to identification of contaminants, pathogens, ingestion of or entanglement in marine debris, evidence of acoustic trauma or blast injury, brain damage, and indicators of individual stress. **Building and enhancing the capacity of the Parties, including national stranding networks and tissue banks, will contribute to this effort.**

3. Assessment of the losses, damage, and potential need for restoration of species, populations, and habitats. Development and application of existing remote sensing methods for assessing marine and coastal environments (including detection of sea mines and ammunition, other objects which can threaten the cetaceans and their prey at the sea floor). Enhancing new technology, including screening techniques for identification of contaminants, pathogens and alien (non-indigenous) species introduced by war related activities.

4. Assessing the impacts on distribution and abundance of prey for cetaceans is necessary.

5. Assessing the increase of bycatch risk and related bycatch mitigation measures in light of shifts in prey distribution and other stress factors affecting animal health.

[16] Recommendation 16.1 – Post-War Plan for the Black Sea Cetaceans. Report of the Sixteenth Meeting of the ACCOBAMS Scientific Committee https://accobams.org/wp-content/uploads/2025/02/SC16.Doc27_Final-Report-of-the-SC16.pdf

Key conclusions

Russian occupation of the Crimean Peninsula has led to systemic human rights violations, the destruction of the region's economy, and the displacement of the indigenous peoples of Ukraine who lived there. Russia's presence in the Black Sea has caused massive human rights violations, military, food and environmental damage. The use of the Crimean Peninsula by the Russian Federation as a military base poses a threat not only to Ukraine but also to other countries.

The consequences of the environmental catastrophe caused by Russia's armed aggression against Ukraine are long-lasting. Restoration of ecosystems requires international cooperation. Only the liberation of the Crimean Peninsula from the Russian occupation will help restore environmental safety and take action to eliminate the negative consequences of the occupation.

An effective response requires:

- Integration of scientific research.
- Strengthening of environmental monitoring of the marine environment, coordination of efforts between authorities, proper management of pollutants, and international support.
- Effective organization of work on the elimination of pollution consequences.
- Monitoring and assessing the impact of pollution on public health and the state of the environment in accordance with the OneHealth principles.
- Creation of new Marine Protected Areas.
- Development of comprehensive mine clearance mechanisms using existing mine clearance initiatives in the North and Baltic Seas[17].
- Strengthening the international sanctions policy against the Russian Federation.

[17] Recommendation 16.1 – Post-War Plan for the Black Sea Cetaceans. Report of the Sixteenth Meeting of the ACCOBAMS Scientific Committee https://accobams.org/wp-content/uploads/2025/02/SC16.Doc27_Final-Report-of-the-SC16.pdf

The Mission of the President of Ukraine in the Autonomous Republic of Crimea (the Mission) was established to facilitate the exercise of the President's powers in the Autonomous Republic of Crimea. After the beginning of the temporary occupation of Crimea by the Russian Federation in February 2014, the Mission started operating from Kherson. In 2019, the Mission opened an additional office in Kyiv to improve interaction and coordination with central executive bodies. The Mission is tasked with maintaining and ensuring political, social, informational, cultural and other ties with Ukrainian citizens living in the temporarily occupied territories; monitoring the observance of their rights and legitimate interests; studying socio-economic and political processes in the temporarily occupied Crimea; preparing relevant analytical materials and submitting them to the President for consideration, etc.

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In 2021, **the Office of the Crimea Platform** was established within the Mission to ensure Ukraine's effective implementation of its commitments under the Crimea Platform.

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CrimeaSOS is a Ukrainian non-governmental organization established in 2014. It was formed as a direct protest against Russia's occupation of Crimea. The NGO is dedicated to promoting human rights and developing social initiatives to support internally displaced persons and other individuals who have suffered due to the ongoing conflict.

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