Особливості формування рослинного покриву на місці колишнього Каховського водосховища

Мойсієнко І.[5,6,2], Куземко А.[1,2], Прилуцький О.[3], Коломицев Г.[4,2], Дідух Я.[1], Борсукевич Л.[7], Чусова О.[1,2], Скобель Н.О.[5,9], Сплодитель А.[8], Ходосовцев О.[5, 6, 1, 2]

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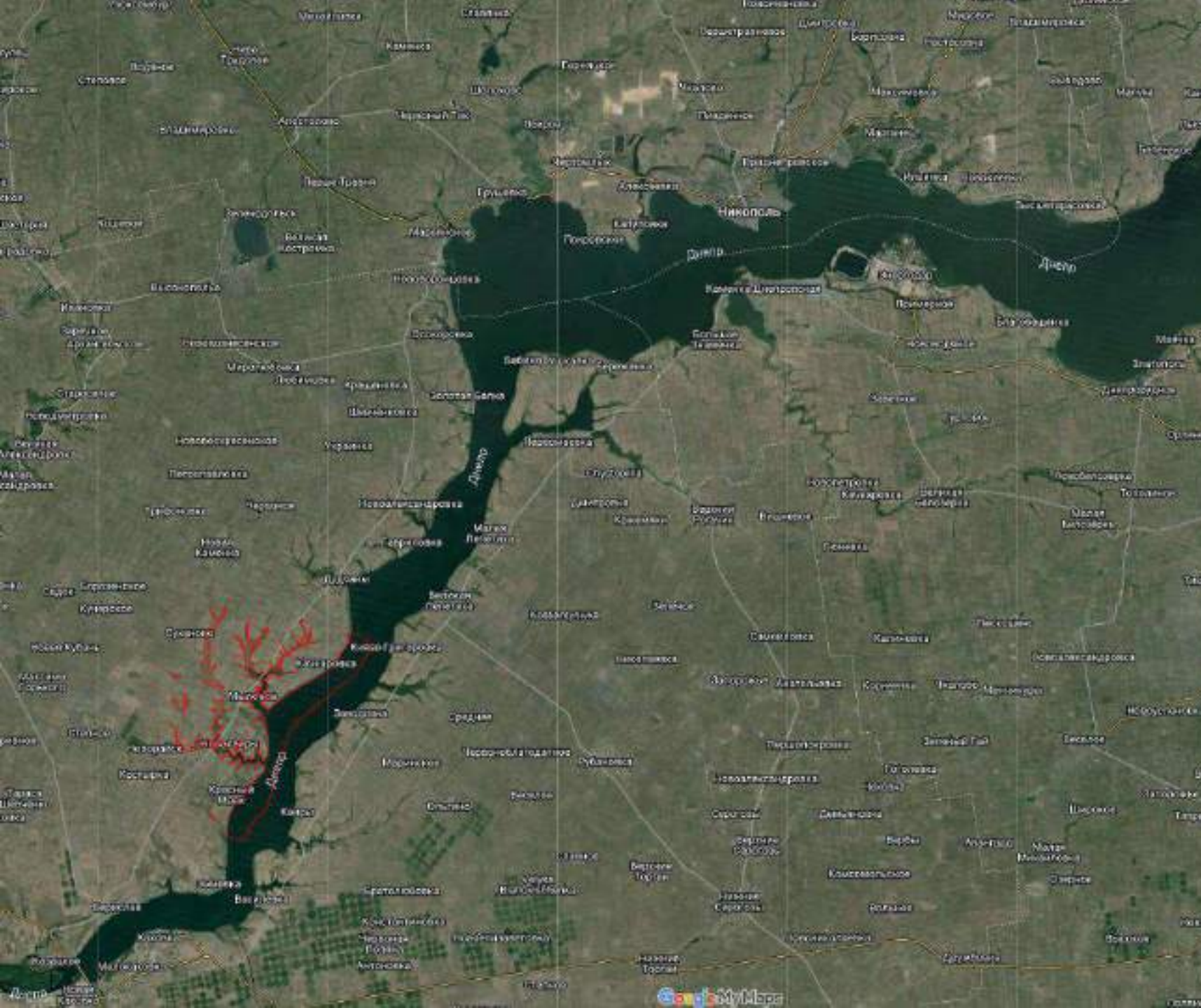
[7]**Львівський національний університет ім. Івана Франка**

[8]**Інститут геохімії, мінералогії та рудоутворення ім. М.П. Семененка НАН України**

[9]**Варшавський університет**


Никополь
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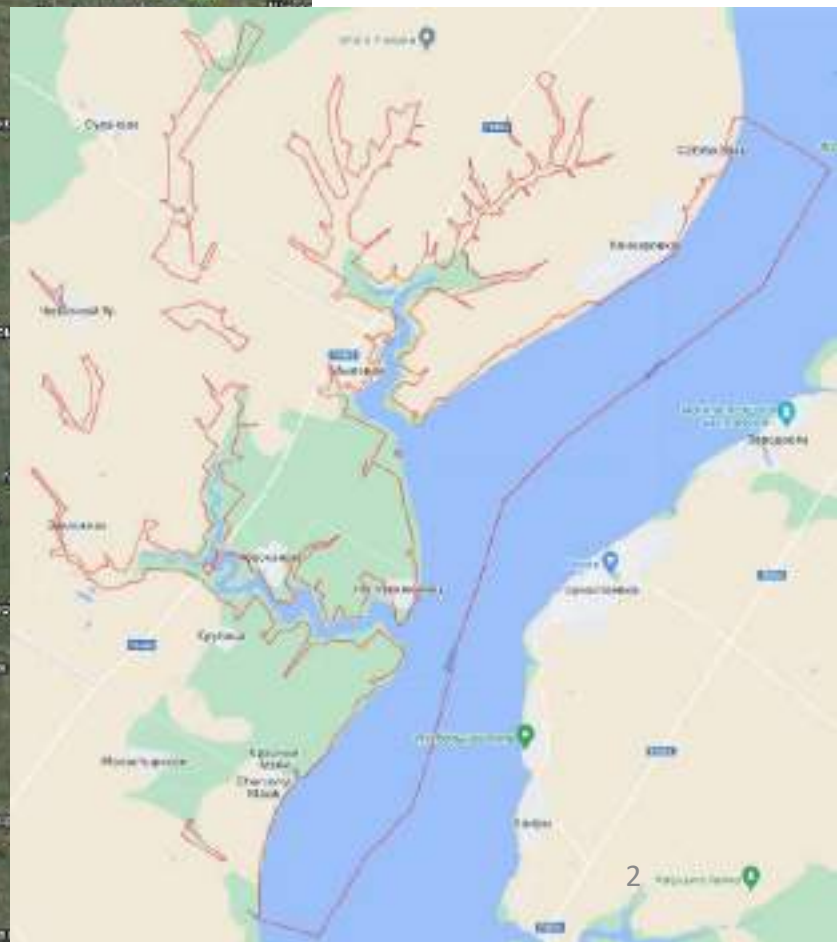
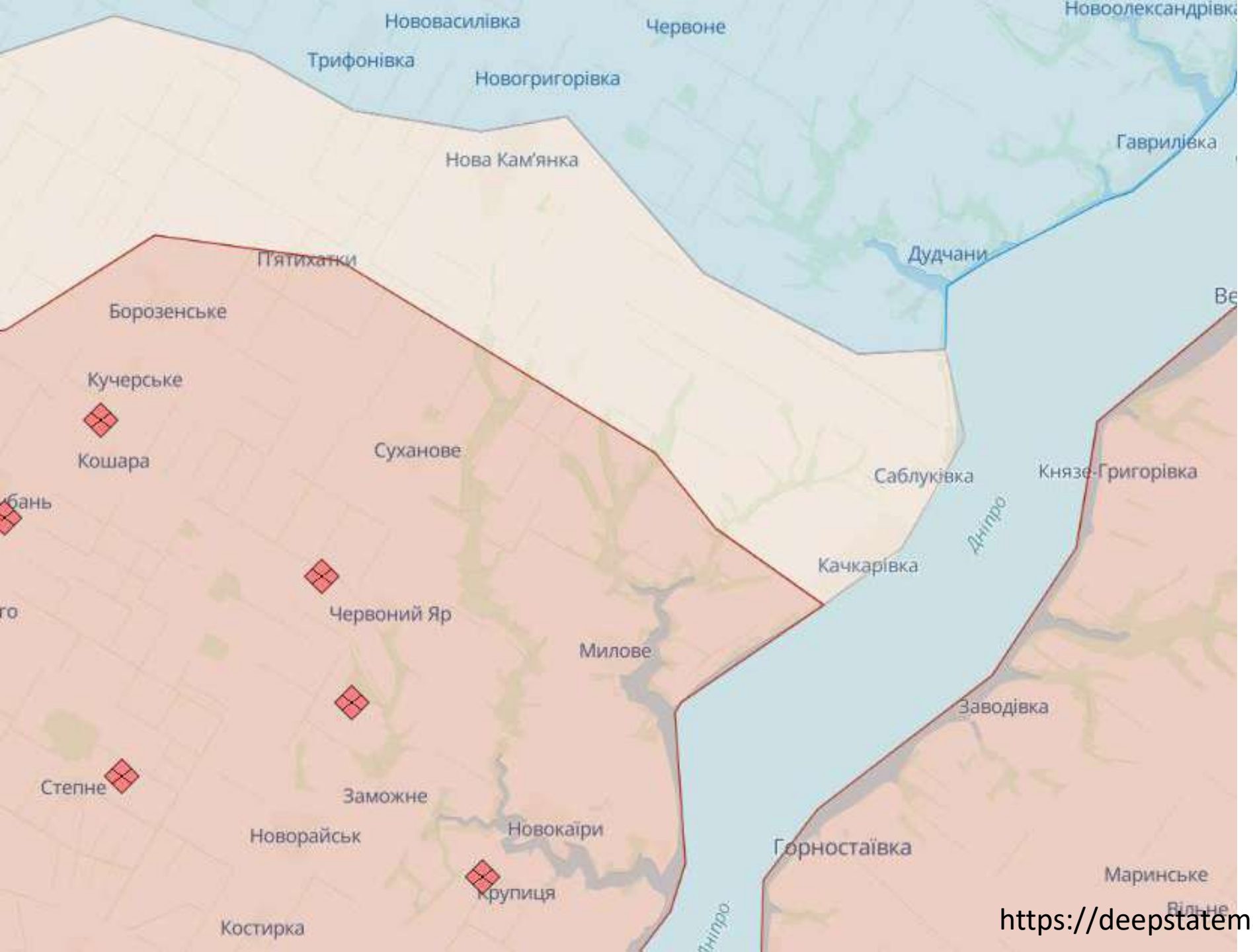


Part 1: The impact of the war on the terrestrial natural complexes near the Kakhovka Reservoir

Kamianska Sich National Nature Park

Painting "Guardians of Zaporizhzhia Liberties" (Serhii Vasylkivskyi, Kherson Art Museum, stolen by Russians in 2022).



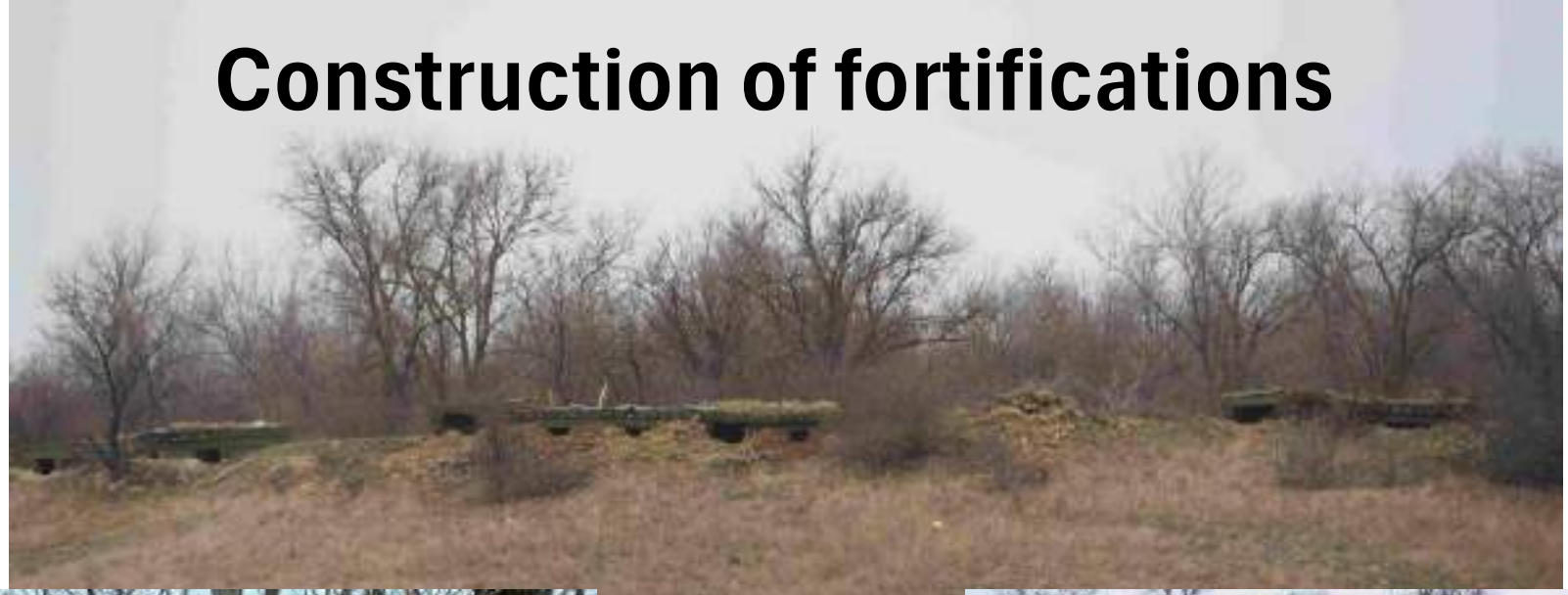
https://deepstatemap.live/#11/47.0666/33.7109

Numerous fires caused by military operations

Almost total mining and dense contamination of the territory with explosive devices

Pollution by garbage

Construction of fortifications



Destruction by tracks and wheels

Craters from explosions

Cutting down trees

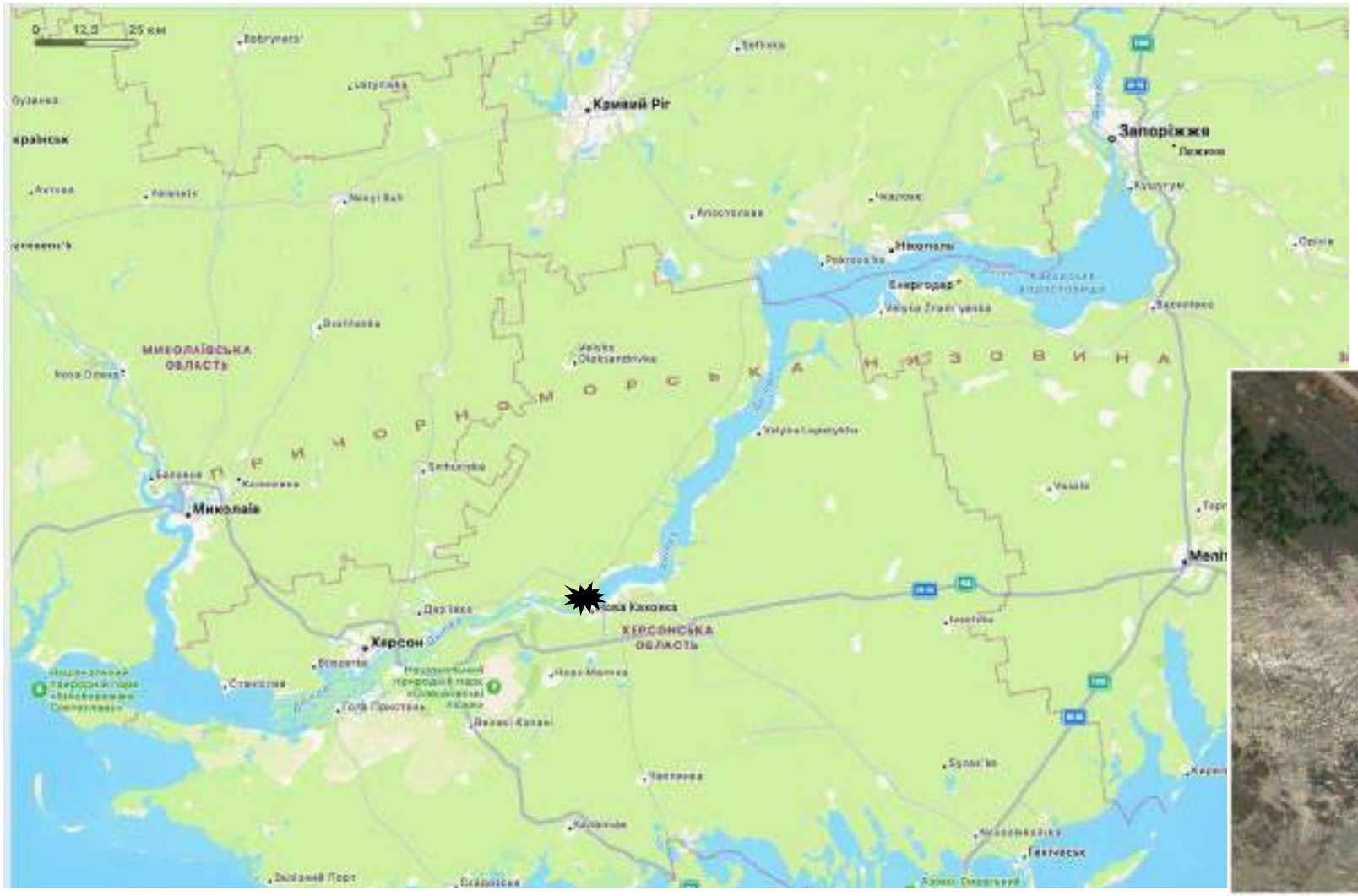
Fuel pollution

Fluctuations in watering of coastal ecosystems due to changes in the level of the Kakhovka Reservoir

Destruction of the park's infrastructure

Thus, we can see that the impact on the national park was very diverse and severe. When we arrived for the first time, we could see only 5% of the territory. The rest of the territory was mined. And this 5% was extremely disturbed. And we thought that if the rest of the territory had the same impact of the war, it would be a disaster. But fortunately, this was not confirmed. We could only move along the roads, and it was along the roads, and especially near the bridges, that the main fighting took place. So we visited the most damaged areas. And further into the steppe, the impact is much less. Unfortunately, the war will continue. And the violation of natural ecosystems continues. There is constant shelling from the Left Bank. Some areas that had already been demined, and which we were able to visit during our first visit in 2022, were not accessible in 2023 because these areas were remotely mined again from the left bank. However, it is now clear that the park's terrestrial natural ecosystems will require a long and costly recovery after the victory.

Part 2: Impressions of exploring the bottom of the former Kakhovka Reservoir



The detonation of the Kakhovka Reservoir dam on 6 June 2023 triggered an ecological disaster, directly or indirectly impacting the ecosystems of the Northern Black Sea countries.

Figure 3. Satellite image shows the Nova Kakhovka dam breached | Image from Skysat courtesy of © 2023 Planet Labs PBC, available under a Creative Commons BY-NC 2.0 license at https://www.planet.com/gallery/ift/post/destruction-of-the-kakhovka-dam)

Flooded area

Figure 3. Satellite image shows the Nova Kakhovka dam breached | Image from Skysat courtesy of © 2023 Planet Labs PBC, available under a Creative Commons BY-NC 2.0 license at https://www.planet.com/gallery/ift/post/destruction-of-the-kakhovka-dam)

Flooded area

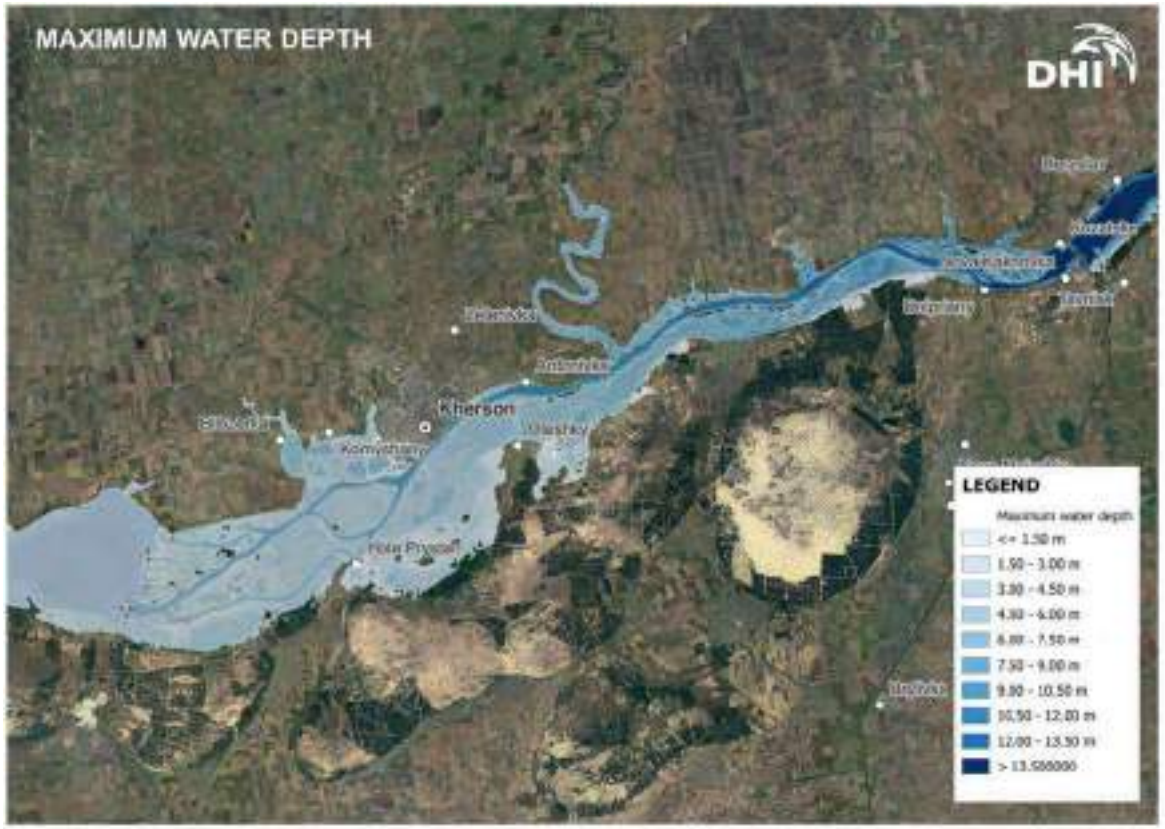


Figure 6. Water depth in flooded area (Source: DHI A/S 2022)

The only population of *Triturus dobrogicus* within Lower Dniper (Kherson region) was fully destroyed: 149 died and 55 alive individuals were found on Black Sea coast, Odesa, 10-11 June 2023

Flooded area

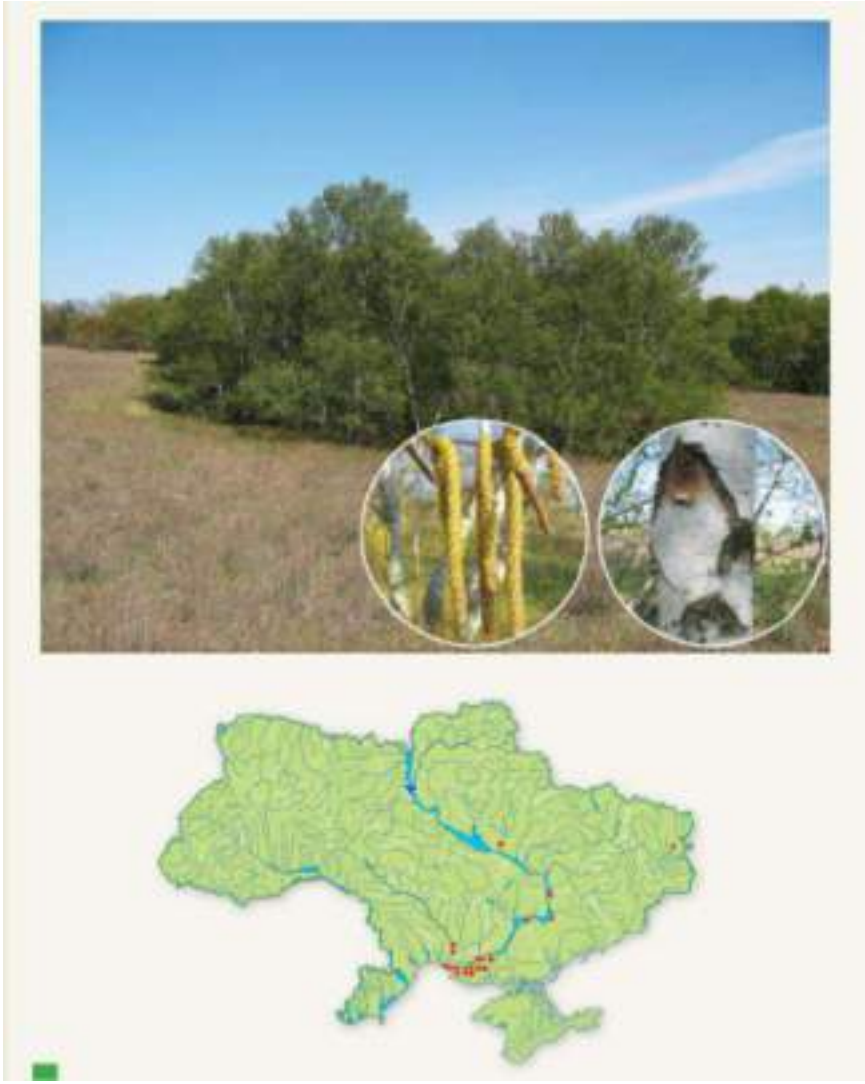
This is my house before and during the flooding and after the bombing
(youtube.com)

Individuals of *Sicista loriger* from Gola Pristan, Kherson region

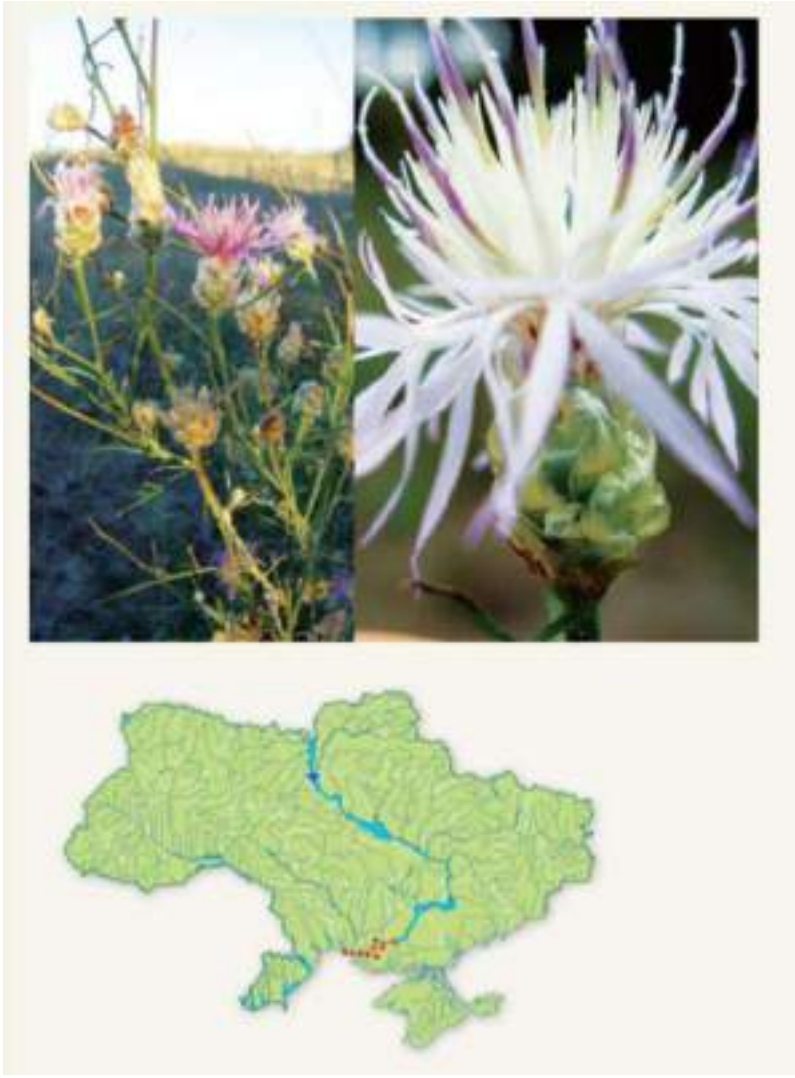
Individual of *Stilodipus telum falzfeini* from Zburiivska arena, Kherson Region, 27 September 2019

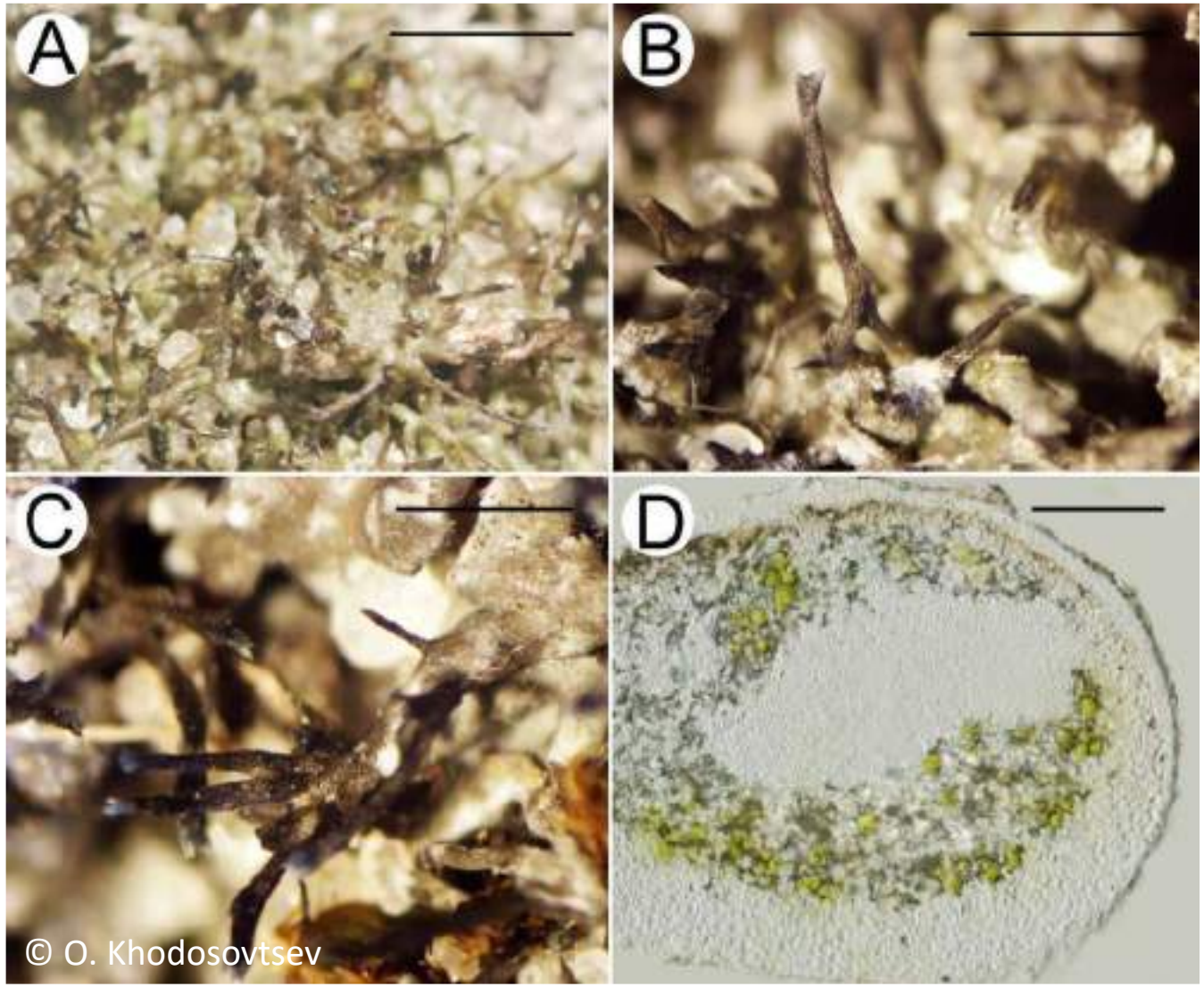
Activity of the *Spalax arenarius*, Zburiivska arena, Kherson Region, 17 October 2019

Береза дніпровська
Betula borysthenica Klokov



Волошка короткоголова
Centaurea breviceps Iljin



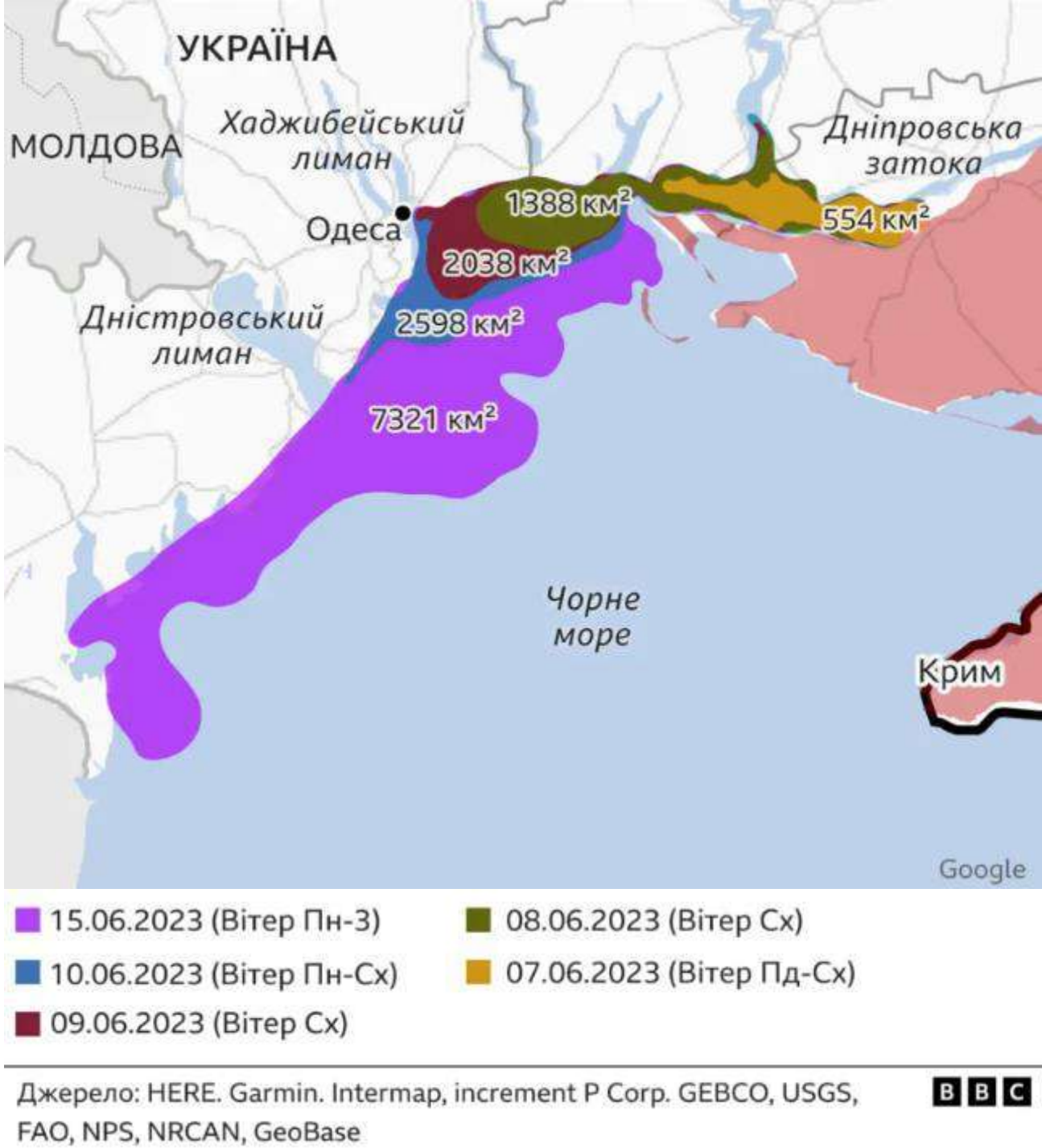


Terricolous lichen *Circinaria ucrainica* Khodos. & Darmostuk ad int. discovered in 2021 from Oleshki sand dunes, Sagy protected area near Oleshki town

Impact on the Black Sea

Within a few days, millions of tons of dirty freshwater entered the Black Sea. This led to a sharp desalination of the sea, which could have had a negative impact on the biodiversity of marine ecosystems. But because of the war, it was not possible to study the extent of this impact.This water was also very polluted. As 2 towns (Oleshky and Hola Prystan), several villages, thousands of summer houses, thousands of hectares of farmland, etc. were completely flooded. There were warehouses with chemicals and fertilizers, farms, sewage treatment plants, cesspools, garbage dumps, etc. Toxic substances and waste from the water got into the sea.

Different colors show the spread of contaminated freshwater during the first 5 days after the Kakhovka hydroelectric power plant explosion. The impact was international in nature. The seas within Romania and Bulgaria were contaminated.



Drainage area

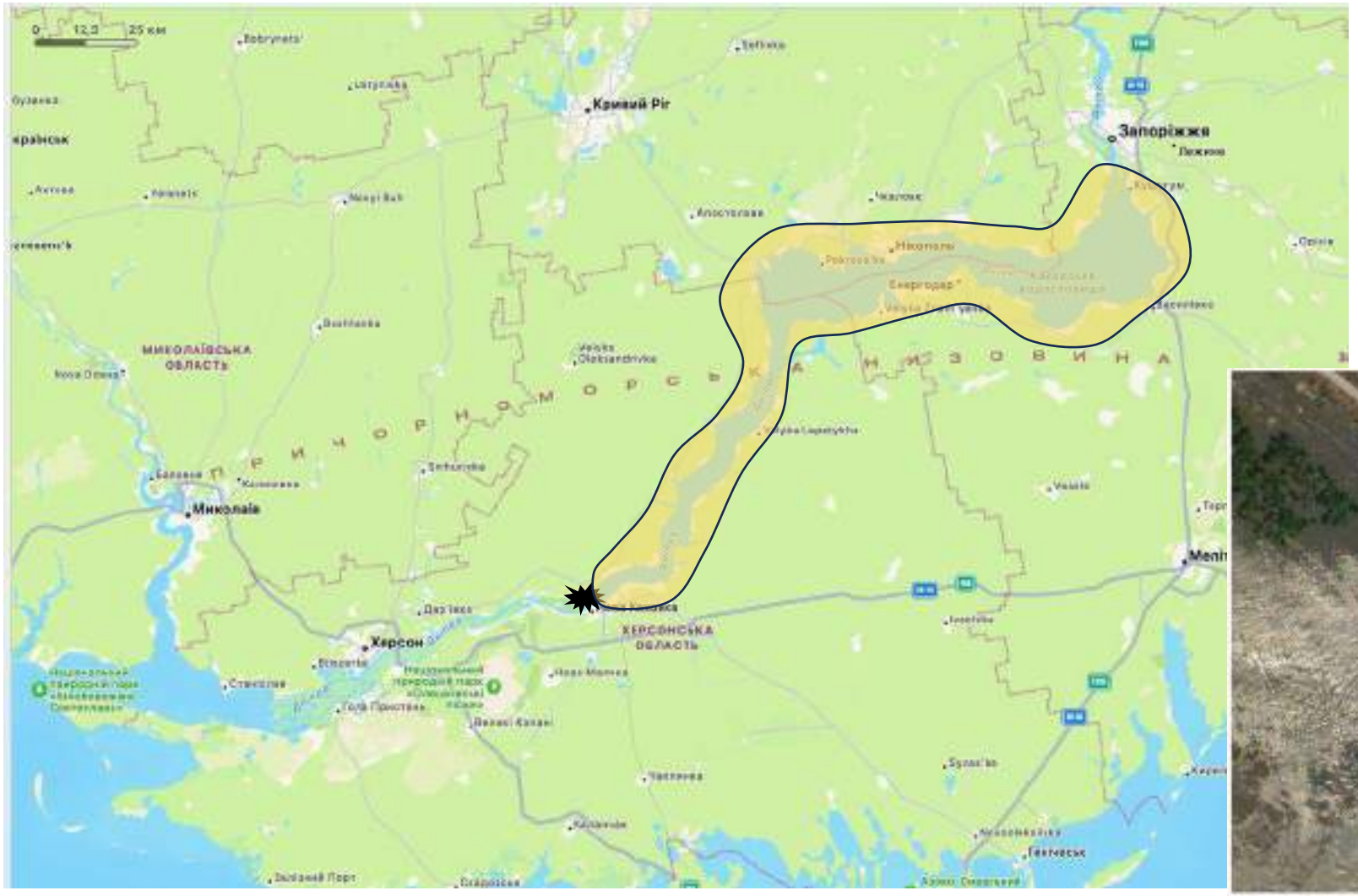
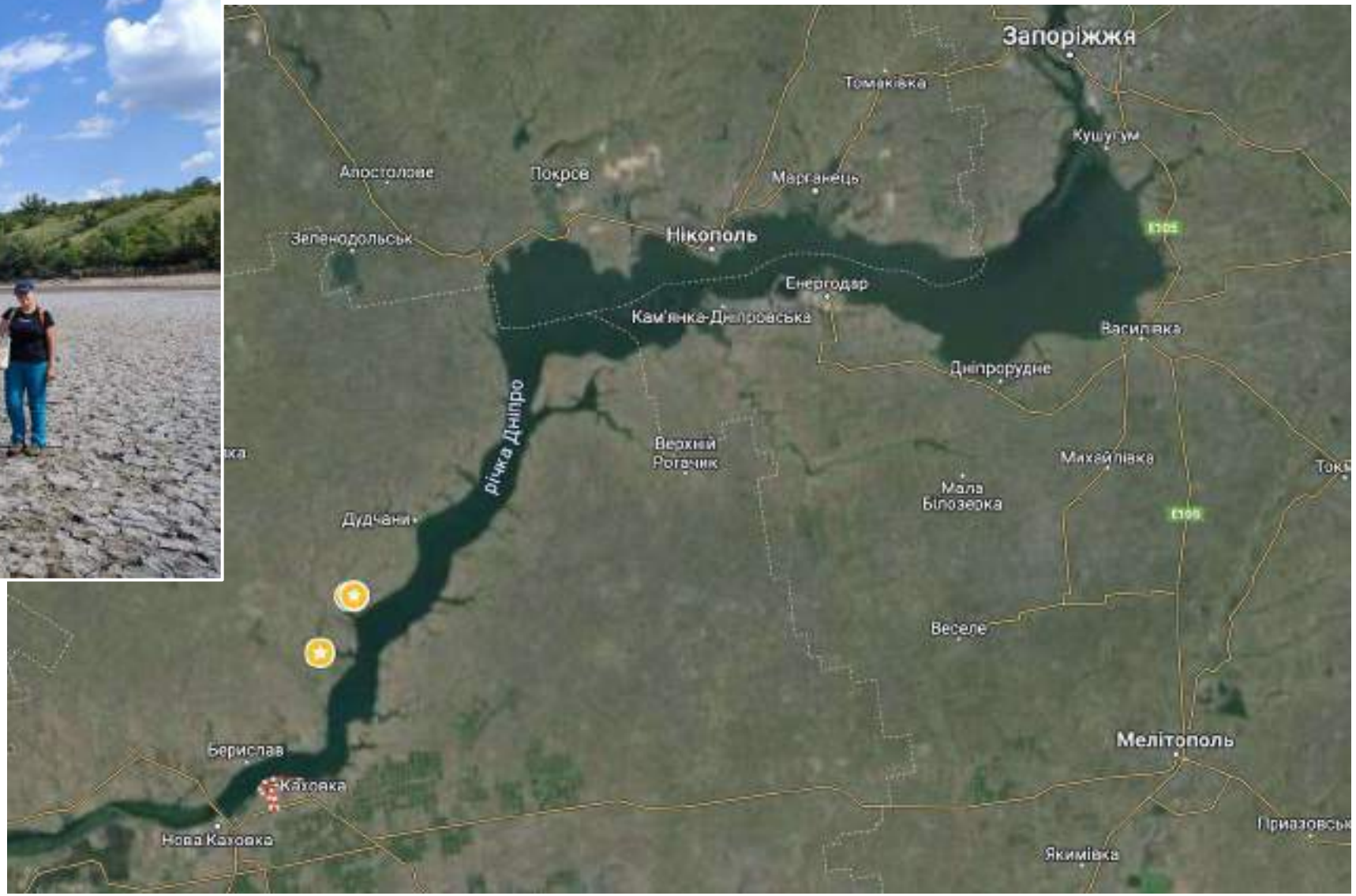


Figure 3. Satellite image shows the Nova Kakhovka dam breached | Image from Skysat courtesy of © 2023 Planet Labs PBC, available under a Creative Commons BY-NC 2.0 license at https://www.planet.com/gallery/ift/post/destruction-of-the-kakhovka-dam)

Hypotheses

- - desert?
- - dust storms from dried silt contaminated with chemicals?
- - invasion by alien species?


Запоріжжя
Томаківка
Кушугум
Апостолове
Покров
Марганець
Зеленодольськ
Нікополь
Енергодар
Кам'янка-Дніпровська
Василівка
Дніпрорудне
Річка Дніпро
Верхній Рогачик
Михайлівка
Мала Білозерка
Дудчани
Веселе
Берислав
Каховка
Нова Каховка
Мелітополь
Якимівка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???

General view of the bottom of the former Kakhovka Reservoir in the drained Respublikanets Bay in the Kamianka Gully

Habitats of the bottom of the former Kakhovka Reservoir, 19 October 2023


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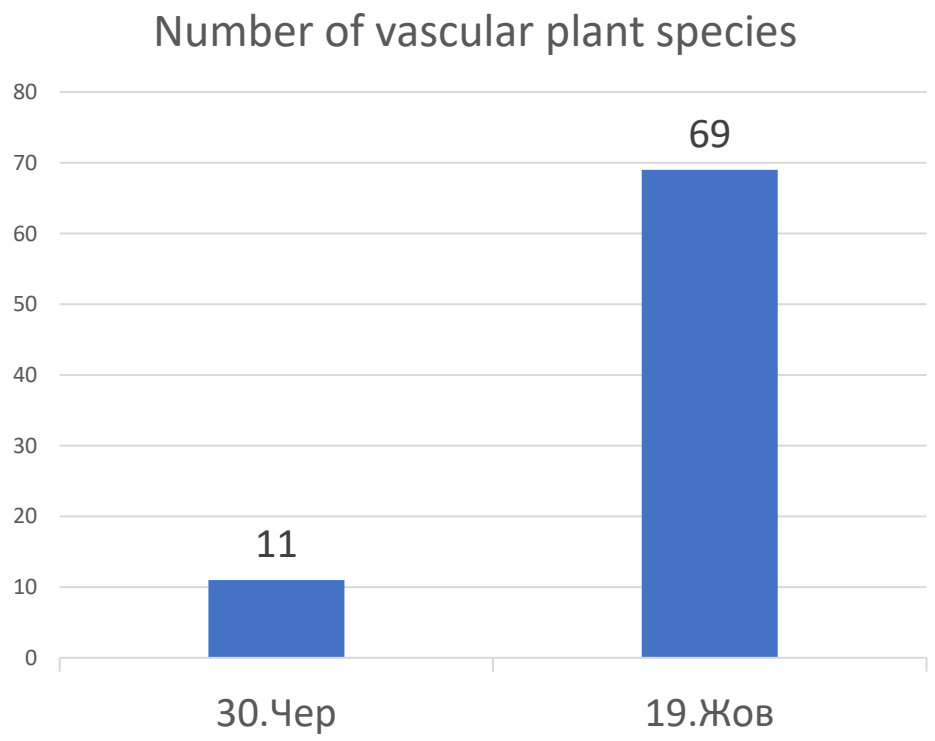
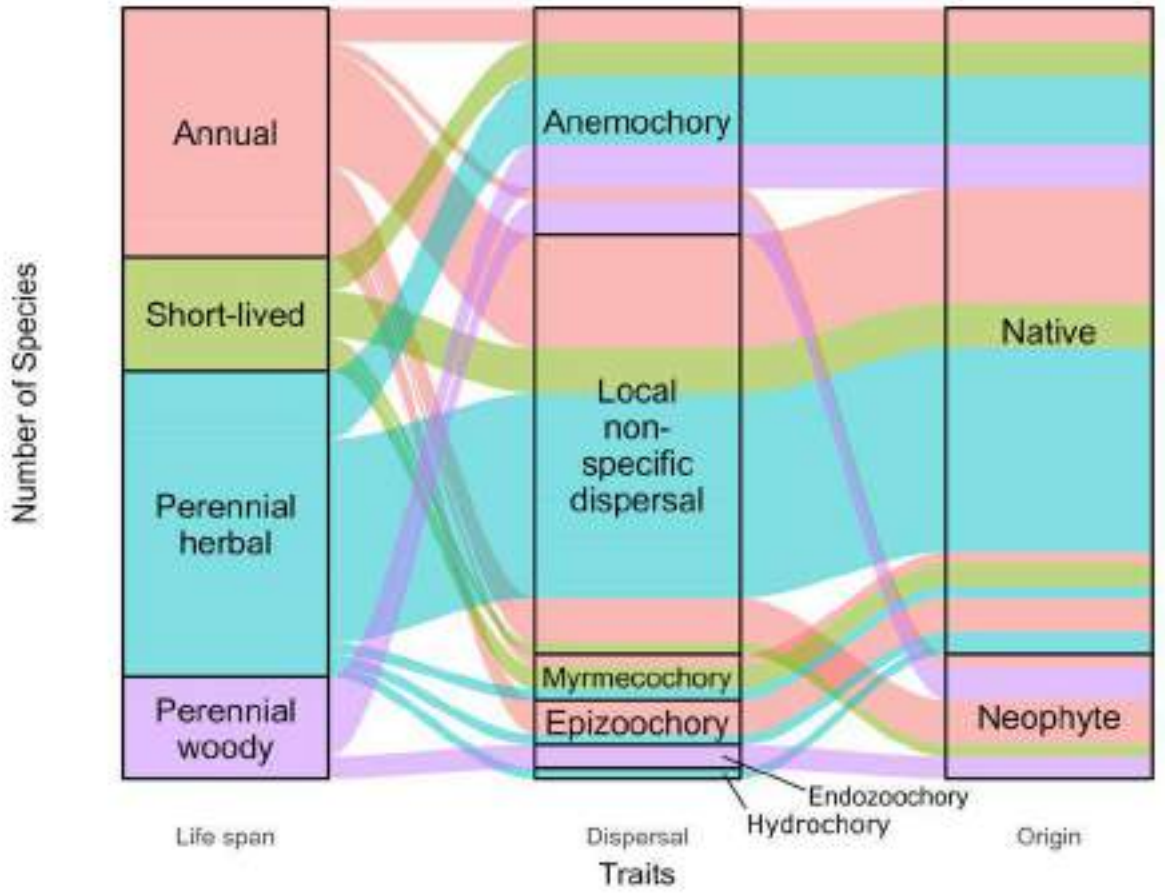
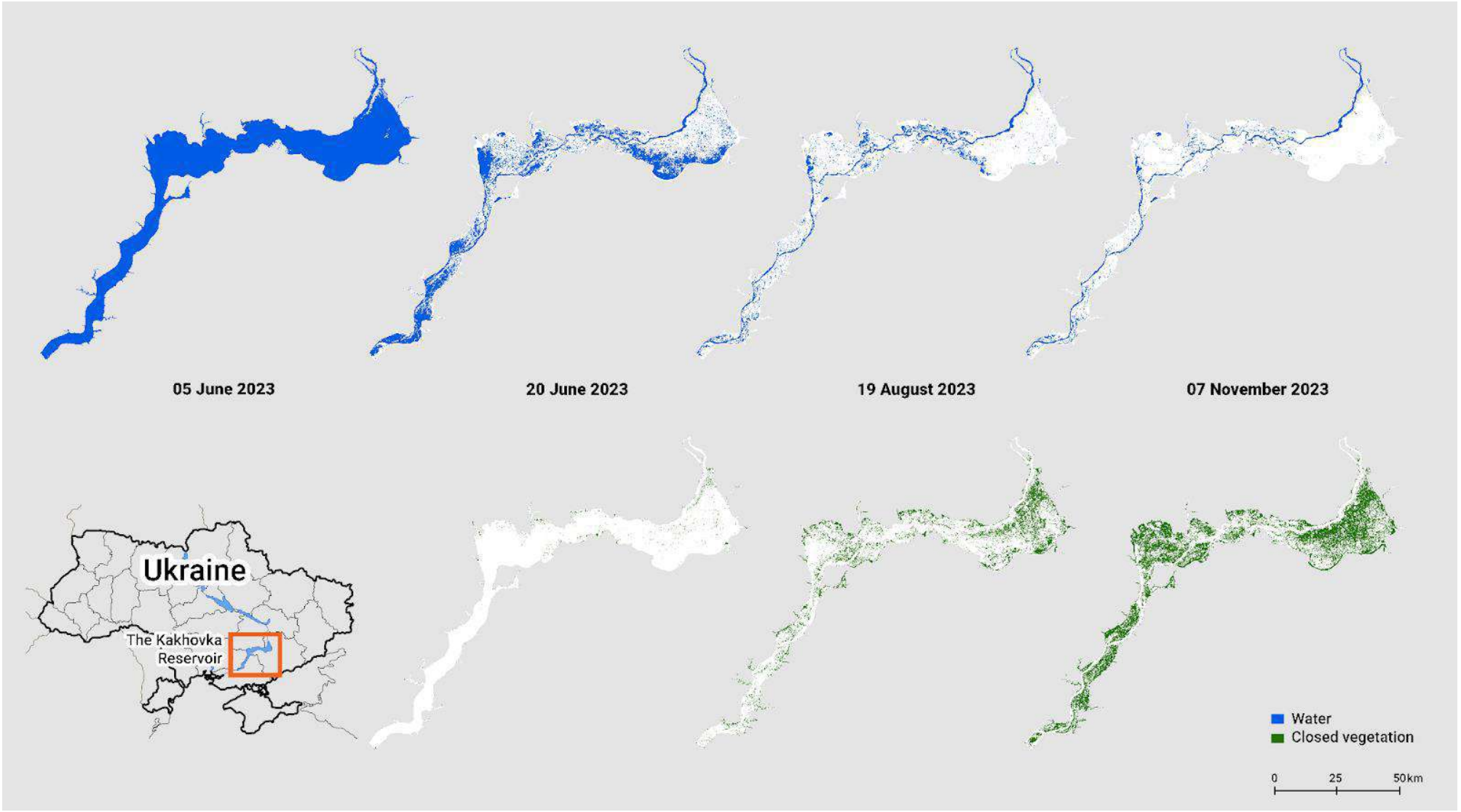


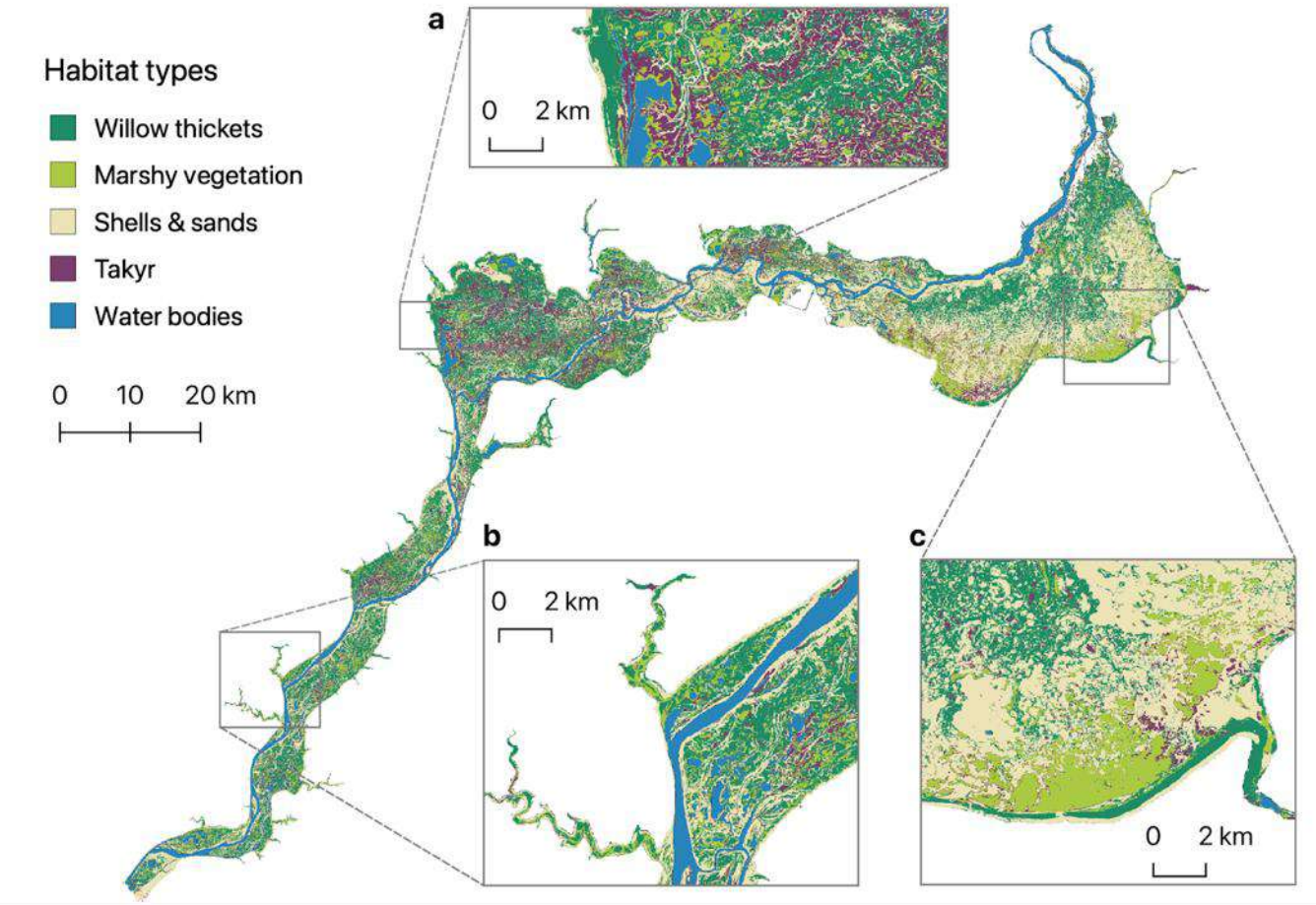


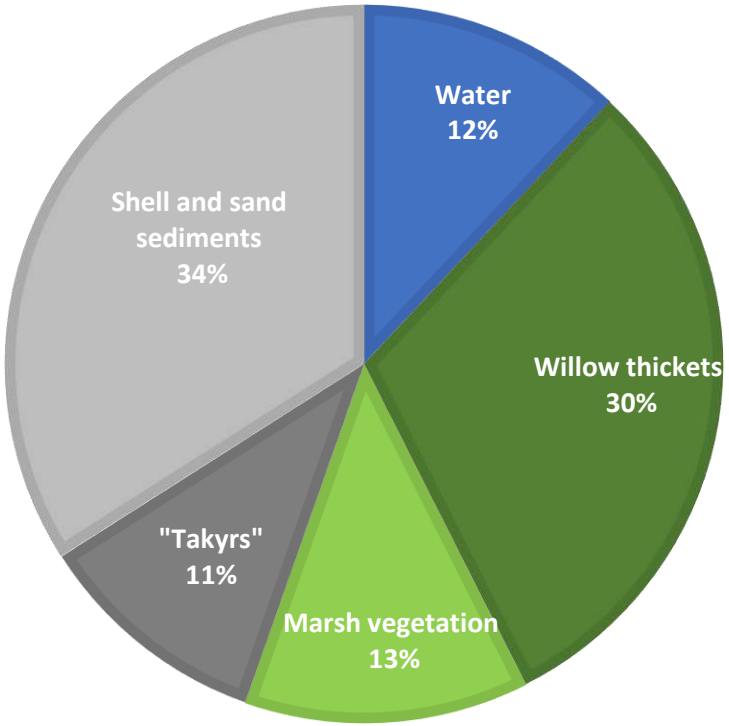
The proportion of traits of the vascular plant species recorded at the exposed bottom of Kakhovka reservoir during a field survey, October 2023.



Water release from the Kakhovka reservoir bed and vegetation growth on the exposed area.

© G. Kolomytsev





© O. Prylutskyi

Distribution of habitat types of the former Kakhovka reservoir, as of November 2023. Spatial prediction based on Random Forest supervised classification of Sentinel-2 satellite imagery, trained by ground truth data collected in October 2023.

Tested hypotheses:

- - desert
- - dust storms from dried silt contaminated with chemicals
- - invasion by alien species

Tested hypotheses

- - desert ✗
- - dust storms from dried silt contaminated with chemicals
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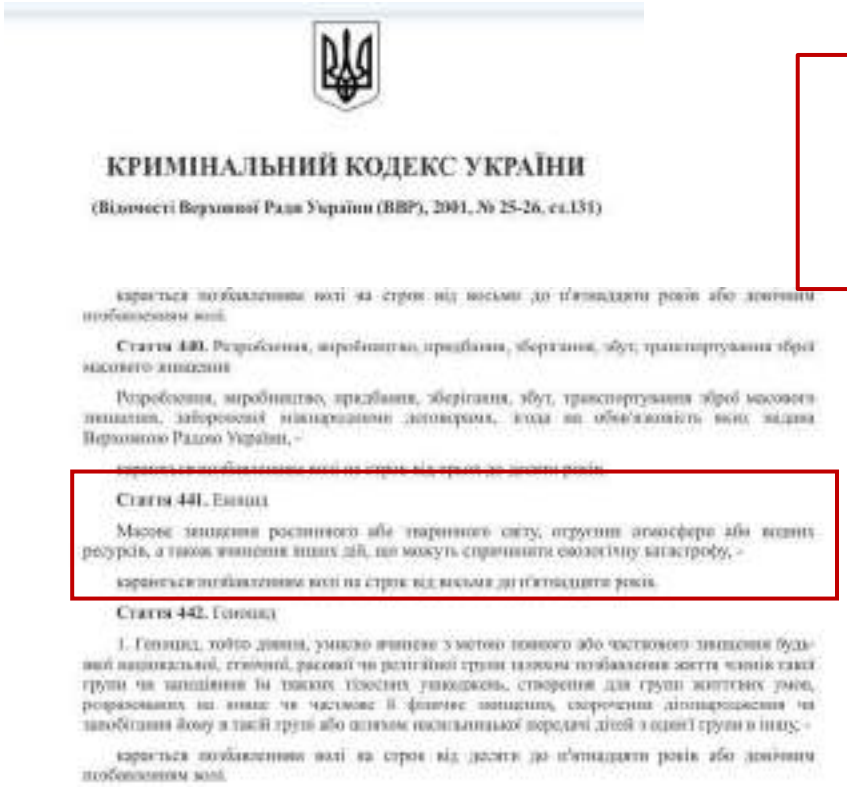
Tested hypotheses

- - desert ✗
- - dust storms from dried silt contaminated with chemicals ✗
- - invasion by alien species

Tested hypotheses:

- - desert ✗
- - dust storms from dried silt contaminated with chemicals ✗
- - invasion by alien species ✗

Ecocide



КРИМІНАЛЬНИЙ КОДЕКС УКРАЇНИ

(Відомості Верховної Ради України (ВВР), 2001, № 25-26, ст.131)

карається позбавленням волі на строк від восьми до п'ятнадцяти років або довічним позбавленням волі.

Стаття 440. Розроблення, виробництво, придбання, зберігання, збут, транспортування зброї масового знищення

Розроблення, виробництво, придбання, зберігання, збут, транспортування зброї масового знищення, забороненої міжнародними договорами, згода на обов'язковість яких надана Верховною Радою України, -

карається позбавленням волі на строк від трьох до десяти років.

Стаття 441. Екоцид

Масове знищення рослинного або тваринного світу, отруєння атмосфери або водних ресурсів, а також вчинення інших дій, що можуть спричинити екологічну катастрофу, -

карається позбавленням волі на строк від восьми до п'ятнадцяти років.

Стаття 442. Геноцид

1. Геноцид, тобто дивні, умисно вчинене з метою повного або часткового знищення будь-якої національної, етнічної, расової чи релігійної групи шляхом позбавлення життя членів такої групи чи заподіяння їм тяжких тілесних ушкоджень, створення для групи життєвих умов, розрахованих на повне чи часткове її фізичне знищення, скорочення дітонародження чи запобігання йому в такій групі або штучним насильницької передачі дітей з однієї групи в іншу, -

карається позбавленням волі на строк від десяти до п'ятнадцяти років або довічним позбавленням волі.

Стаття 441. Екоцид

Масове знищення рослинного або тваринного світу, отруєння атмосфери або водних ресурсів, а також вчинення інших дій, що можуть спричинити екологічну катастрофу, -

караються позбавленням волі на строк від восьми до п'ятнадцяти років.

Article 441. Ecocide

Mass destruction of flora or fauna, poisoning of the atmosphere or water resources, as well as other actions that may cause an ecological catastrophe

shall be punishable by imprisonment for a term of eight to fifteen years.

To restore or not to restore?

To restore or not to restore?

How cost-effective are these options?

To restore or not to restore?

How cost-effective are these options?

- Fully restoring the reservoir to its original state.

To restore or not to restore?

How cost-effective are these options?

- Fully restoring the reservoir to its original state.
- Partially restoring the reservoir.

To restore or not to restore?

How cost-effective are these options?

- Fully restoring the reservoir to its original state.
- Partially restoring the reservoir.
- Addressing water and energy supply issues using modern technologies.

To restore or not to restore?

How cost-effective are these options?

- Fully restoring the reservoir to its original state.
- Partially restoring the reservoir.
- Addressing water and energy supply issues using modern technologies.
- Using ecosystem services from floodplain habitats formed at the former reservoir bottom.

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UNCG
Ukrainian Nature Conservation Group

ENVIRONMENT PEOPLE LAW
The rule of law for the protection of the environment

Armed Forces of Ukraine

… and all our partners for their invaluable support

Acknowledgments:

Advocating for the environment and local communities of the future for the former Kakhovka Reservoir and Kakhovka HPP (2023-2024, FONDATION DE FRANCE)

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Opinions, conclusions and recommendations presented in this publication do not necessarily reflect the views of USAID, the United States Government. The contents are the responsibility of the authors.

Thank you for your attention!