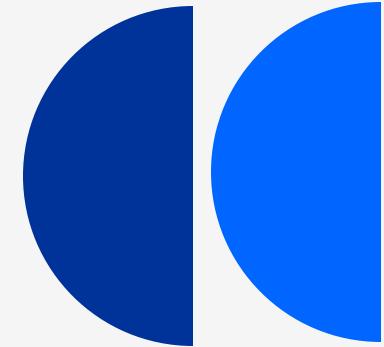




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Пошкоджені війною ґрунти: оцінка та ремедіація. Співпраця СНАУ з сільськими громадами



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(Швейцарія), Сумського національного аграрного університету (Україна)*

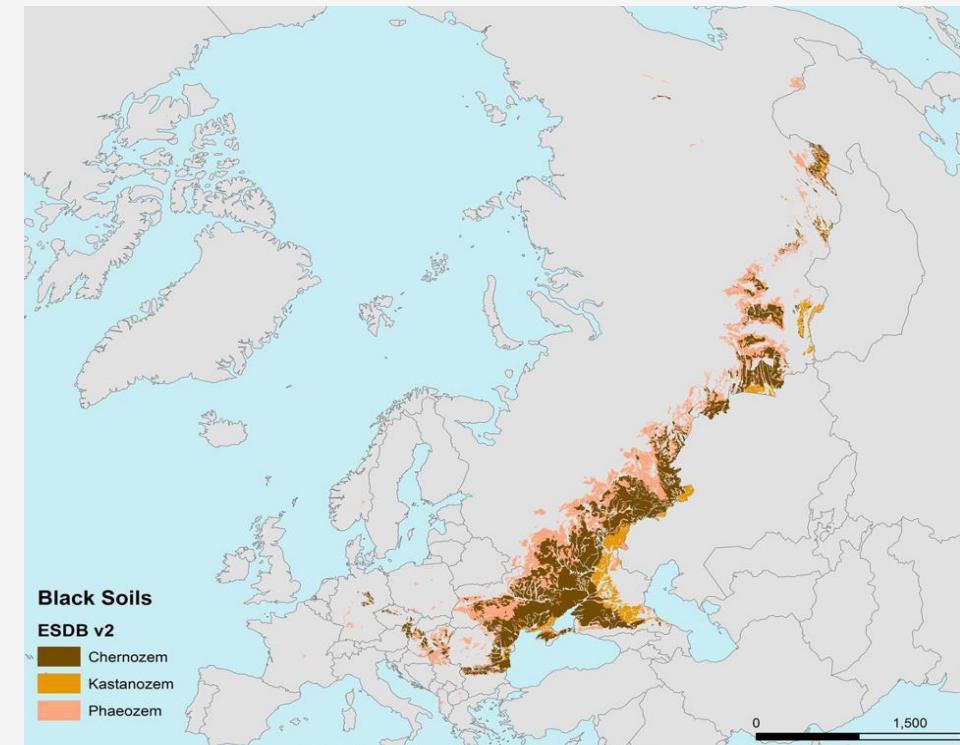
Міжнародна конференція «Зелена угода ЄС: поточні виклики та майбутні
перспективи для України», 30 січні 2026, онлайн

<https://unicom.community>



Why is Ukrainian agriculture so important for Ukraine?

- More than 55% of Ukraine's lands are arable. • Before the war, the agricultural sector contributed up to **12%** of GDP and up to **20%** of GDP with the processing food industry.
- Agriculture provided employment for **14%** of Ukraine's population.
- Agricultural commodities accounted for **41%** of the country's export.



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Why is Ukrainian agriculture so important to the world?

- Ukraine possesses **30%** of the world's black soil. •

Ranked among the top five global grain exporters, exporting **75%** of its agricultural output while domestic consumption accounted for only **20–25%**

- **400 million** people worldwide depend on Ukraine for their food supply



the first exporter of sunflower oil (more than **50%** of world exports)



the third exporter of corn (**11.5%**), barley (**11.5%**), rapeseed (**10%**)



the fifth exporter of wheat



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Can the world cope with hunger without Ukraine?



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13.93 million Ha of agricultural lands
in Ukraine remain potentially
contaminated with UXO and PTEs



yields of most crops and legumes
fell by **30.2%** — **a shortage for the world
food market**



The idleness of one
hectare leaves **50 people**
without bread annually
in China, Pakistan, India,
Bangladesh, etc,



Нова законодавча база ЄС щодо ґрунтів Soil Monitoring Law



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✓ Перше в історії ЄС законодавство, спрямоване саме на ґрунти — набирає чинності з 16 грудня 2025 року.

✓ Це уніфікований юридичний рамковий акт, що зобов'язує всі країни-члени:

- створювати [системи моніторингу](#) стану ґрунтів (фізичні, хімічні, біологічні параметри);
- регулярно [звітувати про стан](#) ґрунтів до ЄК і Європейського агентства з навколишнього середовища;
- [оцінювати](#) ерозію, вміст органічного вуглецю, [забруднення](#) та щільність ґрунту;
- [ідентифікувати та управляти](#) забрудненими ділянками з ризиками для людей/середовища;
- забезпечувати міжнародну [порівнюваність](#) даних в усіх державах ЄС.

Основний акцент — створення якісної наукової бази та даних для подальших управлінських рішень у сільському господарстві, охороні навколишнього середовища та кліматичній політиці.





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Project «Ukraine War-Polluted Soil: Recovery and Remediation»

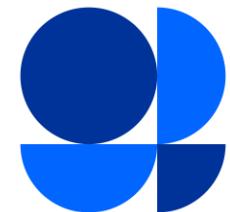
Funder: Department of Agriculture, Forest and Rural Affairs, the UK

Coordinator: The Royal Agricultural University

Partners: Sumy National Agrarian University

LLC Sky Eye

Kherson State Agrarian and Economic University



What did we plane?

- Soil sampling: 5 regions Sumy, Kharkiv, Mykolaiv, Kherson, Donetsk, 2 000 Ha, 8 000 soil samples
- Food safety for 20 000 people
- Improved research capacity: 2 labs (Sumy, Kharkiv),
 - 40 trained experts
- Soil analysis: • GIS referencing: Maxar, Sentinel
- Hot spots mapping: data base and digital map
 - (restricted access)
- Recommendation for policy makers on restoration damaged farmlands



Our stakeholders: Ministry of Agriculture of Ukraine, Ministry of Economy of Ukraine, regional and local authorities, S&M agricultural enterprises, farmers.



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Project KPI. Labs established
to undertake war-polluted soil
specific research

Planned: 2 labs

Done: 2 labs



Purchased/ordered for:

Sky Eye, Kharkiv

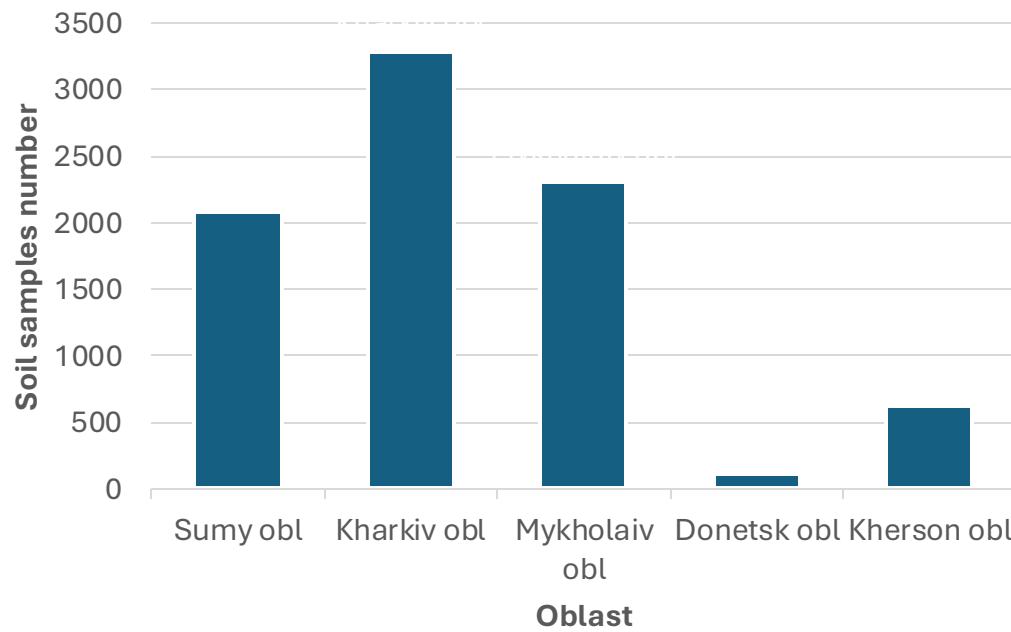
SNAU, Sumy



Project KPI. Number of farms benefited from contamination data

Planned: 5 regions, 25 farms

Done: 5 regions, 30 farms



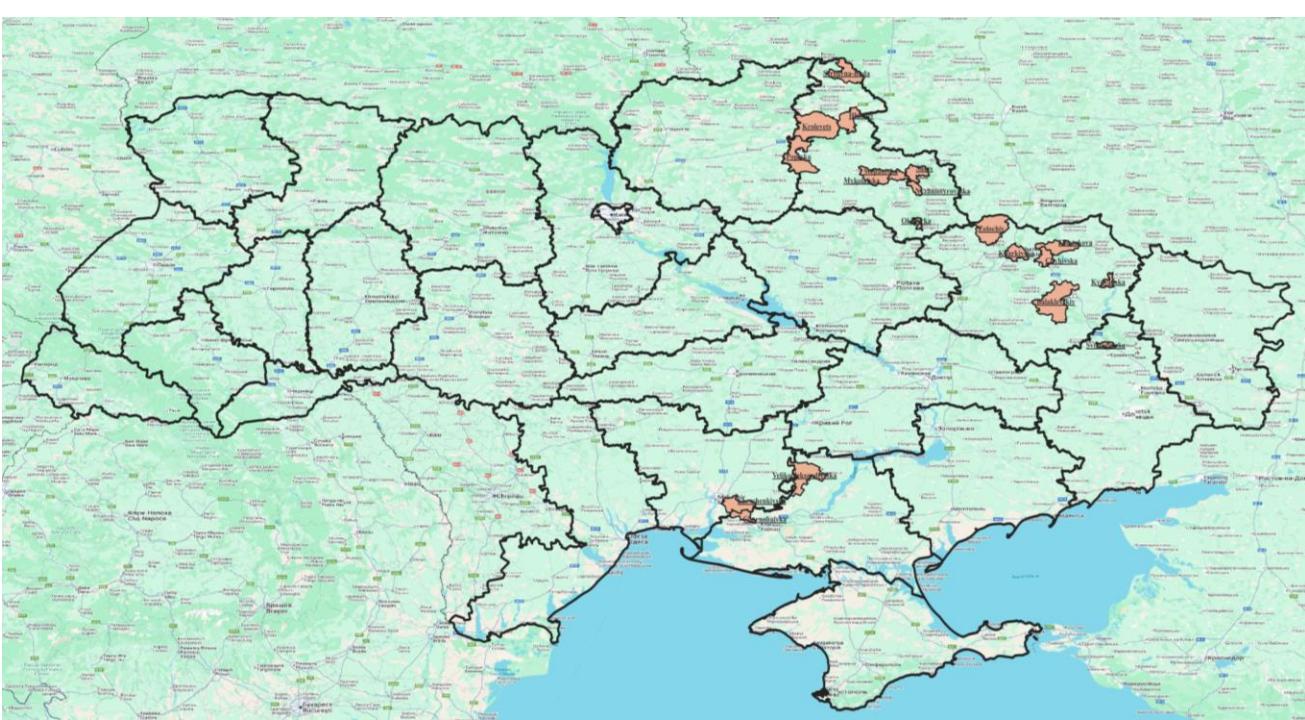
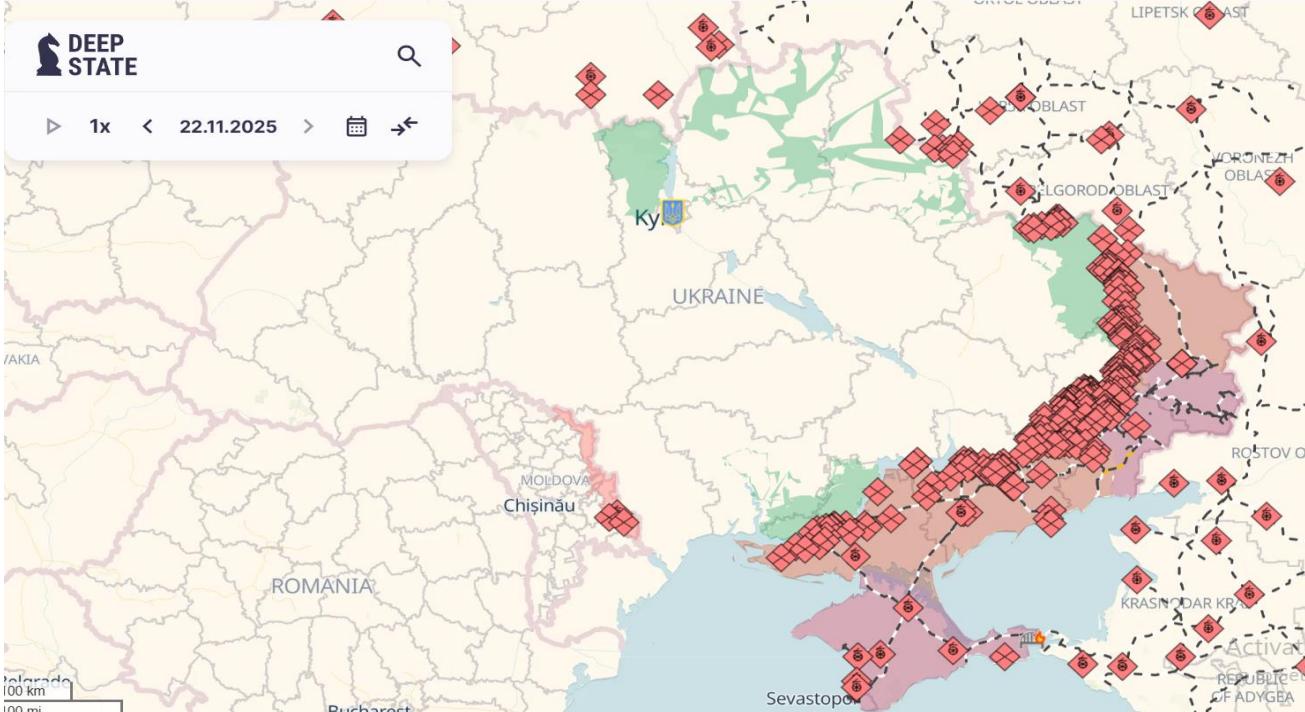
19 territorial communities (Hromadas)



30 farms



3 experimental research fields



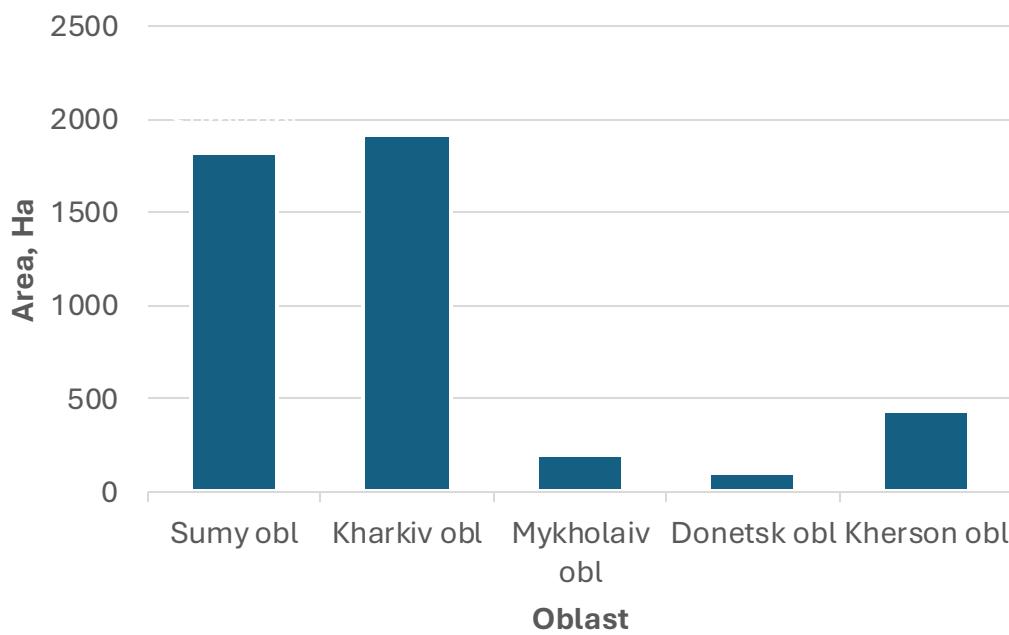
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DeepStateMap.Live is an open-source intelligence interactive online map of the military operations of the Russian and Ukrainian armies during the Russian invasion of Ukraine.

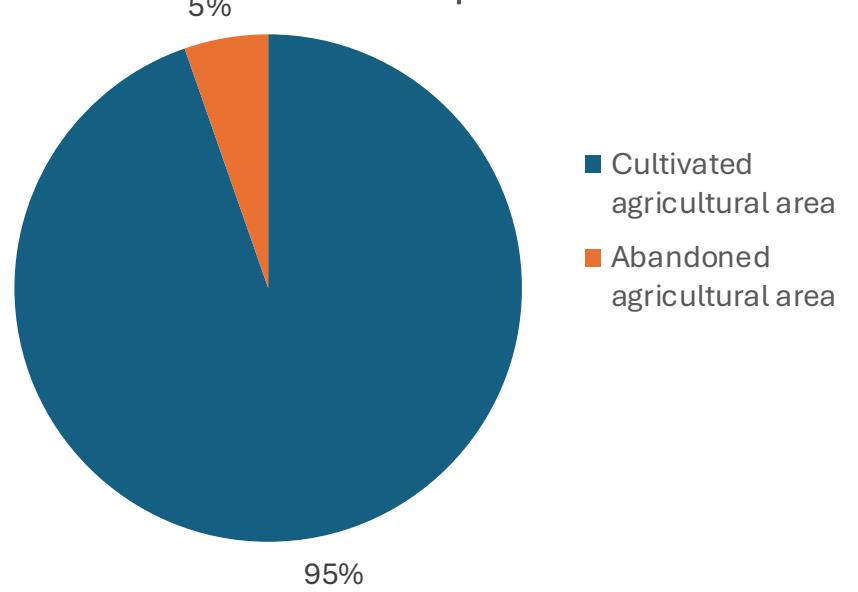
19 communities covered by soil sampling in the frames of the project Ukraine War-Polluted Soil: Recovery and Remediation (DEFRA)

Project KPI. Number of hectares/areas analyzed for soil contamination

Planned: 2000 Ha
Done: 4486 Ha



Soil samples distribution

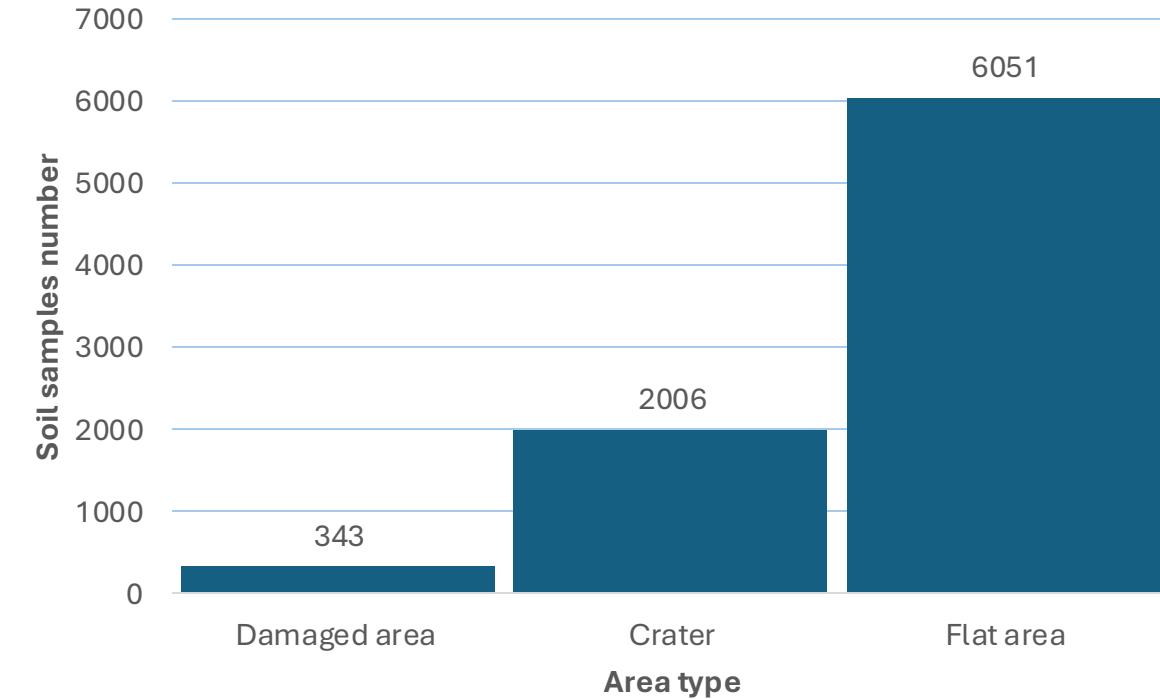
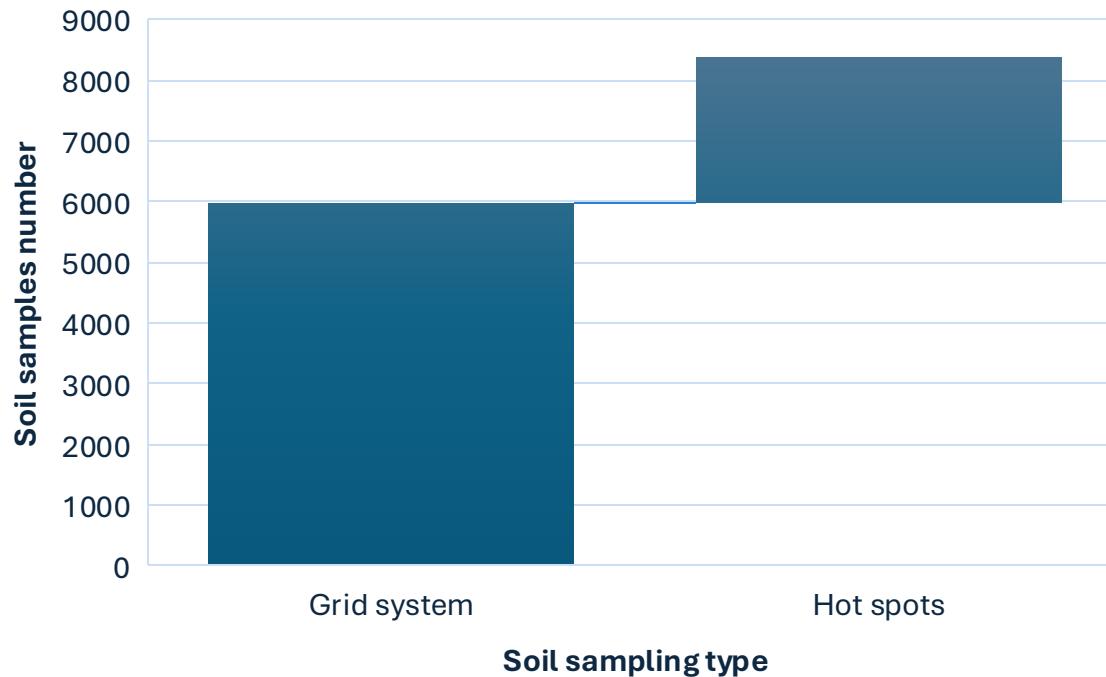


Project KPI. Number of samples taken in Ukraine as part of the research



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Planned: 8000 soil samples
Done: 8400 soil samples



Types of damages identified

1. Explosive impacts and residues
2. Contamination by debris and remnants of weaponry
3. Pollution from destroyed and burnt military vehicles
4. Mechanical disturbance from military activity



Explosive impacts and residues

- Craters from **guided aerial bombs (500 kg)**
- Craters from **Shahed drones / Shahed-136**
- Craters from **FAB-250**
- Craters from **FAB-500**
- Craters from **KAB-500** (precision-guided aerial bomb)
- Craters from **152 mm artillery shells**
- Craters and scatter patterns from **cluster munitions**
- Craters from **MLRS rockets** (including *BM-21 Grad* and *Uragan/Huragan*)
- Damage from **unguided rockets (NUR)**
- Damage from **incendiary munitions**
- Damage from **phosphorus munitions**



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Contamination by debris and remnants of weaponry

- Debris of **TOS-1A “Solntsepyok”**
- Debris of **downed aircraft**
- Debris of **Mi-28N helicopter**
- Fragments of **MLRS rockets** (Grad, Uragan, others)
- Fragments of **152 mm shells**
- Fragments of **guided and unguided aerial bombs**
- **Tank debris, including T-72B3**
- Destroyed or abandoned **unmanned systems**, including **UAV “Molniya”**



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Pollution from destroyed and burnt military vehicles

- Broken **columns of military equipment**
- Burnt or destroyed **armored vehicles**
- Leakage of **fuel and lubricants (FOL)**
- **Oil, hydraulic fluids, and coolant** contamination
- Heavy-metal contamination from **destroyed machinery**



Mechanical disturbance from military activity

- **Tank tracks** and severe soil compaction
- **Deep ruts** from armored vehicles and trucks
- **Topsoil displacement and mixing** from explosive blasts

Project KPI. Improved resilience of individuals, who rely on food delivery from the regions

Planned: 20,000 people
Done: 22,443 people



	$N_{population}$	A sampled agricultural land, Ha	A total land of communities measured, km ²	R average share of fertile agricultural land in Ukraine, %	Improved resilience of people
Sumy	395075	1823.2	4163.66	53.9	3210
Kherson	31182	436.0	1107.3		228
Kharkiv	1603840	1917.36	3025.3		18859
Mykholoiv	14410	196.47	515.8		101
Donetsk	8903	104.4	375.7		45
Total	2053410	4477.43	9187.76		22443

Project KPI: People trained for environmental analysis techniques or soil management/restoration



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Data	June 30 th - July 31 st (12 hours)	October 6 th (3 hours)	October 30 th (1 hour)
Title of the event	Training on soil sampling	Training on XRF measurements	Training on soil degradation and contamination
Link	https://surl.li/gglwpc	https://surl.li/cqahqv	https://surl.lu/bfntit
Participants	10	8	64
Age: 20-35 years 36-50 years	40 % 60 %	35 % 65%	35% 65%
Type of actors: - academics - volunteers - business - local authority	80% 20%	100% - - -	- - 80% 20%
Sector: agriculture	100 %	100%	100%
Sex: M F	50% 50%	35% 65%	45% 55%
Regions	Sumy, Kharkiv, Kherson	Sumy, Kharkiv	Luhansk

Planned: 20 people
Done: 76 people
(6 people were involved in 2 trainings)

Project KPI. Soil analysis

Soil samples analyzed

Kherson obl – 2,100 soil samples

Kharkiv obl – 900 soil samples

Planned: 8,400 soil samples

Done: 3,000 soil samples

A statistical analysis template has been developed for assessing heavy metal concentrations in the soil of an agricultural field aimed at determining background levels and identifying anomalously contaminated areas. As an example, were taken 2 fields in Kharkiv and Kherson Oblasts.

Patents submitted in Ukrainian National Office of Intellectual Property and Innovation **(UKRNOIVI)**

1. Method for determining the optimal duration of soil and sand sample analysis using a portable X-ray fluorescence analyser (pXRF)
2. Soil sampling in craters
3. Soil sampling at sites of burned equipment

Soil analysis results, grid system (Kherson obl.)

- Area – 189 Ha, Kherson obl., Chornobaivka territorial community, private farm enterprise "ETERNO PLUS"
- **Deficiency** of Zinc (Zn) and Copper (Cu) — indicating overall soil impoverishment, likely resulting from long-term agricultural use.
- Slightly **above natural background levels** but remain below their respective MAC limits - Lead (Pb), Vanadium (V), and Barium (Ba) — this may reflect natural geochemical anomalies or excessive application of pesticides and mineral fertilizers.
- The **most critical indicator** is Arsenic (As), highly toxic metalloid: its total content of 18.15 mg/kg exceeds the MAC by ninefold (normative value: 2.0 mg/kg) - potentially linked to natural geochemical processes or anthropogenic inputs, particularly plant-protection products and fertilizers.



Soil analysis results, hot-spot system (Kherson obl.)

The site is identified as an area that shows clear signs of burning while remaining flat, indicating that no crater was formed.

Lead (Pb): its concentration reaches 127.24 mg/kg, approx. four times higher than the regulatory limit of 32 mg/kg.

Zinc (Zn): 595.00 mg/kg – exceeds the upper background levels in 8.5.

Copper (Cu): 322.45 mg/kg - exceeds the upper background levels in 6.3 times.

This contamination profile clearly confirms that the 'damaged area' is a zone of intense chemical impact associated with ammunition-related components.



Potential recommendations

Actions

- Apply micronutrient fertilizers containing zinc (Zn) and copper (Cu) in easily available chelated forms (EDTA, DTPA) to correct the severe deficiency across the field.
- Perform excavation of the contaminated hotspot.
- Use phytostabilization with plants that reduce As migration (species with high Fe/Mn content in the rhizosphere).
- Apply biochar enriched with iron oxides, which is a highly effective arsenic sorbent.
- Conduct local soil replacement or mixing the upper soil layer with clean soil or sorbents.

Additional Measures

- Investigate the source of arsenic (As) contamination
- Conduct annual monitoring (before the planting season) of Lead (Pb), Vanadium (V), and Barium (Ba) to track potential accumulation or fluctuations.
- Conduct a detailed assessment of mobile (bioavailable) arsenic fractions, which determine actual plant uptake risk.
- Avoid using the field for food crops, especially cereals and vegetables known to accumulate As.
- Avoid phosphate fertilizers, as they significantly increase arsenic mobility in soil.

Services for the supply of **satellite data** - £3,950 and services for special **processing** (orthorectification) of satellite data £ 560

Total: satelite data: €4,510 out of €7,200

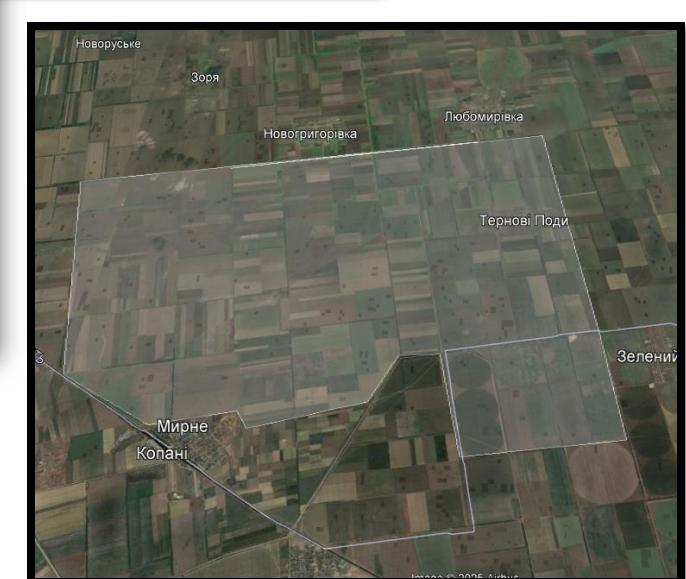
Areas of interest: craters,
burned/crashed
techniques, war changed
landscapes

Kherson: 62.5 sq km

Kharkiv: 81.4 sq km

Sumy: 73.2 sq km

Total: 216,1 sq km



Satellite Data



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Type of the accident: Helicopter MI 28H crash

The coordinates of the affected area:

1.50.062684, 36.403958 (Kharkiv region)

Type of the area:

- agricultural field (before 2022)
- abandoned area (after 2022)

Data of the accident: 01.04.2022

The observation of chronological changes (2022–2025) of the damaged areas is important for building a factual dataset for training and validating artificial intelligence models aimed at detecting various types of impacts on soil cover.



Undamaged field, May 2021 (GoogleEarth)



Visual identification of debris,
April 2022 (Googleearth)



Visual identification
of debris, April 2022
(Maxar)



Visual identification
of debris, April 2025
(Maxar)

GIS Data



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- First report based on high-resolution satellite data covering 254 km² in Sumy, Kherson, and Kharkiv oblasts has been prepared.
- Three main categories of war-related soil disturbance were identified and analysed over the 2022–2025 period:
 - *Destroyed military hardware*
 - *Abandoned military fortifications*
 - *Explosion craters and associated soil disturbance*
- Based on these results, work is underway on a scientific publication with the tentative title: Operational detection of war-related landscape impacts in Ukraine using high-resolution satellite imagery (WorldView-2, WorldView-3; Maxar).
- Additional regions have been identified for further GIS-based analysis (Kharkiv obl, 70 km²).
- Negotiations with a GIS data provider to expand satellite coverage are currently in progress (remaining budget for satellite imagery: GBP 2,690).

Map of contaminated areas



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<https://ecomonitoring.org/test/index.htm>





Social Innovation and Engagement Award, September 11th, 2025, Prague



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Thank you for your attention



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