

The War Effect on the State of Ukrainian Soils and Agriculture

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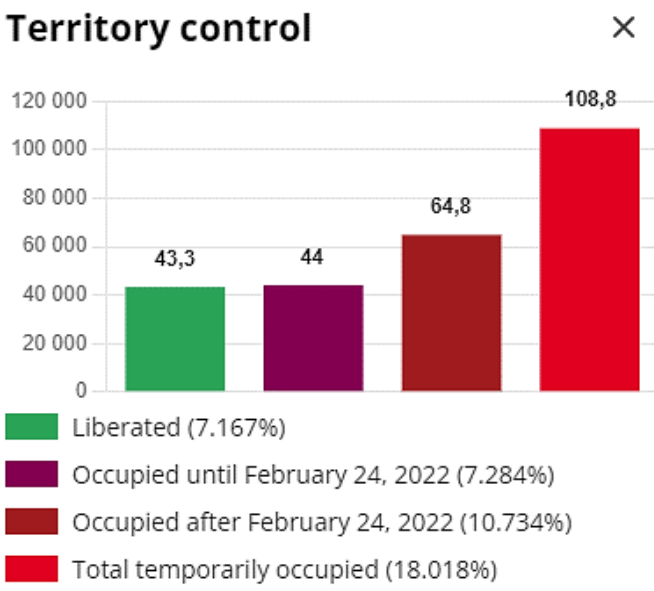
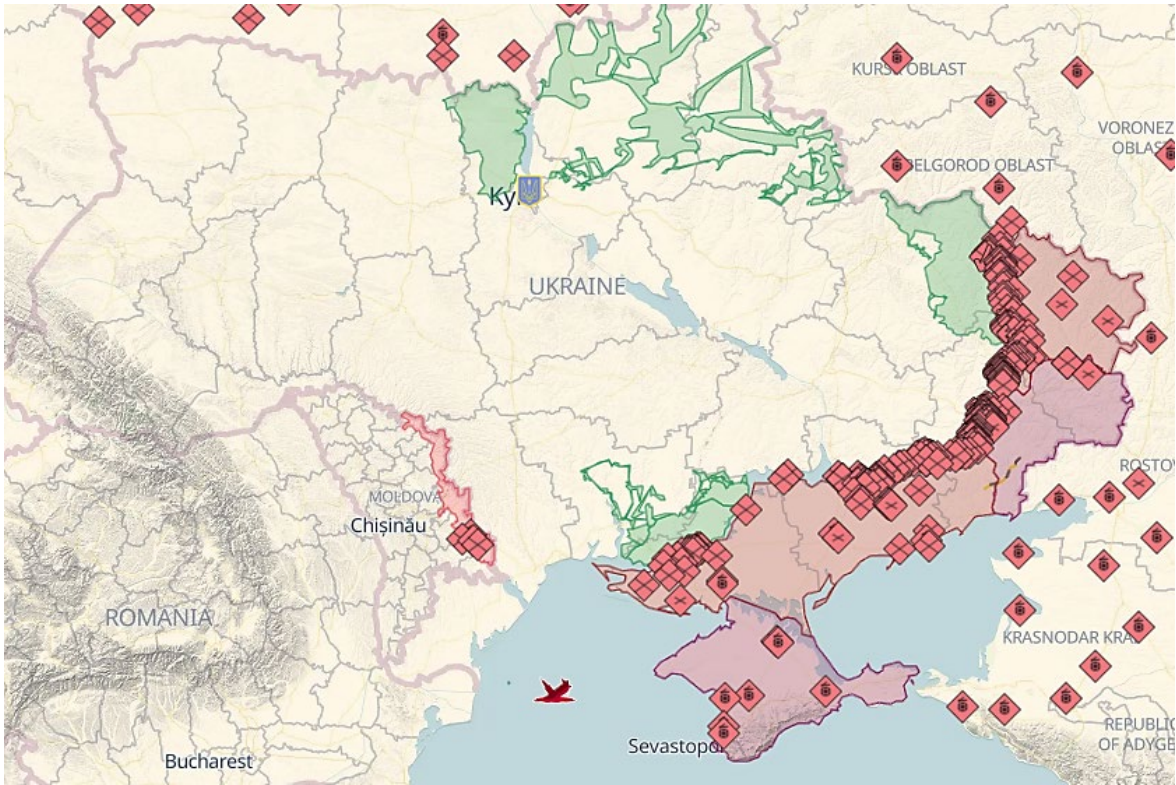


A satellite map of Europe and surrounding regions. A white callout bubble with a blue border points to the territory of modern-day Ukraine. The bubble contains text about the area's size relative to Europe. Yellow text at the bottom of the map provides historical context.

**60.4 million ha,
almost 6% of the
European territory**

**Ukraine was formed into the
state of 'Rus' in 882 A.D.**

Workshop on Assessing and Addressing Environmental Impacts of War in Ukraine



- liberated less than 2 weeks ago;
- liberated;
- territory with unknown status;
- territory occupied by russians;
- territory of Crimea and occupied in 2014-2015;
- occupied territories of other states;
- railways;
- enemy unit;
- enemy headquarters;
- enemy airfields;
- enemy directions.

Occupied area is 18.018% of Ukrainian territory before 2014

<https://deepstatemap.live/en#6/50.036/34.102>

Land area and cover of Ukraine:

- Total area is **60.355 MM** ha or almost **6% of the European territory**,
- 92% in economic use and only 8% (4.5 million ha) is in its natural state,
- **Agricultural land area is 42.8 MM ha (70.9%),**
- Forested land – 10.60 MM ha (17.6%),
- Urban land – 2.51 MM ha (4.2%),
- Bogs – 0.98 MM ha (1.6%),
- **Dry lands with xerophytic plants – 0.02 MM ha (0.03%),**
- Gullies, sand and rock - 1.03 MM ha (1.7%),
- Water resources – 2.42 MM ha (4.0%).

Agricultural land use:

Arable land – 32.47 MM ha (53.8%),
Abandoned land – 0.31 MM ha (0.5%),
Perennial crops – 0.90 MM ha (1.5%),
Hayland – 2.41 MM ha (4.0%),
Pasture – 5.48 MM ha (9.1%).

Arable land area of Ukraine comprises
26.9% of the European total

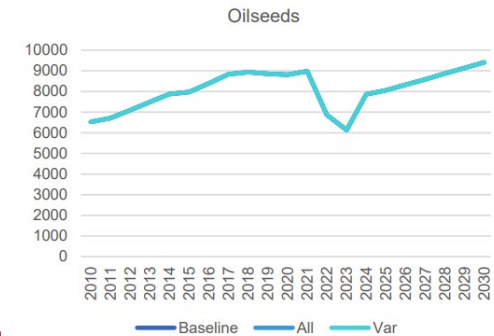
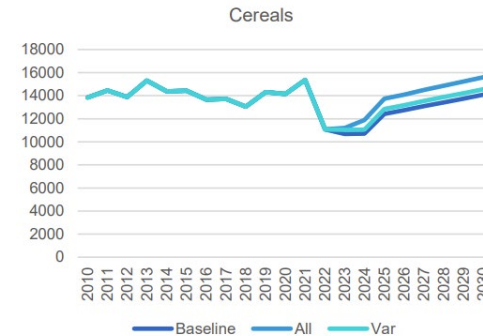
The per capita area of arable land in
Ukraine is 3x greater than the
European average
(0.7 vs 0.25 hectares)



>\$80 BILLION HAS BEEN LOST IN THE AGRICULTURE SECTOR OF UKRAINE

\$10.3 billion loss from damage of:

- agricultural machinery: **\$5.8 billion;**
- stolen inputs and outputs: **\$1.97 billion;**
- storage facilities: **\$1.8 billion;**
- perennial crop plantations: **\$398 million;**
- livestock: **\$254 million;**
- aquaculture and fishery: **\$35 million.**



Acreage of cereals and oilseeds
in 2010-2030, thsd ha

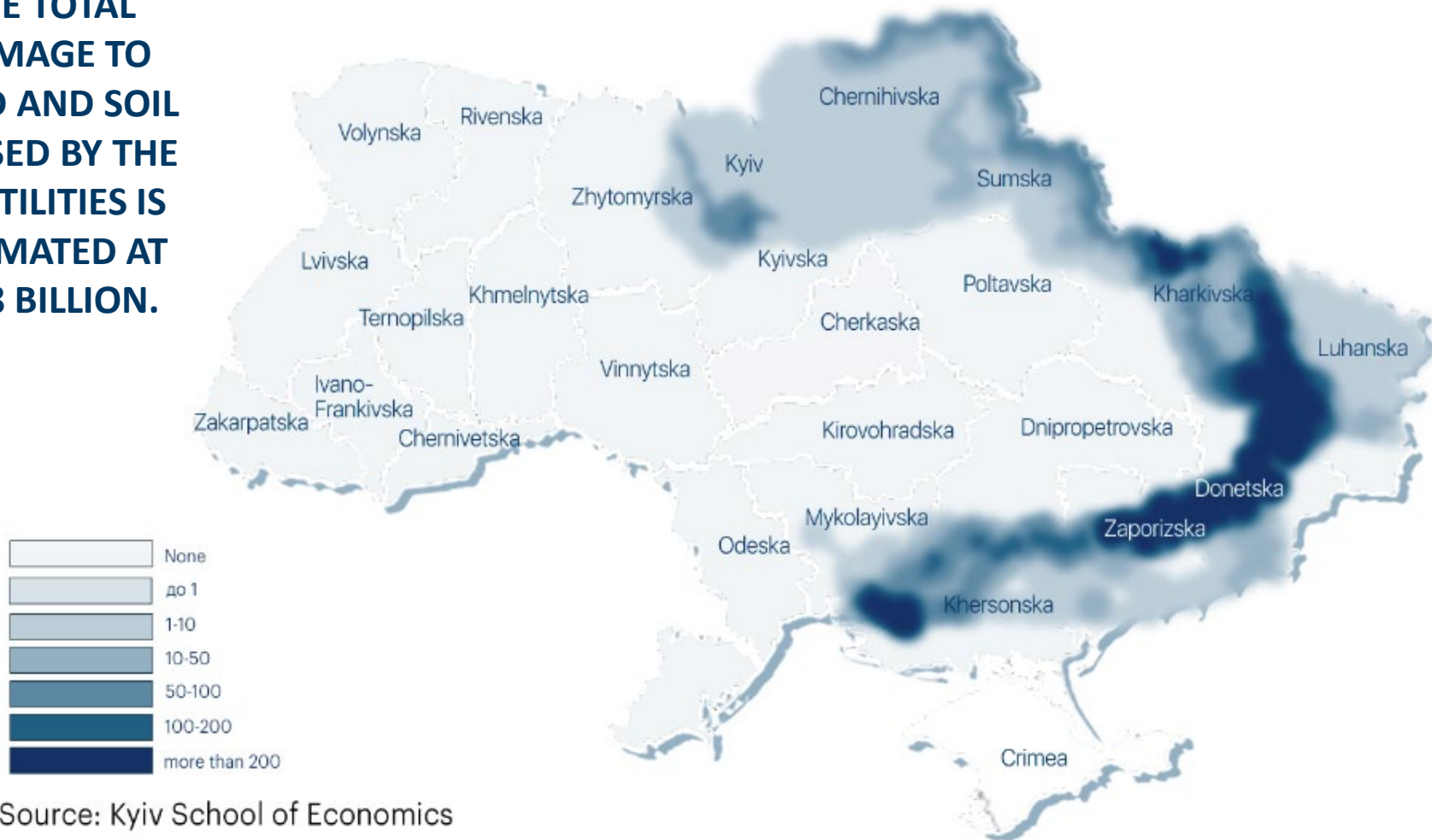
Source SSSU for 2021-2022, own
estimation for 2023-2030, <https://kse.ua>

Rapid Damage and Needs Assessment (RDNA) report prepared by the Government of Ukraine,
World Bank, United Nations, and the European Union, https://kse.ua/wp-content/uploads/2024/02/RDNA3_eng.pdf



VOLUME LOSSES FROM SOIL DISTURBANCE AS PER KM²

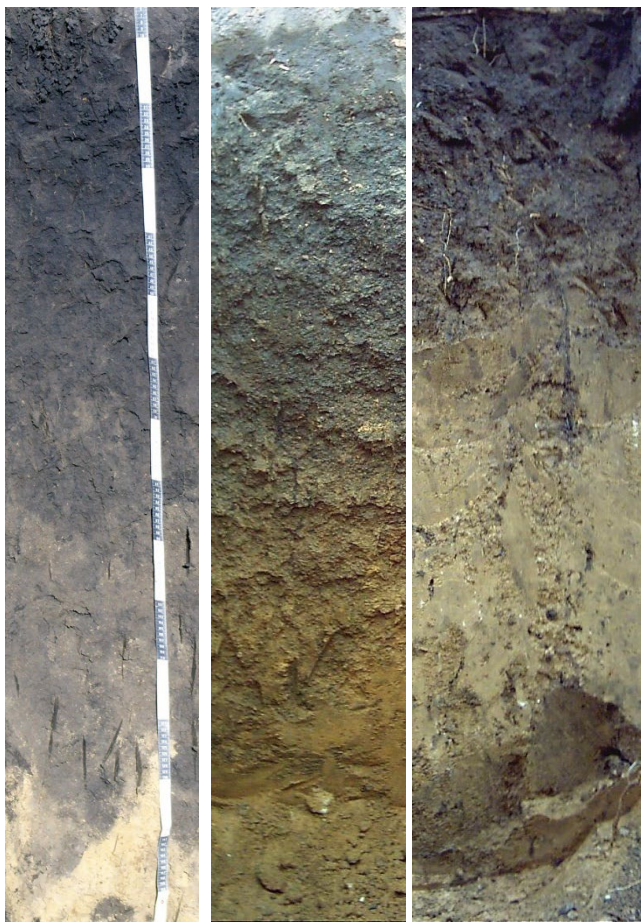
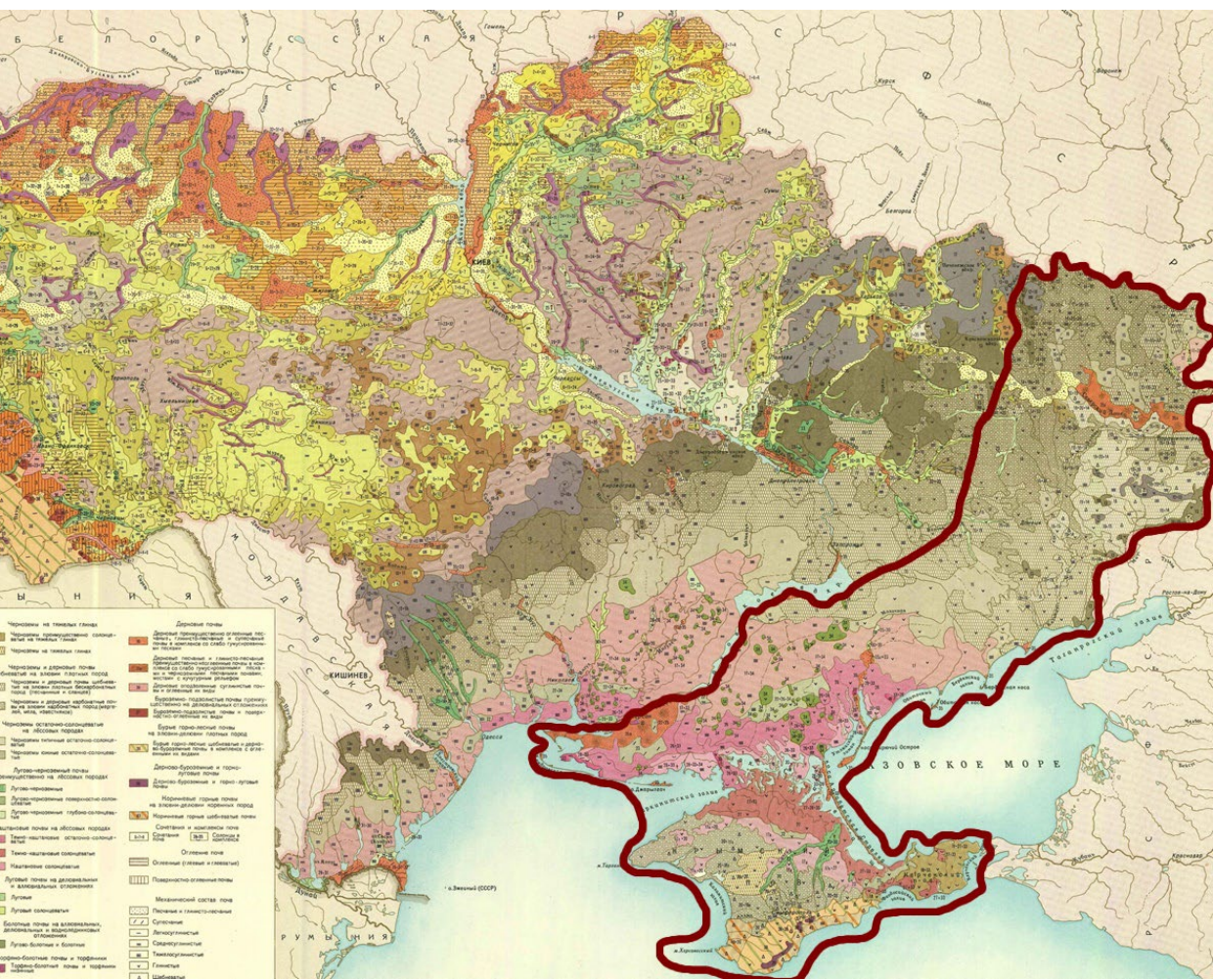
**THE TOTAL
DAMAGE TO
LAND AND SOIL
CAUSED BY THE
HOSTILITIES IS
ESTIMATED AT
\$9.8 BILLION.**



Source: Kyiv School of Economics



THE MOST FERTILE SOILS IN UKRAINE AND THE WORLD - CHERNOZEMS - HAVE BEEN STOLEN



Typical Ordinary Southern
CHERNOZEMS

HOSTILITIES HAVE SUBJECTED LANDS IN THE LIBERATED TERRITORIES TO MULTIPLE TYPES OF DEGRADATION

- Mechanical degradation
- Physical degradation
- Chemical contamination
- Biological degradation



MECHANICAL DEGRADATION

Trenches



© Maxar Technologies, <https://zn.ua>



Ukrainska Pravda, 26.11.2022. Trenches at Bahmut. Photo: Viktor Borinets

MECHANICAL DEGRADATION

Dugouts



Photo: Valeriia Burlakova, <https://novynarnia.com>

Sinkholes, Craters



Kyiv, Ukraine, February 15, 2024, Thomas Peter/Reuters

MECHANICAL DEGRADATION

Fuel and Lubricant storage sites



Bohdana Deresh, ArmyInform correspondent,
<https://armyinform.com.ua>

Ammunition storage sites



[State Bureau of Investigation,](https://dbr.gov.ua/news)
<https://dbr.gov.ua/news>

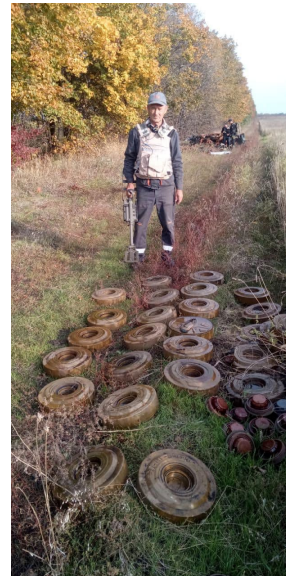
MECHANICAL DEGRADATION

Garbage Dumps



Photo Visty, 29.01.2024, <https://popasnaya.city>

Mines



3.10.2022.,
JSC Kharkivgaz,
<https://kh.dsoua.com>

Avia bombs



02.04.24.,
<https://censor.net>

MECHANICAL DEGRADATION



Royal Agricultural University (UK), Sumy National Agrarian University (Ukraine),
<https://soil-expert.snau.edu.ua>. Training of Experts to Assess Soils Damaged due to Hostilities



PHYSICAL DEGRADATION

SEVERE COMPACTION OF TYPICAL CHERNOZEM FROM MOVEMENT OF HEAVY MILITARY VEHICLES



Satellite imagery has revealed evidence of soil compaction near the village of Kutuzivka, Kharkiv region



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PHYSICAL DEGRADATION

Podzolized Chernozem compaction due to the passage of military vehicles across the field



04.2023

06.2023

07.2023

08.2023

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01.05.2024

03.05.2024

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PHYSICAL DEGRADATION

Soil Erosion in Craters



06.2022



08.2022

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PHYSICAL DEGRADATION

Over time the crater walls are sloughing and collapsing



04.2022



04.2022

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PHYSICAL DEGRADATION

Landscape/Soil Self Recovering



03.2023



07.2023

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PHYSICAL DEGRADATION

Soil subsidence frequently occurs in craters that have been refilled by Farmers

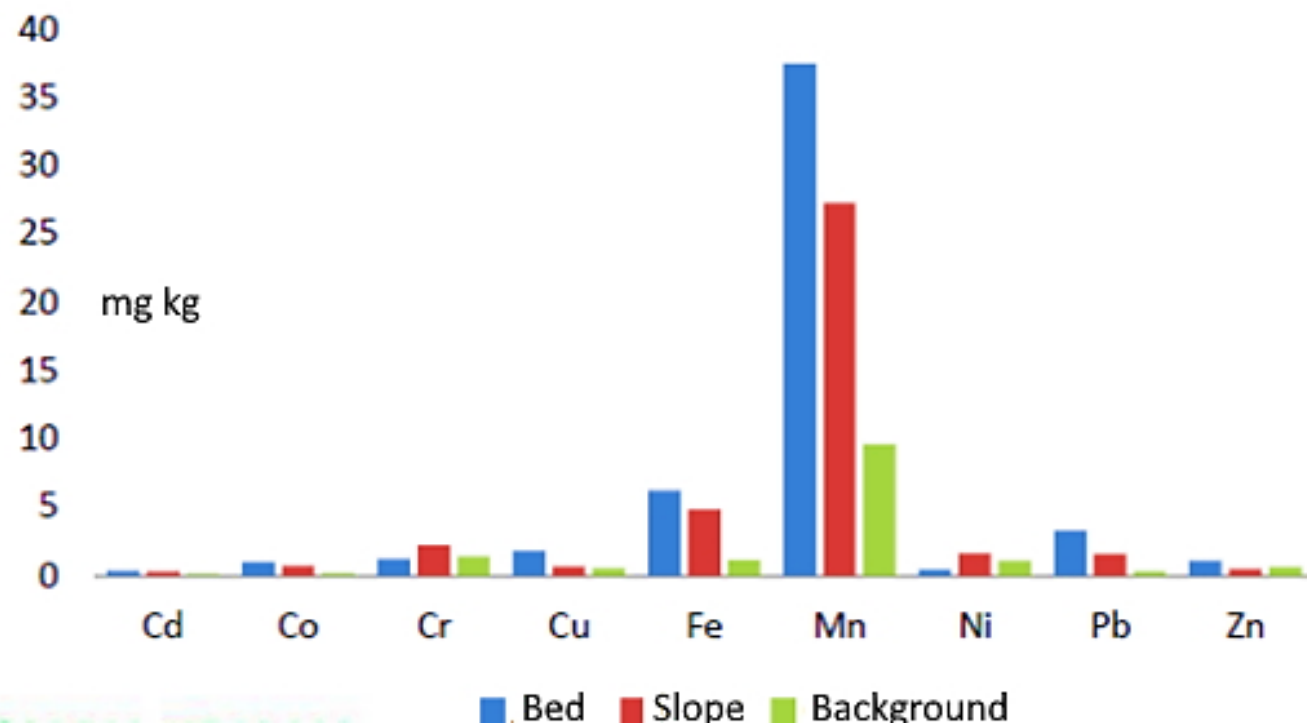
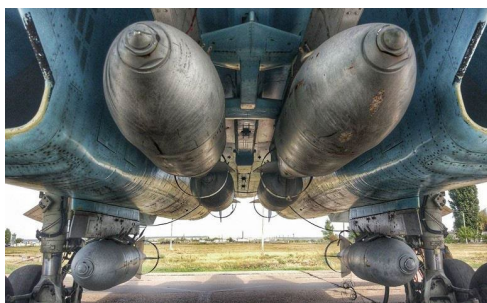


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CHEMICAL CONTAMINATION

Chemical Contamination of Craters from Avia Bomb Explosions

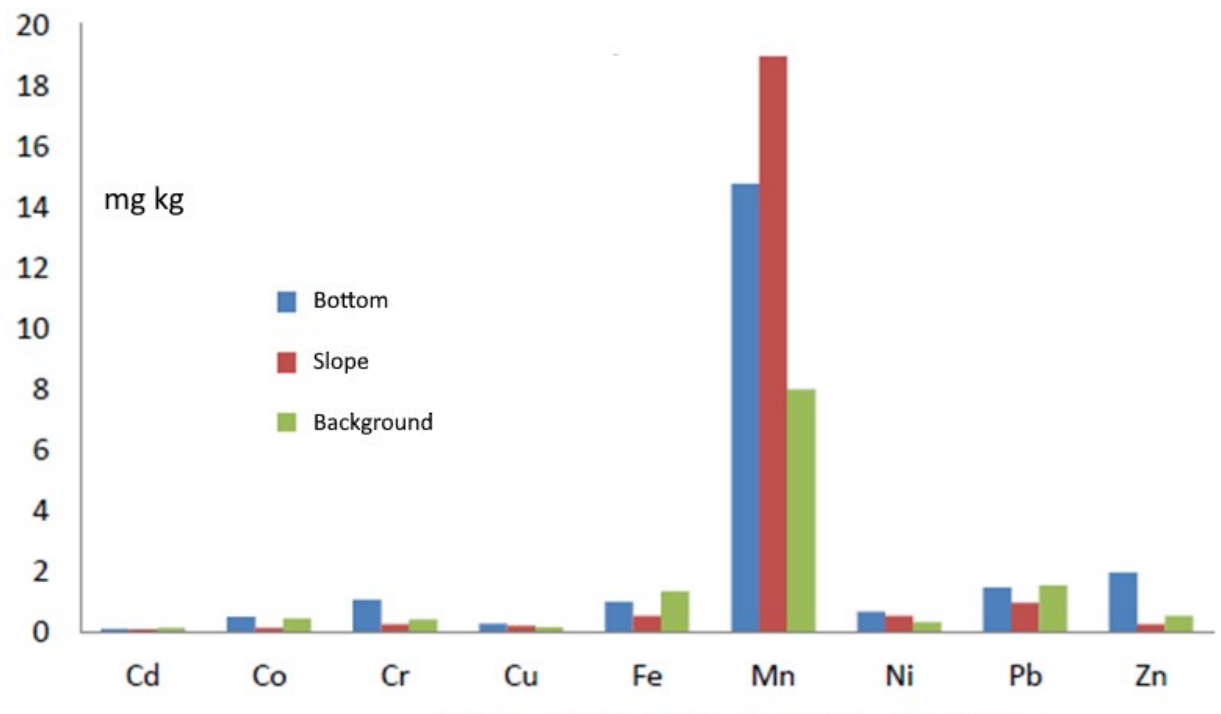


Novy Korotych village

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CHEMICAL CONTAMINATION

Chemical Contamination of Craters from GRAD system (BM21) Rockets



Katerynivka village

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<https://theclassytim.medium.com/using-image-processing-to-count-artillery-craters-in-ukraine-b8768c45309>



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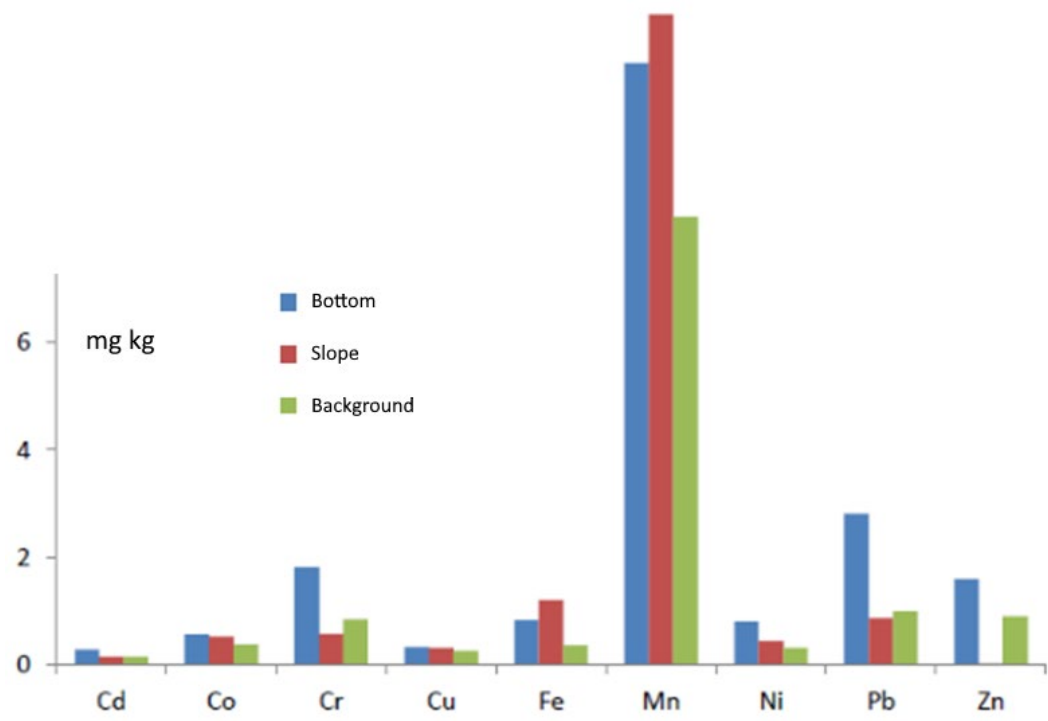
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CHEMICAL CONTAMINATION

Chemical Contamination of Craters from Ballistic C-300/400 Rockets

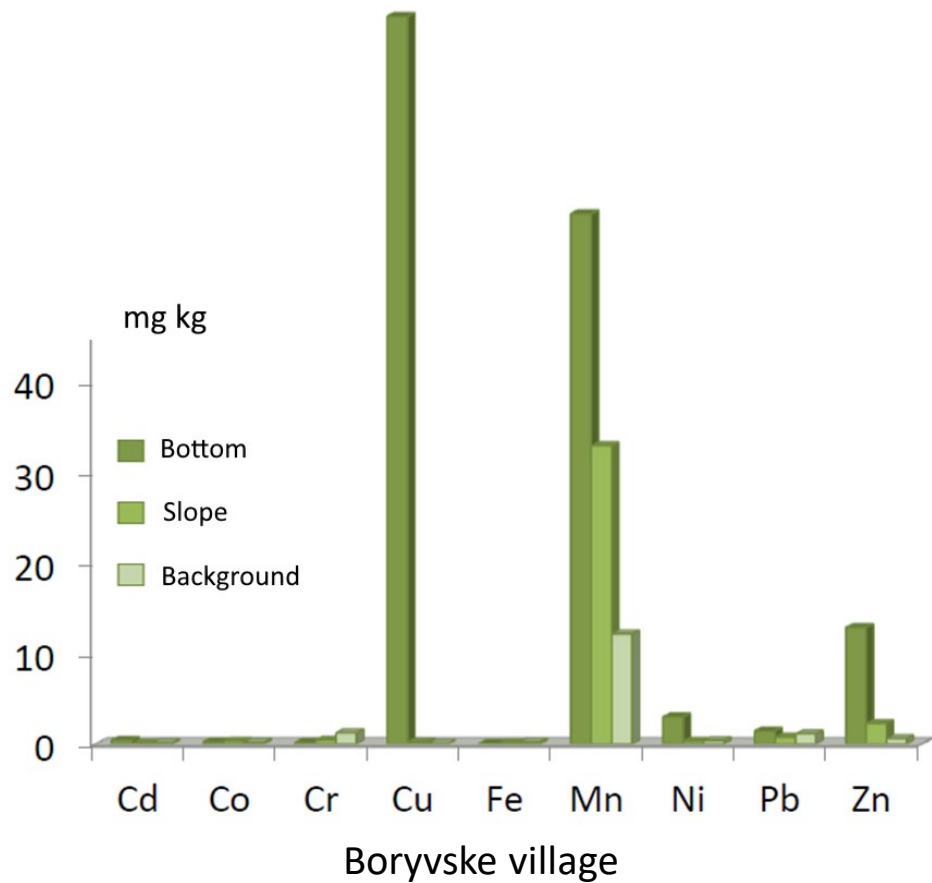


Zoryanske village

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CHEMICAL CONTAMINATION

Chemical Contamination of Craters from Mortar Explosions



<https://newch.tv/blyzko-50-vybukhiv-chernihivshchyna-shchodnia-poterpaie-vid-vorozhykh-obstriliv-71733>

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<https://soil-expert.snau.edu.ua>. Training of Experts to Assess Soils Damaged due to Hostilities



MAXIMUM PERMISSIBLE CONCENTRATION OF CHEMICAL
ELEMENTS IN CRATERS IS USUALLY NOT OBSERVED

There is several-fold increased content of chemical elements comparatively to
background level

GRAD systems (BM21)

Cr	2,6
Mn	1,85
Co	1,1
Ni	2
Cu	1,65
Zn	2,2

Mortars

Cd	3,58
Ni	7,55
Co	1,24
Zn	22,07
Mn	4,77
Pb	1,3
Cu	22,8

C-300/400 Systems

Cr	2,15
Cu	1,3
Ni	2,6
Cd	2
Fe	2,3
Zn	1,8
Co	1,5
Mn	1,3
Pb	2,8

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University (Ukraine), <https://soil-expert.snau.edu.ua>.
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CHEMICAL CONTAMINATION

Chemical Contamination from Abandoned Military Equipment and Ordnance



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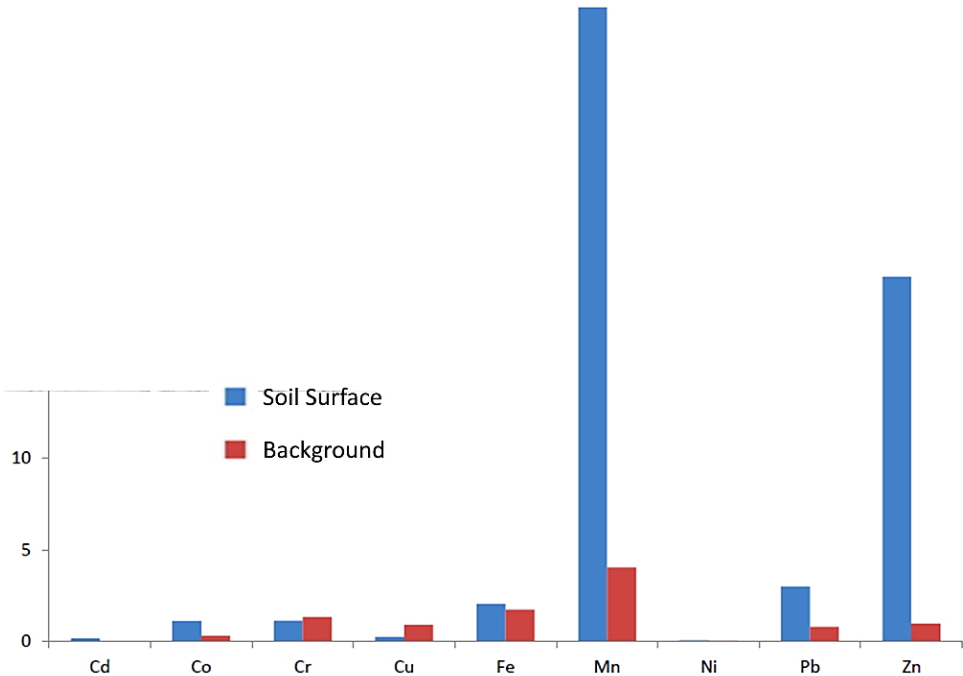
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CHEMICAL CONTAMINATION

Chemical Contamination of Soil from destroyed Infantry Fighting Vehicles



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CHEMICAL CONTAMINATION

Chemical Contamination of Soil from Abandoned Destroyed Tanks



Element	Soil, mg kg ⁻¹	Maximum permissible concentration
Cd	13,5	0,7
Co	174	5,0
Cr	2,01	6,0
Cu	1313	3,0
Fe	151,08	-
Mn	9,69	1500,0
Ni	2,7	4,0
Pb	291,52	6,00
Zn	8521,5	23,00
S	28.34	160.0

T 72B3

<https://defence-ua.com>, Royal Agricultural University (UK), Sumy National Agrarian University (Ukraine),
<https://soil-expert.snau.edu.ua>. Training of Experts to Assess Soils Damaged due to Hostilities

CHEMICAL CONTAMINATION

Chemical Contamination of Soil from Abandoned Destroyed Tanks



T80

Element	Soil, mg kg ⁻¹	Maximum permissible concentration
Cd	1,5	0,7
Co	1,39	5,0
Cr	7,82	6,0
Cu	2,05	3,0
Fe	1,40	-
Mn	-	1500,0
Ni	2,11	4,0
Pb	99,34	6,00
Zn	8,74	23,00
S	55.99	160.0

<https://mil.in.ua>, Royal Agricultural University (UK), Sumy National Agrarian University (Ukraine), <https://soil-expert.snau.edu.ua>. Training of Experts to Assess Soils Damaged due to Hostilities

CHEMICAL CONTAMINATION

Main Contaminants in Soil from Abandoned and Destroyed Tanks

DIESEL ENGINE



T 72



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T80

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ECOLOGICAL DEGRADATION

- reduction of vegetative cover
- loss of native habitats
- detrimental effects of fires
- decline of plants biomass and species composition
- increase of pests / diseases, loss of predators



Fires

<http://surl.li/kuiea>



Mice in Trenches

<https://rubryka.com/article/navala-myshej-v-okopah>

RECLAMATION OF TECHNOGENIC DEGRADED SOILS



DEMINEING

ALGORITHM FOR RESTORATION OF SOILS DEGRADED BY HOSTILITIES

1. Use remote sensing to detect military artifacts, natural anomalies or soil cover heterogeneities in farm fields;
2. Survey of the territory by means of proximal equipment;
3. Direct examination of military artifacts on site;
4. Mine clearance and mechanical removal of contaminants;
5. Sample soils, bedrock, groundwater, sediments, plants, etc.
6. Laboratory analysis of selected samples;
7. Map degraded and polluted soils;
8. Develop measures for remediation and restoration of disturbed landscapes;
9. Conduct necessary soil restoration measures.



*Thank you very much for your concern and attention to
Ukraine!*

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