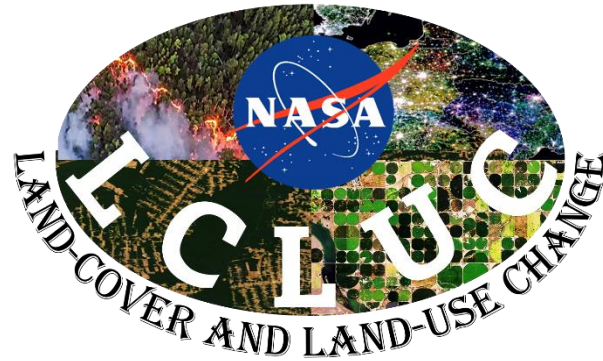




High-Impact Hot Spots of Land Cover Land Use Change: Ukraine and Neighboring Countries



University of Maryland, College Park MD, USA

Space Research Institute NAS Ukraine & SSA Ukraine, Kyiv, Ukraine

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

University of Copenhagen, Copenhagen, Denmark



Team

PI



Sergii Skakun
UMD

Co-I's



Joanne Hall
UMD



Natacha Kalecinski
UMD



Jean-Claude Roger
UMD



Yiqun Xie
UMD

Collaborators



Nataliia Kussul
SRI/NTUU KPI



Andrii Shelestov
NTUU KPI



Alexander Prishchepov
U. Copenhagen

Graduate students



Yiming Zhang
UMD

FINESST



Abdul Qadir
UMD



Michael Adegbenro
UMD



Christian Abys
UMD

FINESST



Leonid Shumilo
UMD



Jaemin Eun
UMD



Erik Duncan
UMD

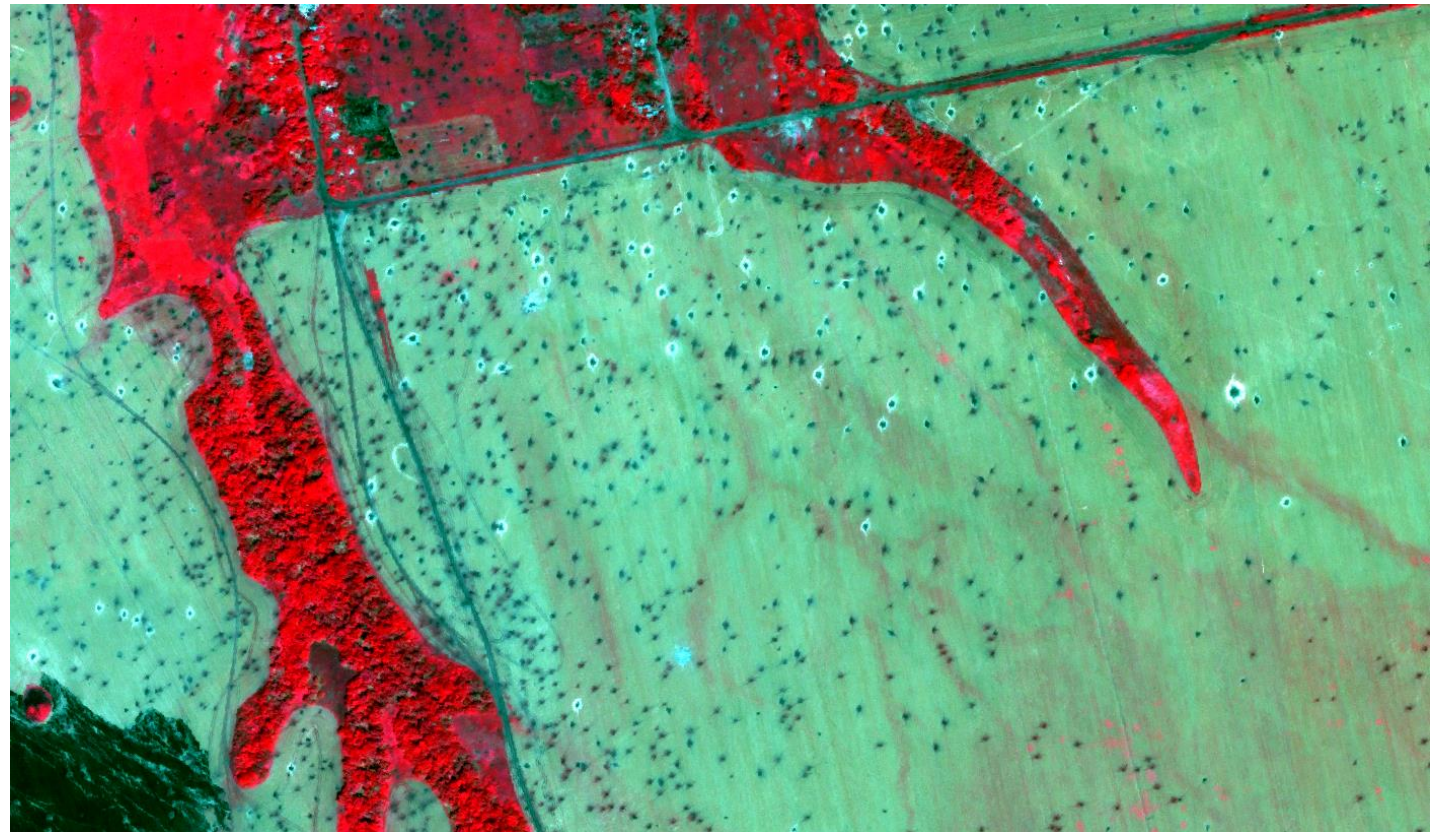


Gasmine Myers
UMD



Project overview

- The **overall scientific goal** of the project is to **analyze** and **quantify** the impact of land cover and land use change in Ukraine targeting **agricultural, forestry,** and **urban** sectors (Jan/2021-Dec/2023)
- Foci:
 - Impact of **war** in Ukraine on agriculture & environment
 - Changes in **elevation** & characterization in Ukraine
 - **Wheat** expansion & intensification in Russia





M-46 130mm field gun

Massive use of heavy weaponry

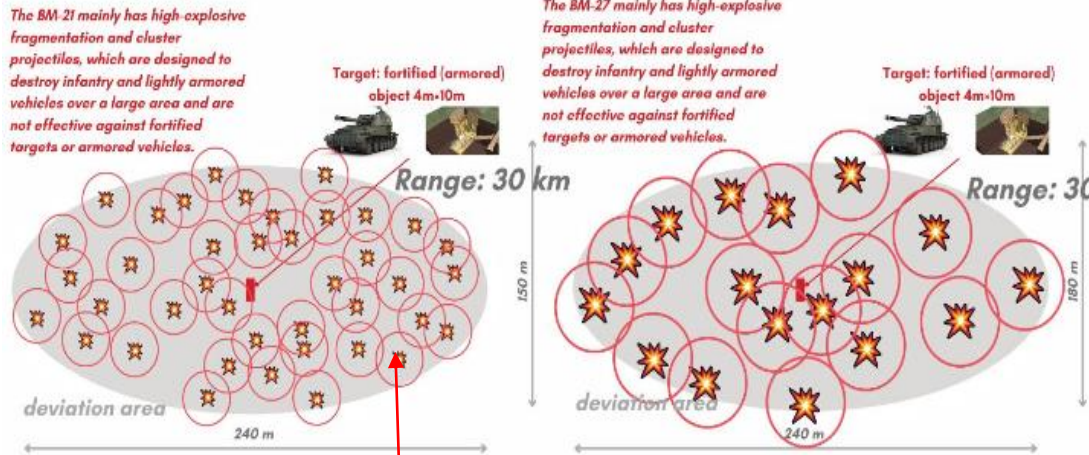


~ Using 110,000 shells per month
 ~ Asking for 250,000 shells per month



~ Estimated 5,000,000 shells fired
 ~ Up to 60,000 per day in July, 2022

<p>BM-21 "GRAD" / "TORNADO-G"</p> <p>Caliber - 122 mm Range - 20-40 km Longitudinal deviation of 0.5% from the range Transverse deviation of 0.8% from the range Number of rockets - 40 The impression area of one volley is 145,000 m² The impression area of one shell is 3,625 m²</p>	<p>BM-27 "URAGAN"</p> <p>Caliber - 220mm Range - 35 km Number of rockets - 16 Longitudinal deviation of 0.5% from the range Transverse deviation of 0.8% from the range The impression area of one volley is 420,000 m² The impression area of one shell is 26,250 m²</p>
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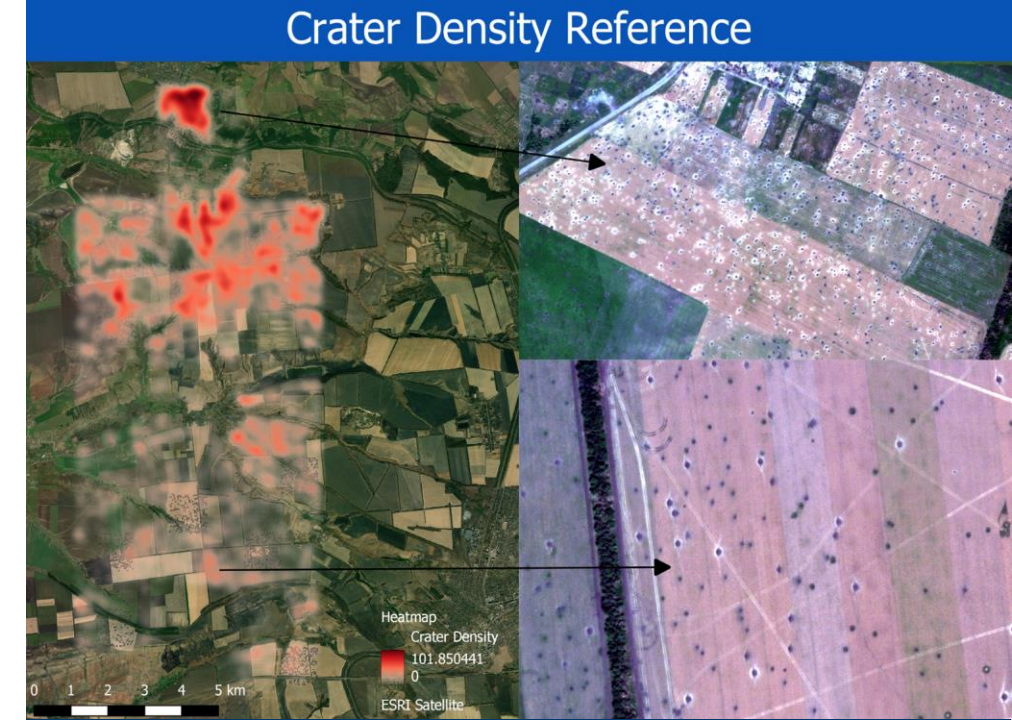


BM-21 Grad

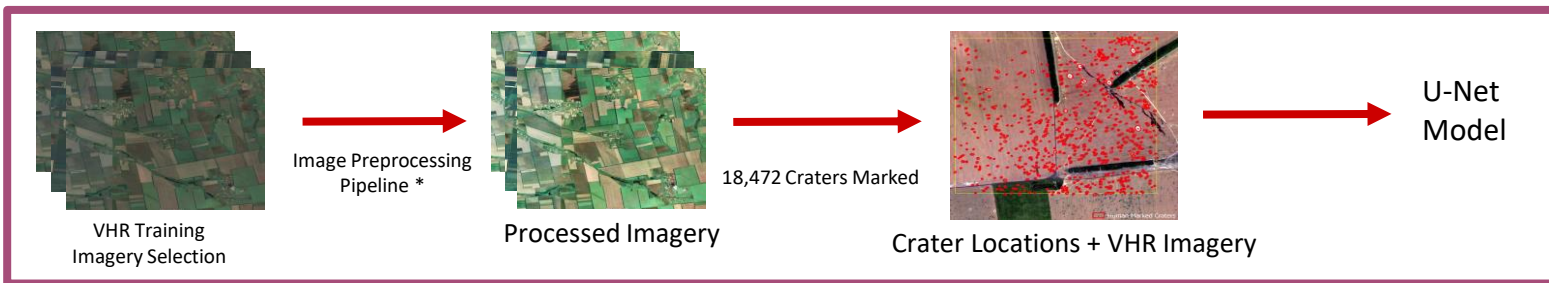


Majority of Artillery shelling is **un-guided**

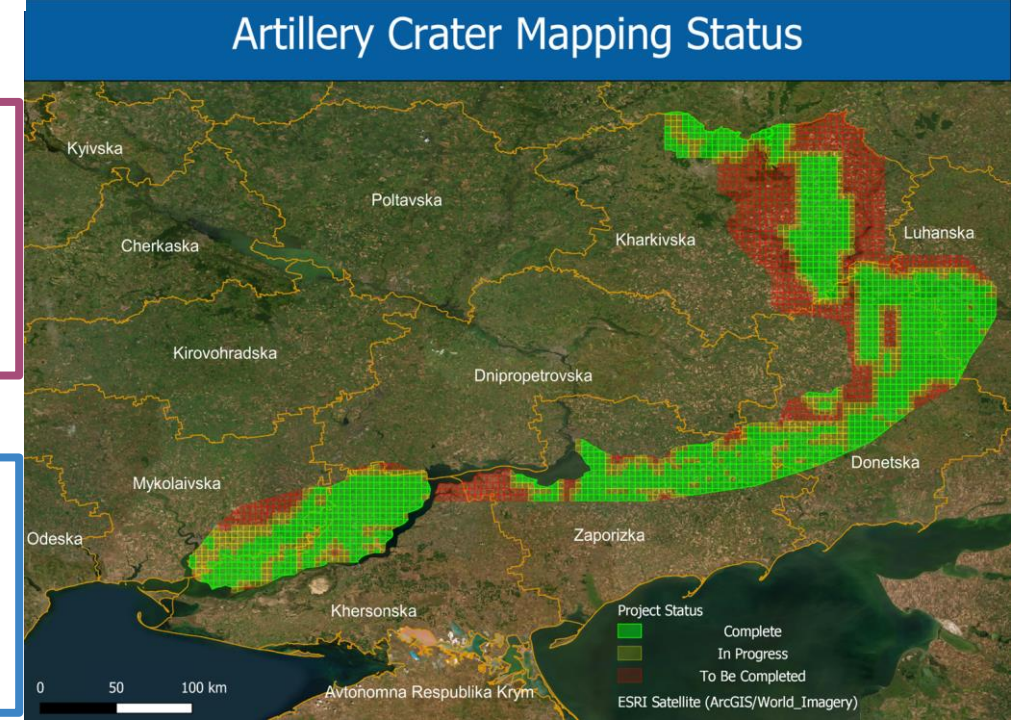
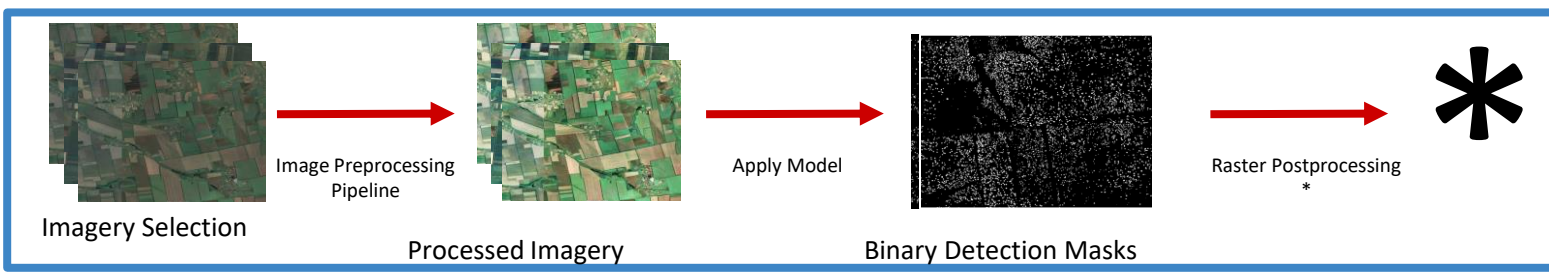
- Using the U-Net Segmentation model for crater detection
- Created VHR imagery processing pipeline for multi-terabytes of data
- Detecting on a per-crater level
- Using crater locations, we can scale up into hazard maps
- Agricultural, de-mining, and environmental products can be developed from crater dispersal



Training A Crater Detection Model, with 2022 Imagery

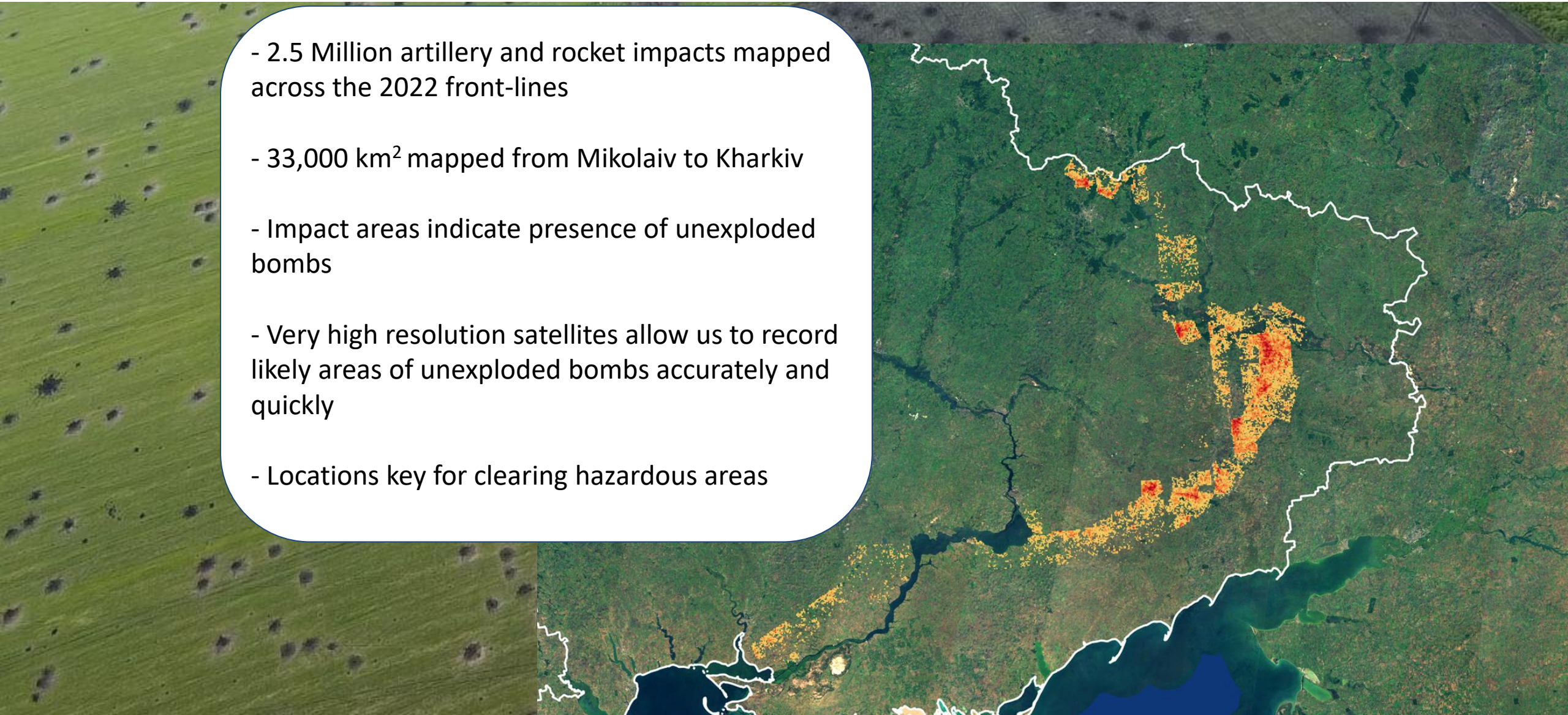


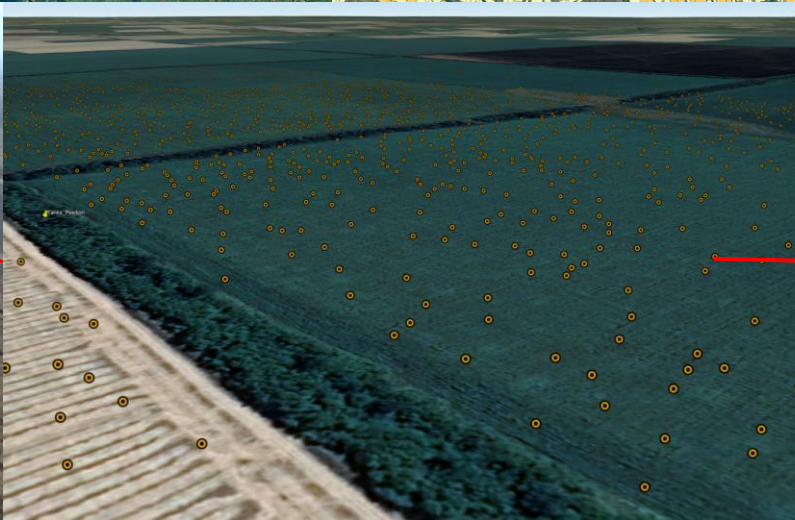
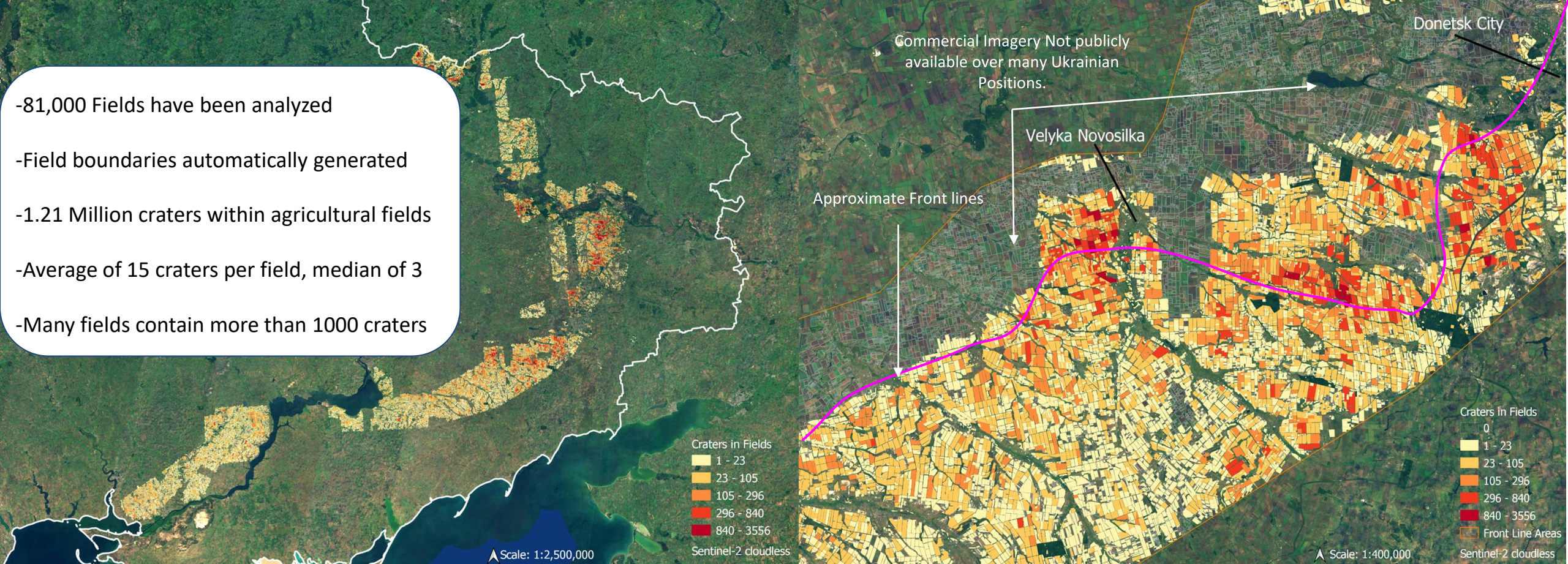
Mapping With Trained Model



Artillery and Rocket Crater Detection and Monitoring with VHR Satellite Imagery

- 2.5 Million artillery and rocket impacts mapped across the 2022 front-lines
- 33,000 km² mapped from Mikolaiv to Kharkiv
- Impact areas indicate presence of unexploded bombs
- Very high resolution satellites allow us to record likely areas of unexploded bombs accurately and quickly
- Locations key for clearing hazardous areas



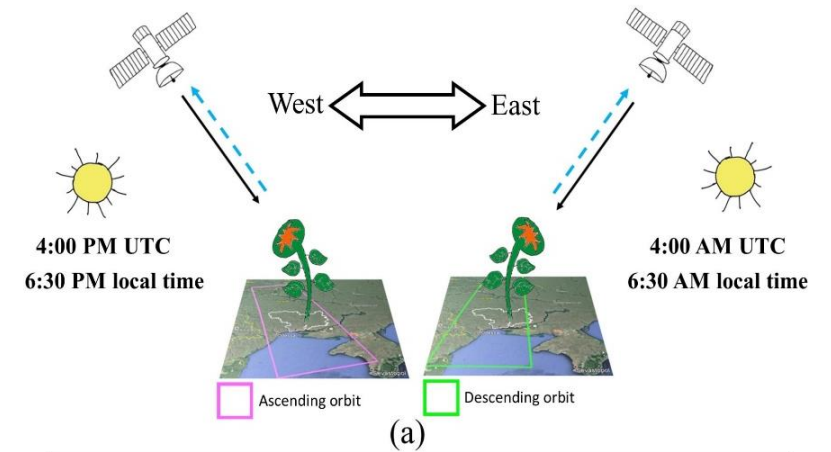




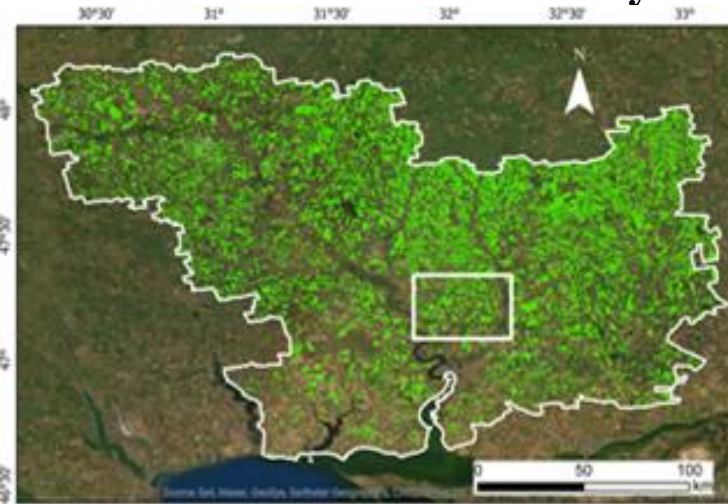
Sunflower mapping using Sentinel-1 data



- Heliotropic and directional behavior of sunflower observed in Sentinel-1 data.
- SAR based generalized model developed for automatic sunflower mapping.
- The proposed generalized spatio-temporal classifier can map sunflower with high accuracy (>85%) early in season, without any additional field labels.

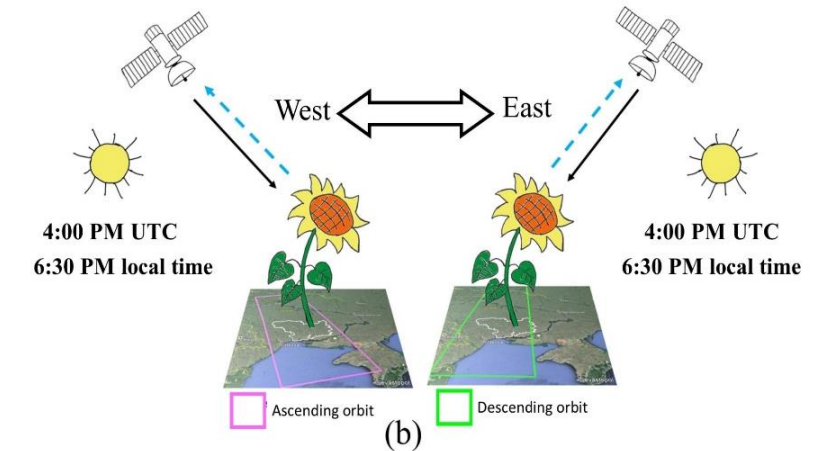


Mykolaiv, Ukraine



User' accuracy = 0.91

Producer's accuracy = 0.92



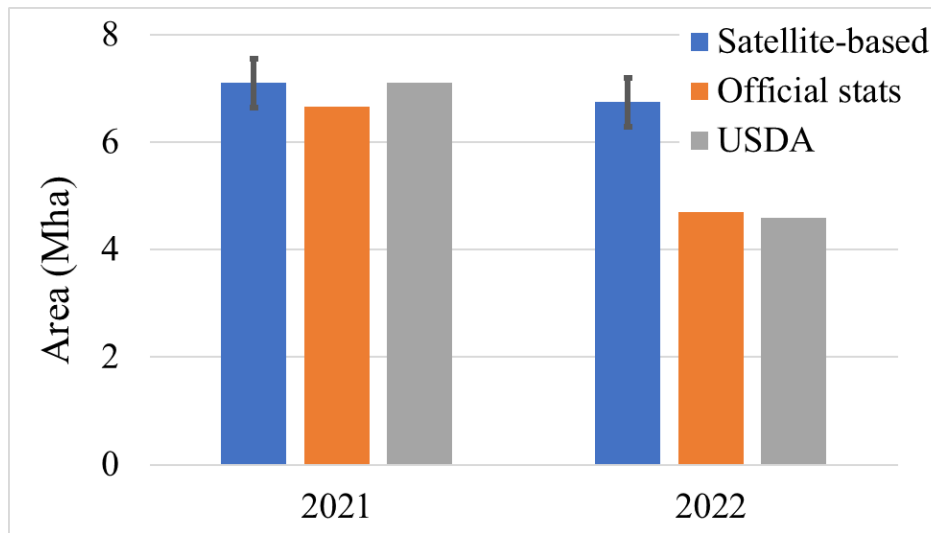
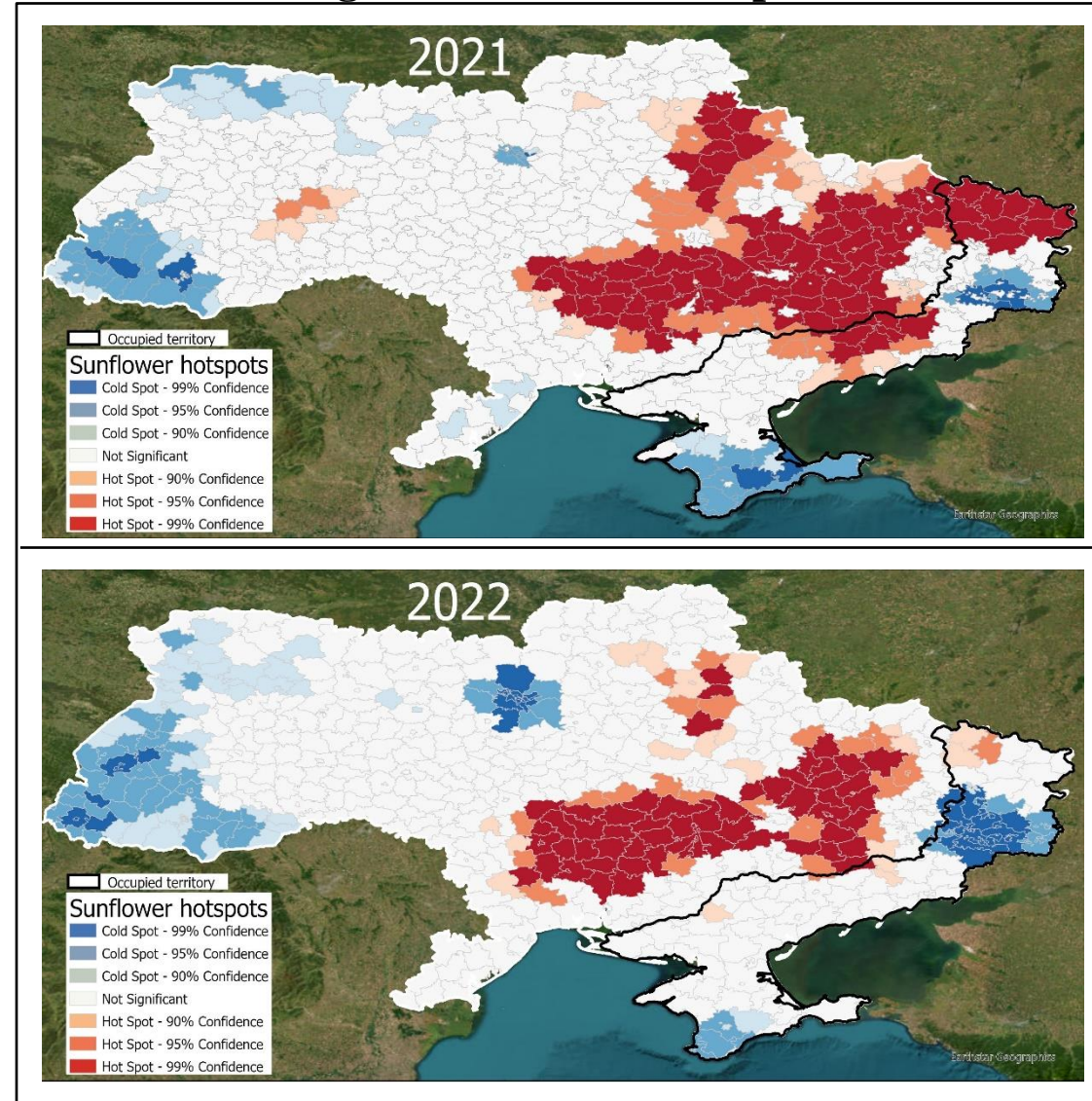
Heliotropic/directional behavior in sunflower as detected by Sentinel-1 ascending and descending orbit during initial (a) pre-flowering stage and (b) during flowering stage.



Impact of war on sunflower crop

- Sunflower hotspots disappeared from South, South-West Ukraine.
- Almost 5% decrease in overall sunflower area in comparison to 2021.
- Decrease in sunflower area in Temporary occupied territories compensated by increase in sunflower area in free Ukraine.

Changes in sunflower hotspots



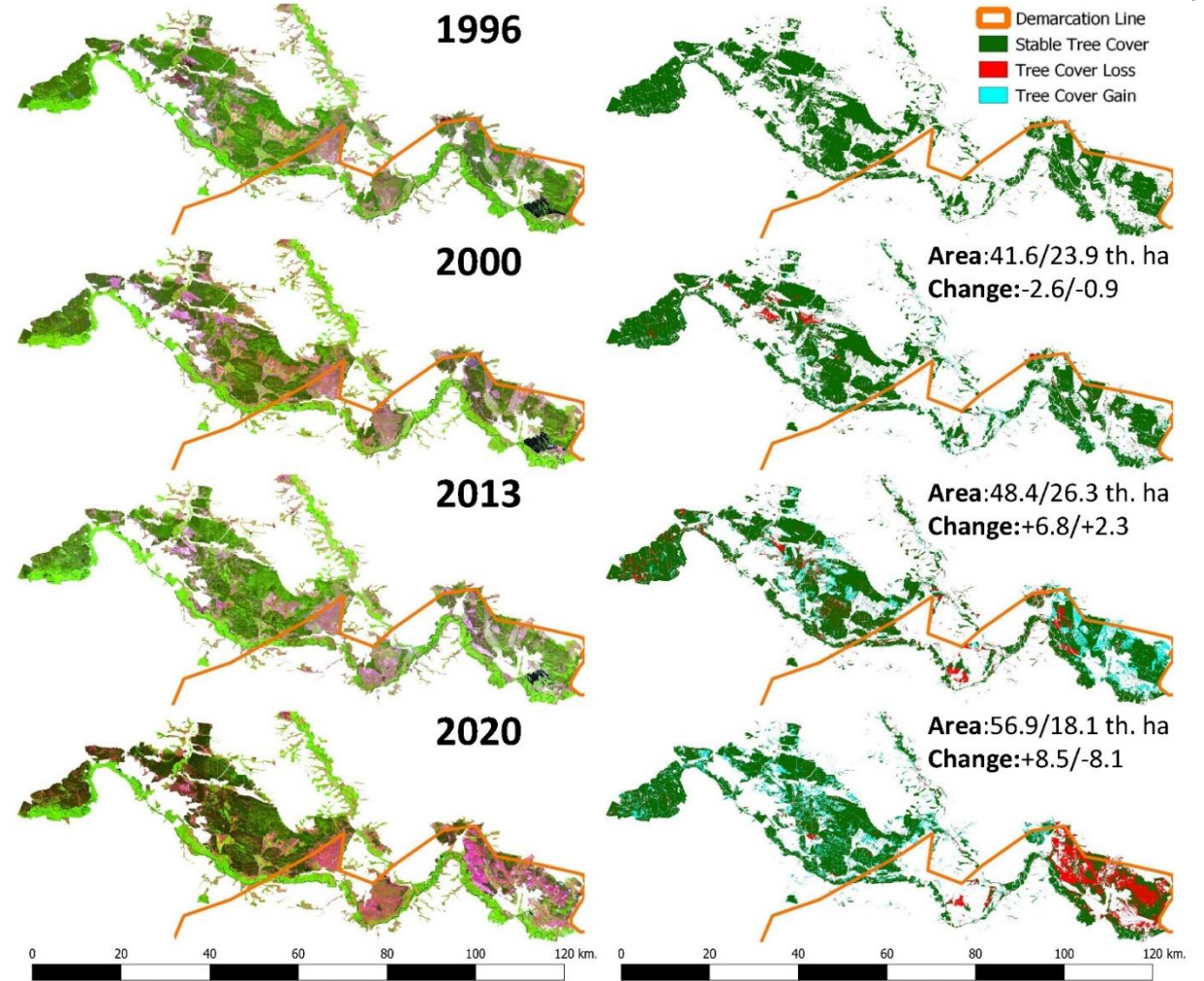
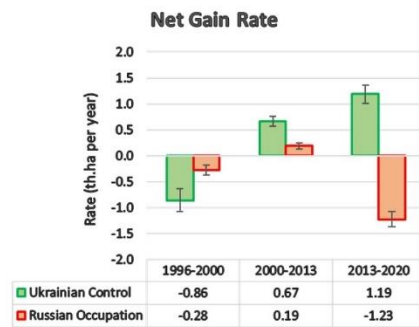
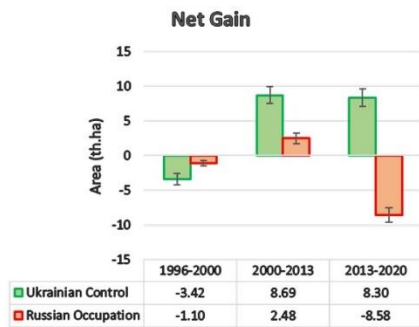
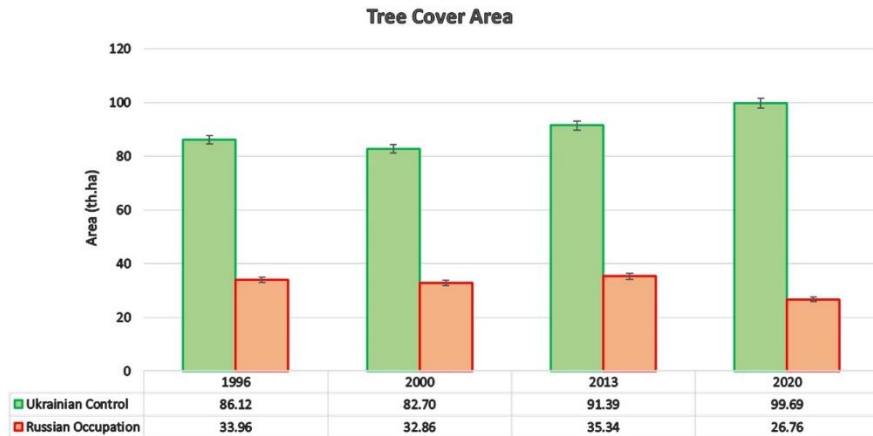
	2021	2022
Official estimates	6.67	4.70
USDA estimates	7.10	4.60
Satellite-based estimates	7.10(±0.23)	6.75 (±0.23)

Sampling-based sunflower area estimation and comparison with official statistics



Emerald Network occupation in Luhansk region

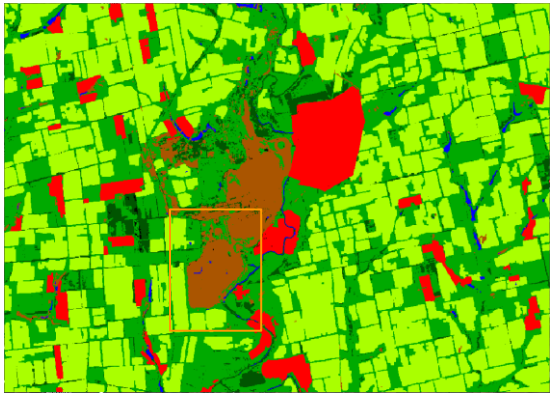
- Emerald Network policies are effective for the conservation of vulnerable and damaged in the warfare environmental protected areas.
- Separation of ecosystems from the environmental protection institution and policies through occupation of territory is causing extreme degradation and ecosystem services losses.



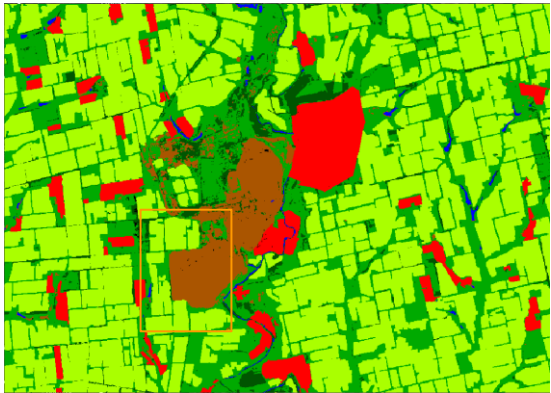
Year	Ukrainian Control			Russian Occupation		
	Area	Error	p-value	Area	Error	p-value
1996-2000	-3.42	0.86	7.57E-05	-1.10	0.40	0.005443
2000-2013	8.69	1.22	1.39E-12	2.48	0.79	0.001819
2013-2020	8.30	1.25	3.69E-11	-8.58	1.02	6.34E-17



DEM Changes and Characterization: Ukraine



2000

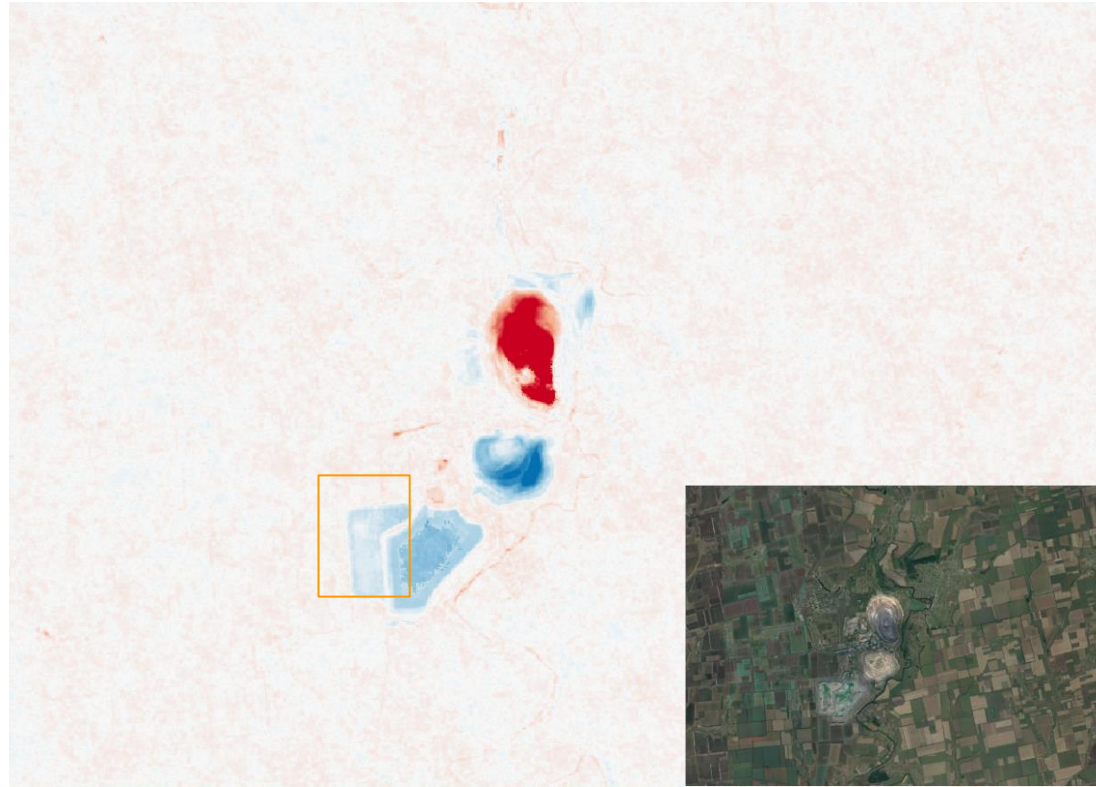


2010

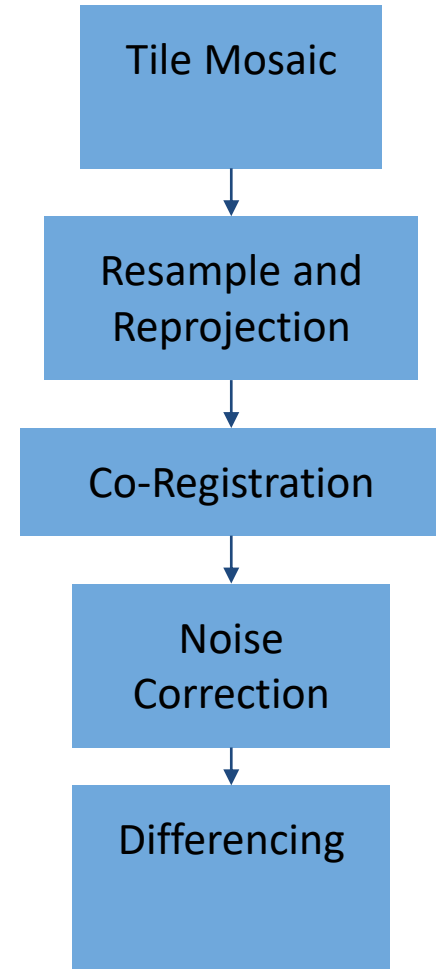
- Artificial
- Cropland
- Forest
- Grassland
- Bare land
- Water

Elevation (m)

- -36
- -27
- -18
- -9
- 0
- 9
- 18
- 27
- 36



Bare land gain due to subsidence & uplift at mining site in Shyrokivs'kyi district of Dnipropetrovsk.

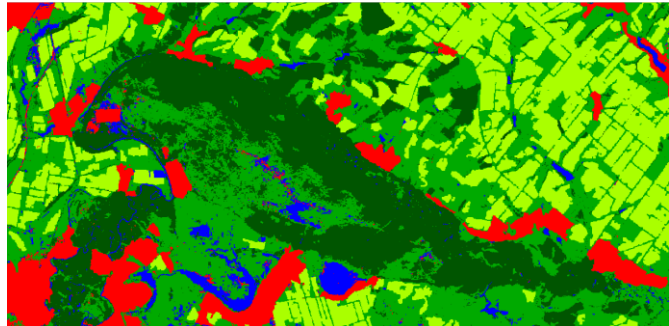


Grassland to Bare land: 4180.5 km
 Water to Bare land: 335.7 km
 Forest to Bare land: 896.4 km
 Bare land to Grassland: 4572.0 km

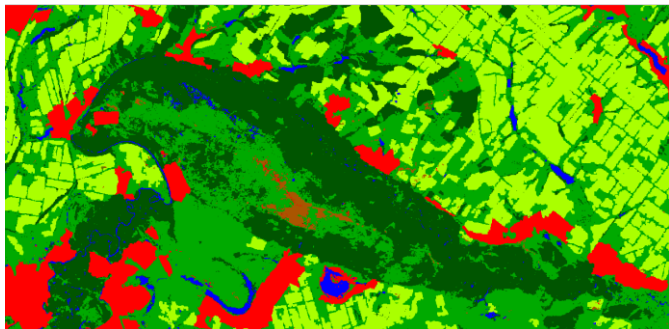
Using elevation differences between SRTM (Shuttle Radar Topography Mission; February 11, 2000) Copernicus GLO (Global; January 01, 2011 - July 01, 2015) DEM to identify land-surface changes across Ukraine's terrain.



DEM Changes and Characterization: Ukraine



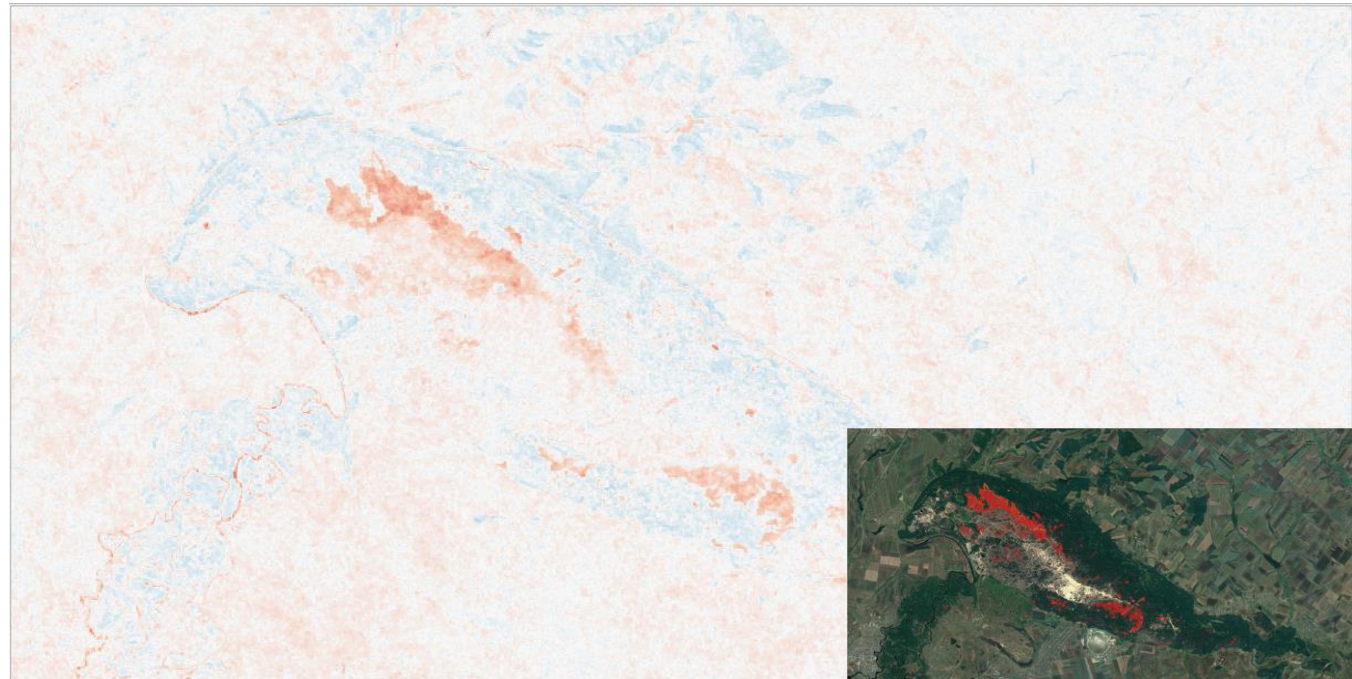
2010



2000

- Artificial
- Cropland
- Forest
- Grassland
- Bare land
- Water

- Forest to Grassland: 25346.7 sq km
- Forest to Cropland: 1637.1 sq km
- Forest to Water: 3576.6 sq km
- Forest to Artificial: 342.0 sq km
- Forest to Bare land: 18.9 sq km



Elevation (m)

- -24
- -16
- -8
- 0
- 8
- 16
- 24

Forest range in Novomoskovsk, Dnipropetrovsk underwent forest loss from 2000 to 2015 ranging from -4 m to -14 m with losses coinciding with GLAD Forest loss dataset (bottom right).

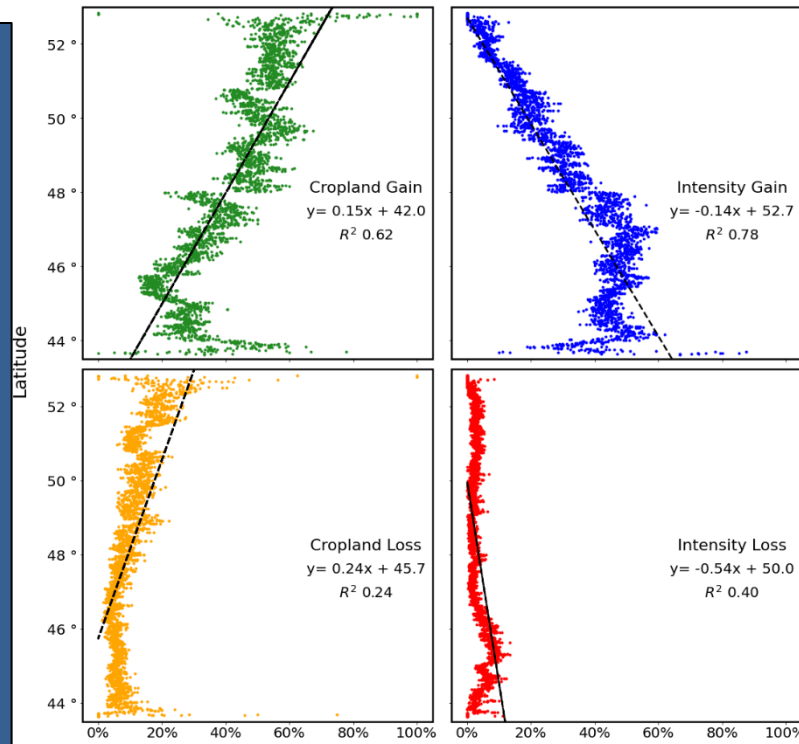
The study of terrain changes through remote sensing and geospatial techniques can serve as a useful tool for tracking environmental change in regions undergoing substantial degrees of change.



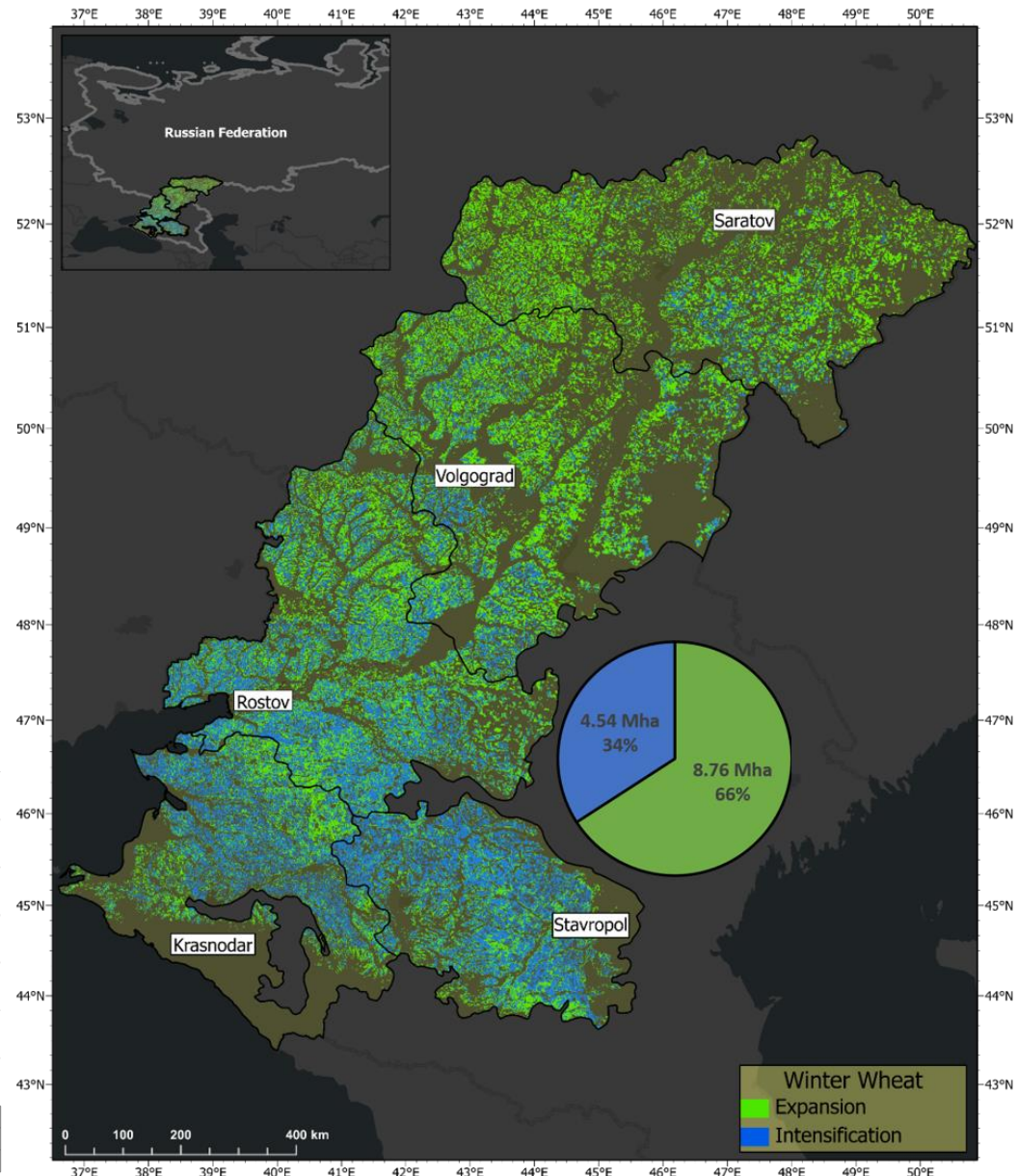
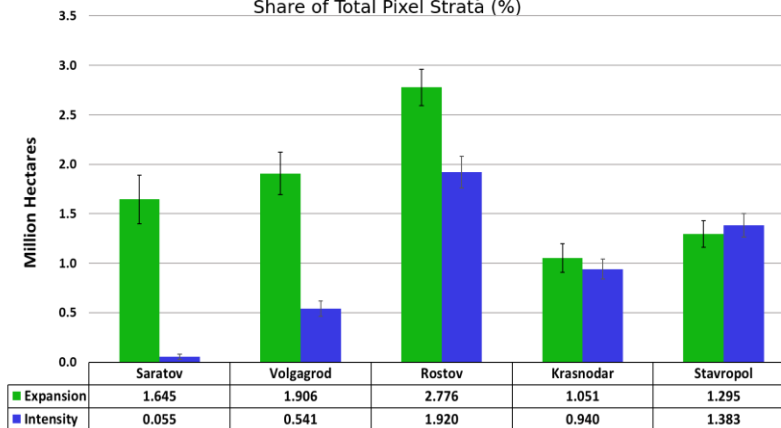
Two Decades of Winter Wheat Expansion & Intensification in Russia



Winter Wheat Cropland Change Relative to Latitude



Winter Wheat Cropland Growth Expansion & Intensification
Share of Total Pixel Strata (%)



Motivation

- ❖ Since 2000, Russia increased wheat production by 149% including a 117% increase in winter wheat cropland (federally reported statistics)
- ❖ Spatial distribution and method of growth currently unknown

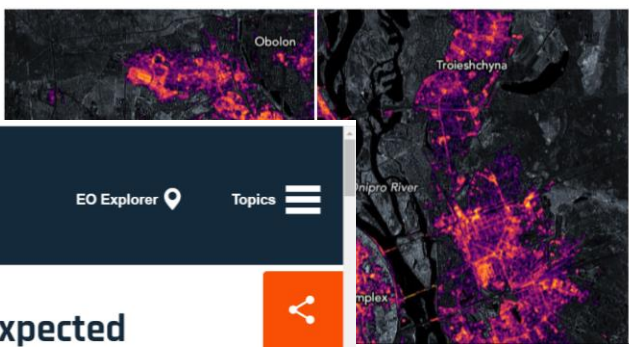
Key Results

- ❖ 40% change in LCLU due to winter crops
- ❖ 29% of change due to growth
 - ❖ Expansion – 66%
 - ❖ Intensification – 34%
- ❖ Latitudinally Dichotomous Growth
 - ❖ Northern Expansion
 - ❖ Southern Intensification
- ❖ 69% Capacity remains for continued intensification

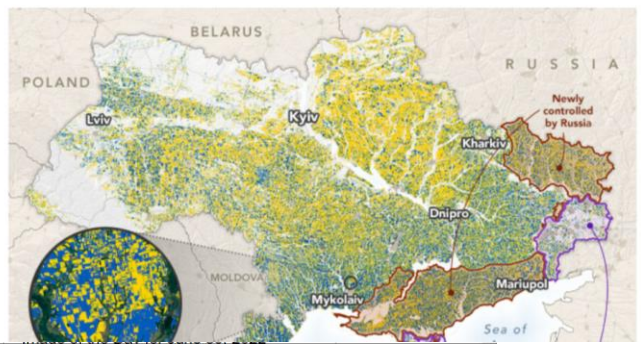
RESEARCH
Russian Attack on Ukraine Also Targeted Global Food Supply

UMD Experts Predict That Poorer Nations Will Suffer Most as Chaos Grips Agriculture in Black Sea Region
 By Chris Carroll / Mar 30, 2022

Tracking Night Lights in Ukraine

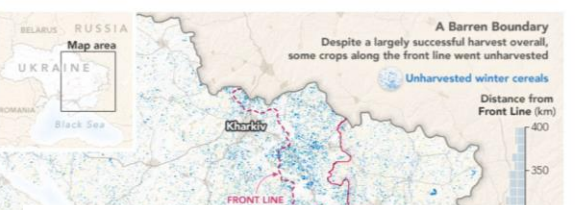


Measuring War's Effect on a Global Breadbasket



View this area in EO Explorer
 NASA Harvest researchers are using satellite observations and economic data to track how the Russia-Ukraine conflict is disrupting the global food system.
 Image of the Day for July 1, 2022

Larger Wheat Harvest in Ukraine Than Expected

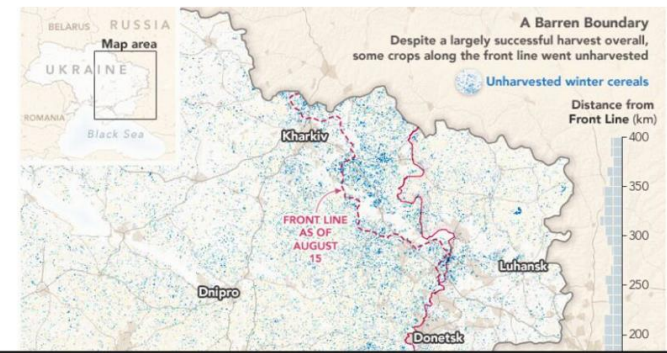


View this area in EO Explorer
 A satellite-based analysis indicates that
The New York Times

Politics
Russia Reaped \$1 Billion of Wheat in Occupied Ukraine, NASA Says

- NASA Harvest uses satellite imagery to model wheat crop
- A quarter of Ukraine wheat is grown on land claimed by Russia

Russia now occupies roughly 22 percent of Ukraine's farmland, according to a NASA analysis.



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Dissemination, outreach, trainings

- **Two FINESST** grants (A. Qadir, L. Shumilo)
- **7 papers** published (4 in revision)
- Presentations: AGU, SCERIN, ESA LPS, AAAI
- Training:
 - NASA-ESA Trans-Atlantic Training (TAT) 2022
 - Quantitative Remote Sensing Summer School 2022 (by UMD)