UN-SPIDER RSO Ukraine. Current activities

Prof. Kussul Nataliia

Head of Department of Mathematical Modelling and Data Analysis

NTUU "Igor Sikorsky Kyiv Polytechnic Institute“,

Who we are?

National Technical University of Ukraine «Kyiv Polytechnic Institute»

- Department of Mathematical Modelling and Data Analysis

Space Resesrch Institute National Academy of Sciences of Ukraine

- Department of space information technologies and systems

- GEO Working Plan **- GEOGLAM, JECAM, EuroGEO**
- **UN-SPIDER RSO**
- **Copernicus Academy**

Our expertize

- Satellite monitoring
- Machine learning on sate
- Land cover/land use
- Geospatial intelligence

Interactive Map

Select from any JECAM study site in the world to learn more

Journals & Magazines > IEEE Geoscience and Remote Se... > Volume: 14 Issue: 5

Deep Learning Classification of Land Cover and Crop Types Using Remote Sensing Data

Publisher: IEEE Cite This PDF

Nataliia Kussul ; Mykola Lavreniuk ; Sergii Skakun ; Andrii Shelestov **All Authors**

795 Paper Citations

28474 Full Text Views

Abstract

Document Sections

Abstract:

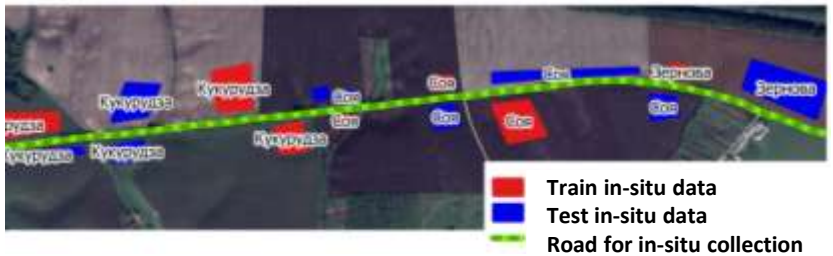
Deep learning (DL) is a powerful state-of-the-art technique for image processing including remote sensing (RS) images. This letter describes a multilevel DL architecture that targets land cover and crop type classification from multitemporal

Methodology of LC/LU classification

Input data

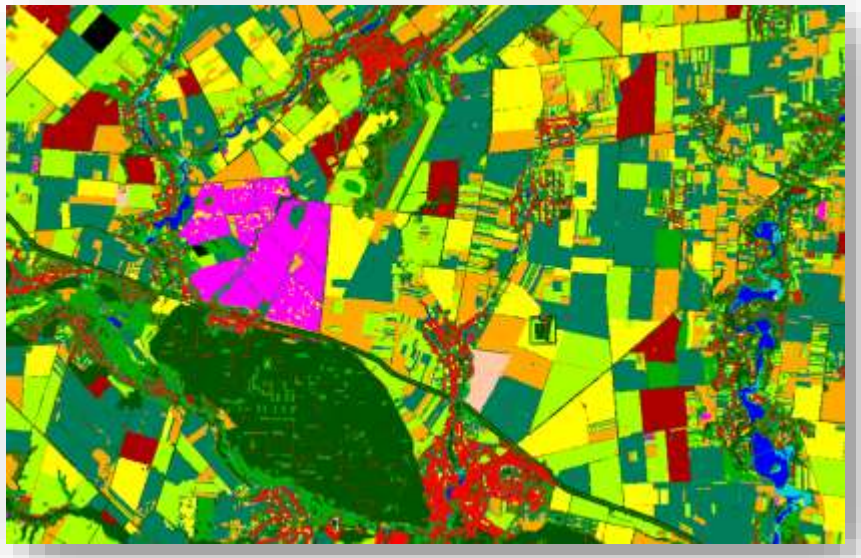
Time series satellite data
(**Sentinel-1,2**)

In-situ data along the roads



Artificial Intelligence

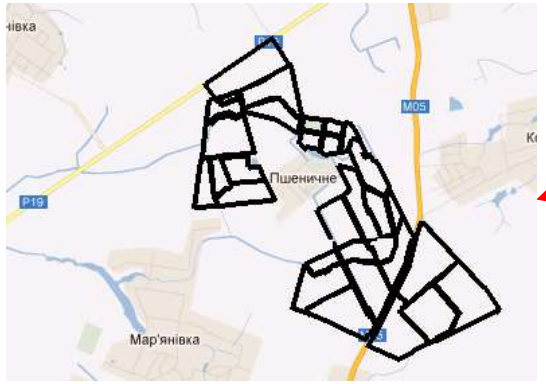
LC/LU classification map



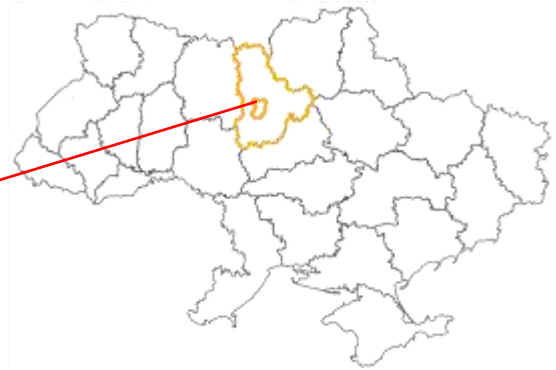
Joint Experiment of Crop Assessment and Monitoring

JECAM

- ***Мережа полігонів***
- ***Розробка методів валіації***
- ***Оцінка посівних площ***
- ***Класифікація сільськогосподарських культур***
- ***Адаптація моделей росту культур***



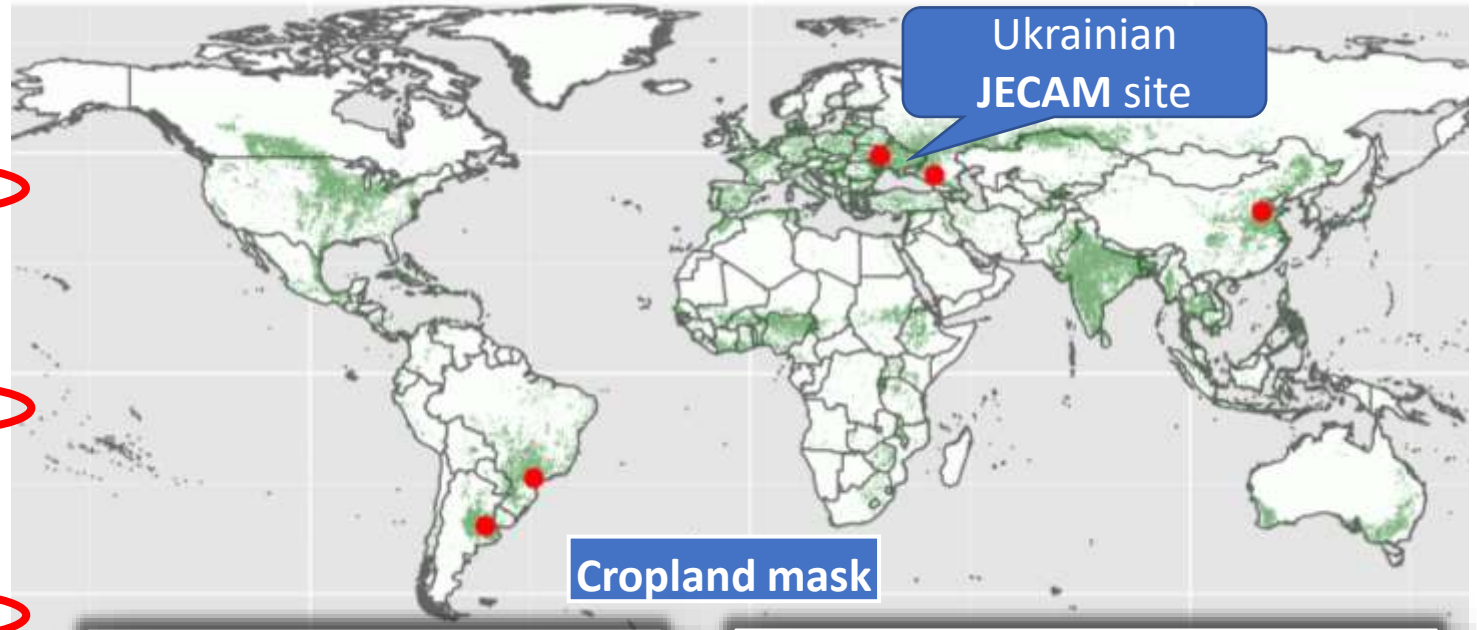
Територія інтенсивного спостереження

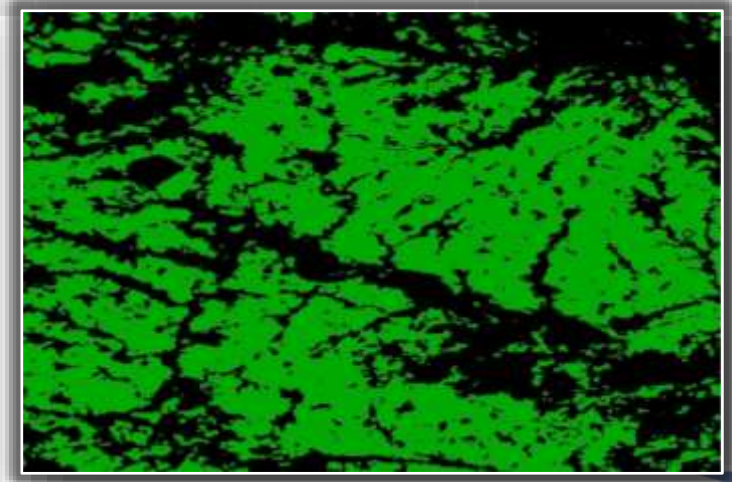


Київська область & Васильківський район

Validation methodology for JECAM

site	method	OA
Ukraine	iki	93.62
Ukraine	inta	96.58
Ukraine	radi	95.91
Ukraine	sri	98.04
Ukraine	ucl	97.58
Argentina	iki	90.74
Argentina	inta	92.66
Argentina	radi	90.52
Argentina	sri	95.49
Argentina	ucl	85.33
Brazil	iki	90.26
Brazil	inta	89.54
Brazil	radi	84.45
Brazil	sri	91.60
Brazil	ucl	91.15
China	iki	90.58
China	inta	91.23
China	radi	90.58
China	sri	90.58
China	ucl	88.31
Russia	iki	98.19
Russia	inta	95.40
Russia	radi	94.48
Russia	sri	98.38
Russia	ucl	95.21



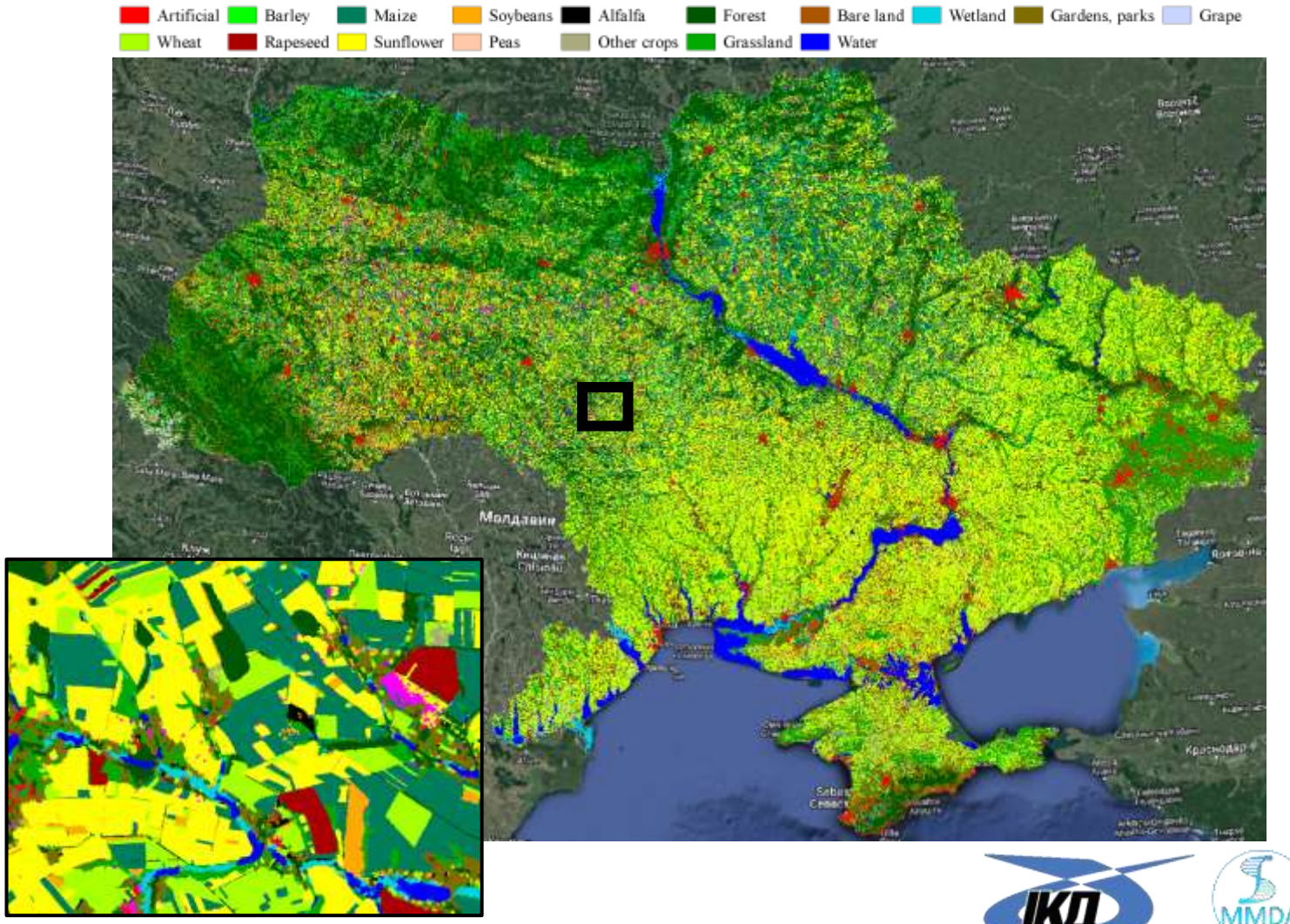


Waldner, F., De Abelleyra, D., Verón, S.R., Zhang, M., Wu, B., Plotnikov, D., Bartalev, S., Lavreniuk, M., Skakun, S., Kussul, N., Le Maire, G., Dupuy, S., Jarvis, I., Defourny, P. Towards a set of agrosystem-specific cropland mapping methods to address the global cropland diversity (2016) International Journal of Remote Sensing, 37 (14), pp. 3196-3231.

Classification in CREODIAS Cloud

Ukraine 2021

Class	PA	UA	F1
Artificial	96,7	98,2	97,4
Cereal	98,6	99,8	99,2
Rapeseed	98,9	99,7	99,3
Buckwheat	93,1	57	70,7
Maize	97,7	98,3	98
Sugar beet	98,6	91,3	94,8
Sunflower	97,2	99,6	98,4
Soybeans	94,5	92,8	93,6
Other crops	75,5	44,5	56
Forest	99,3	98	98,7
Grassland	96,5	89,2	92,7
Bareland	96,9	44,9	61,4
Water	100	99,9	100
Wetland	92,6	83,1	87,6
Peas	89,3	92,7	91
Alfalfa	63,6	72,3	67,7
Low trees	76,9	86,5	81,4
Grape	91,2	86,4	88,7
Overall Accuracy	97,6		



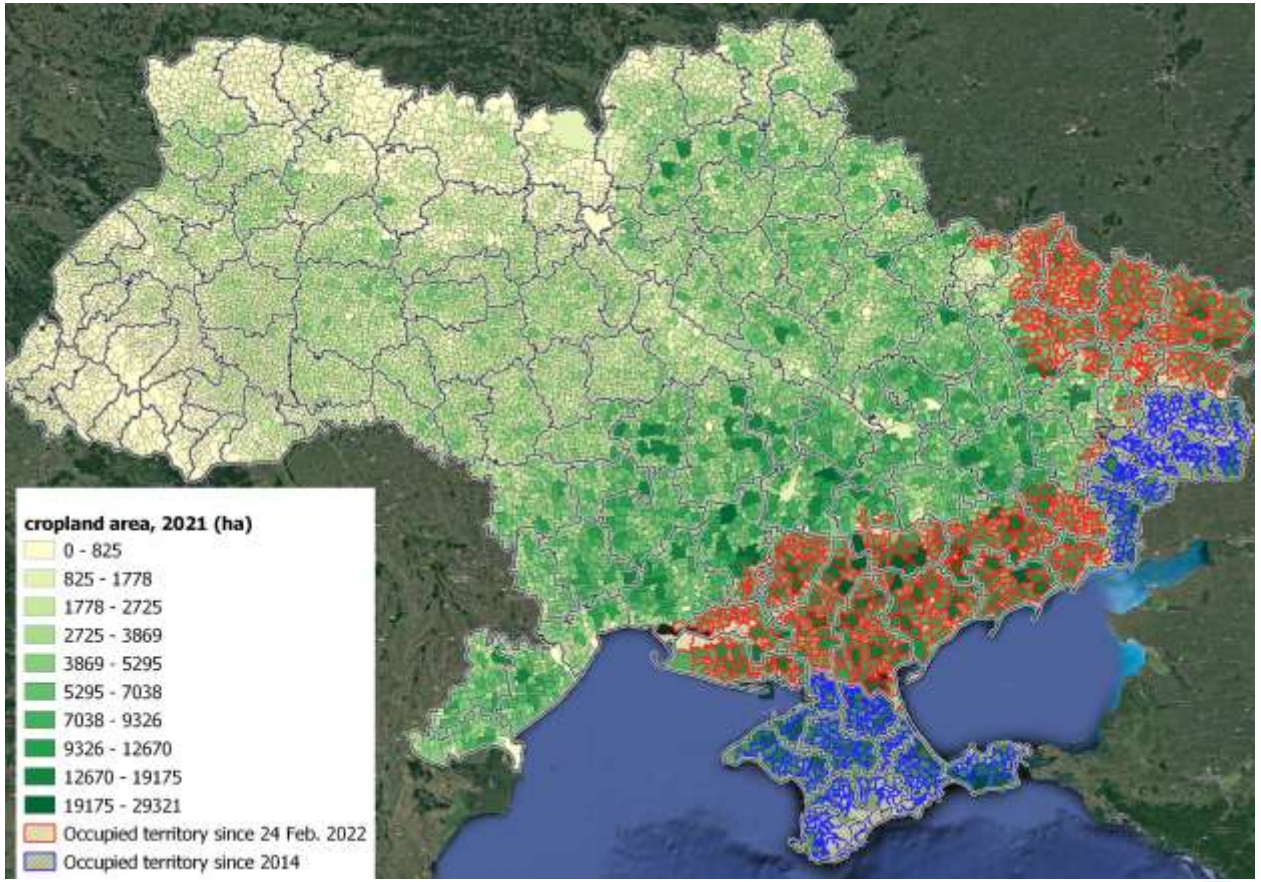
Crop classification for Ukraine, 2022

Class	PA (%)	UA (%)	F1 (%)
Artificial	93,2	98,5	95,8
Wheat	96,5	95,5	96
Rapeseed	99,9	100	100
Buckwheat	62,6	93,4	75
Maize	94,8	94,2	94,5
Sugar beet	100	86,7	92,9
Sunflower	98	98,5	98,2
Soybeans	80,3	84,2	82,2
Other crops	70,8	9,2	16,3
Forest	99,9	97,5	98,7
Grassland	95,3	85,2	90
Bareland	94,6	82,5	88,1
Water	99,6	100	99,8
Wetland	91,8	88,9	90,3
Barley	78,3	84,2	81,2
Peas	100	99,1	99,5
Alfalfa	94,8	83	88,5
Gardens, parks	83	97,1	89,5
Grapes	85,9	96,3	90,8
Potato	76,4	100	86,7
	OA = 95%		

Occupied cropland 2022

In MLN ha	Occupied since 2014	Occupied since 24 Feb. 2022	Not occupied	Total MLN ha
Cropland	1,73 (5.6%)	5,70 (18.3%)	23,58 (76.1%)	31,00
Winter crops 2022	0,59 (6.6%)	2,05 (22.9%)	6,33 (70.5%)	8,97

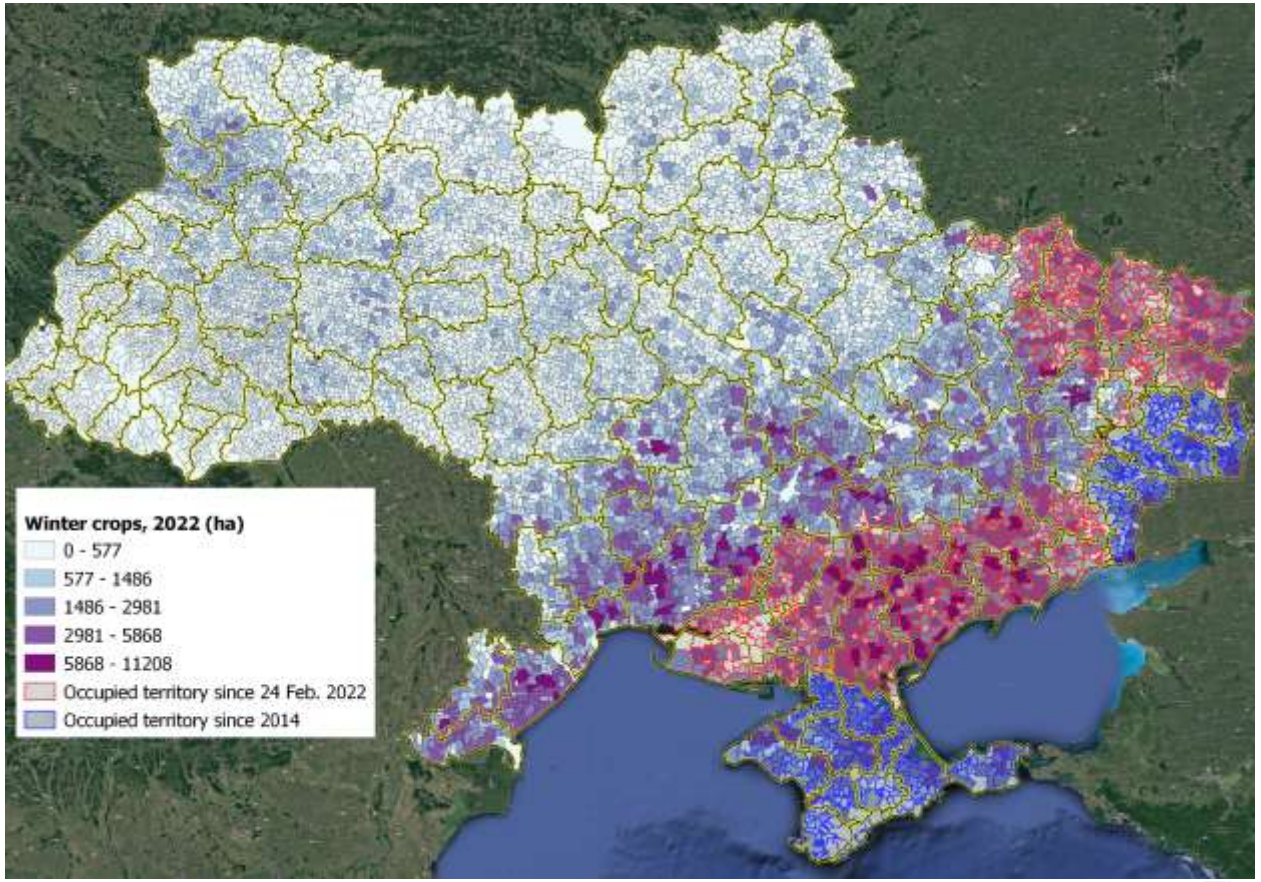
Total **occupied** cropland is **5.7 MLN ha**



Occupied winter crops 2022

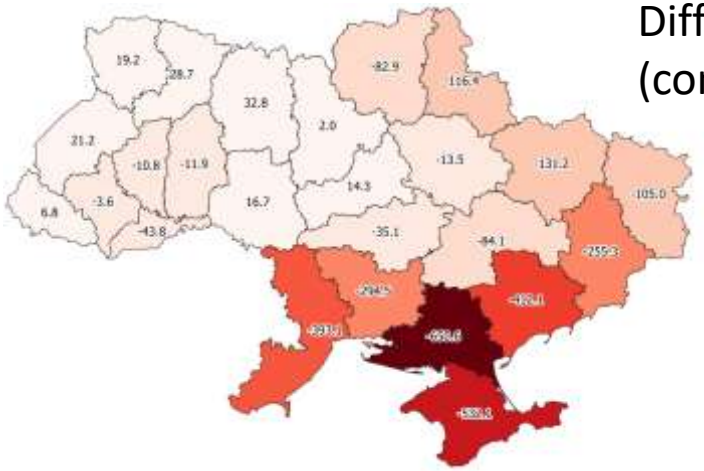
In MLN ha	Occupied since 2014	Occupied since 24 Feb. 2022	Not occupied	Total
Cropland	1,73 (5.6%)	5,70 (18.3%)	23,58 (76.1%)	31,00
Winter crops 2022	0,59 (6.6%)	2,05 (22.9%)	6,33 (70.5%)	8,97

Total **occupied** winter crops is **2.05 MLN ha**

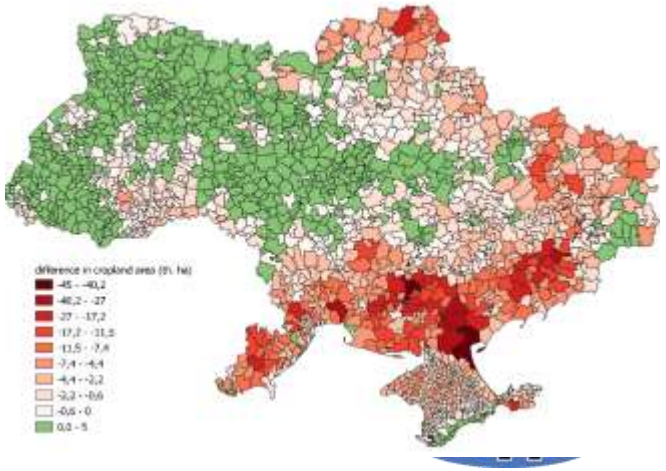


Cropland difference between 2021 & 2022

	Cropland 2021, th ha	Cropland 2022, th ha	Difference in Cropland area, th ha	Difference in Cropland area, %
AR of Crimea	1182,67	650,6	-532,1	-45,0
Khersonska	1765,72	1115,1	-650,6	-36,8
Zaporizka	1968,60	1556,5	-412,1	-20,9
Odeska	2071,75	1678,6	-393,1	-19,0
Donetska	1364,92	1109,7	-255,3	-18,7
Chernivetska	257,35	213,6	-43,8	-17,0
Mykolaivska	1770,21	1475,7	-294,5	-16,6
Sumska	1256,47	1140,1	-116,4	-9,3
Luhanska	1171,90	1066,9	-105,0	-9,0
Kharkivska	1872,06	1740,8	-131,2	-7,0
Chernihivska	1401,22	1318,4	-82,9	-5,9
Dnipropetrovska	2068,38	1984,2	-84,1	-4,1
Kirovohradska	1783,98	1748,9	-35,1	-2,0
Ivano-Frankivska	281,28	277,6	-3,6	-1,3
Ternopilska	874,31	863,6	-10,8	-1,2
Khmelnytska	1234,85	1222,9	-11,9	-1,0
Poltavska	1798,63	1785,1	-13,5	-0,8
Kyivska	1200,51	1202,5	2,0	0,2
Vinnytska	1615,31	1632,1	16,7	1,0
Cherkaska	1218,88	1233,2	14,3	1,2
Lvivska	606,43	627,6	21,2	3,5
Volynska	524,71	543,9	19,2	3,7
Zhytomyrska	885,33	918,1	32,8	3,7
Rivnenska	504,27	533,0	28,7	5,7
Zakarpatska	76,85	83,7	6,8	8,9
Ukraine total	**30756,58**	**27722,3**	**-3034,2**	**-9,9**



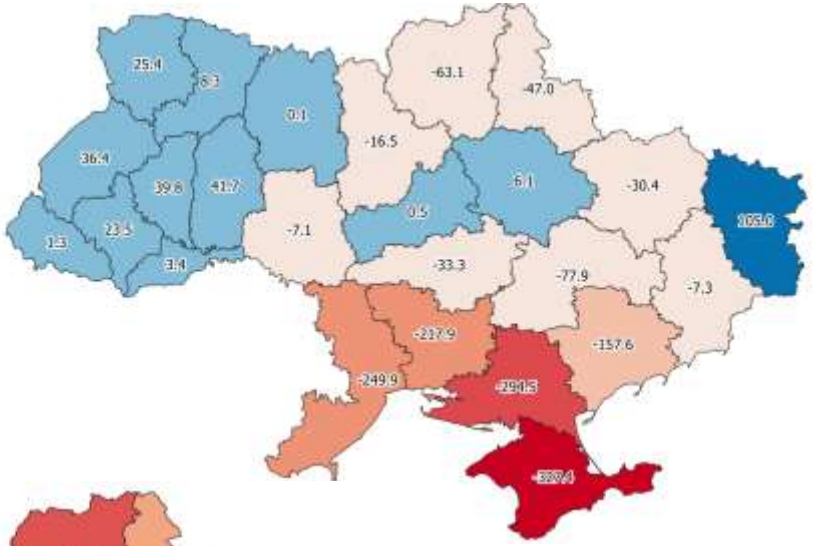
Difference in th. ha (compared to 2021)

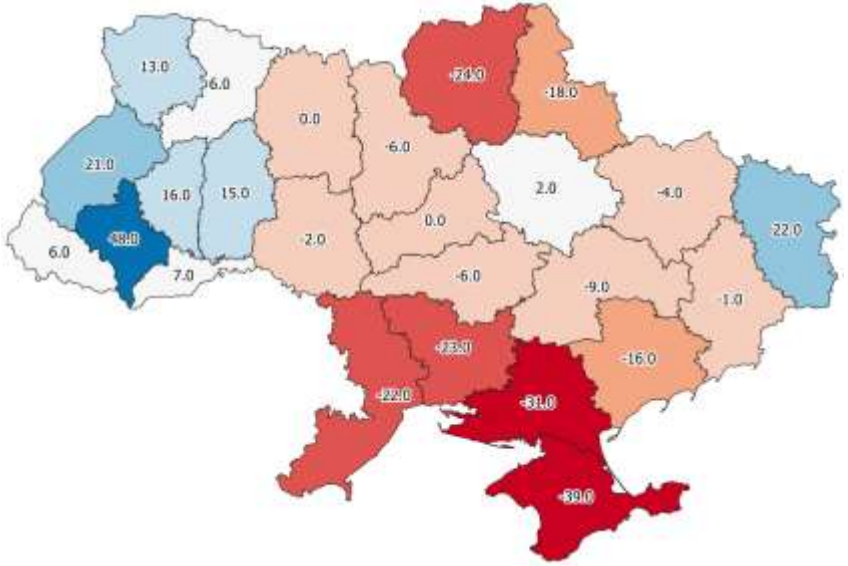


Cereal area difference between 2021 & 2022

	Cereal 2021, th ha	Cereal 2022, th ha	Difference in cereal area, th ha	Difference in cereal area, %
AR of Crimea	833,5	506,1	-327,4	-39,3
Khersonska	952,7	658,2	-294,5	-30,9
Chernihivska	261,2	198,0	-63,1	-24,2
Mykolaivska	954,7	736,8	-217,9	-22,8
Odeska	1141,2	891,3	-249,9	-21,9
Sumska	259,2	212,2	-47,0	-18,1
Zaporizka	1005,0	847,5	-157,6	-15,7
Dnipropetrovska	825,7	747,8	-77,9	-9,4
Kirovohradska	544,5	511,1	-33,3	-6,1
Kyivska	291,0	274,5	-16,5	-5,7
Kharkivska	786,6	756,2	-30,4	-3,9
Vinnytska	424,0	416,9	-7,1	-1,7
Donetska	703,0	695,7	-7,3	-1,0
Zhytomyrska	218,2	218,2	0,1	0,0
Cherkaska	283,1	283,6	0,5	0,2
Poltavska	350,5	356,6	6,1	1,7
Rivnenska	149,6	157,9	8,3	5,5
Zakarpatska	20,9	22,2	1,3	6,3
Chernivetska	45,5	48,9	3,4	7,4
Volynska	202,0	227,4	25,4	12,6
Khmelnytska	278,2	319,9	41,7	15,0
Ternopilska	243,2	283,0	39,8	16,4
Lvivska	171,3	207,7	36,4	21,3
Luhanska	486,3	591,4	105,0	21,6
Ivano-Frankivska	48,8	72,2	23,5	48,1
Ukraine total	**11479,8**	**10241,3**	**-1238,5**	**-10,8**

Difference in th.ha
(compared to 2021)



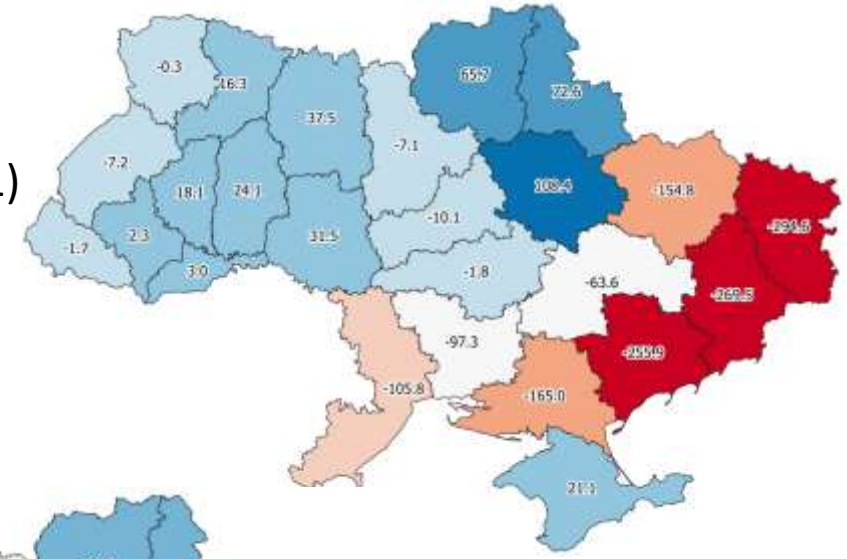


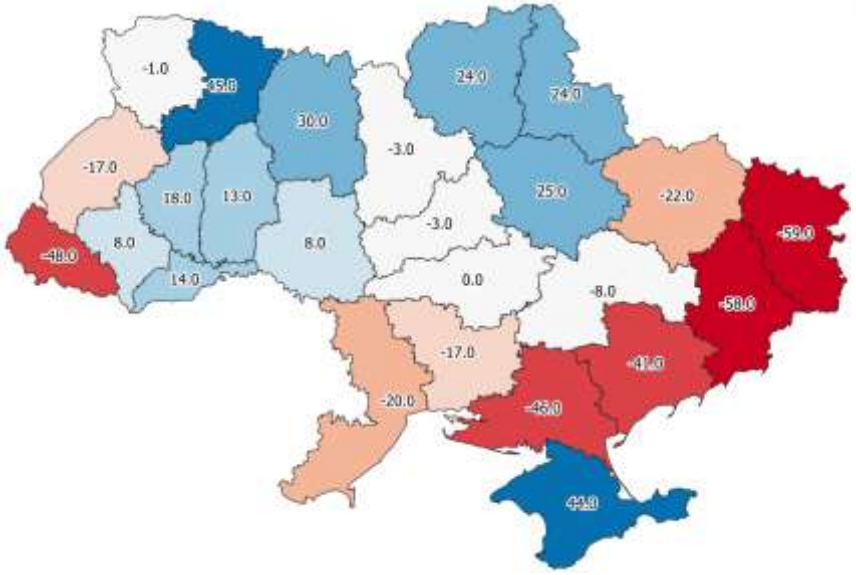
Difference in %
(compared to 2021)

Sunflower area difference between 2021 & 2022

	Sunflower 2021, th ha	Sunflower 2022, th ha	Difference in Sunflower area, th ha	Difference in Sunflower area, %
Luhanska	503,0	208,4	-294,6	-58,6
Donetska	464,5	195,0	-269,5	-58,0
Zakarpatska	3,7	1,9	-1,7	-47,8
Khersonska	357,1	192,1	-165,0	-46,2
Zaporizka	626,8	370,9	-255,9	-40,8
Kharkivska	694,7	540,0	-154,8	-22,3
Odeska	533,4	427,6	-105,8	-19,8
Lvivska	42,8	35,6	-7,2	-16,9
Mykolaivska	588,3	491,0	-97,3	-16,5
Dnipropetrovska	846,7	783,1	-63,6	-7,5
Cherkaska	311,3	301,2	-10,1	-3,2
Kyivska	234,5	227,4	-7,1	-3,0
Volynska	36,3	36,0	-0,3	-0,9
Kirovohradska	702,1	700,3	-1,8	-0,3
Ivano-Frankivska	29,3	31,5	2,3	7,7
Vinnytska	385,4	416,9	31,5	8,2
Khmelnytska	191,3	215,5	24,1	12,6
Chernivetska	20,7	23,6	3,0	14,4
Ternopilska	99,9	118,0	18,1	18,1
Chernihivska	276,6	342,4	65,7	23,8
Sumska	304,7	377,3	72,6	23,8
Poltavska	434,4	542,8	108,4	24,9
Zhytomyrska	126,3	163,7	37,5	29,7
AR of Crimea	47,5	68,5	21,1	44,4
Rivnenska	36,3	52,7	16,3	45,0
Ukraine total	**7897,5**	**6863,4**	**-1034,1**	**-13,1**

Difference in th.ha
(compared to 2021)



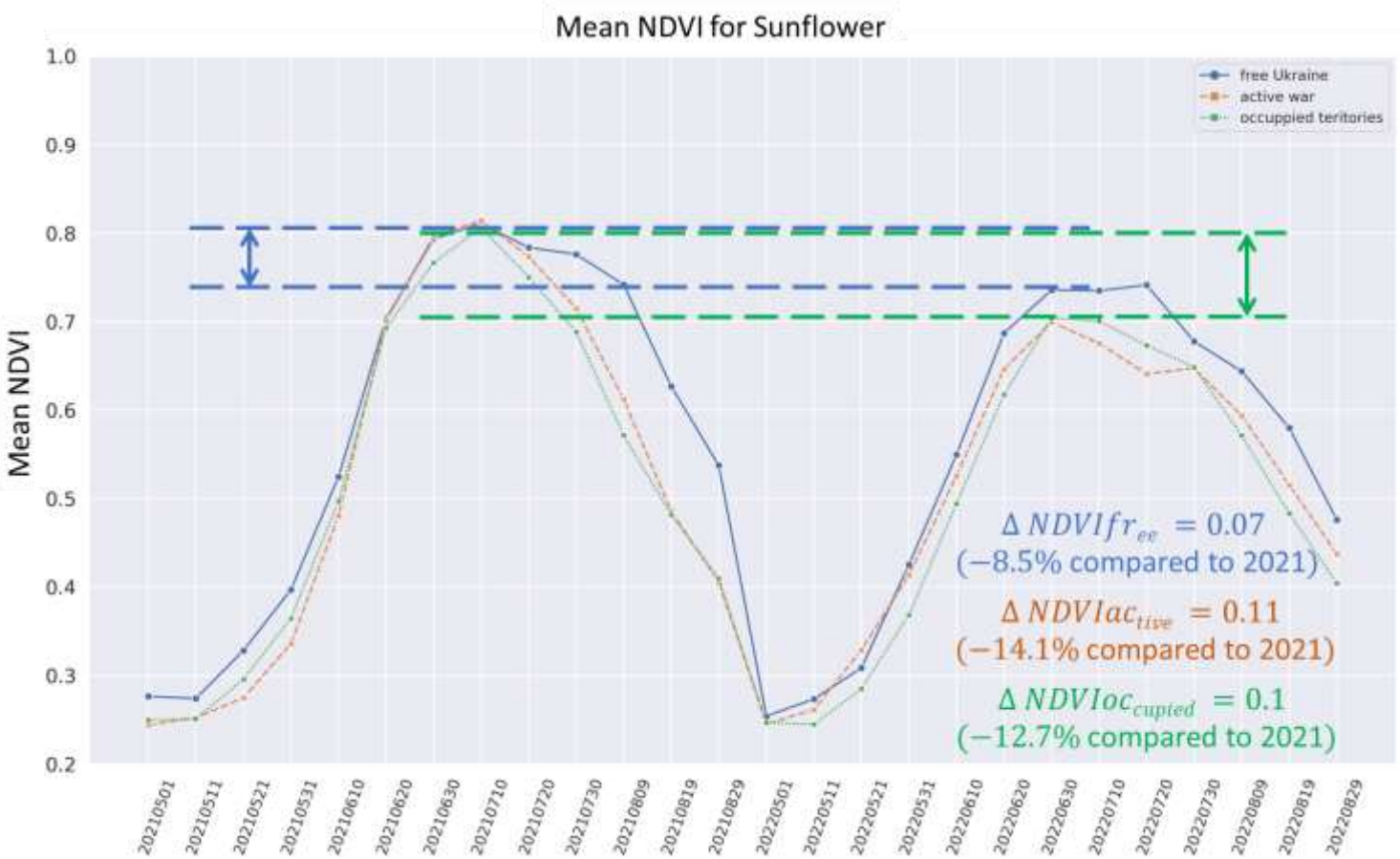


Difference in %
(compared to 2021)

NDVI analysis at village level for sunflower

2021 & 2022

	2021, mean ndvi values			2022, mean ndvi values		
date	free Ukraine	active war	occuppied teritories	free Ukraine	active war	occuppied teritories
05-01	0,28	0,24	0,25	0,25	0,25	0,25
05-11	0,27	0,25	0,25	0,27	0,26	0,24
05-21	0,33	0,27	0,30	0,31	0,33	0,29
05-31	0,40	0,34	0,36	0,43	0,41	0,37
06-10	0,52	0,48	0,50	0,55	0,53	0,49
06-20	0,70	0,70	0,69	0,69	0,65	0,62
06-30	0,79	0,80	0,77	0,74	0,70	0,70
07-10	0,81	0,81	0,81	0,74	0,68	0,70
07-20	0,78	0,77	0,75	0,74	0,64	0,67
07-30	0,78	0,71	0,69	0,68	0,65	0,65
08-09	0,74	0,61	0,57	0,64	0,59	0,57
08-19	0,63	0,49	0,48	0,58	0,52	0,48
08-29	0,54	0,41	0,41	0,48	0,44	0,40



WORKING PAPER

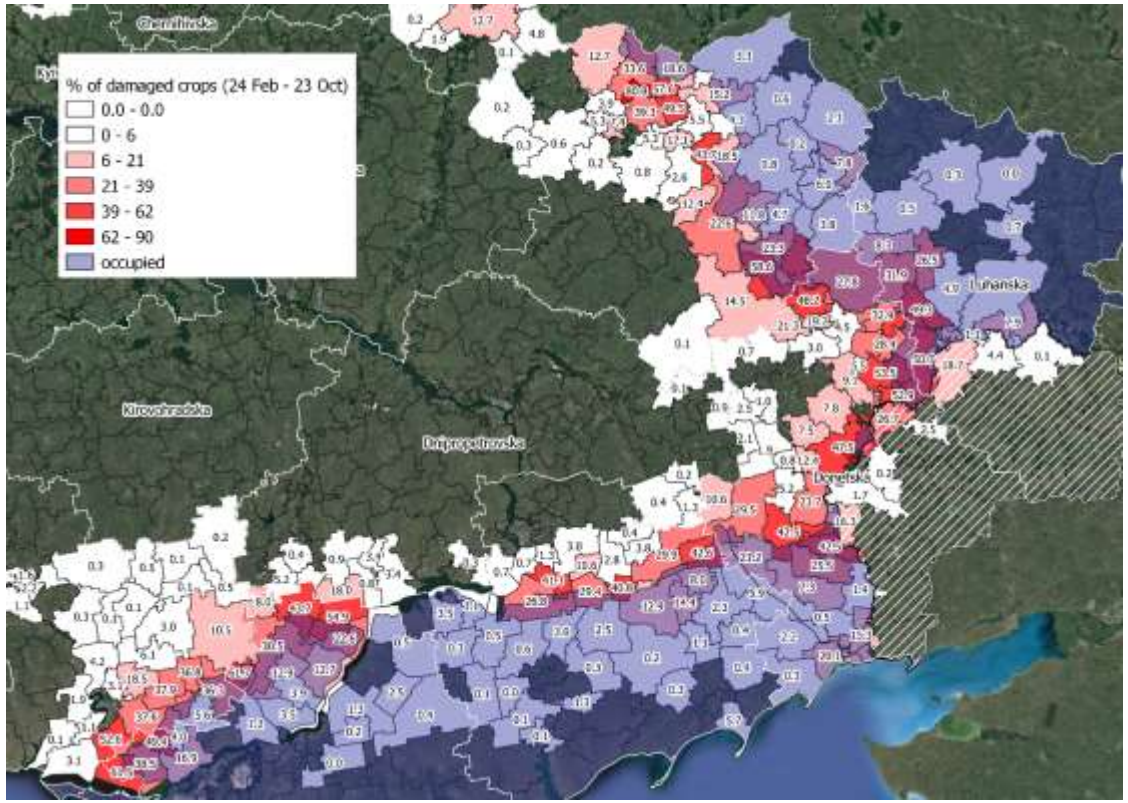
Quantifying War-Induced Crop Losses in Ukraine in Near Real Time to Strengthen Local and Global Food Security

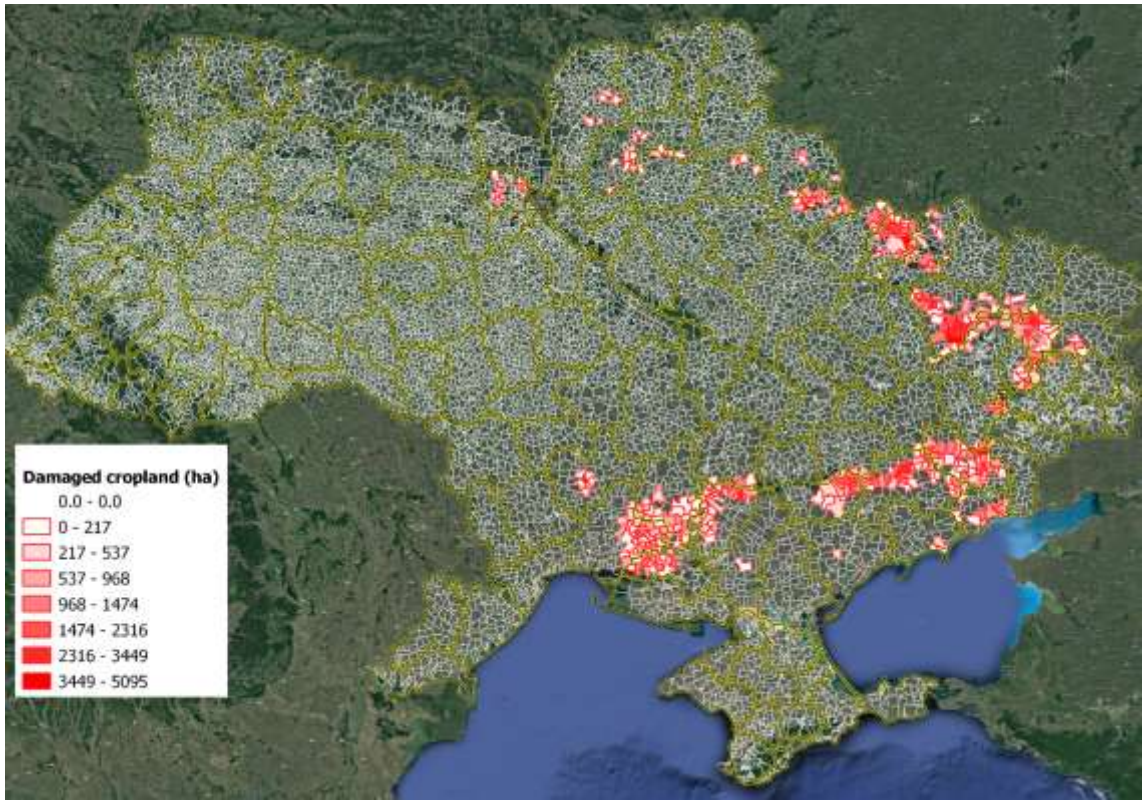
15% yield reduction in 2022 output loss of **4.2 million tons** of winter cereal

https://openknowledge.worldbank.org/handle/10986/37665

Damaged cropland

Total directly **damaged** area is **657 th. ha** **(as of 23 October 2022)**





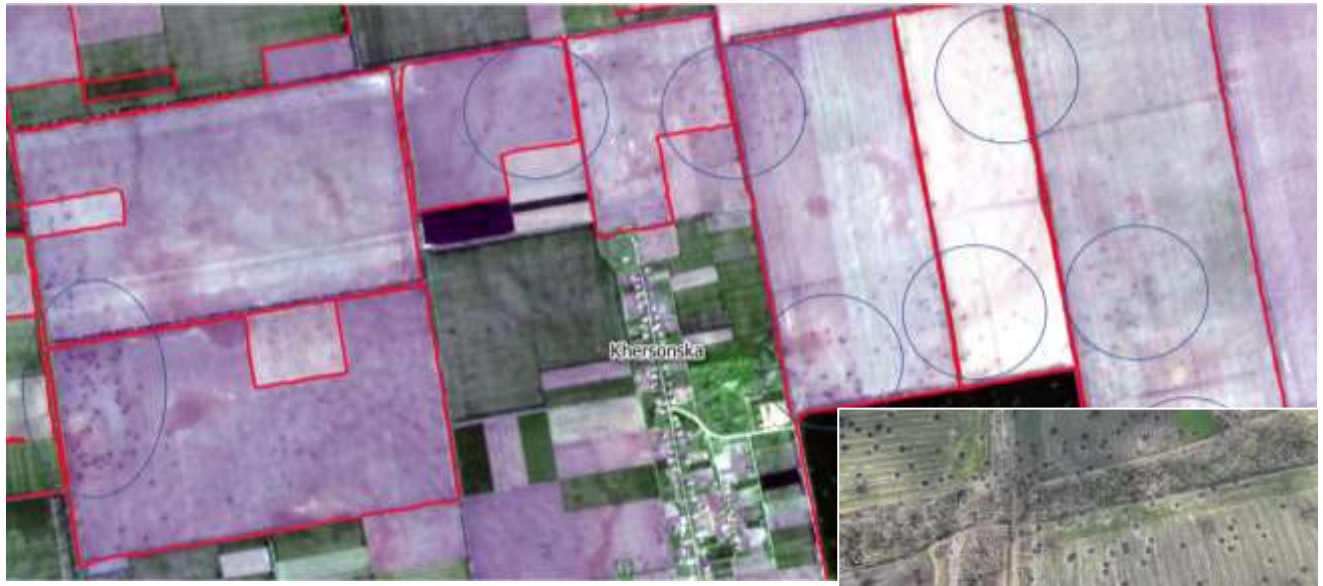
Damaged fields (examples)

Zaporizka oblast, Vasylivskii region, Stepnohirska OTG

Sentinel-2

Khersonska oblast, Beryslavskii region, Novovorontsovska OTG

Sentinel-2



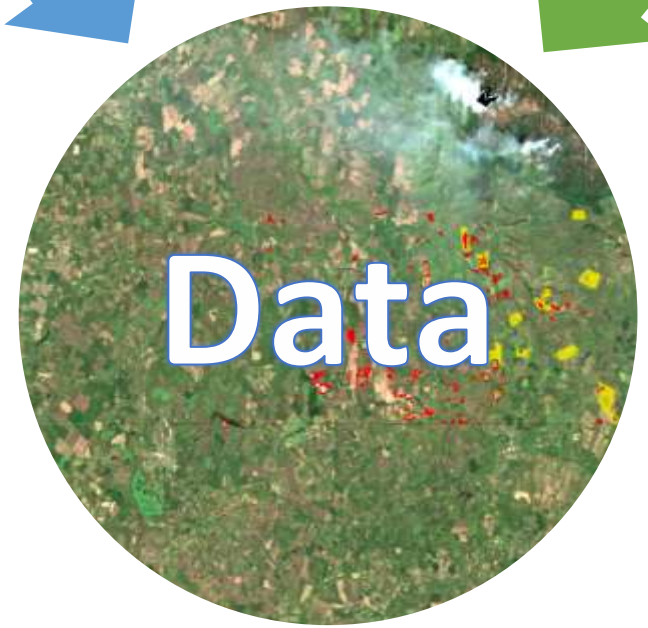
Kharkivska oblast, Izum

Drone

Detection of war-damaged fields based on NDVI using Sentinel-2 data

Data

The parcels deliniation polygons developed by the Sinergise company for Ukraine within the EO4UA



Methodology

The method of detecting damaged territories is based on the calculation of the relative difference of NDVI for the shortest interval of time before and after active hostilities in a specific territory, according to the following formulas:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

where:
NIR - near infrared
RED - infrared

$$dNDVI_t = \frac{NDVI_{t+1} - NDVI_t}{NDVI_t} * 100\%$$

where:
dNDVIt- is the relative percentage difference of NDVI at point t.
NDVIt– NDVI value before potential damage to the territory at point t.
NDVIt+1 - NDVI value after potential damage to the territory at point t.

Algorithm

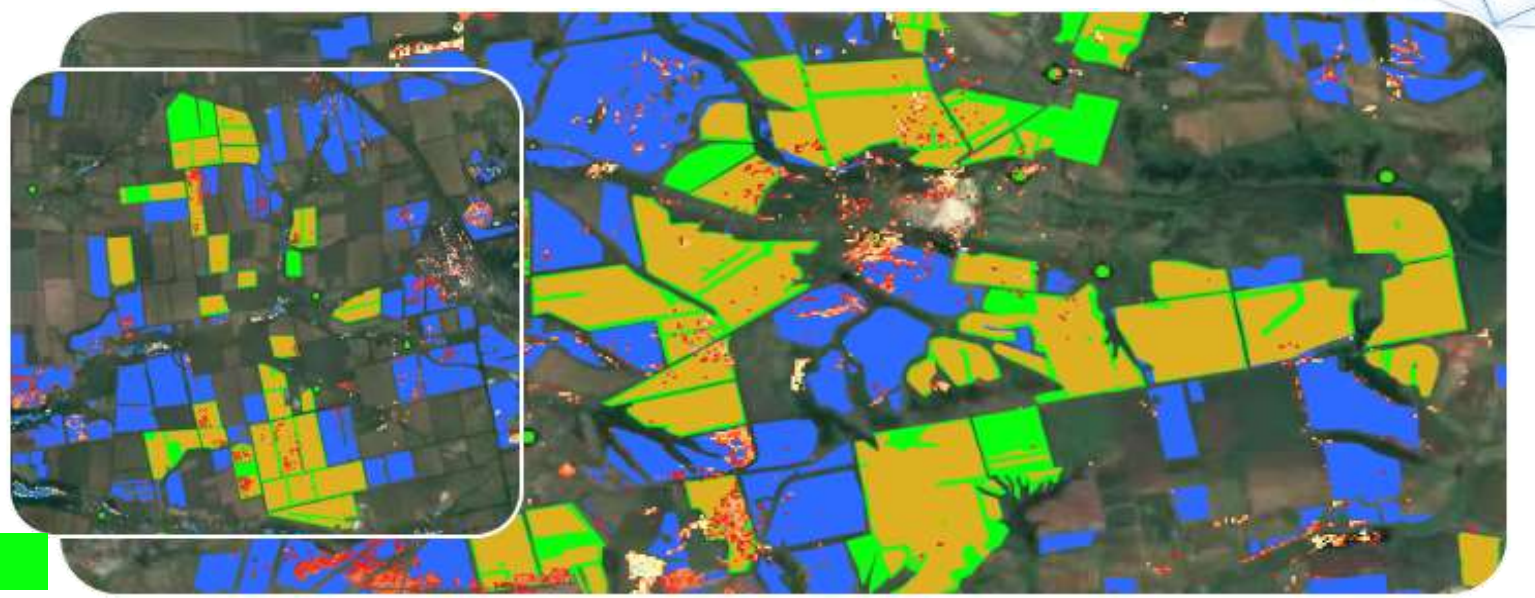
1. Application of a crop mask
2. Calculation of NDVI before and after hostilities
3. Calculation of the relative difference of NDVI
4. Creating a relative difference NDVI mask with a given numerical threshold

Note: (the threshold varies depending on the vegetation period within 20-30%)

5. Find damaged pixels using a relative difference NDVI mask
6. Conducting zonal statistics along the vector boundaries of agricultural fields of Ukraine, having previously retreated 3 meters inward from the borders of the polygons
7. **Selection of fields where the percentage of damaged area does not exceed 70% of the field area.**

Results

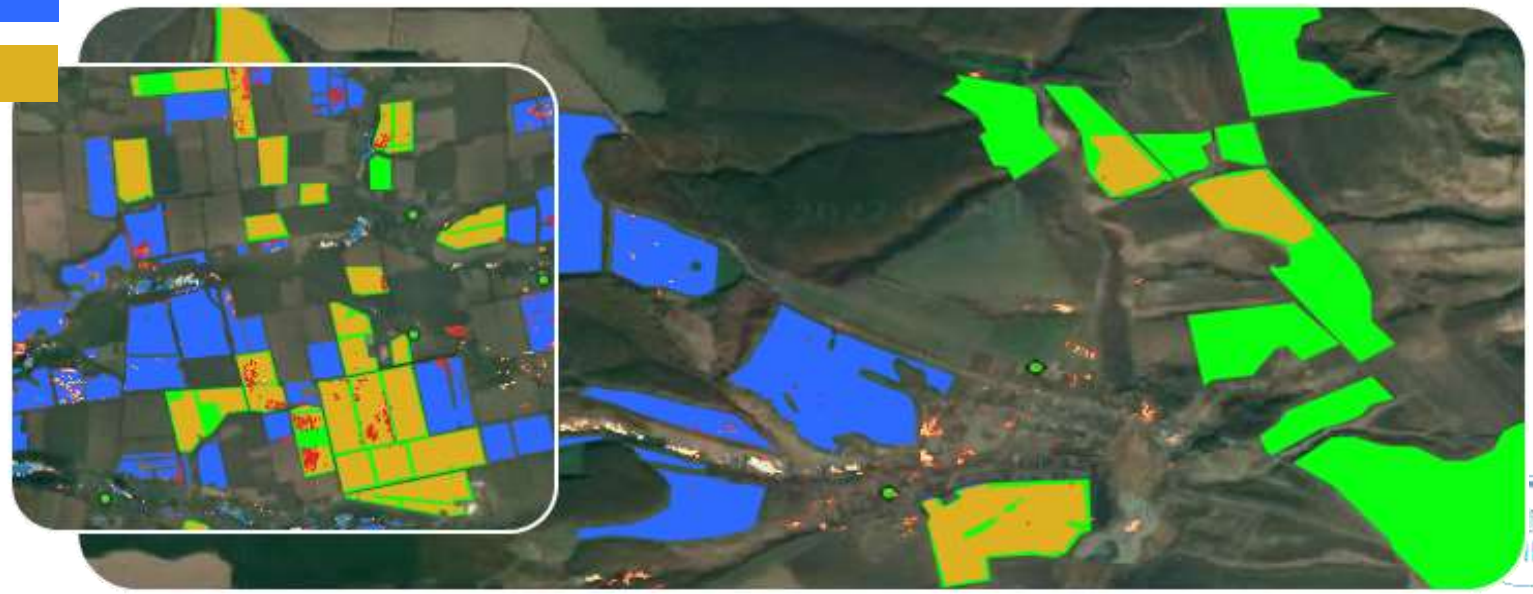
Period: 06 June – 19 June
Donetsk Region



Manually marked fields

Damaged based on NDVI

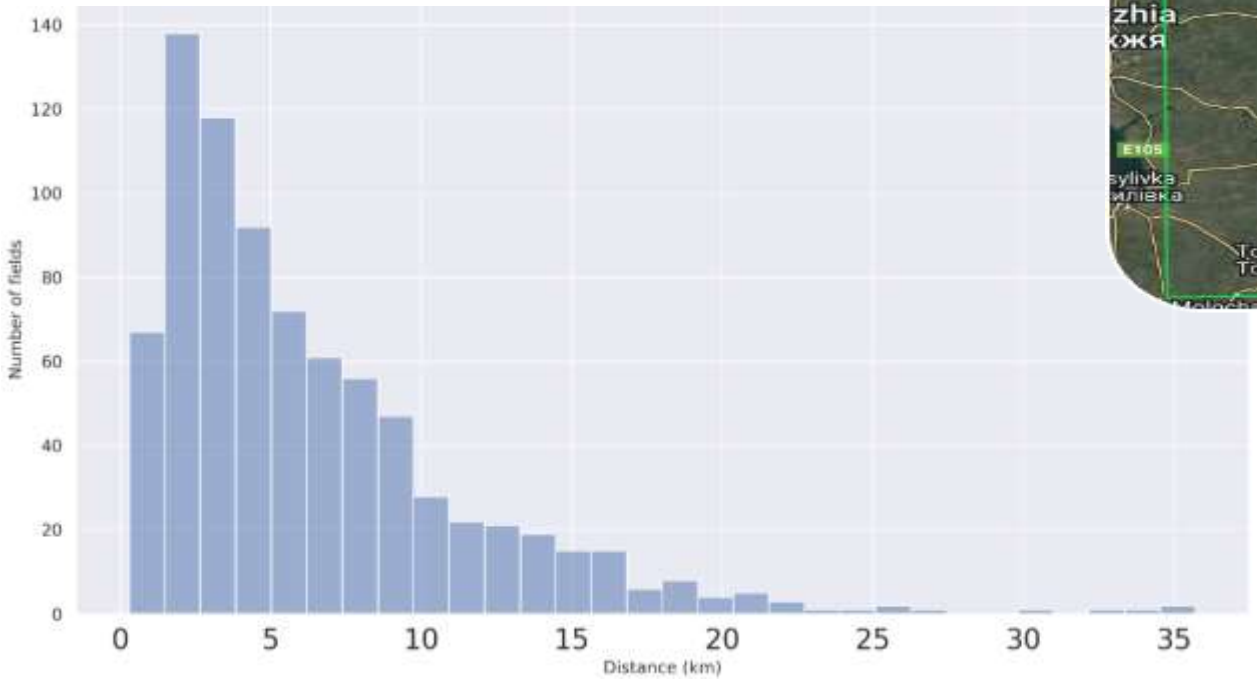
Intersection (Manually & based on NDVI)

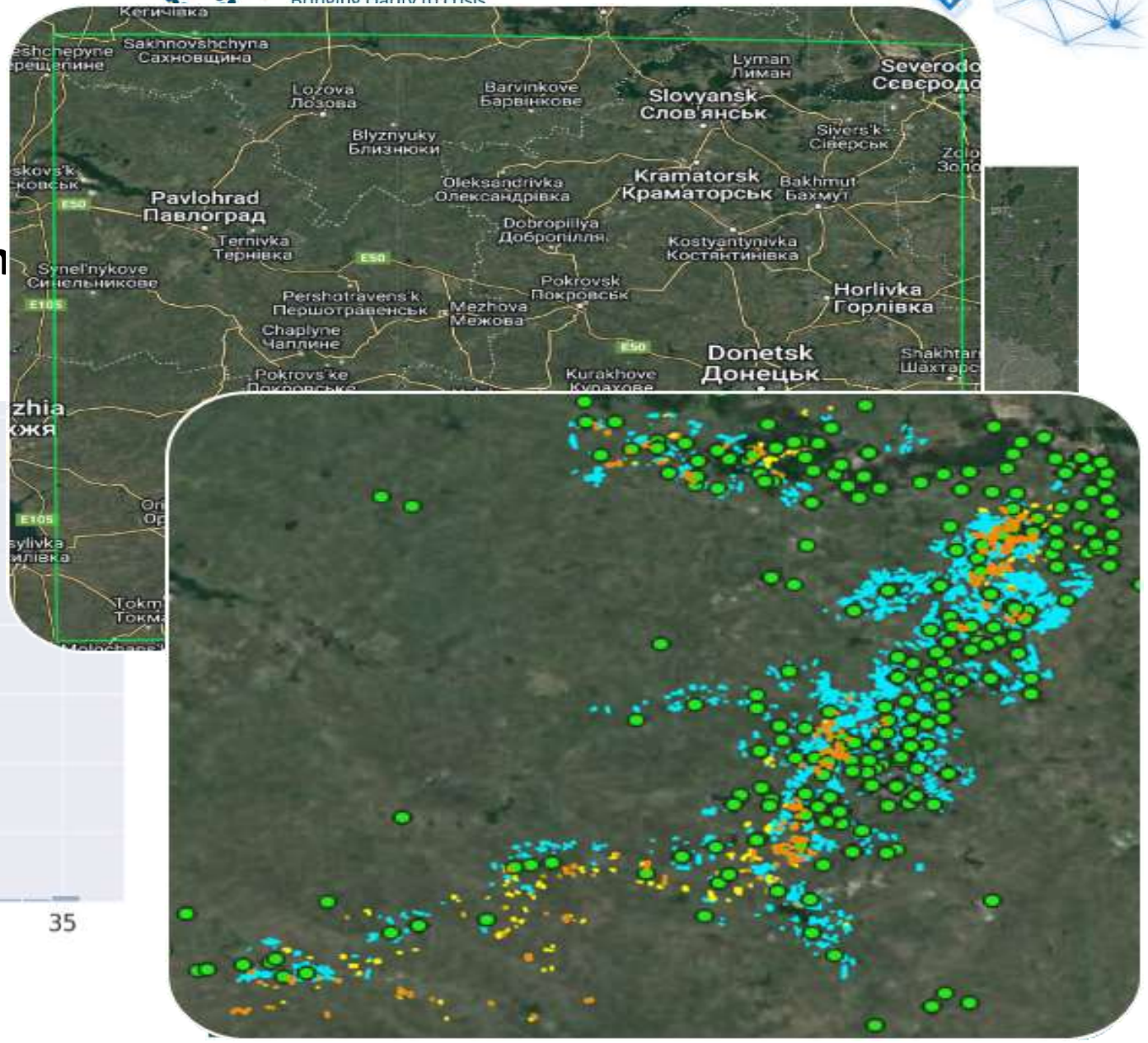


Validation with ACLED

Period 8. : 06 June – 19 June

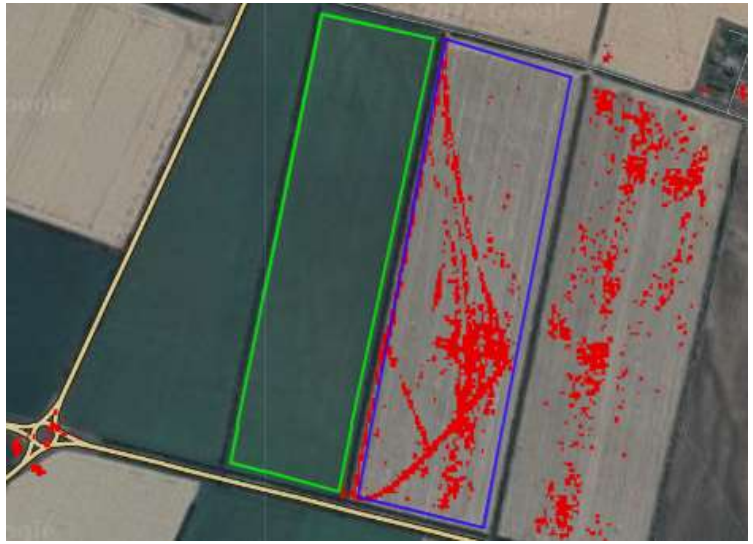
The distance of the damaged fields from official locations of shelling

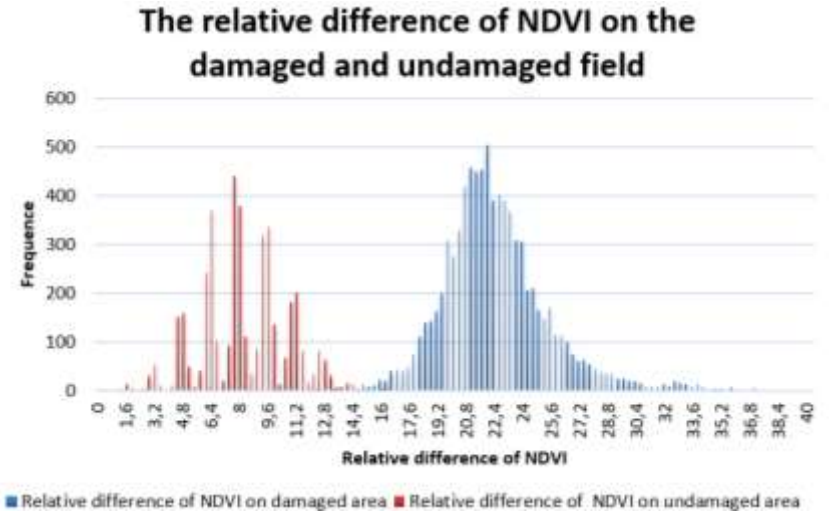




Results

Period: 06 June – 19 June
Donetsk Region





Point damage

Traces of military equipment

Automatic identification of bombs pits

Red, Green, Blue, NIR satellite bands

Mean $NDVI_{field}$ calculation

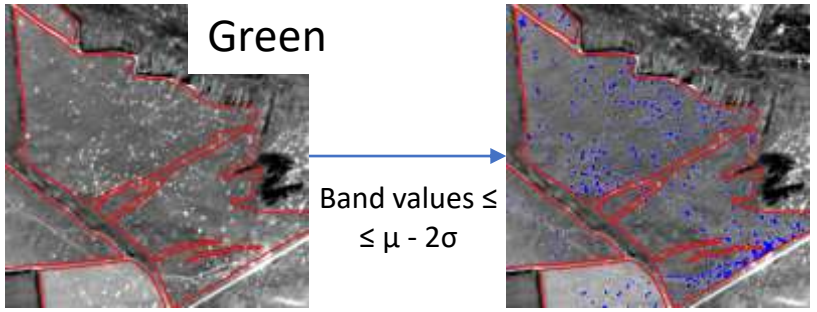
$$NDVI_{field} = mean\left(\frac{NIR_i - RED_i}{NIR_i + RED_i}\right),$$

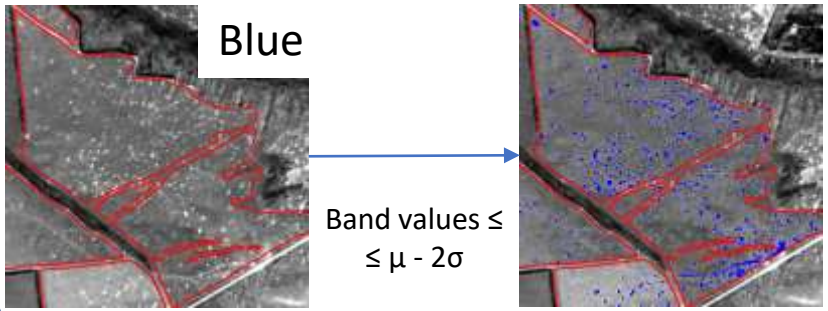
where i *– pixel within the field*

low vegetation

high vegetation

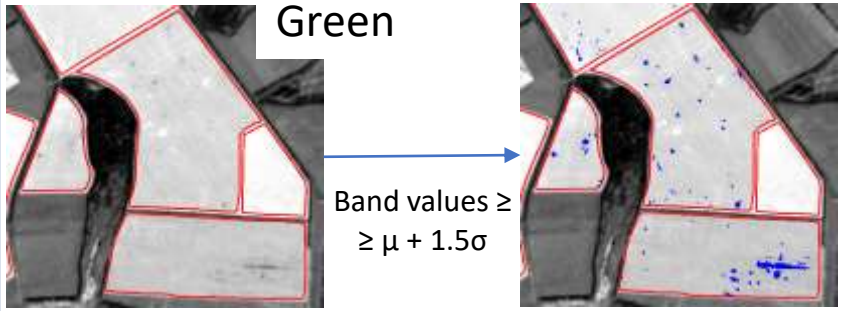
Green and Blue bands use

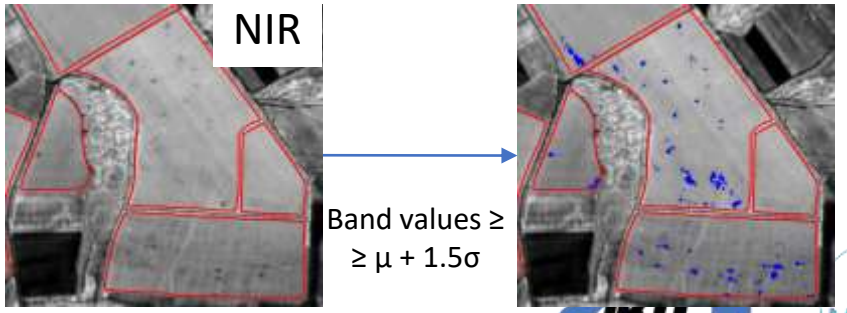




μ – mean band's value at field level

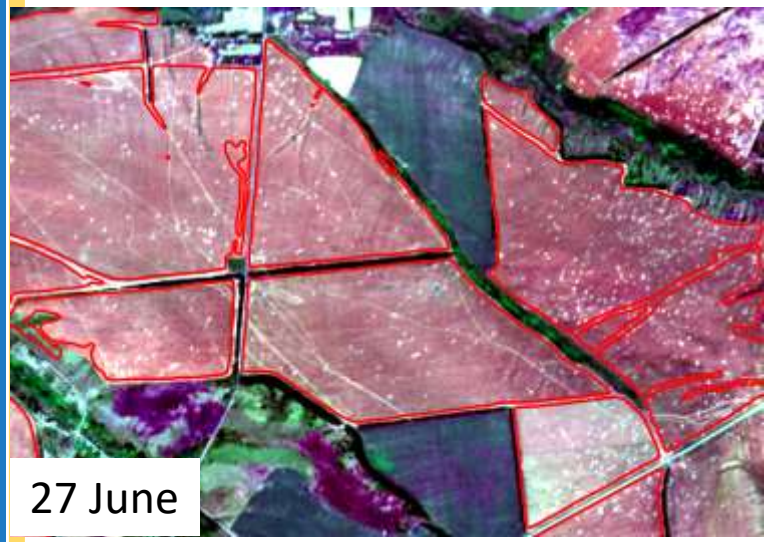
Green and NIR bands use



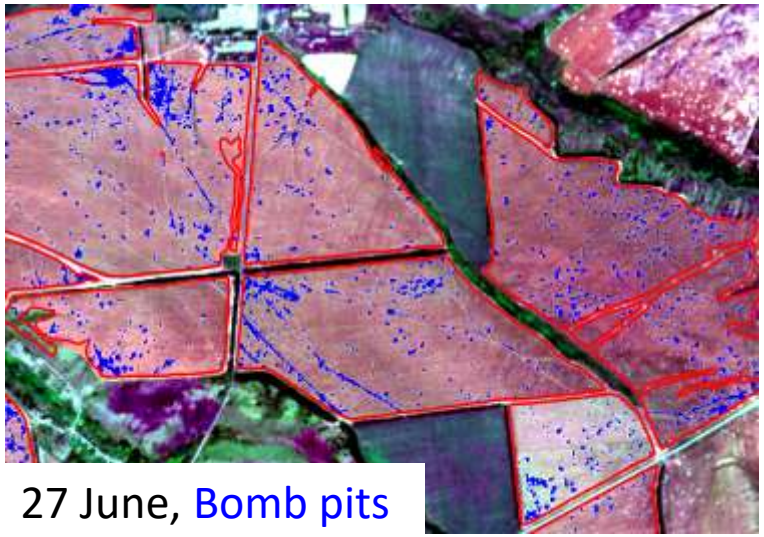


σ – standard deviation of band's value at field level

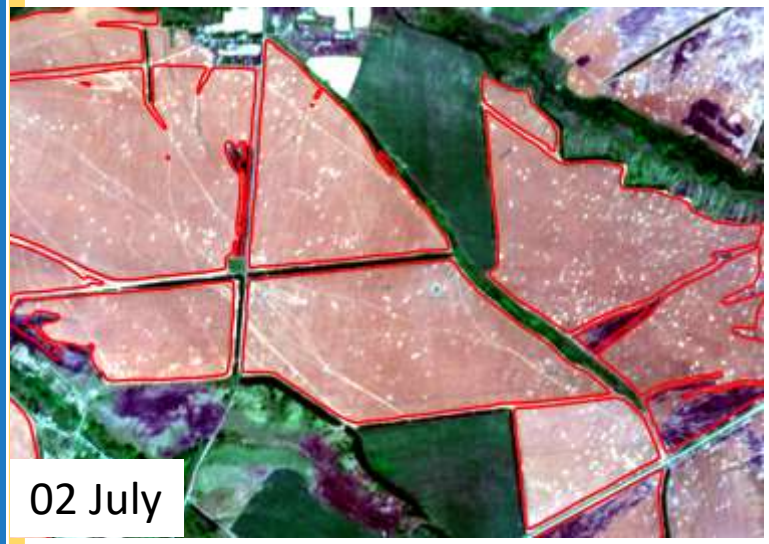
Detection of new bomb craters



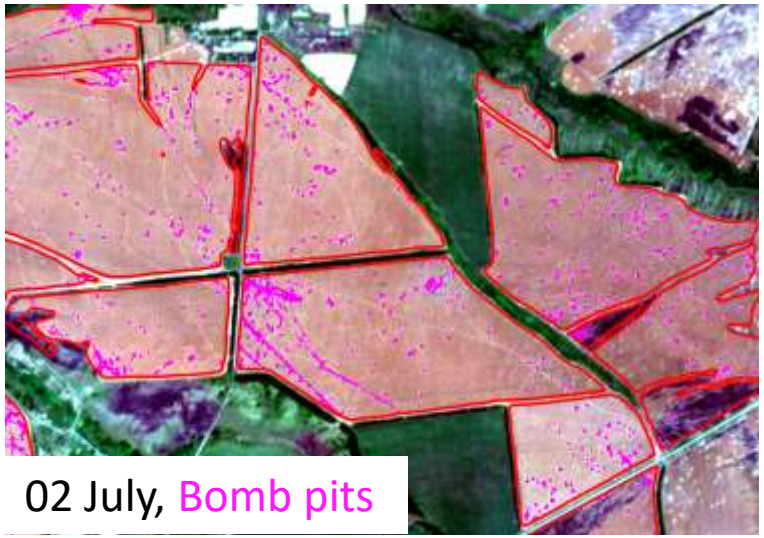
27 June



27 June, Bomb pits

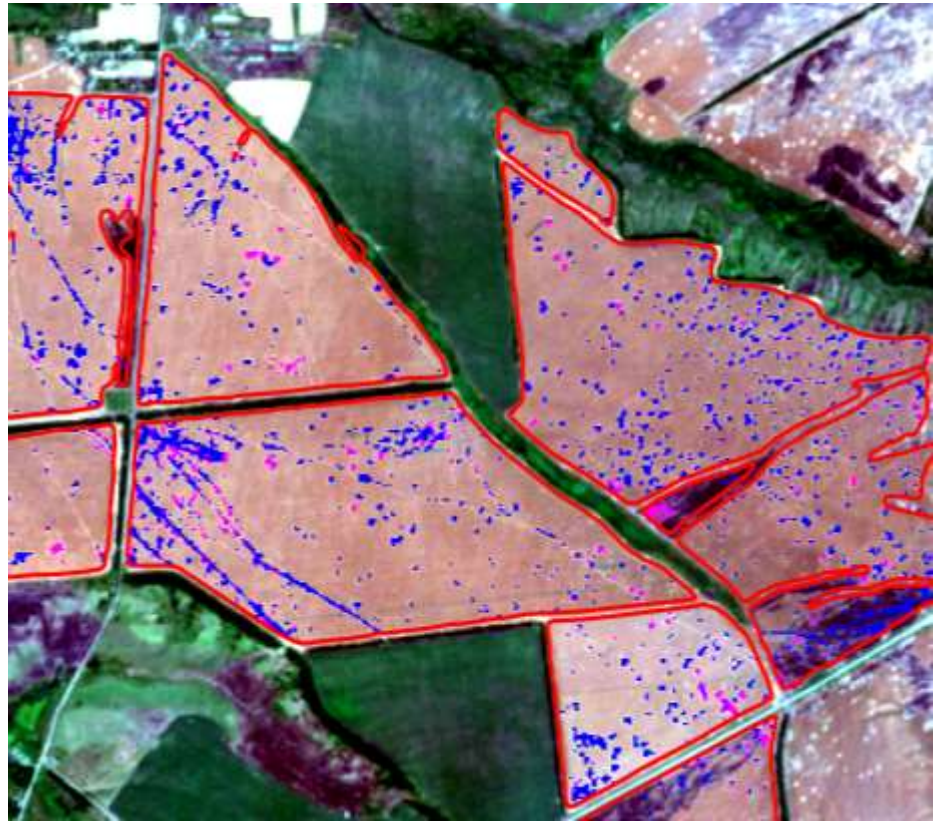


02 July



02 July, Bomb pits

New bomb craters for 5 day period



27 June 2022

02 July 2022

Fires detection

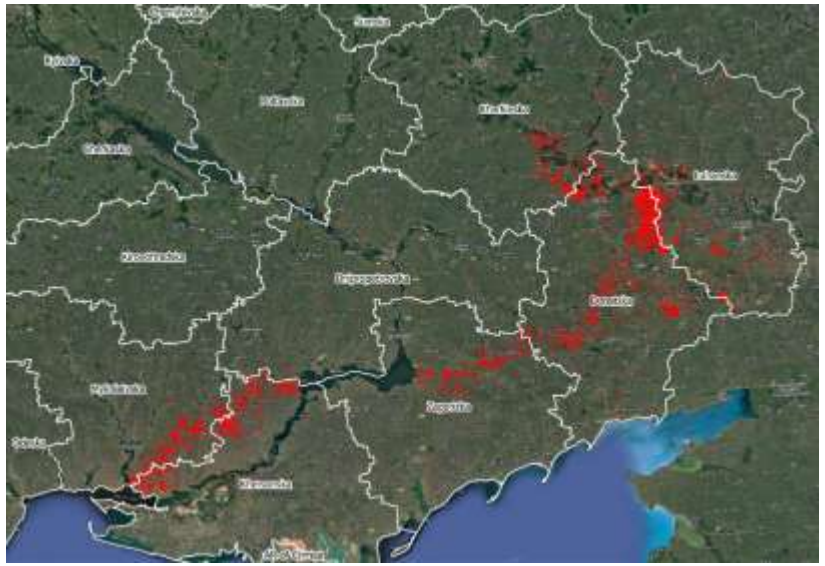
Fires detection (July 2022)

Overall burned area is 104.2 th. ha

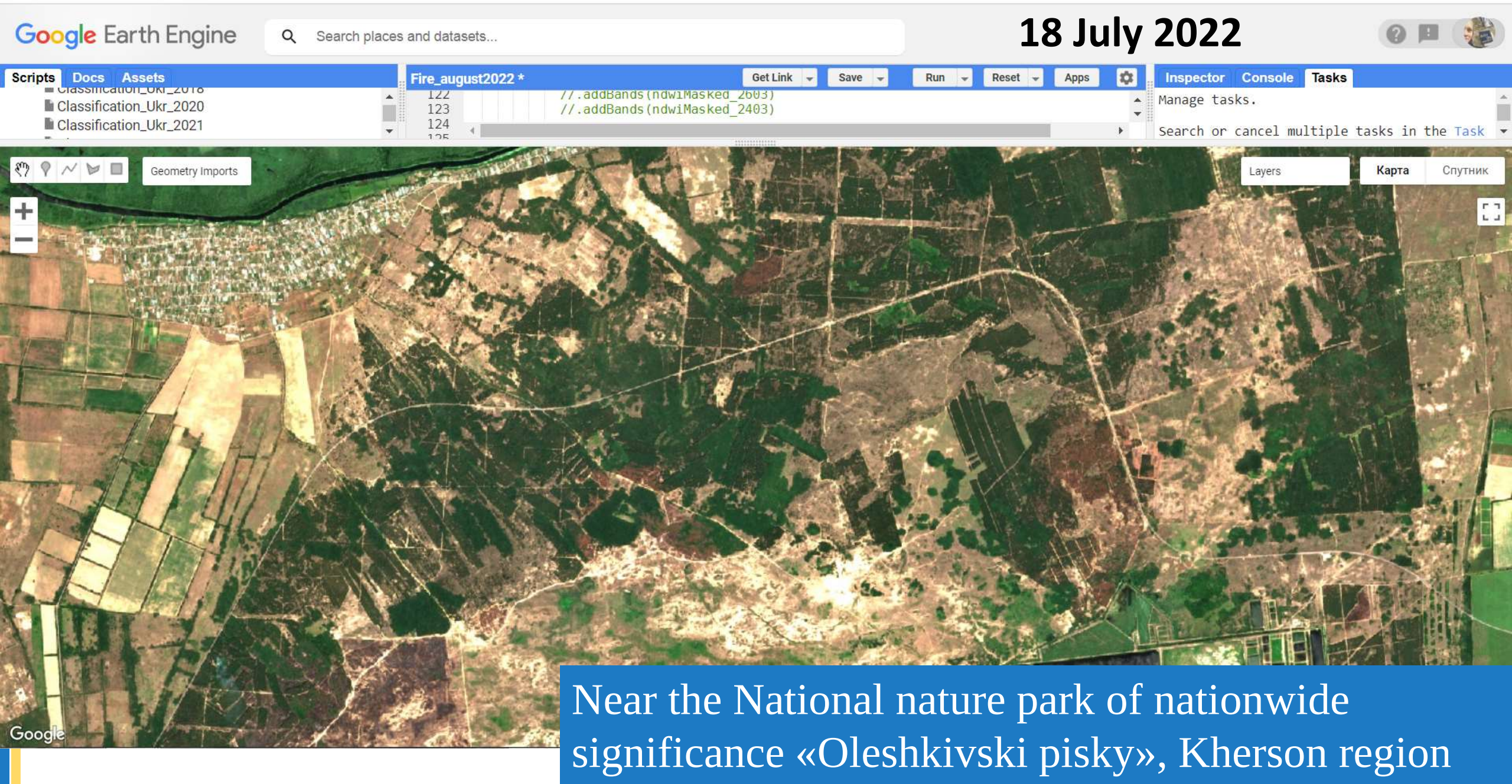
- 70 th. ha – cereal crops
- 7.8 th. ha – summer crops
- 25 th. ha – grassland

Damaged **317 th. tons** of grain

	Cereal	Rapeseed	Summer crops	Grassland	Forest	Total (ha)
Donetska	25823,7	4,3	144,8	10122,6	266,3	36361,6
Khersonska	10843,2	87,3	4129,4	4684,9	150,6	19895,3
Mykolaivska	14556,3	41,0	1398,2	2964,9	286,8	19247,1
Zaporizka	9173,0	81,2	1774,7	1448,5	61,4	12538,8
Luhanska	3396,0	30,1	175,3	4859,1	287,7	8748,2
Kharkivska	5395,0	0,1	43,2	769,0	87,1	6294,4
Dnipropetrovska	745,6	7,7	152,4	163,0	2,5	1071,2
Poltavska	45,1	13,1	1,0	0,9	0,0	60,1
Odeska	3,0	0,0	7,7	1,8	0,0	12,6



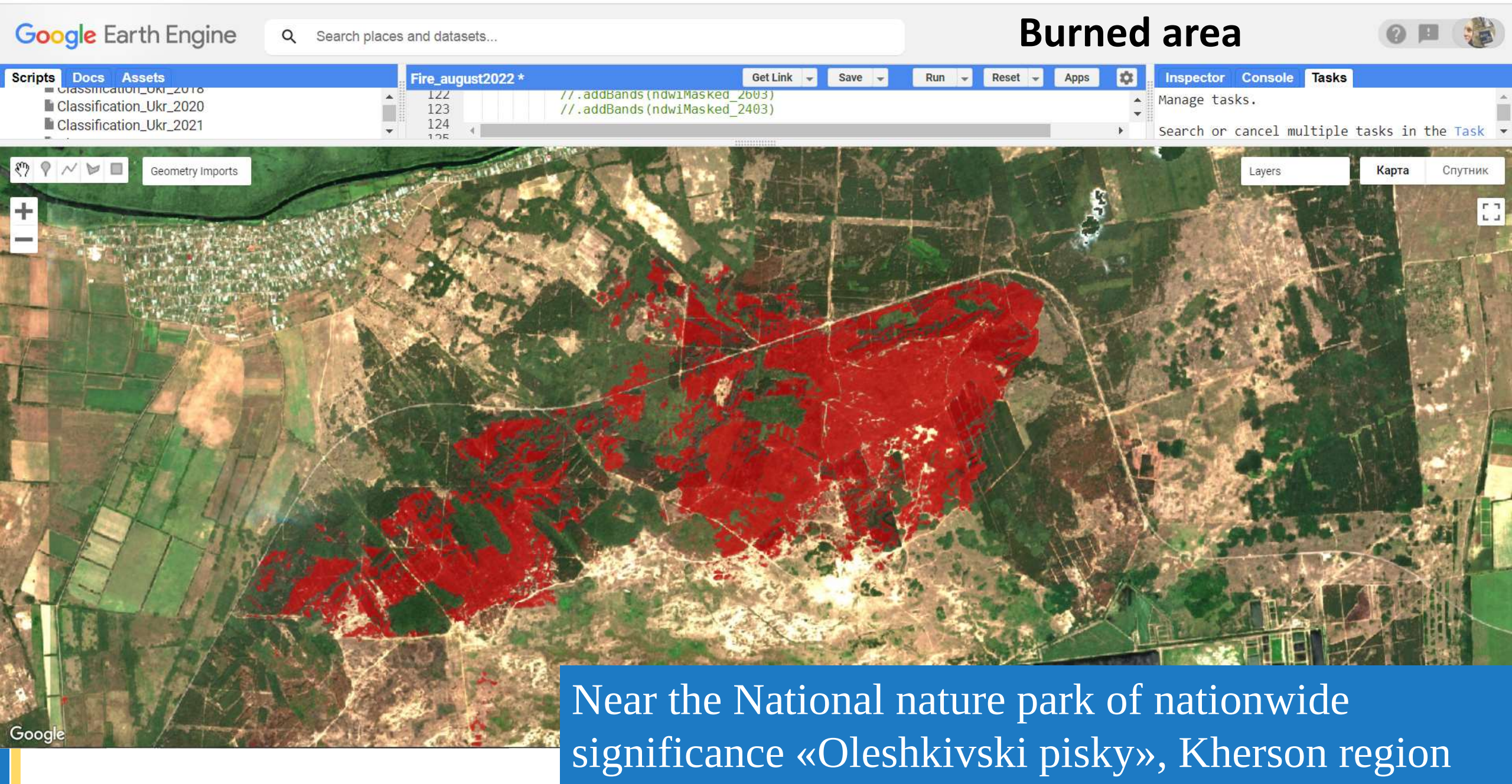
*Leonid Shumilo, Yailymov Bohdan, Shelestov Andrii **Active fire monitoring service for Ukraine based on satellite data.** *IGARSS 2020 – 2020 IEEE International Geoscience and Remote Sensing Symposium. – Waikoloa, HI, USA. – P. 2913-2916. DOI: 10.1109/IGARSS39084.2020.9323922*



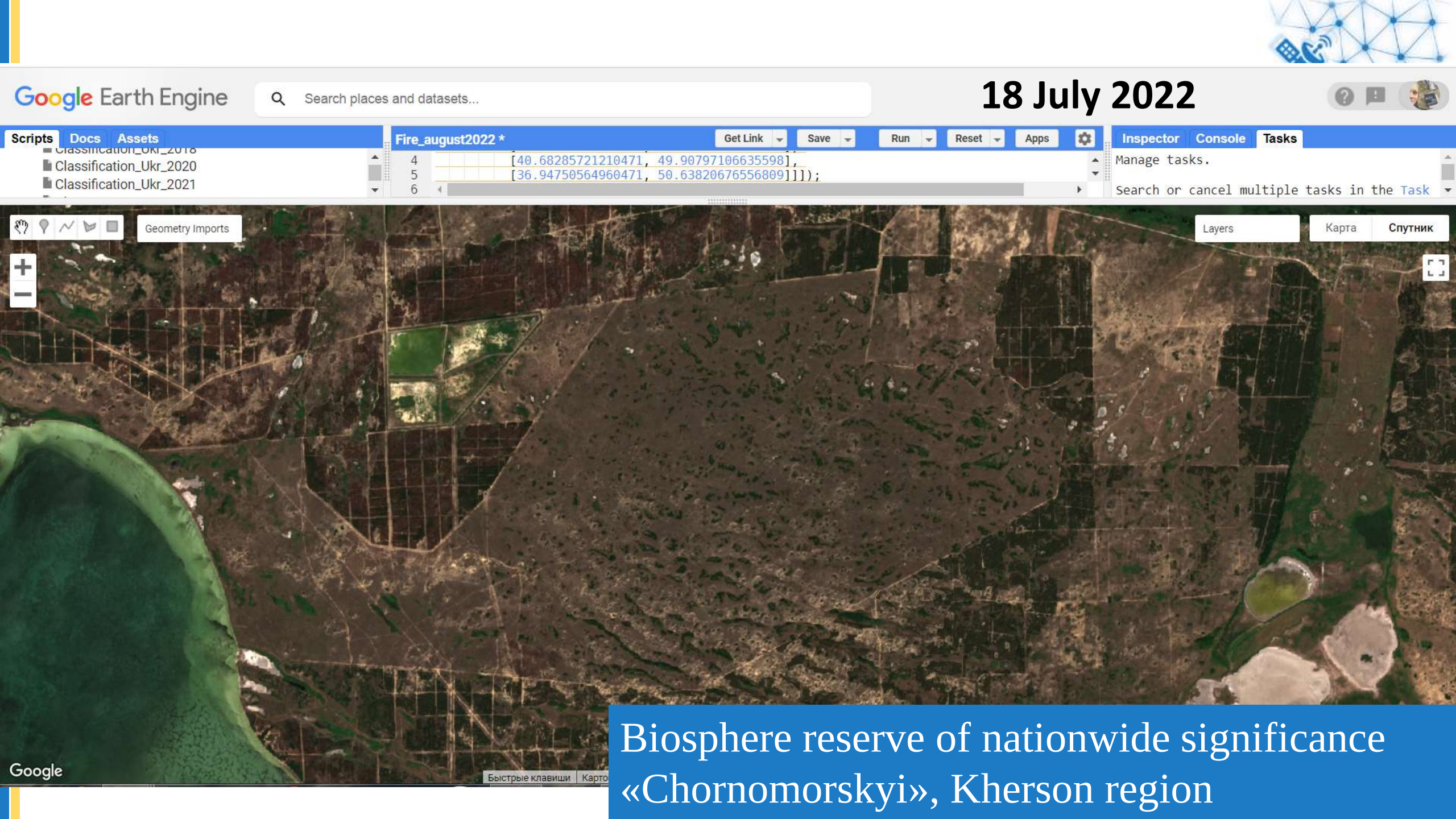
Near the National nature park of nationwide significance «Oleshkivski pisky», Kherson region

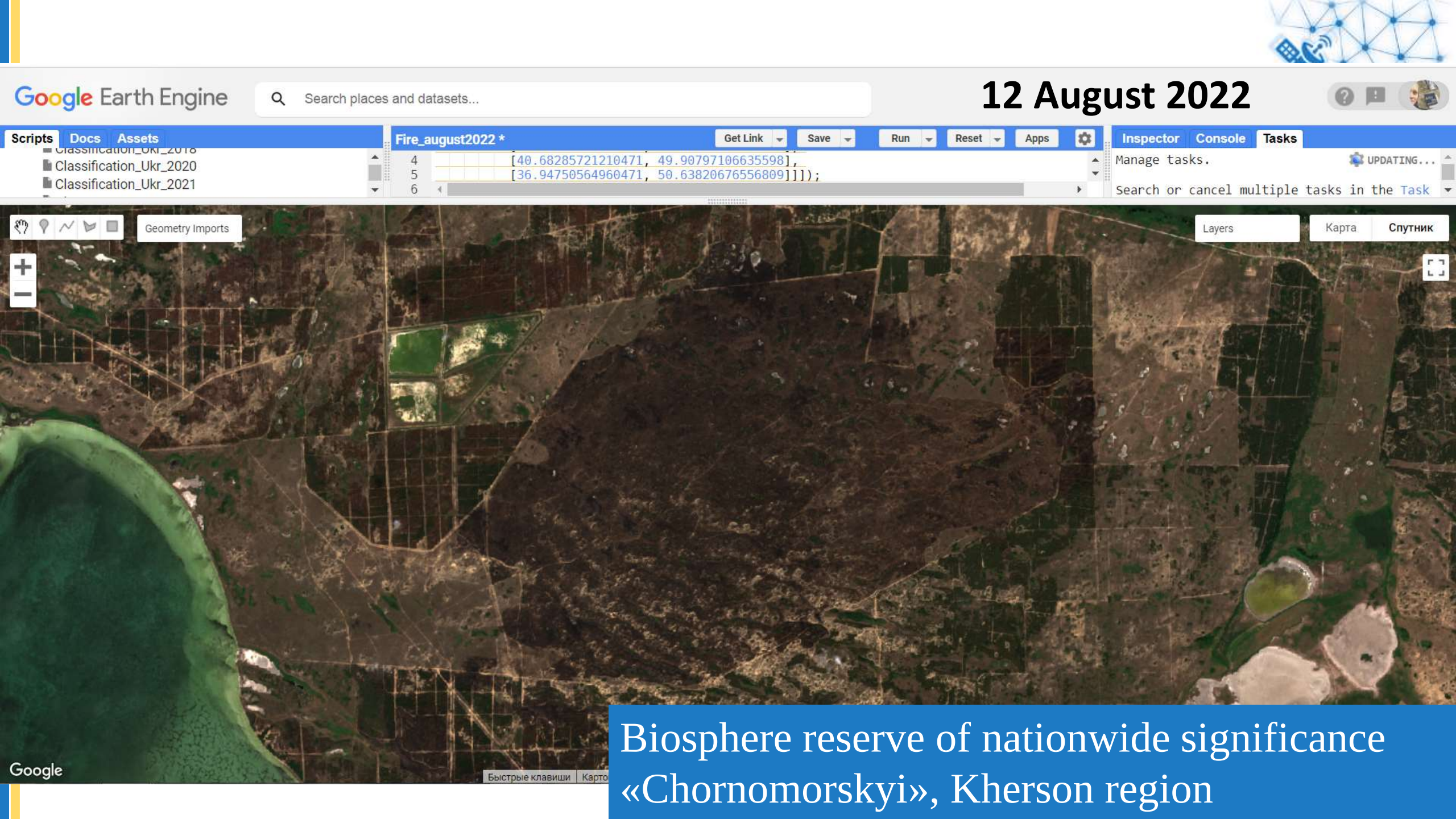

Google Earth Engine
Search places and datasets...
12 August 2022
Scripts
Docs
Assets
Classification_Ukr_2020
Classification_Ukr_2021
Fire_august2022 *
Get Link
Save
Run
Reset
Apps
122 //.addBands(ndwiMasked_2603)
123 //.addBands(ndwiMasked_2403)
124
Inspector
Console
Tasks
Manage tasks.
Search or cancel multiple tasks in the Task
Geometry Imports
Layers
Карта
Спутник
Google
Near the National nature park of nationwide significance «Oleshkivski pisky», Kherson region

Burned area

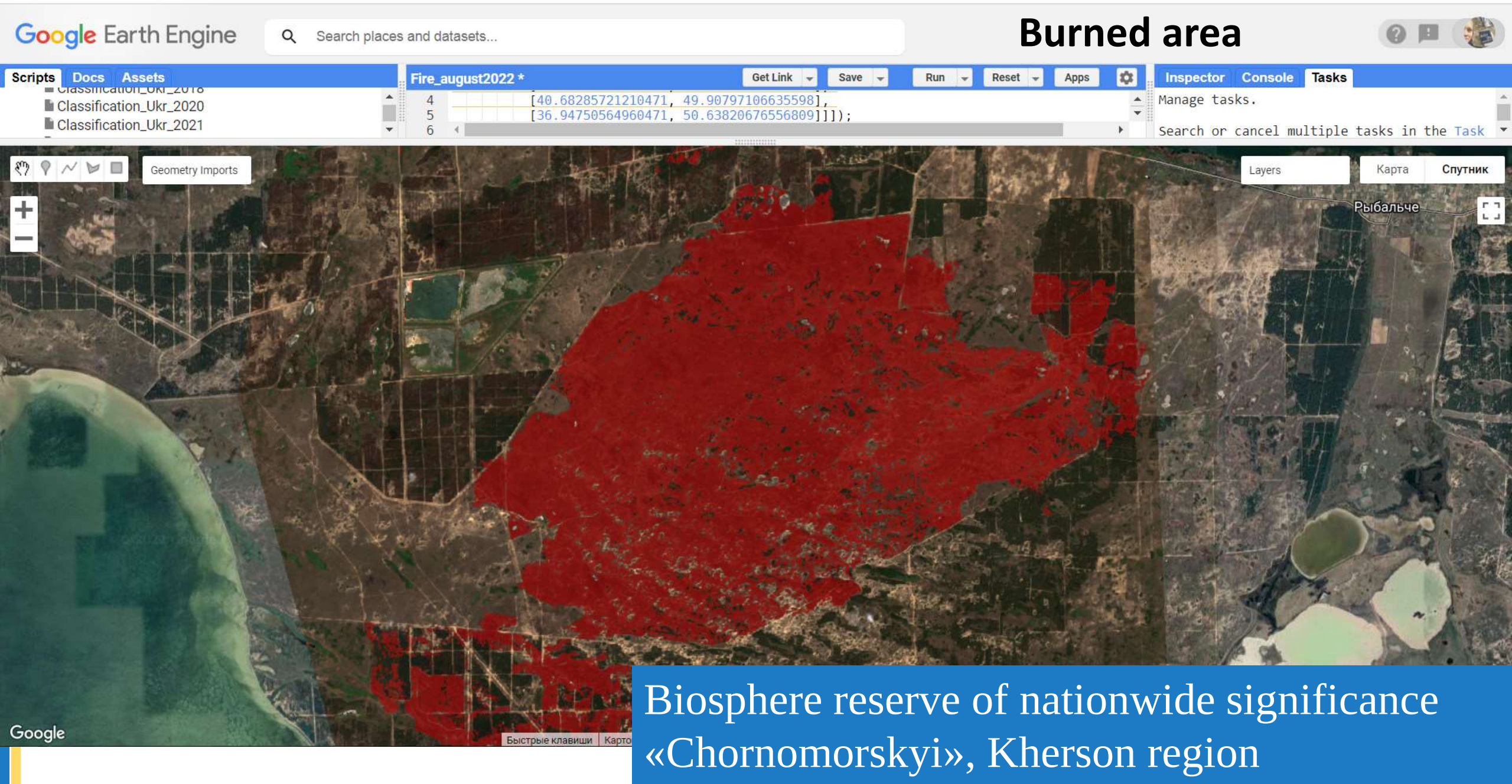


Near the National nature park of nationwide significance «Oleshkivski pisky», Kherson region


Google Earth Engine
Search places and datasets...
18 July 2022
Scripts
Docs
Assets
Classification_Ukr_2020
Classification_Ukr_2021
Fire_august2022 *
Get Link
Save
Run
Reset
Apps
[40.68285721210471, 49.90797106635598],
[36.94750564960471, 50.63820676556809]]]);
Inspector
Console
Tasks
Manage tasks.
Search or cancel multiple tasks in the Task
Geometry Imports
Layers
Карта
Спутник
Google
Быстрые клавиши
Biosphere reserve of nationwide significance «Chornomorskyi», Kherson region


Google Earth Engine
Search places and datasets...
12 August 2022
Scripts
Docs
Assets
Classification_Ukr_2020
Classification_Ukr_2021
Fire_august2022 *
Get Link
Save
Run
Reset
Apps
[40.68285721210471, 49.90797106635598],
[36.94750564960471, 50.63820676556809]]]);
Inspector
Console
Tasks
Manage tasks.
UPDATING...
Search or cancel multiple tasks in the Task
Geometry Imports
Layers
Карта
Спутник
Google
Быстрые клавиши
Biosphere reserve of nationwide significance «Chornomorskyi», Kherson region

Burned area



Biosphere reserve of nationwide significance «Chornomorskyi», Kherson region

Cloud platforms for satellite data processing

- **Amazon Web Services (AWS)**
- **Google Earth Engine**
- **DIAS, for instance, CREODIAS**
  - **OCRE project**
- **Open Data Cube**

EO4UA initiative based on CREODIAS

- Free platform for sharing data and products
- Initiator - CloudFerro
- Partners – public and private institutions

Discussion

- War damage assessment
  - methodology development – ready to share
- Consulting and best practices on Machine Learning and Cloud Computing
- Trainings
  - our main competence, ready to contribute