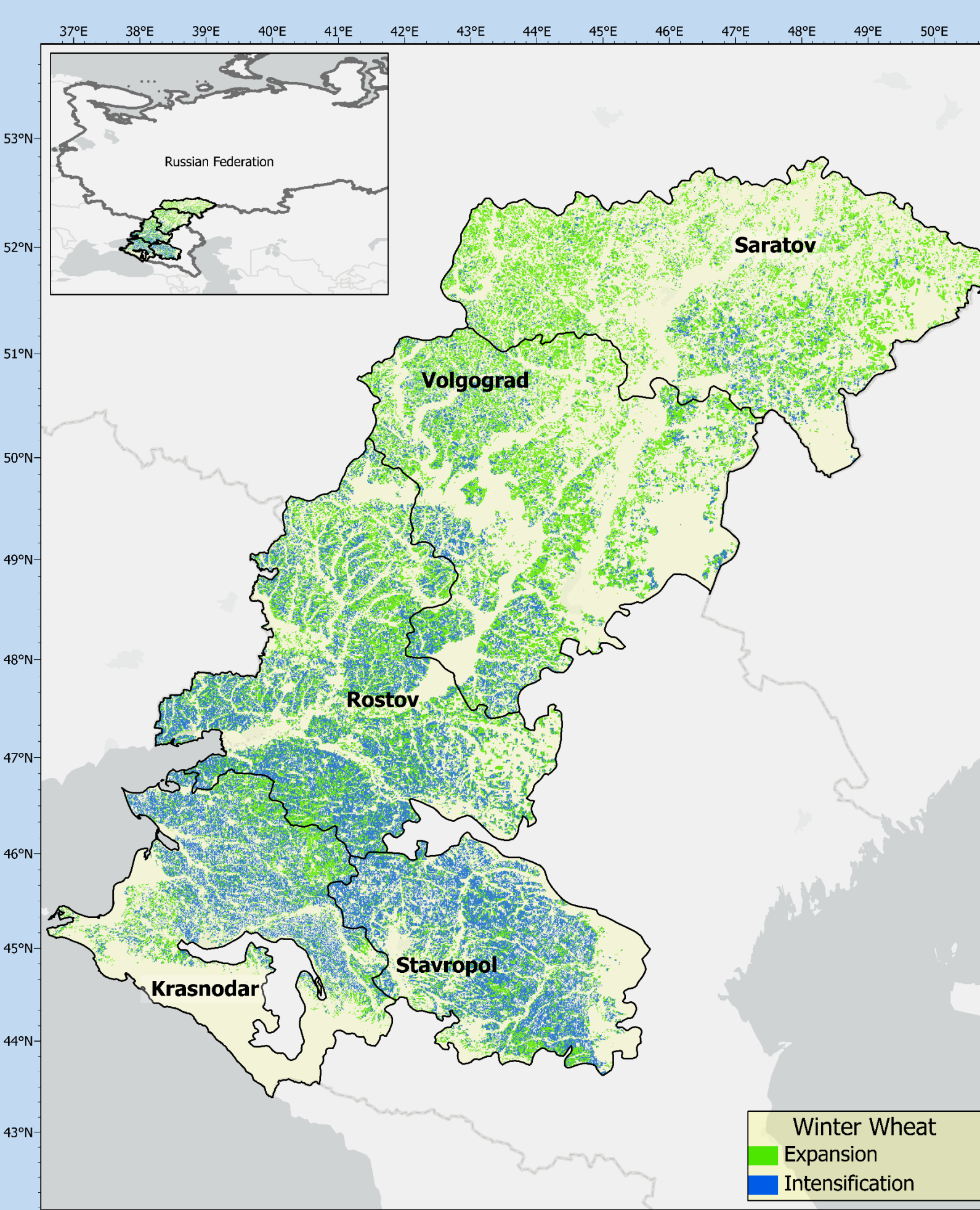


Winter Wheat in Russia



Significant change in land cover/land use from 2000 to 2020 in southwestern Russia

Net cropland increase (Expansion & Intensification): **13 Mha**

Expansion: **8.7 Mha**

Intensification: **4.5 Mha**

Expansion and intensification are **latitudinally dichotomous**. Expansion in the **north** and intensification in the **south**.

Area found to be larger contributor than **yield** in crop production increase.

Unexploded Ordnance Mapping in Ukraine



Artillery craters can be detected in satellite imagery at 0.3-0.5 m resolution

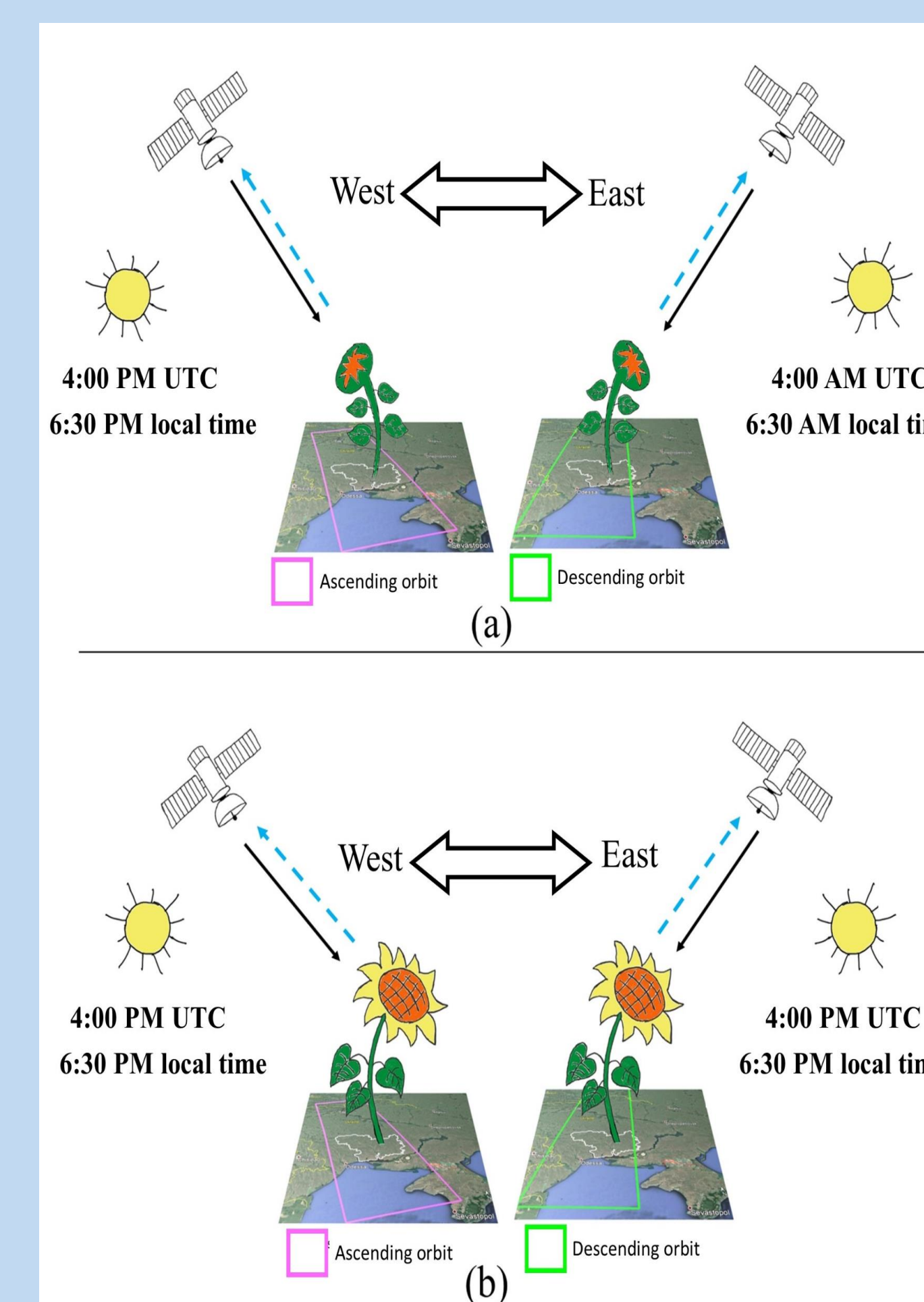
Deep learning UNET model yields an F-score of 0.89

Model's performance depends on crater's size

First regional scale mapping of shelling in the 2014 and 2022 wars in Ukraine

Translated outputs into UXO hazard maps for humanitarian and post-conflict rehabilitation use

Sunflower Mapping using Sentinel-1 Data

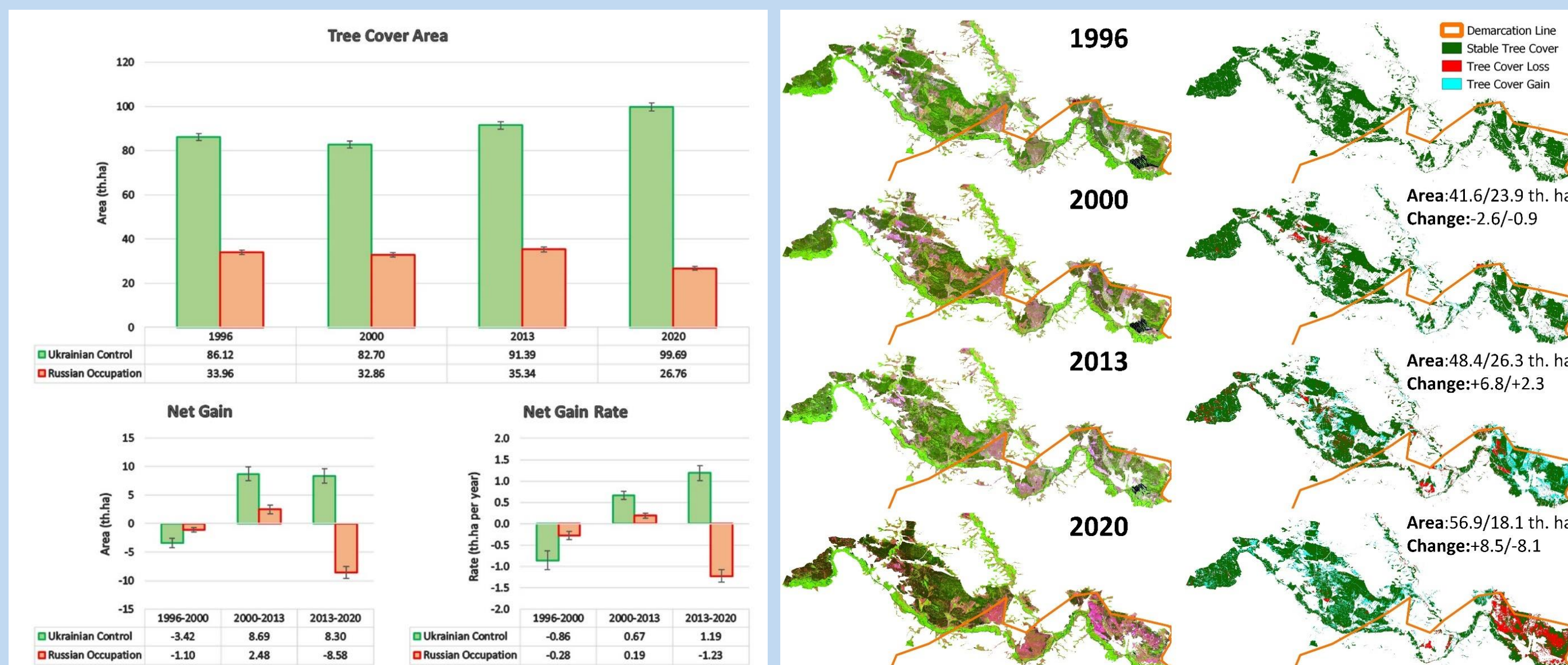


Heliotropic and directional behavior of sunflower observed in Sentinel-1 data

Date of beginning and end of flowering detected with approx. 4 days accuracy.

The proposed generalized spatio-temporal classifier can map sunflower with high accuracy (>85%) early in season, without any additional field labels.

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.

Changes in Night-time Lights 2012-2016

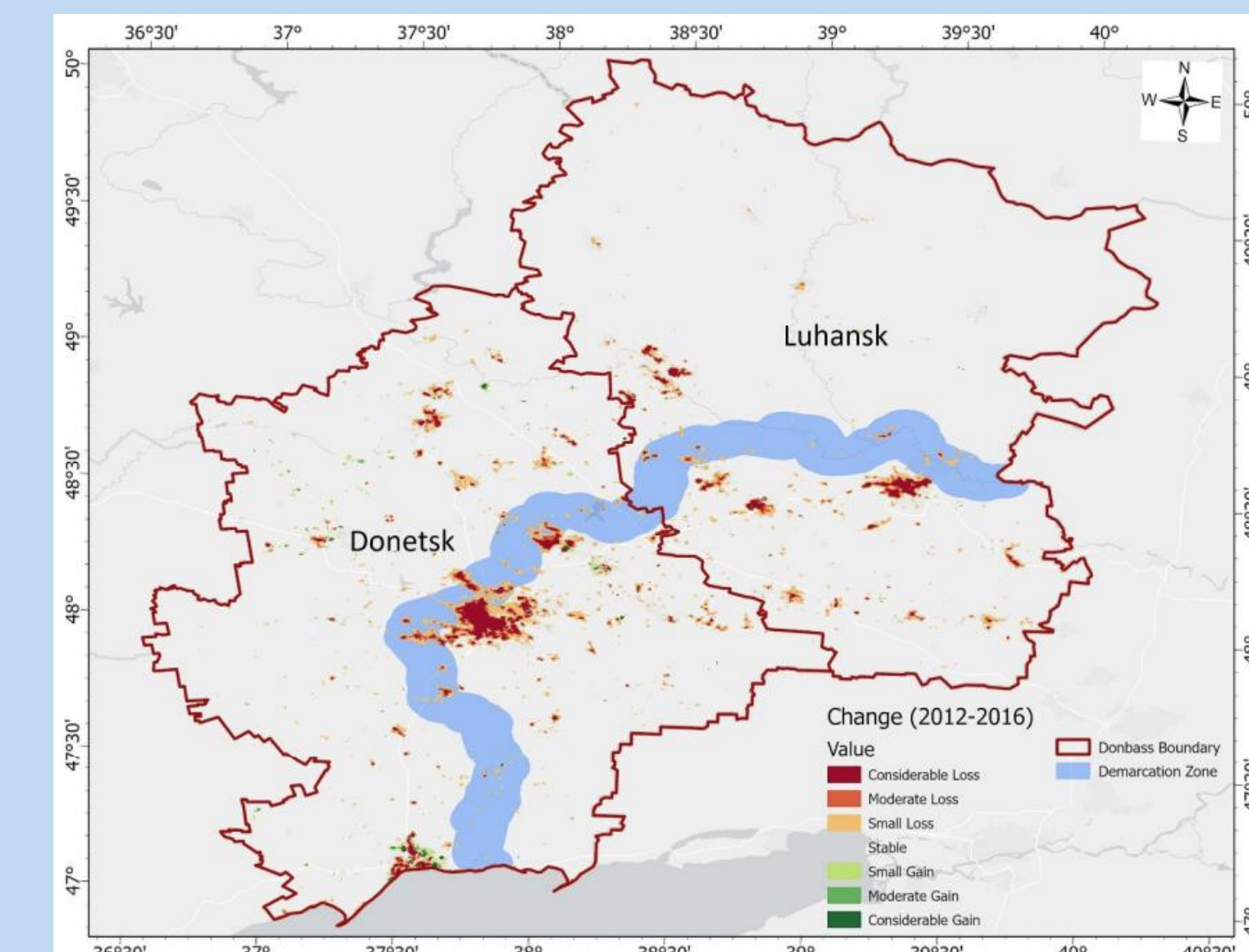


Table 5. Land-use characteristics within official city boundaries.

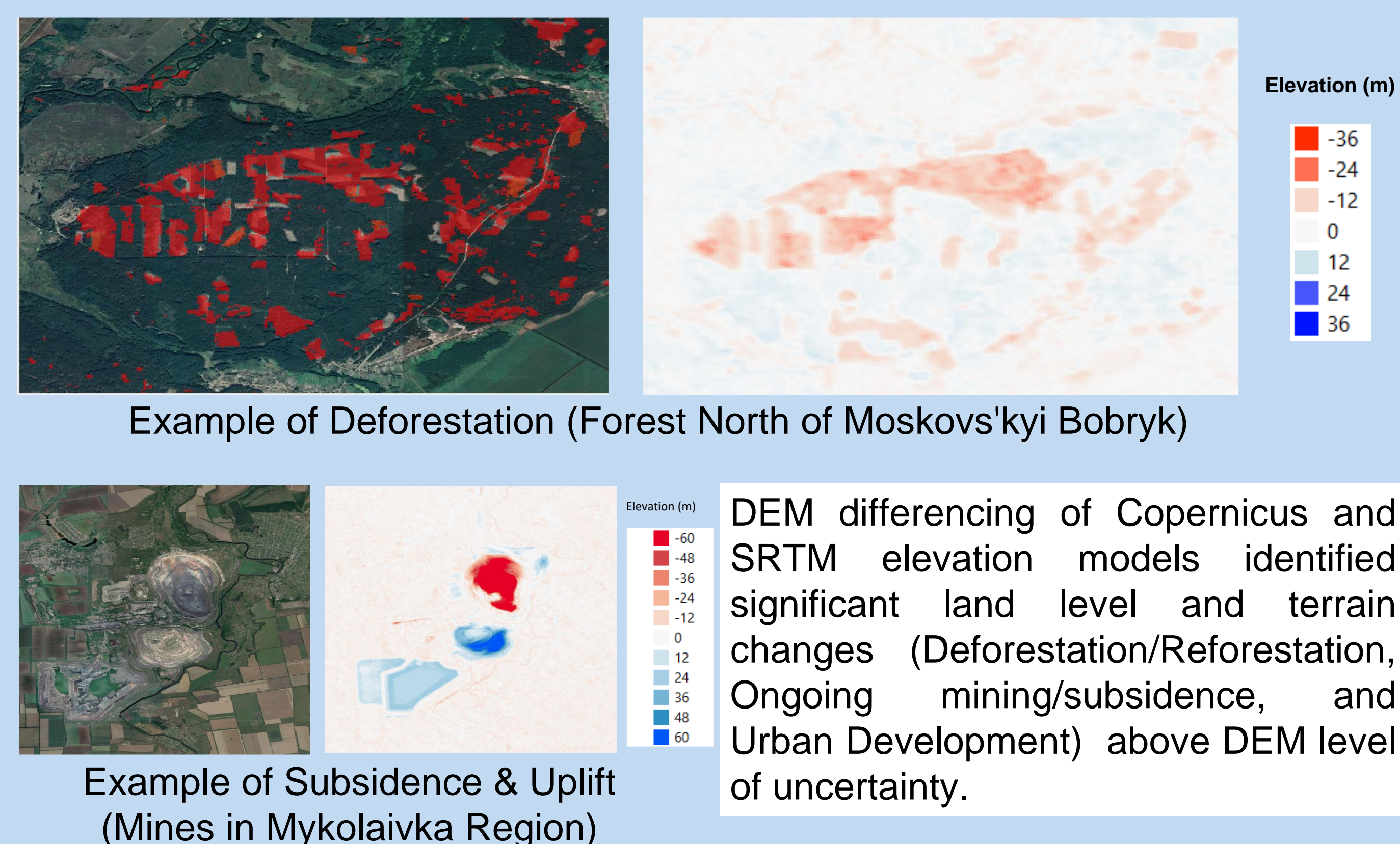
Land type	Loss total
Agriculture	4.5%
Forest	3%
Industry	24%
Residential	43.5%
Rail/road	8%
Urban (commercial)	17%

Table 6. Land-use characteristics outside of official city boundaries.

Land type	Loss total
Agriculture	33%
Forest	4.5%
Industry	36.5%
Residential	17.5%
Rail/road	8%

Night-time light loss highlights which land-use classes were most sensitive to war. Decoupling administrative boundaries highlights sensitive human-environment interactions.

Changes in DEM: SRTM-Copernicus

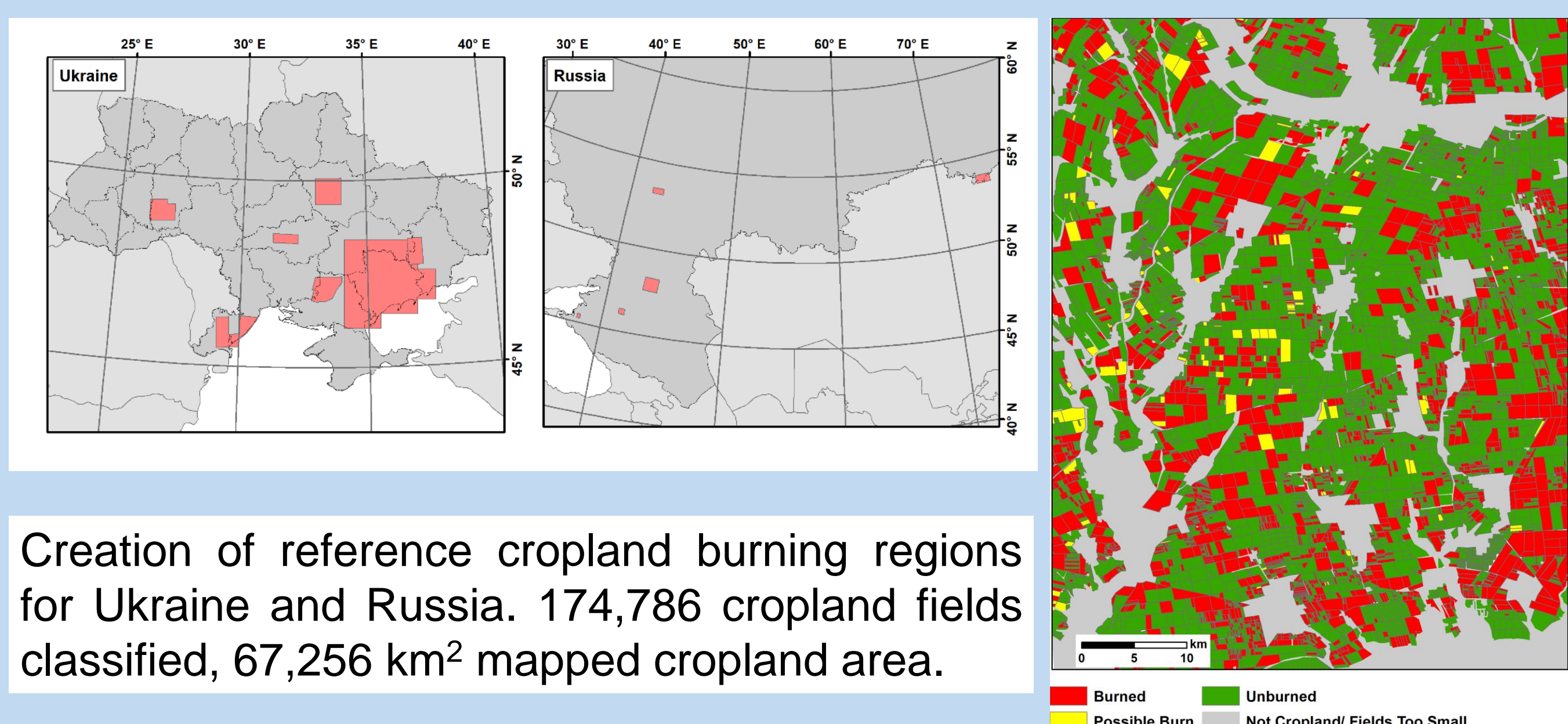


Example of Deforestation (Forest North of Moskovs'kyi Bobryk)

Example of Subsidence & Uplift (Mines in Mykolaivka Region)

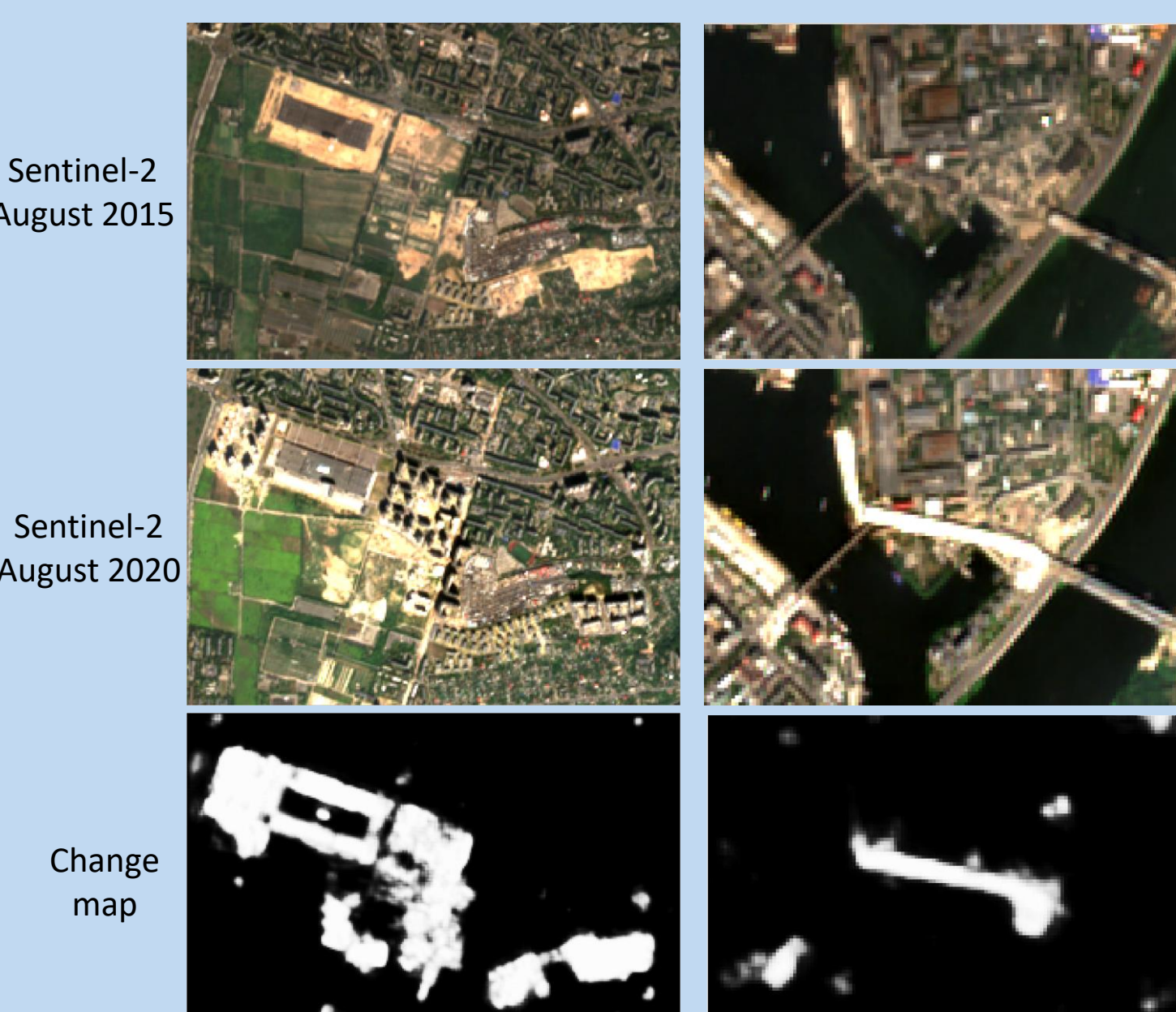
DEM differencing of Copernicus and SRTM elevation models identified significant land level and terrain changes (Deforestation/Reforestation, Ongoing mining/subsidence, and Urban Development) above DEM level of uncertainty.

Cropland Burning



Creation of reference cropland burning regions for Ukraine and Russia. 174,786 cropland fields classified, 67,256 km² mapped cropland area.

Urban Changes



Based on Onera Change Detection Dataset, Sentinel-2 and UNET

Results for Kyiv (2015-2020):
 PA change: 72.1 ± 11.6%
 UA change: 86.0 ± 3.5%

Area of change: 17.0 ± 2.8 km² (2.1% of total area)
 Active construction: ~38%
 Residential properties: ~40%
 Commercial properties: ~15%

Publications

- Abys, C., Skakun, S., & Becker-Reshef, I. (2022). **The Rise and Volatility of Russian Winter Wheat Production.** *Environmental Research Communications*, <https://doi.org/10.1088/2515-7620/ac97d2>
- Eun, J., & Skakun, S. (2022). **Characterizing land use with night-time imagery: the war in Eastern Ukraine (2012–2016).** *Environmental Research Letters*, 17, art. num. 095006.
- Zhang, Y., Skakun, S., Adegbenro, M.O., & Ying, Q. (2022). **Leveraging the use of labeled benchmark datasets for urban area change mapping and area estimation: a case study of the Washington DC–Baltimore region.** *International Journal of Digital Earth*, 15(1), 1169-1186.
- Xie, Y., He, E., Jia, X., Chen, W., Skakun, S., Bao, H., ... & Ravirathnam, P. (2022). **Fairness by "Where": A Statistically-Robust and Model-Agnostic Bi-Level Learning Framework.** *The Thirty-Sixth AAAI Conference on Artificial Intelligence (AAAI'22)*.
- Shumilo, L., Lavreniuk, M., Skakun, S., Kussul, N. (2021). **Is Soil Bonitet an Adequate Indicator for Agricultural Land Appraisal in Ukraine?** *Sustainability*, 13, art. num. 12096.

Acknowledgements

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