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Monitoring of Urban Changes with Sentinel 1 and 2 Data in Mariupol, Ukraine, in 2022/23

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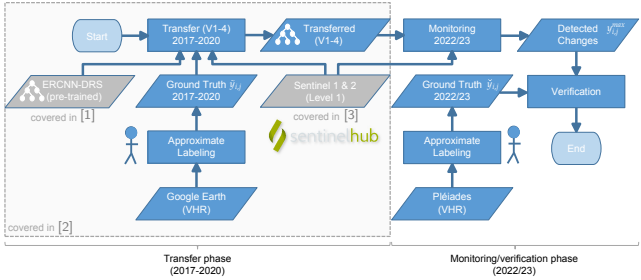
MINISTRY OF EDUCATION, YOUTH AND SPORTS

Objectives

- Multi-modal Sentinel 1 and Sentinel 2 observations to be used together (both level 1) for high temporal resolution
- Demonstration of the combination of recent works for monitoring urban changes in Mariupol, Ukraine:



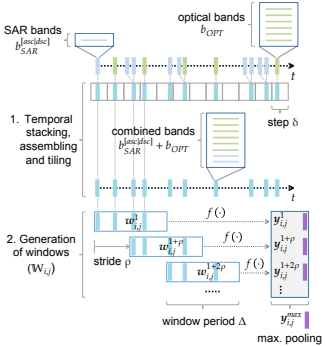
All covered in [4]

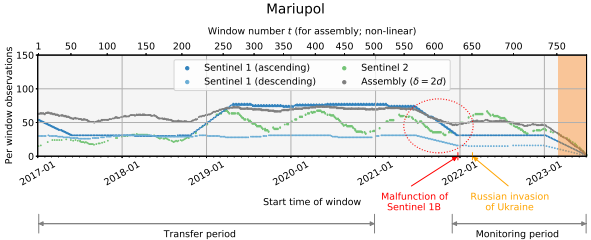
- Analysis of how the malfunction of Sentinel 1B (23 December 2021) influences the monitoring performance
- Showcasing the methods for a disaster event (Russo-Ukrainian war)

Data Processing

- The *rsdtlib* [3] tool was used to...
  - retrieve Sentinel 1 and Sentinel 2 data from *SentinelHub*
  - process data to windowed time series (with stacking, assembling, and tiling)

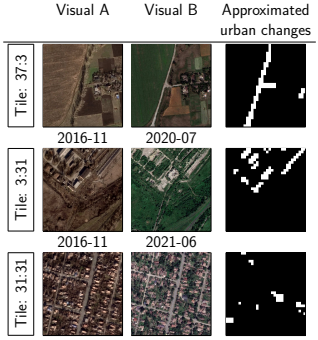
- Two periods were considered:
  - Transfer period (2017-2020) for transfer learning to the region of Mariupol, Ukraine
  - Monitoring period (November 2021 and later)

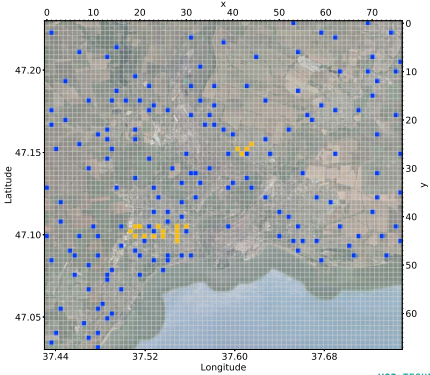




Transfer

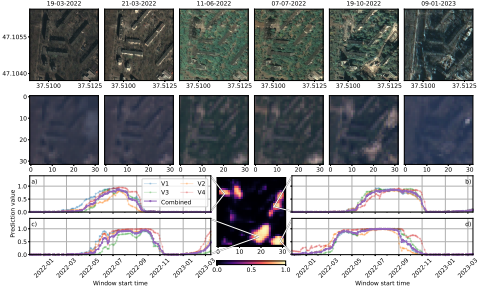
- Selection of 164 tiles (training + validation) and label with a change map for 2017-2020
- Balanced representation of changes: favor diverse changes of smaller extent
- Labeling was accomplished with freely available Google Earth™ historic imagery
- Applied transfer learning on pre-trained model from [1] (multiple times)

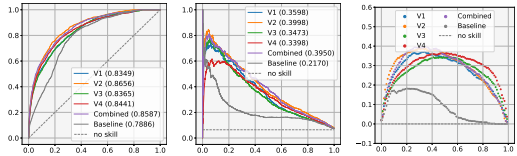




Monitoring

- Applied the transferred model(s) to the present (November 2021 and following)
- Airbus Pléiades has been used for validation since recent Google Earth imagery was not available at the time of the project
- With an uncertainty of half a year, the changes are localizable over time
- The malfunction of Sentinel 1B did not overly impact our method

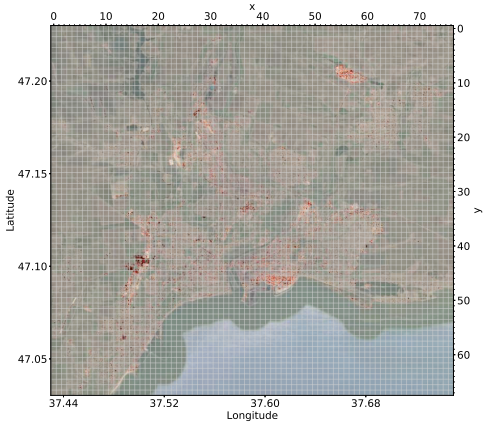




ROC (left) and PR (middle) curves; Cohen's Kappa is shown for different thresholds (right). Area under the ROC/PR curves are in parenthesis.

Example

The monitoring applied to the time frame November 2021 to mid 2023 is shown below. Changes are highlighted in red (superimposed over a static image from 2019 for reference) and are a maximum over every window's inference.



References

[1] Georg Zitzlsberger, Michal Podhorányi, Václav Svato, et al. "Neural Network-Based Urban Change Monitoring with Deep-Temporal Multispectral and SAR Remote Sensing Data". In: *Remote Sensing* 13.15 (2021). ISSN: 2072-4292. DOI: 10.3390/rs13153000. URL: https://www.mdpi.com/2072-4292/13/15/3000.

[2] Georg Zitzlsberger, Michal Podhoranyi, and Jan Martinovic. "A Practically Feasible Transfer Learning Method for Deep-Temporal Urban Change Monitoring". In: *International Journal of Remote Sensing* (2023). DOI: 10.1080/01431161.2023.2243021.

[3] Georg Zitzlsberger, Michal Podhoranyi, and Jan Martinovi. "rsdtlib: Remote sensing with deep-temporal data library". In: *SoftwareX* 22 (2023), p. 101369. ISSN: 2352-7110. DOI: https://doi.org/10.1016/j.softx.2023.101369. URL: https://www.sciencedirect.com/science/article/pii/S2352711023000651.

[4] Georg Zitzlsberger and Michal Podhoranyi. "Monitoring of Urban Changes With Multimodal Sentinel 1 and 2 Data in Mariupol, Ukraine, in 2022/23". In: *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 17 (2024), pp. 5245–5265. DOI: 10.1109/JSTARS.2024.3362688.

The project is hosted on GitHub. See for the trained models, data, videos, etc.

Acknowledgments

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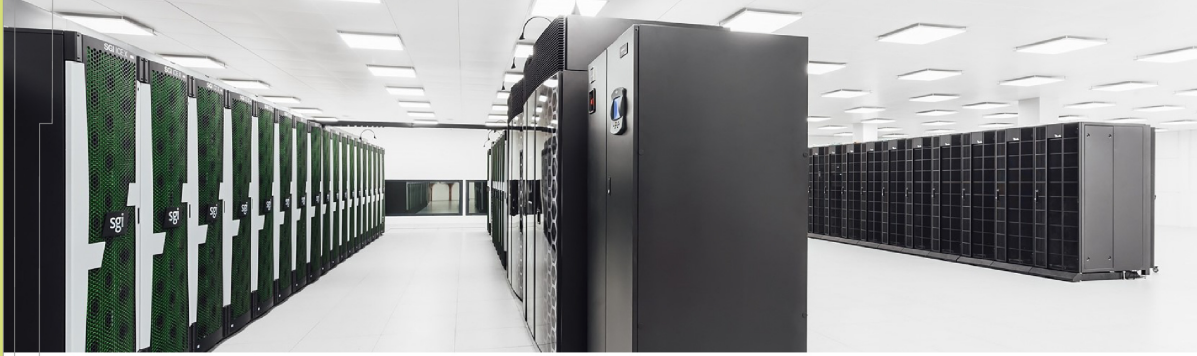

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