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Enhancing the user uptake of Land Cover / Land Use information derived from the integration of Copernicus services and national databases „InCoNaDa”

The National Centre for Research and Development

Detection of land cover changes using Google Earth Engine and Sentinel-2 data

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Outline

1. Introduction
2. Study areas
3. Data
4. Methodology
5. Results
6. Conclusions

Land cover change (images from Google Earth Pro)

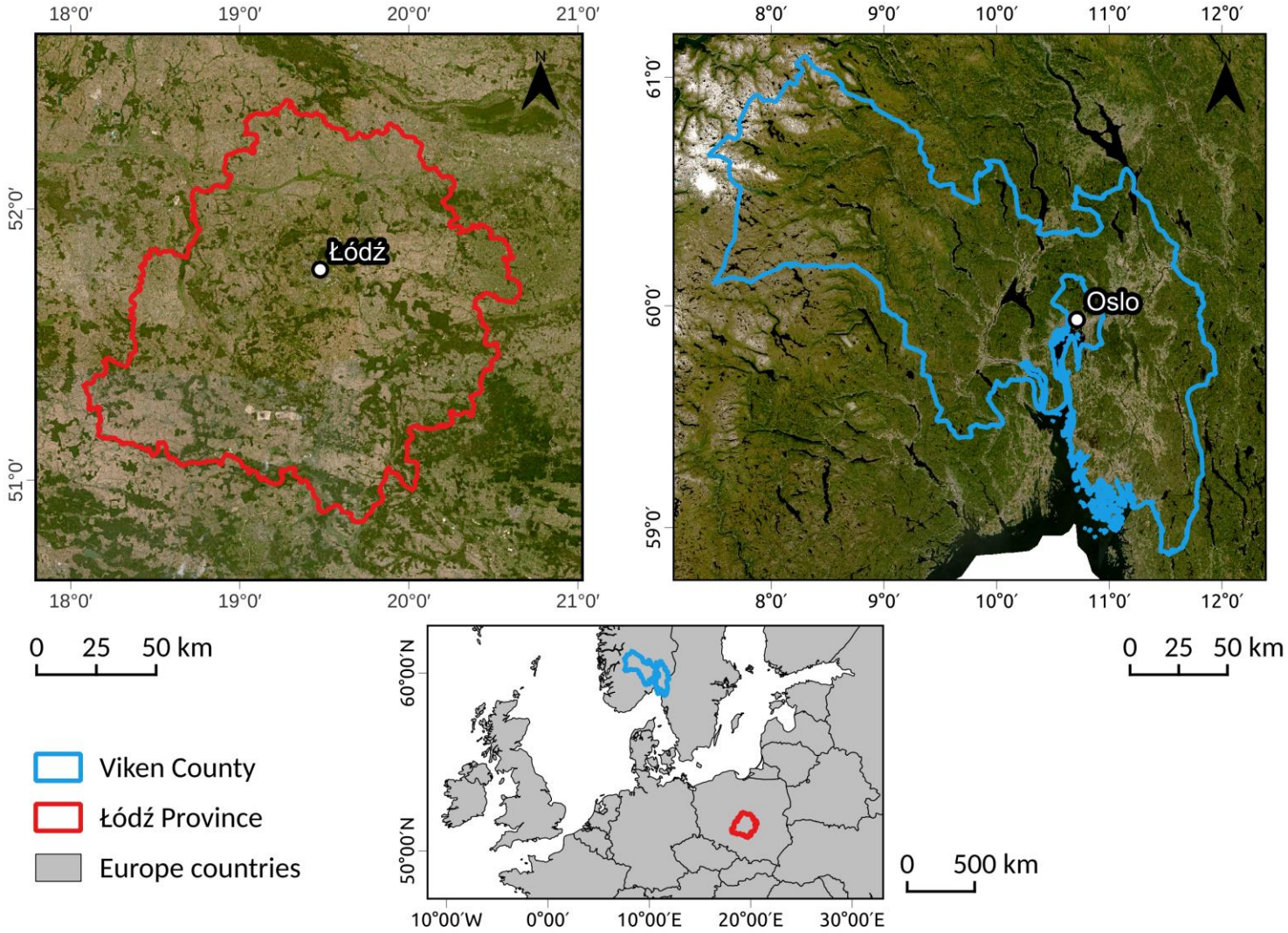
Introduction

- **The aim of this study** was to develop a method to detect land cover changes (LCCs) based on the multitemporal Sentinel-2 data and machine learning approach.
- The study was conducted on **an annual basis** over the period 2018-2021 for the study area in Poland and Norway.
- The algorithm was developed using a cloud-based Google Earth Engine (GEE) platform which provides access to a time series of Sentinel-2 images and other spatial products as well as powerful cloud computing facilities.

Study area

Poland – Łódź Province
(area = 1.8 mln ha)

Norway – Viken County and Oslo
(area = 2.5 mln ha)



Data

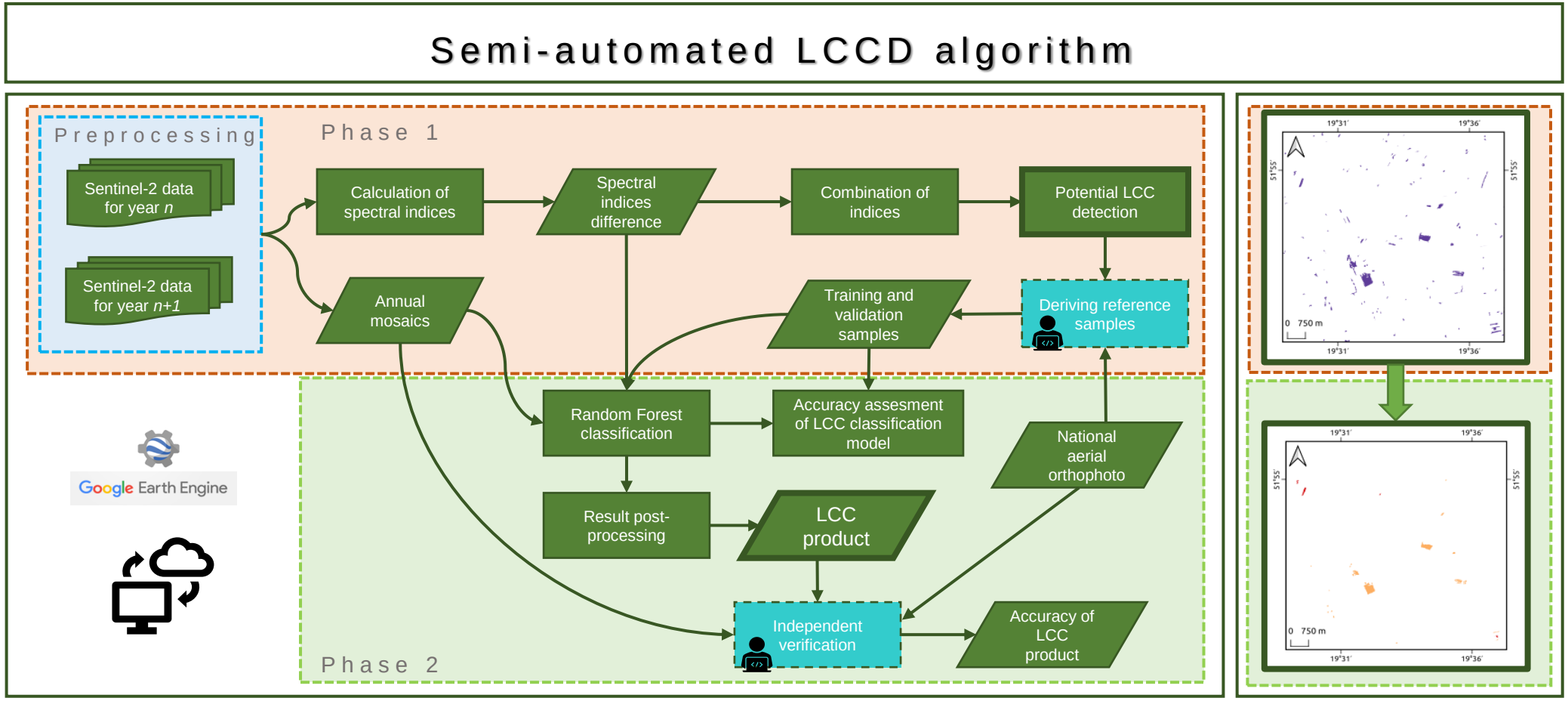
Data:

- a time series of Sentinel-2 images acquired in the growing season from May to September over the period 2018-2021 – Sentinel-2 MSI: MultiSpectral Instrument, Level 2A product
- Sentinel-2 Cloud Probability product applied to mask out cloudy pixels

Reference datasets for independent verification:

- national orthophotos
- annual Sentinel-2 mosaics

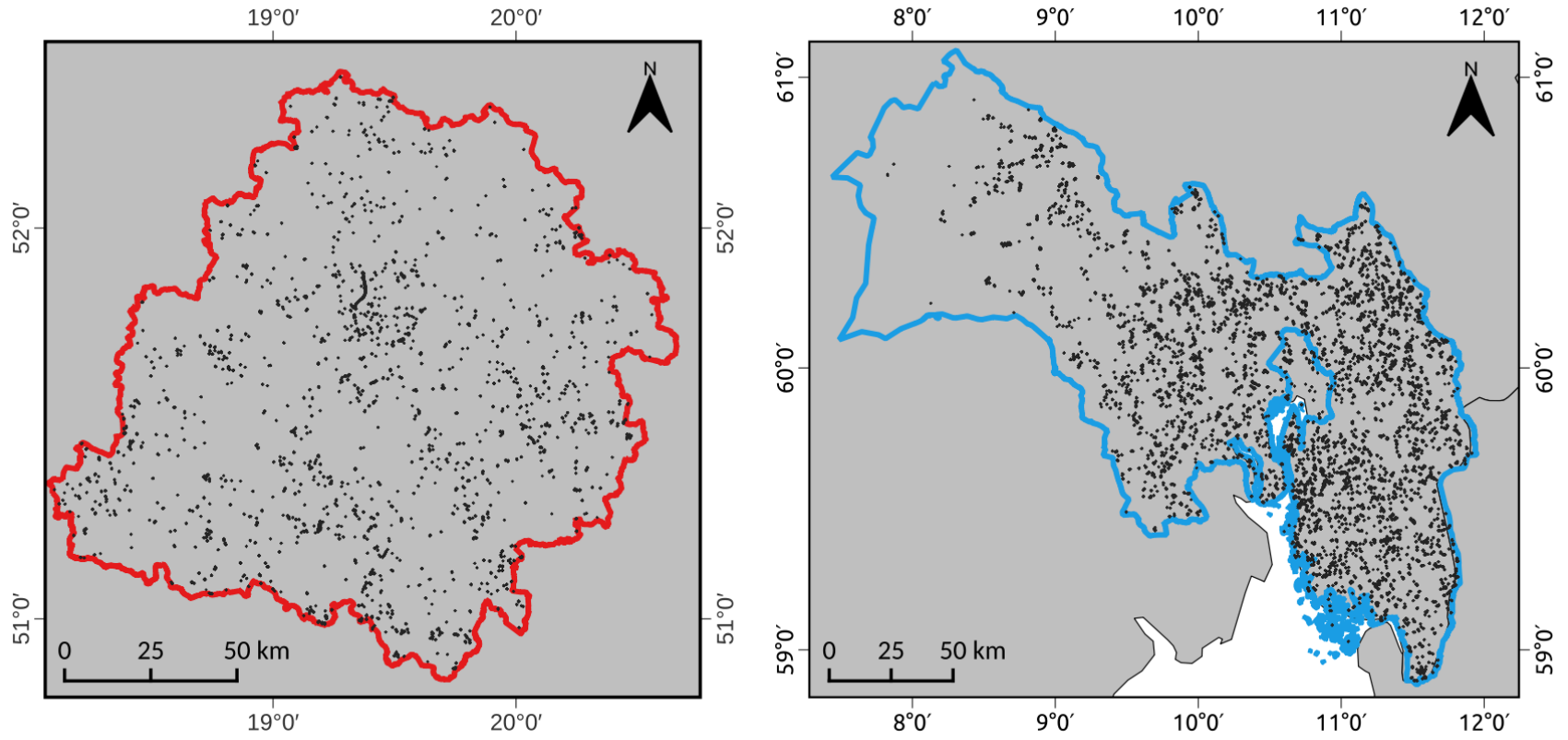
Methodology scheme



Change type classes:
0) no-change,
1) woody coverage converted to non-woody vegetation i.e. clearcuts,
2) vegetated surfaces (woody and non-woody) converted to sealed surfaces like newly built-up areas, infrastructure, and construction sites with unvegetated surfaces or agriculture areas with bare soil in Norway

Results

As a result, three LCC maps were obtained for the following intervals: 2018-2019, 2019-2020, 2020-2021. The minimum mapping unit of LCC product was 0.2 ha.



Distribution of LCCs detected in Poland and Norway over the period 2020-2021

Accuracy assessment

The accuracy of the LCC classification results was assessed for each of the time interval for both study areas using the validation samples. The LCC results reached high accuracy – in both study areas for all time intervals the overall accuracy (OA) was equal to or greater than 0.96 and the Kappa coefficient greater than 0.95.

Accuracy assessment of the LCC classification model for Poland and Norway

	OA	Kappa	User's accuracy (UA)			Producer's accuracy (PA)		
			Class 0	Class 1	Class 2	Class 0	Class 1	Class 2
Poland								
2018-2019	0.96	0.95	0.98	0.99	0.98	0.95	1.00	0.94
2019-2020	0.98	0.97	0.98	0.99	0.98	0.98	1.00	0.96
2020-2021	0.98	0.97	0.99	1.00	0.98	0.97	1.00	0.97
Norway								
2018-2019	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019-2020	0.99	0.99	1.00	1.00	1.00	0.99	0.99	0.99
2020-2021	0.97	0.96	0.98	0.99	0.98	0.96	0.99	0.97

Independent verification

Independent verification was carried out for the period **2020-2021** based on visual inspection of the aerial orthophotos and Sentinel-2 mosaics. OA for both study areas was around 0.93-0.94. The changes in class 2 reached slightly lower accuracy (UA around 0.83), and around 30 points of the actual class 0 (no-change) were misassigned to this class, mostly arable land.

(a) LCC 2020–2021 Poland

Actual class \ Predicted class	0	1	2	Total	PA
0	198	2	33	233	0.850
1	0	198	0	198	1.000
2	2	0	167	169	0.988
Total	200	200	200	600	
UA	0.990	0.990	0.835	OA = 0.94	
F1-Score	0.915	0.995	0.905	macroF1-Score = 0.84	

(b) LCC 2020–2021 Norway

Actual class \ Predicted class	0	1	2	Total	PA
0	197	1	31	229	0.860
1	2	196	3	201	0.975
2	0	2	164	166	0.988
Total	199	199	198	596	
UA	0.990	0.985	0.828	OA = 0.93	
F1-Score	0.921	0.980	0.901	macroF1-Score = 0.82	

Confusion matrices and statistics for the independent verification of LCC results 2020-2021 for three classes in study area in Poland and in Norway

Example of LCC detected on the annual basis for the period 2018-2021

Conclusions

- The two-step land cover change algorithm allows to detect changes with high accuracy at the regional scale.
- The independent verification performed in Poland and Norway proved the effectiveness and reliability of the algorithm in detecting LCCs in different climatic zones.
- In general, the large proportion of detected changes in both countries was related to class 1, converting the woody into non-woody vegetation, which is partly associated with forest management practices.
- The number of changes related to class 2: detection of construction sites and newly built-up areas was larger in Poland than in Norway. In Poland, the total area of changes in classes 1 and 2 decreased over time. In Norway, the situation was rather stable, except the period 2020-2021 due to the massive clay landslide.
- The presented method showed its universality, adaptability, and applicability at the regional scale.

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Thank you for your attention!

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