Norway grants

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

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Land cover change (images from Google Earth Pro)

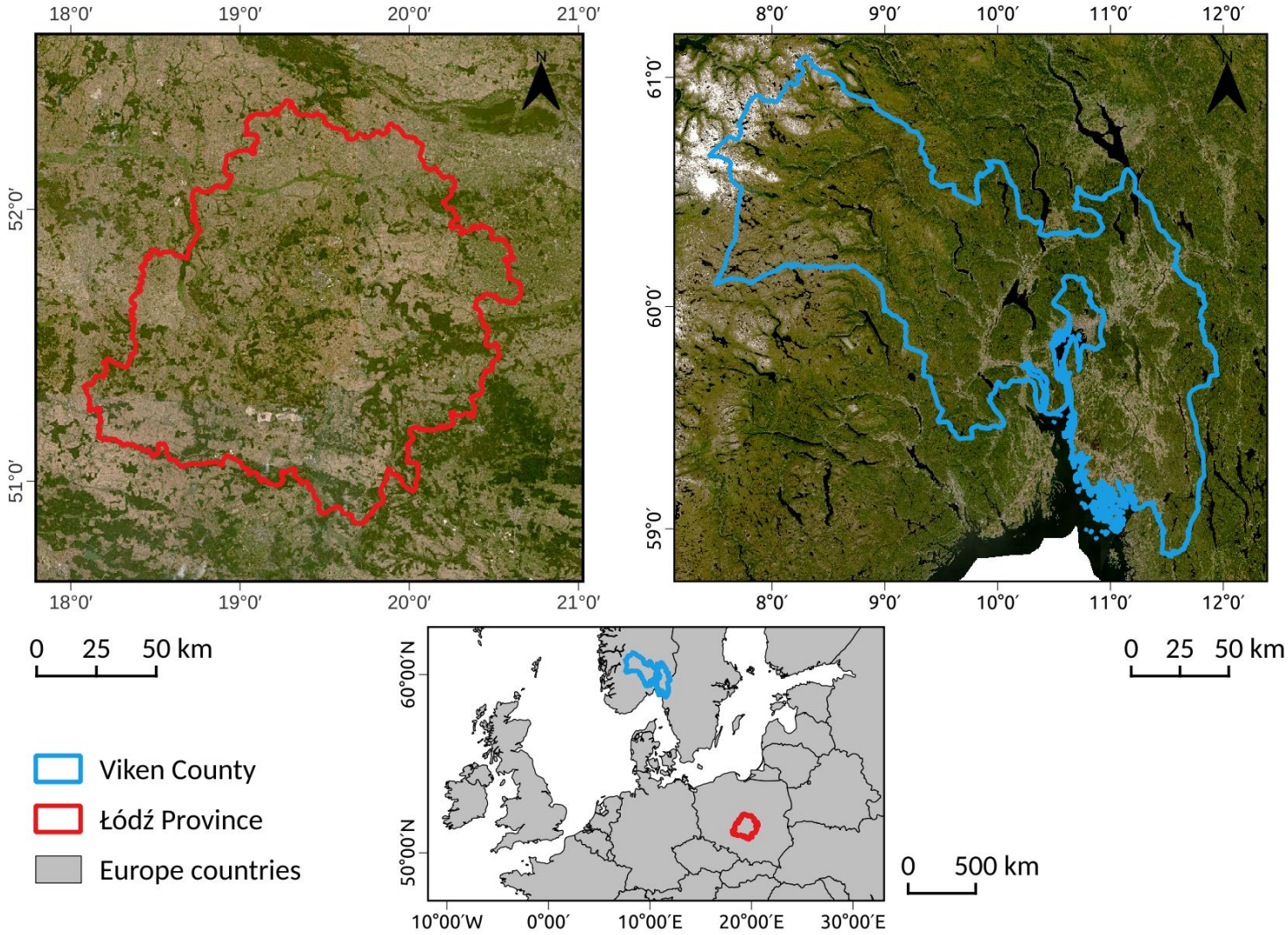
Introduction

- **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

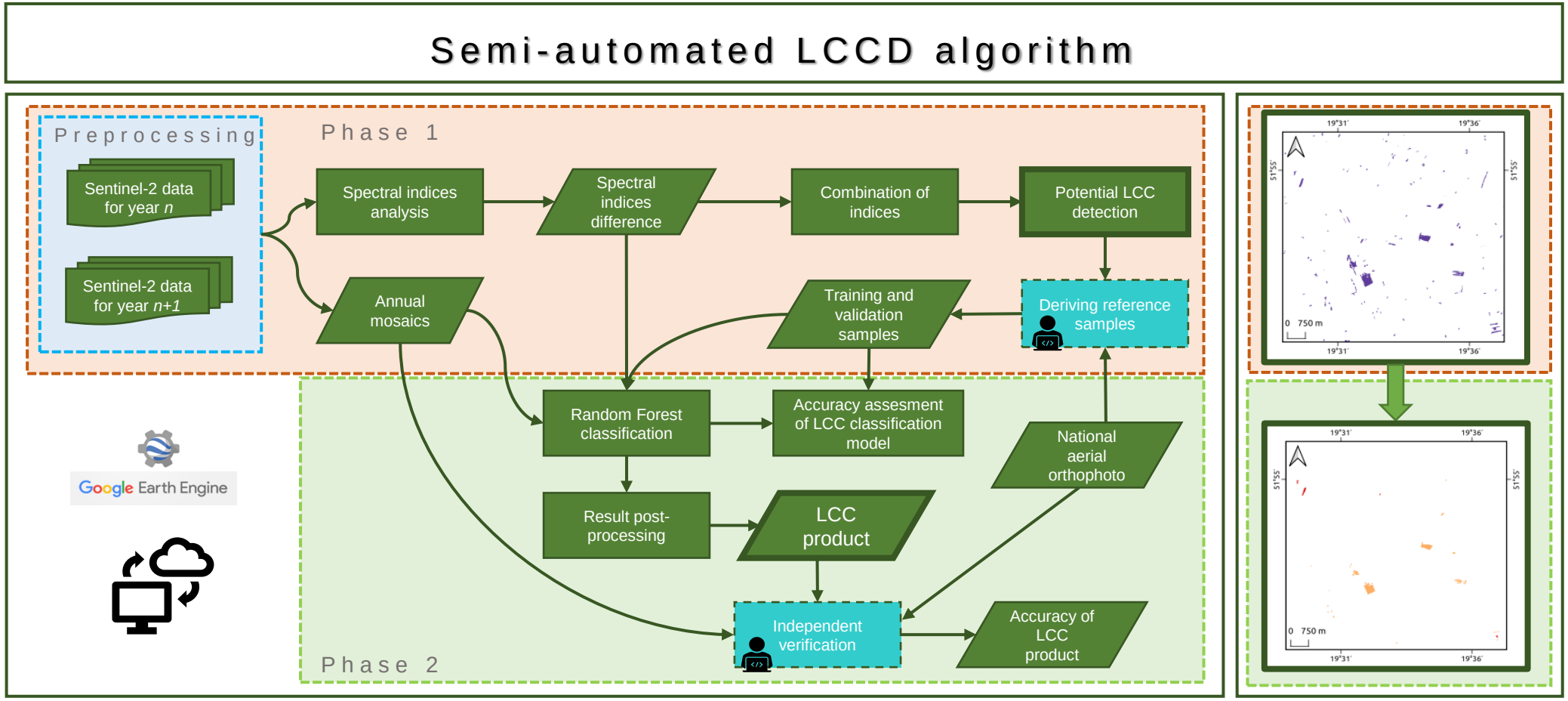
Data:

- 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:

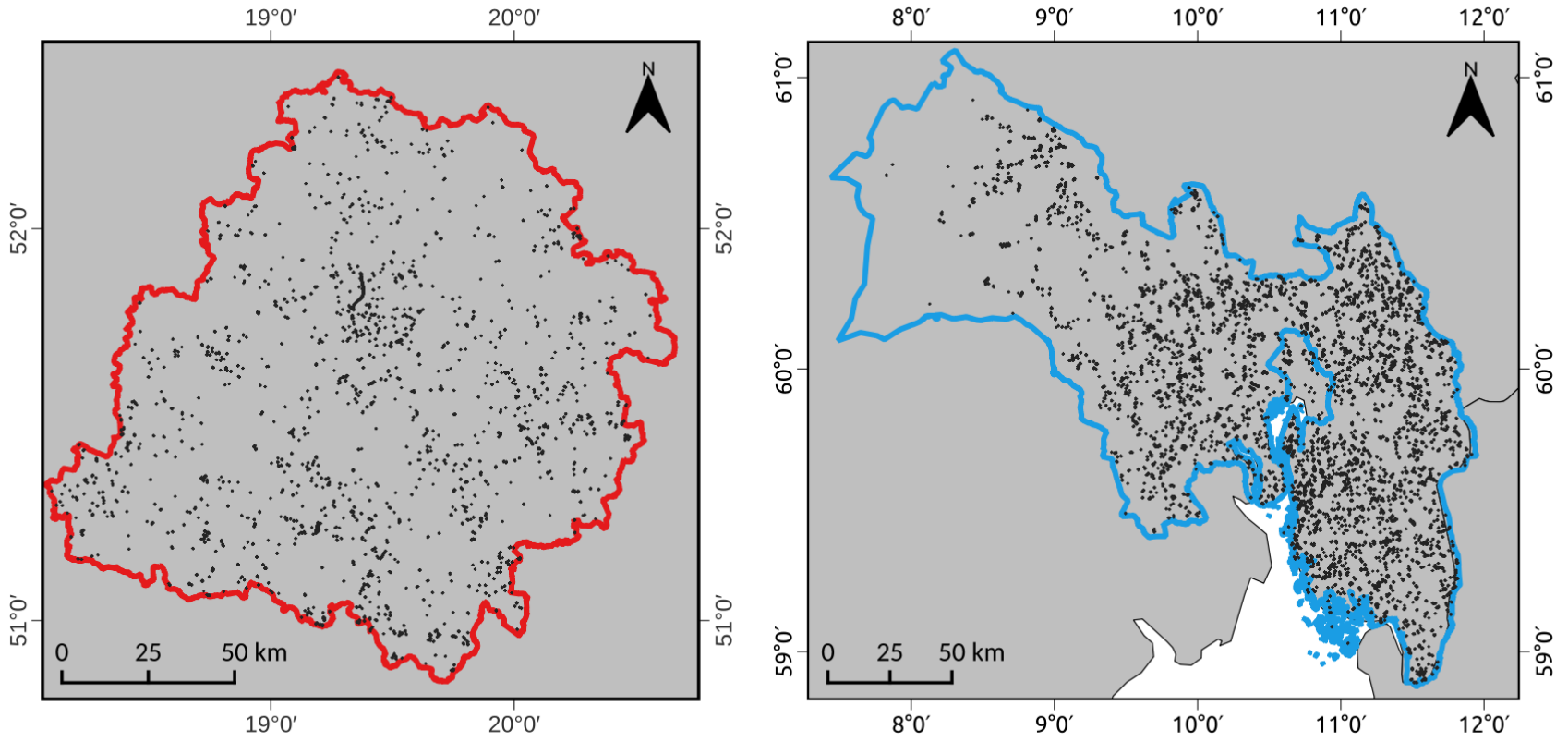
0) no-change,

1) woody coverage converted to non-woody vegetation i.e. clearcuts, arable land,

2) vegetated surfaces (woody and non-woody) converted to sealed surfaces like newly built-up areas or constructed sites

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 0.97 and the Kappa coefficient greater than 0.95.

	OA	Kappa	User's accuracy			Producer's accuracy		
			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

Accuracy assessment of the LCC classification model for Poland and Norway

Independent verification

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

Poland		Actual			
		Class 0	Class 1	Class 2	Total
Prediction	Class 0	198	0	2	200
	Class 1	2	198	0	200
	Class 2	33	0	167	200
	Total	233	198	169	600
					OA = 0.94

Norway		Actual			
		Class 0	Class 1	Class 2	Total
Prediction	Class 0	197	2	0	199
	Class 1	1	196	2	199
	Class 2	30	3	165	198
	Total	228	201	167	596
					OA = 0.94

Confusion matrix for the independent verification of LCC results 2020-2021

	Precision	Recall	F1-Score	Misclassification rate	False positive rate	True negative rate
Poland						
Class 0	0.990	0.850	0.915	0.062	0.005	0.995
Class 1	0.990	1.000	0.995	0.003	0.005	0.995
Class 2	0.835	0.988	0.905	0.058	0.077	0.923
Average	0.938	0.946	0.938	0.041	0.029	0.971
Norway						
Class 0	0.990	0.864	0.923	0.055	0.005	0.995
Class 1	0.985	0.975	0.980	0.013	0.008	0.992
Class 2	0.833	0.988	0.904	0.059	0.077	0.923
Average	0.936	0.942	0.936	0.043	0.030	0.970

Statistics from the confusion matrix for the independent verification of 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 or agricultural land, 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 is 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 is 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.

Norway grants

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Thank you for your attention!

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