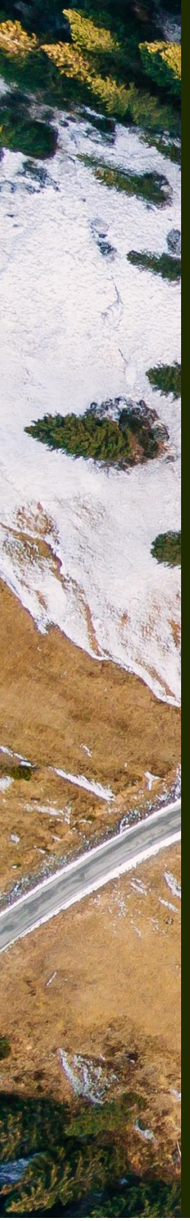
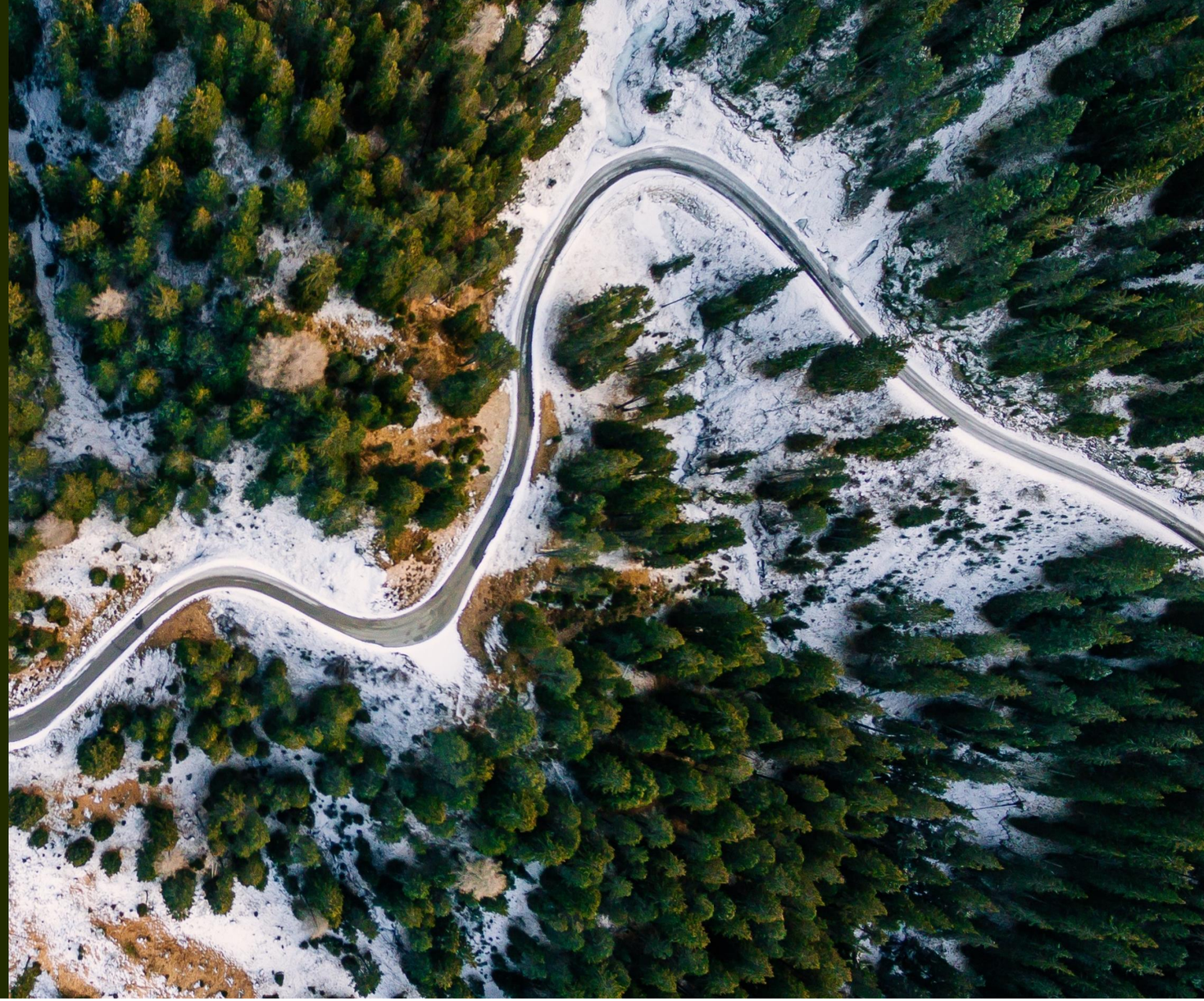
Classification of Satellite Images Using Dynland Technology





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Dynland clustering algorithm includes the following main steps:

1. Forming clusters around each pixel including 10 nearest neighbors in the multispectral feature space
2. Uniting clusters with significant overlap (>80%)
3. Eliminating clones to leave only unique clusters
4. Repeating 2) and 3) until there are no changes
5. Performing growth of clusters by adding nearest neighbors
6. Performing cleaning of the set of clusters leaving only one instance of multiple similar clusters
7. Repeating 5) and 6) until there are no changes in the set of clusters

The algorithm is nonparametric.

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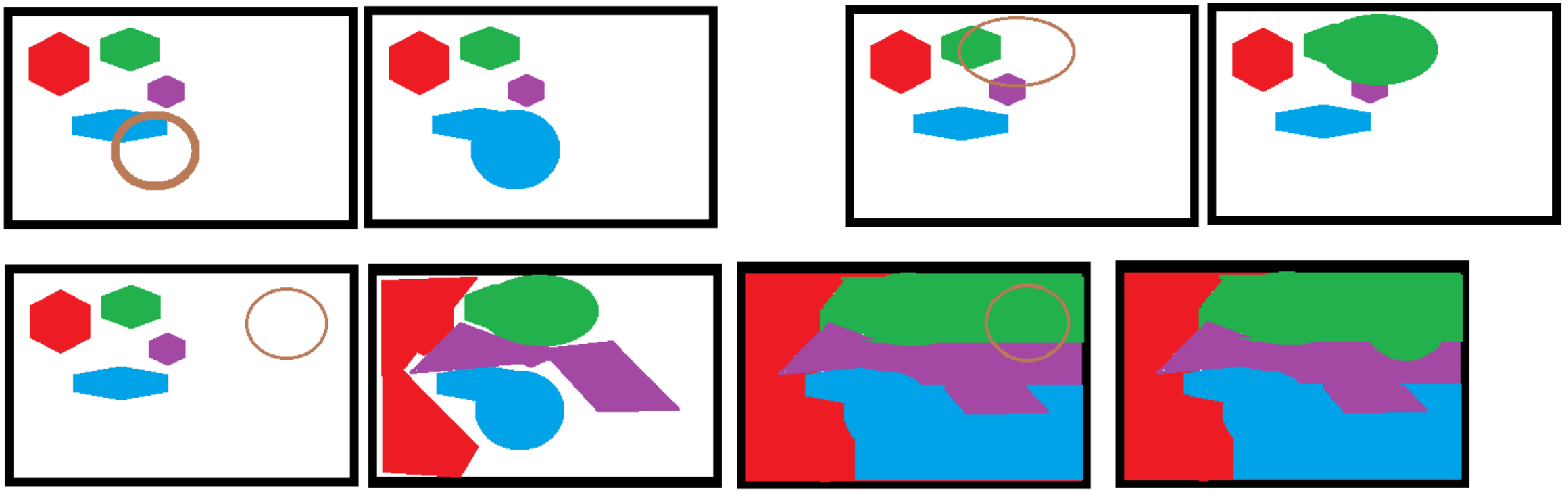
Classification algorithm



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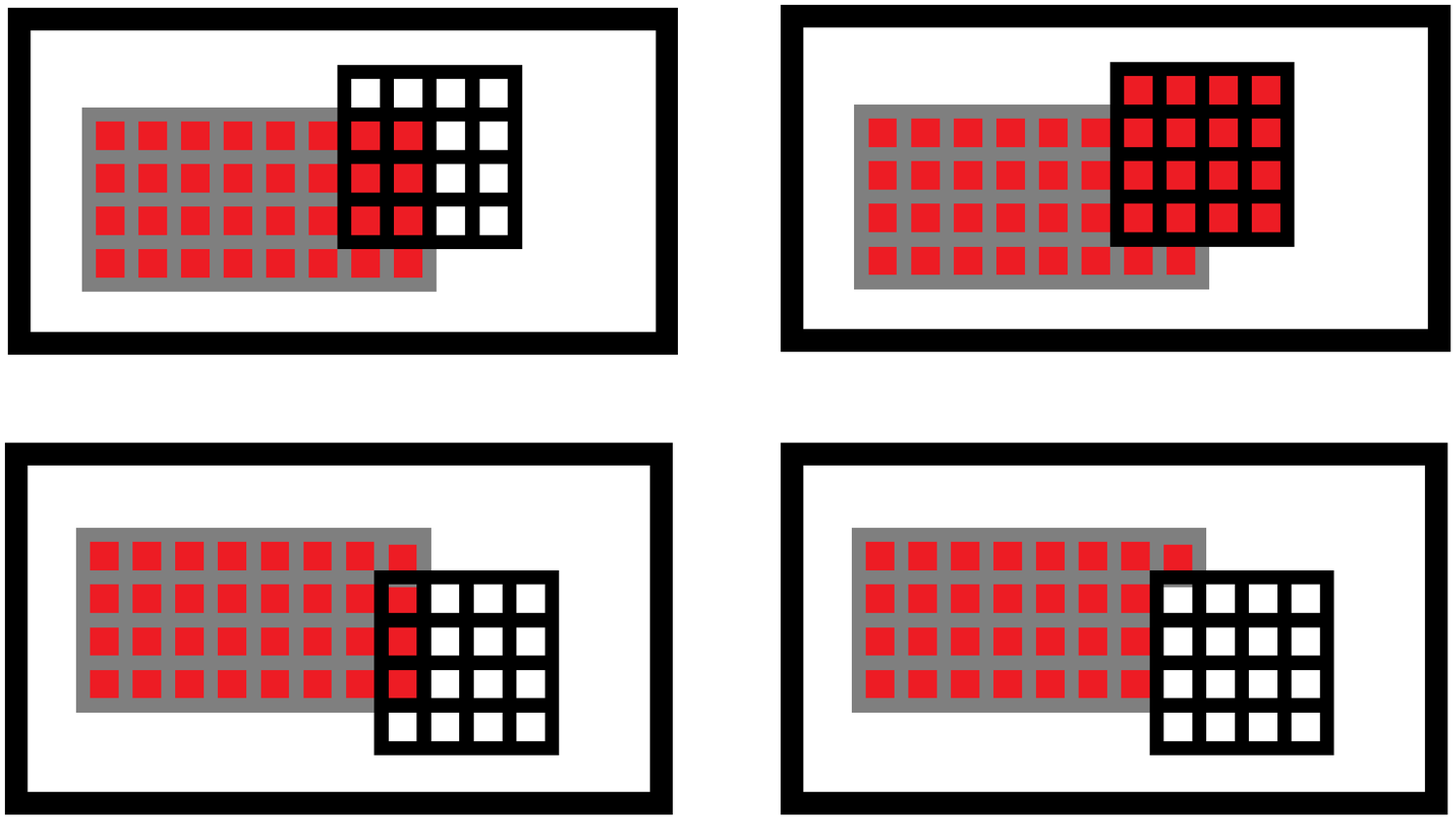
Classification with threshold (25%)



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Clusterer limitations

- Huge computational resources
- Max image size $5*10^5$ pixels

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Increase clustering step

- Cluster each n-th pixel along each axis
- Rest are added to original clusters based on spectral similarity
- How it affects classification?

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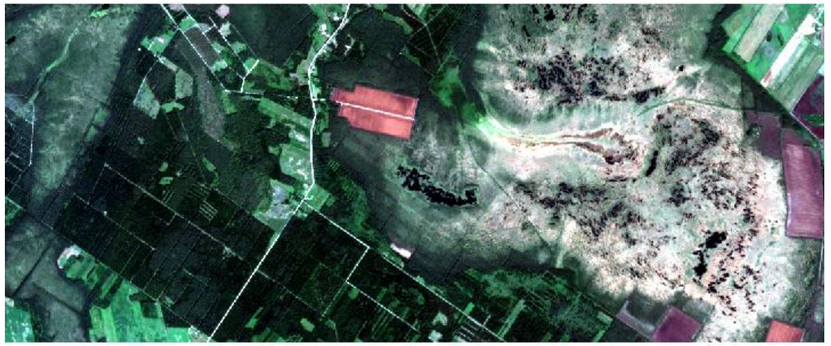
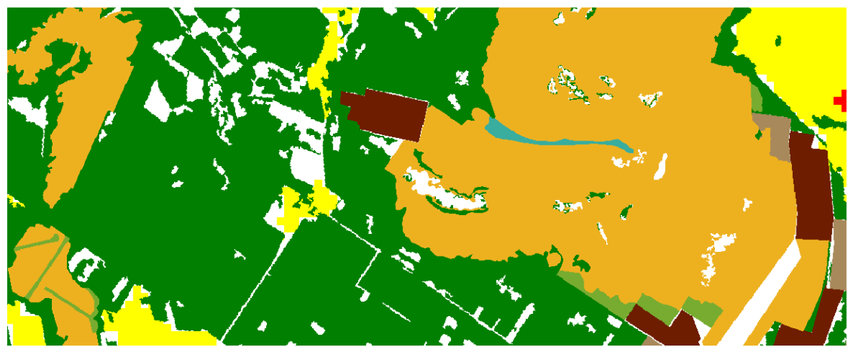
Images and reference

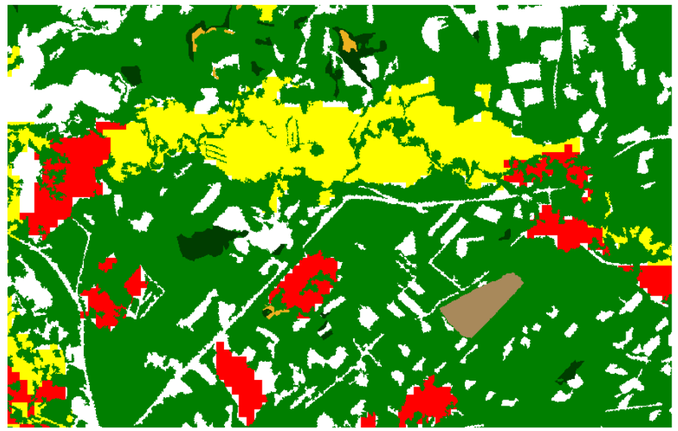
Dobele area true color Sentinel-2 image taken on 1st August, 2018. Center coordinates 56.44°N, 22.82°E.

Cenu bog area true color Sentinel-2 image taken on 1st August, 2018. Center coordinates 56.86°N, 23.81°E



Zakumuiza area true color Sentinel-2 image taken on 10th September, 2019. Center coordinates 56.97°N, 24.43°E.





Yellow: agriculture,
green: forests;
orange: active raised bogs;
light green: degraded raised bogs;
light blue: transition mires and quaking bogs;
brown: licensed peat extraction sites; tan: abandoned peat extraction sites

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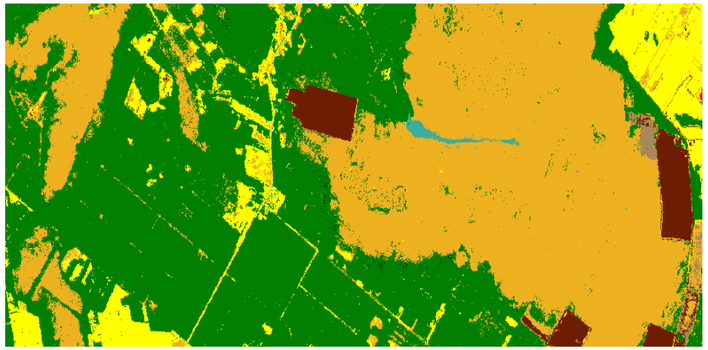
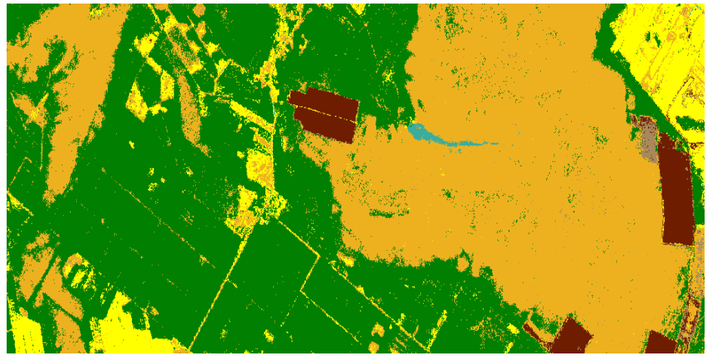
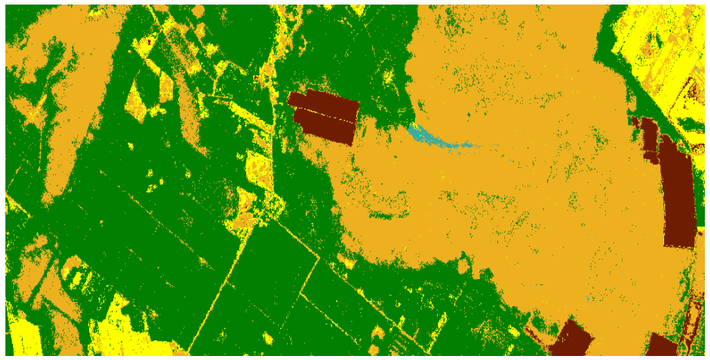
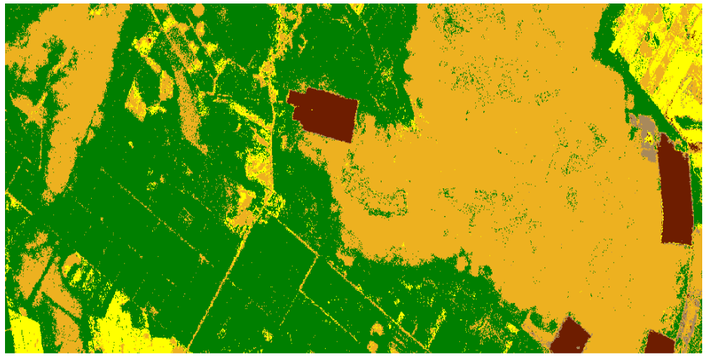
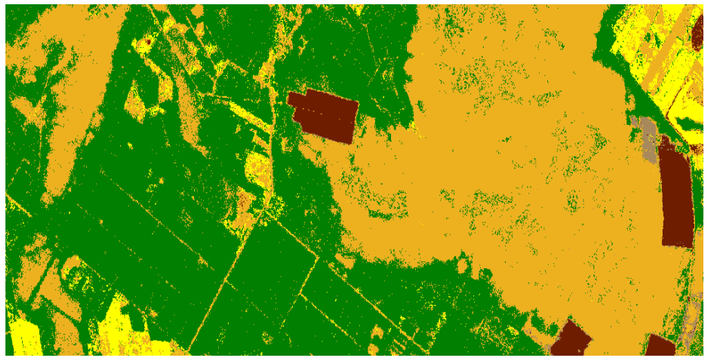
Degradation of classification

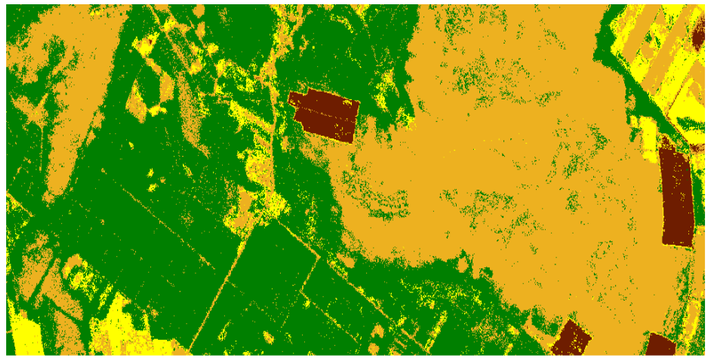
1 

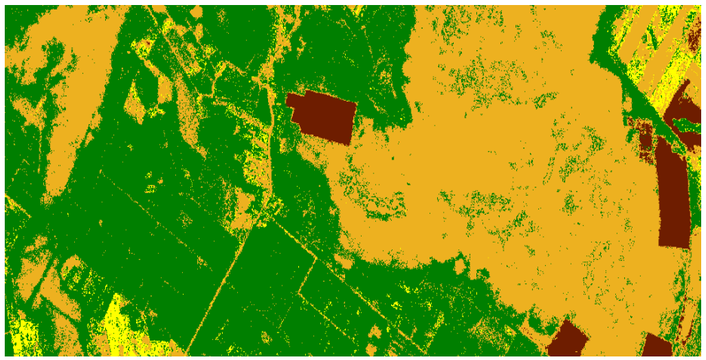
2 

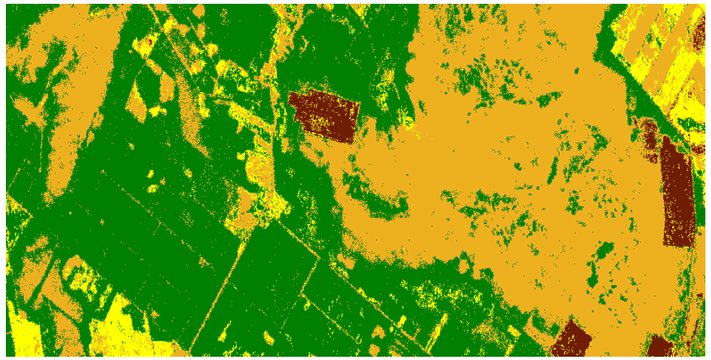
3 

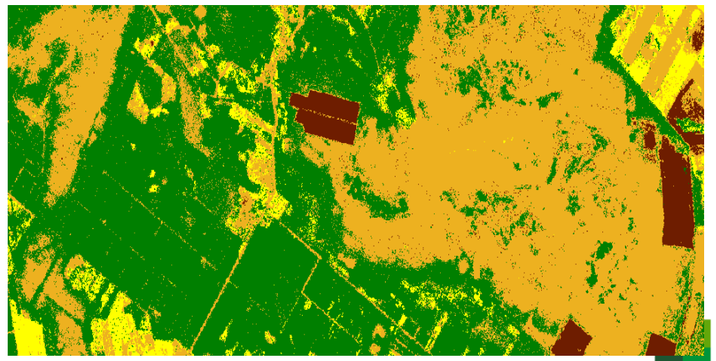
4 

5 

6 

7 

8 

9 

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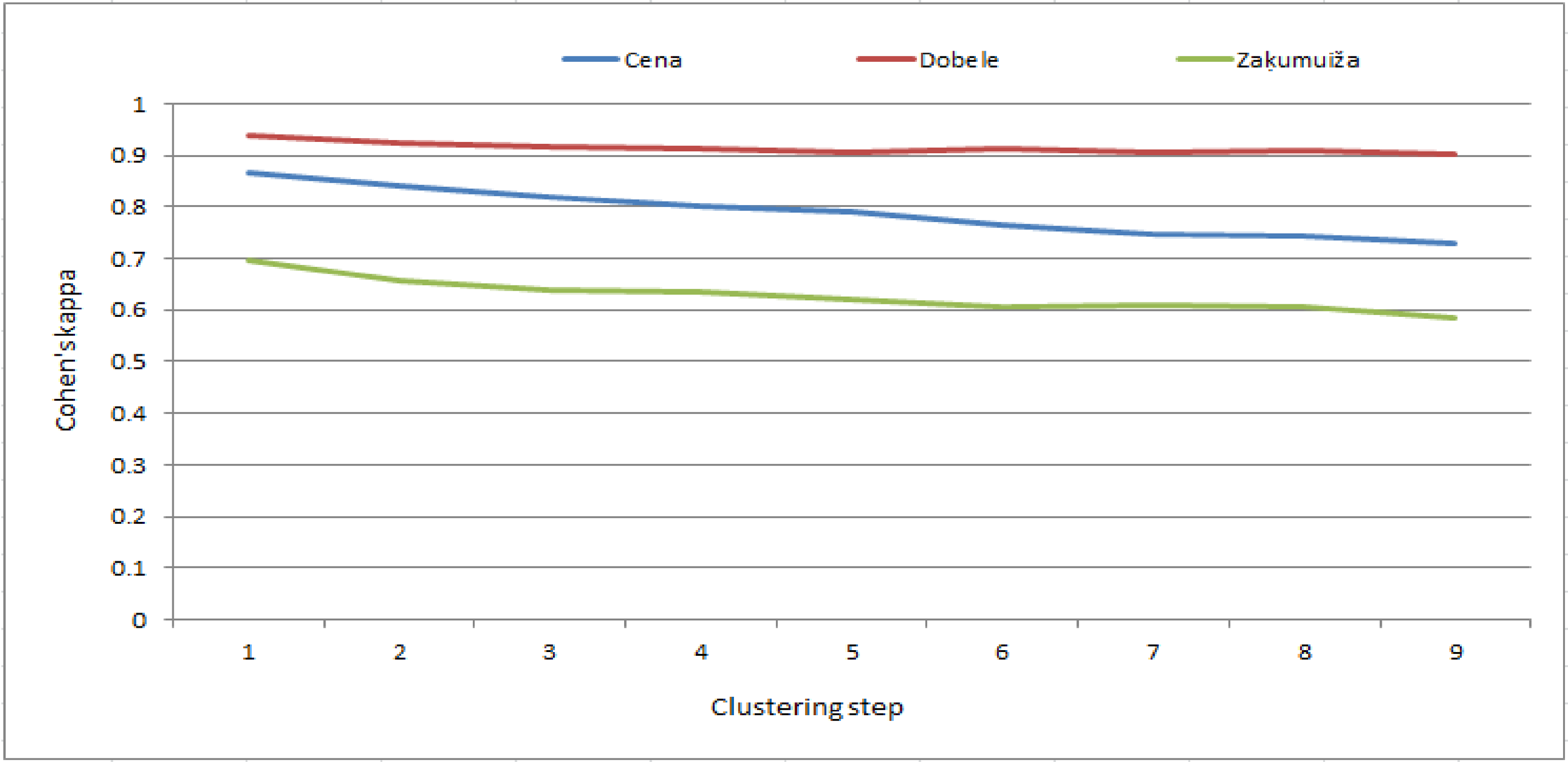
Evaluation with Cohen’s kappa



Reclassification

- Larger image is classified by separate fragments
- Some of the fragments may not have full reference
- How to classify?

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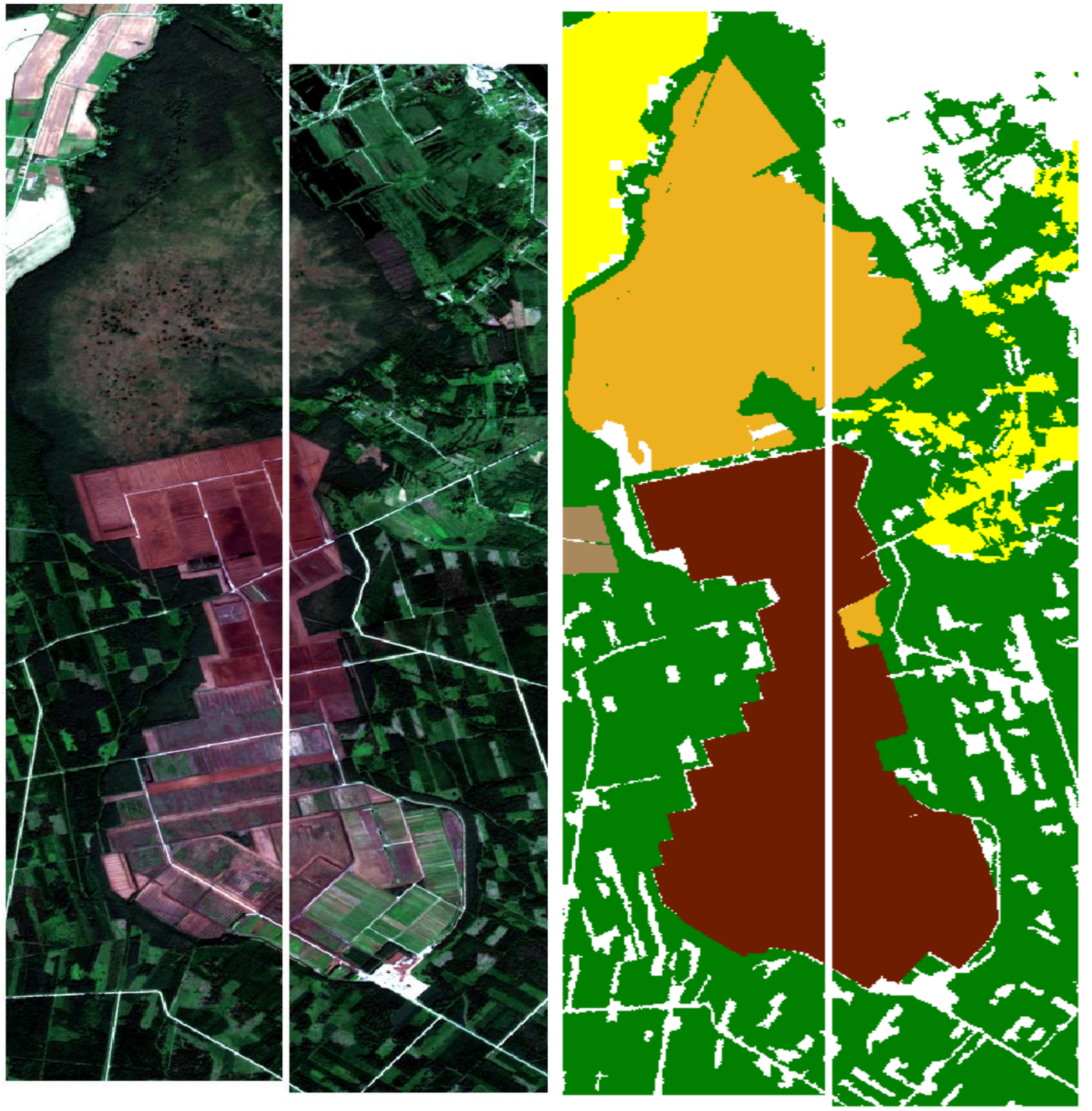
Kaigu bog

- **Kaigu** bog area true color Sentinel-2 image. Center coordinates 56.86°N, 23.81°E
- Reference image of the Kaigu bog area (yellow: agriculture, green: forests; orange: active raised bogs; brown: licensed peat extraction sites; tan: abandoned peat extraction sites).



Reclassification testing

- One class removed from reference
- Other image used as reference image with full reference
- Repeated for each category and each image

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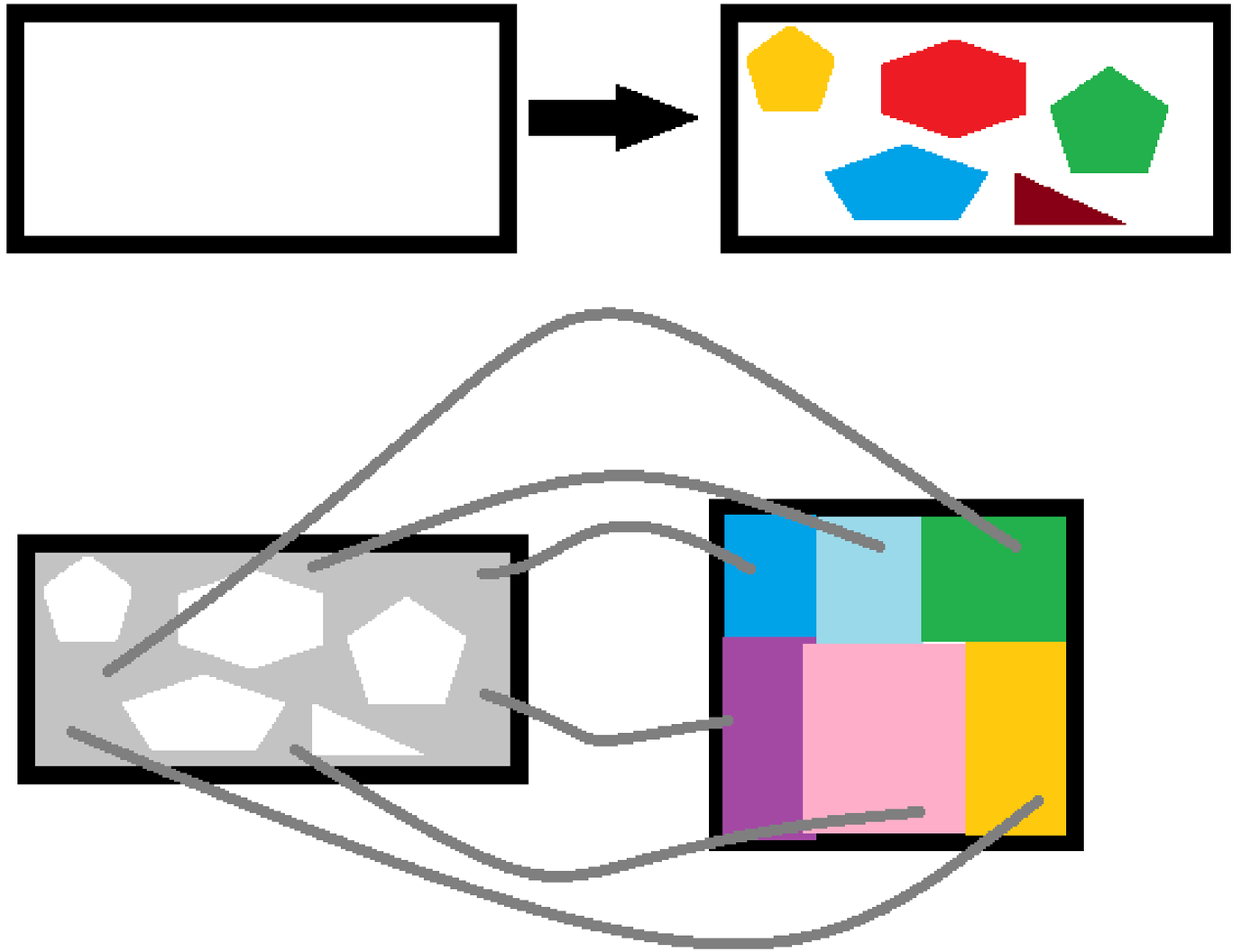
First approach

- Target image classified with threshold
- Pixels assigned based on spectral similarity to reference image pixels



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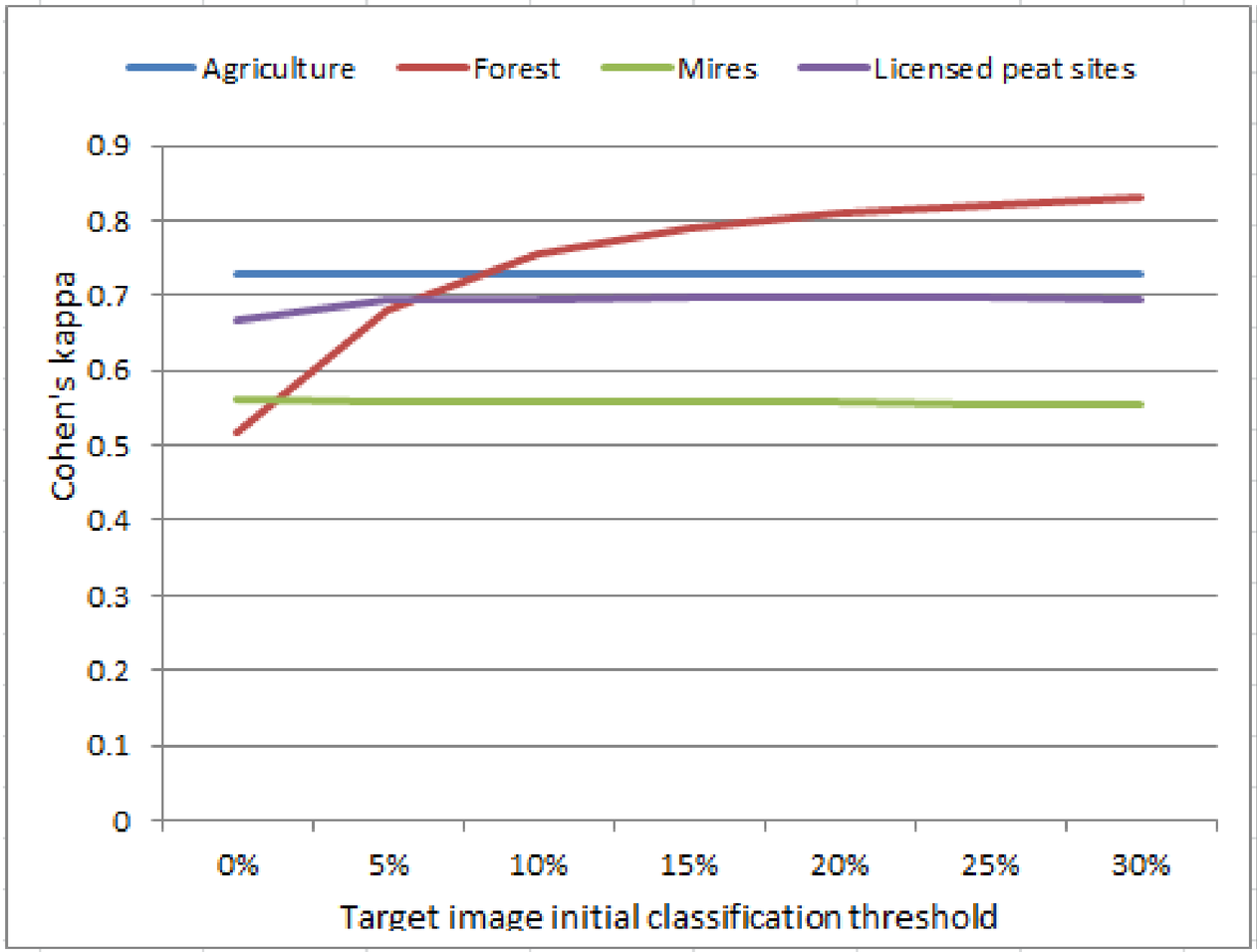
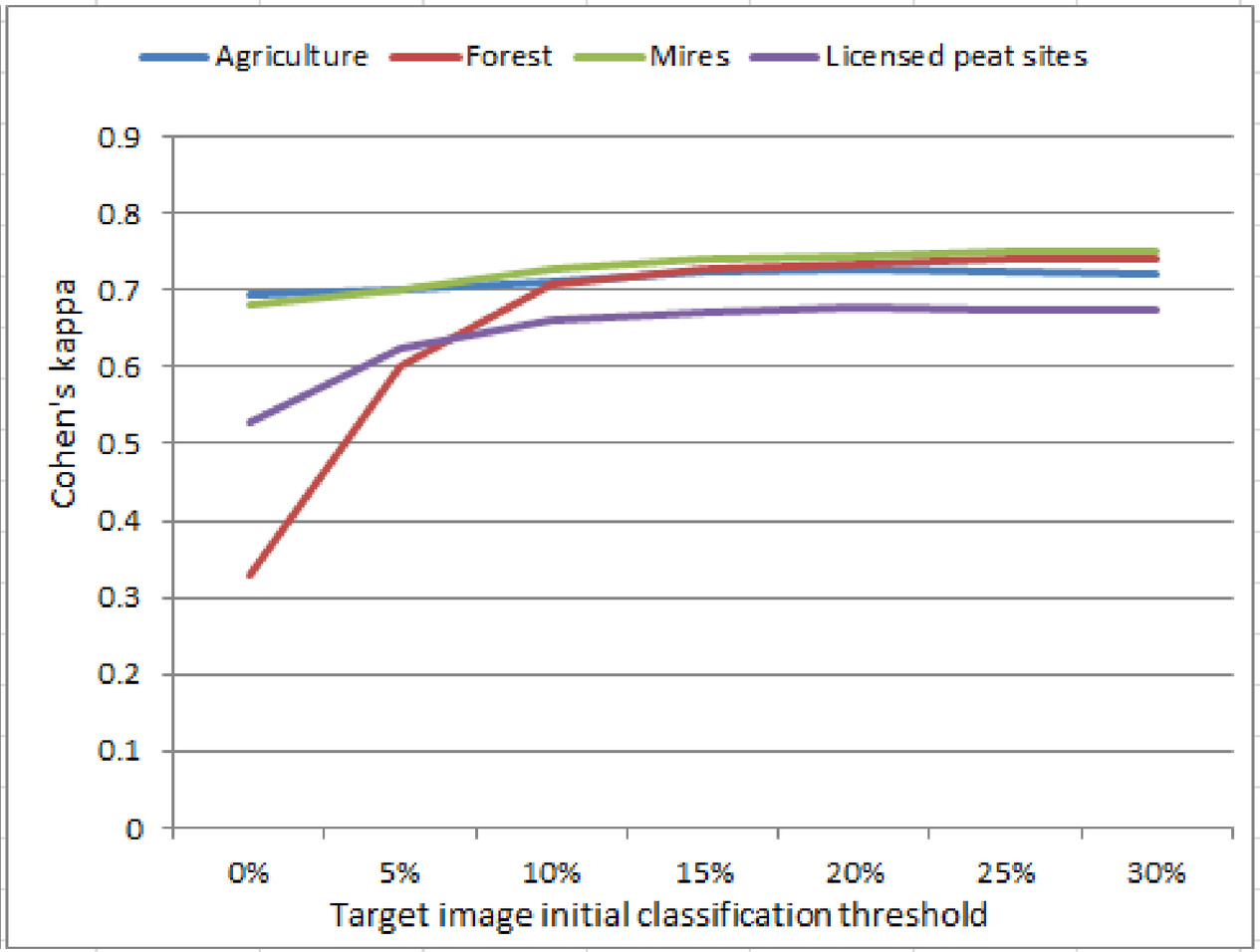

Agriculture
Forest
Mires
Licensed peat sites
Cohen's kappa
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0%
5%
10%
15%
20%
25%
30%
Target image initial classification threshold


Agriculture
Forest
Mires
Licensed peat sites
Cohen's kappa
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0%
5%
10%
15%
20%
25%
30%
Target image initial classification threshold

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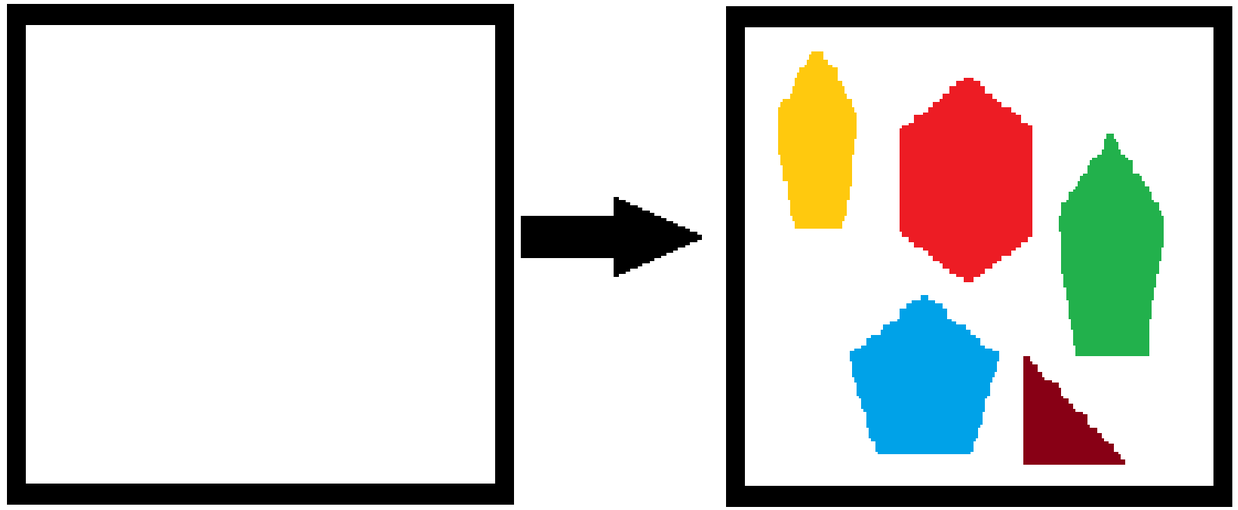
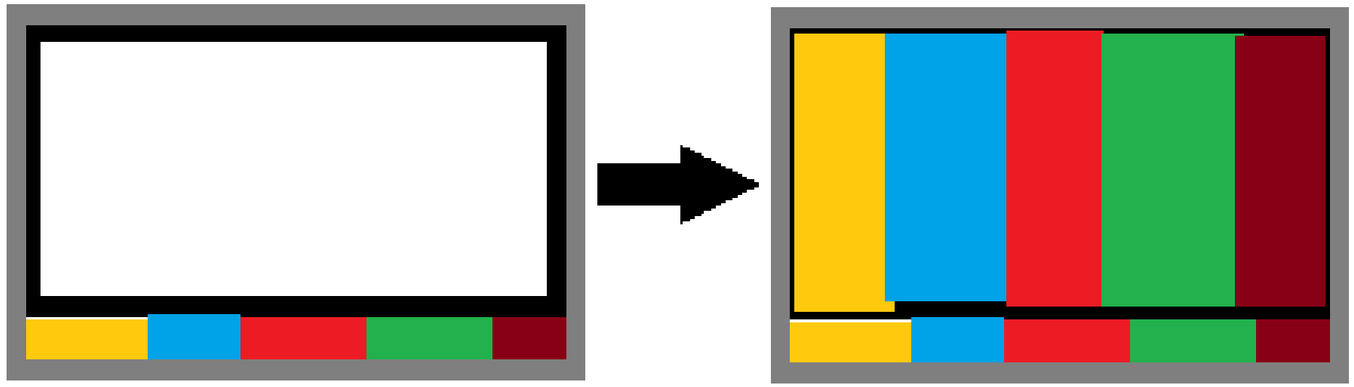
Second approach

- Reference image classified with threshold
- Results added to target image
- Combined image clustered
- Combined image classified





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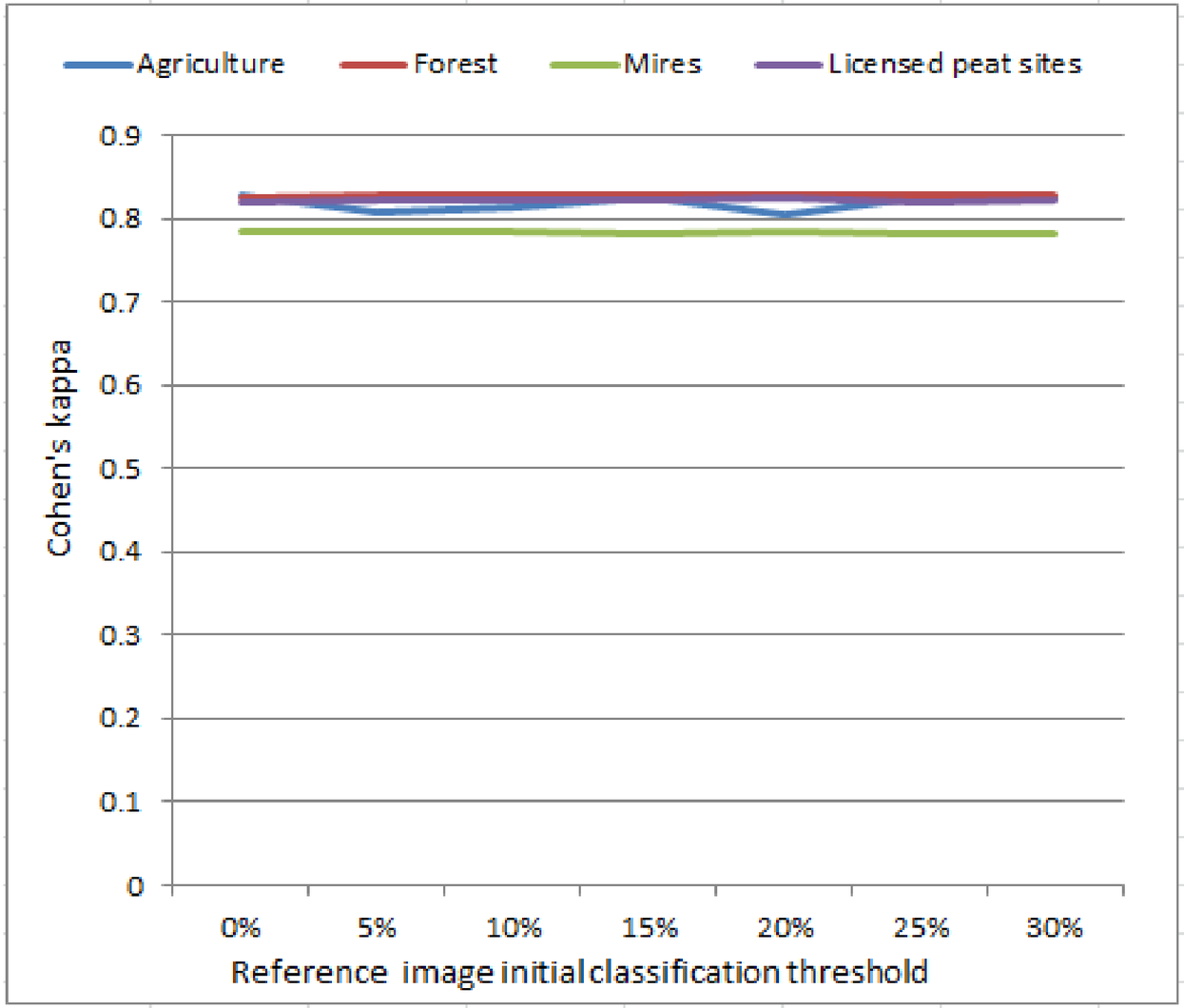
Agriculture
Forest
Mires
Licensed peat sites
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Cohen's kappa
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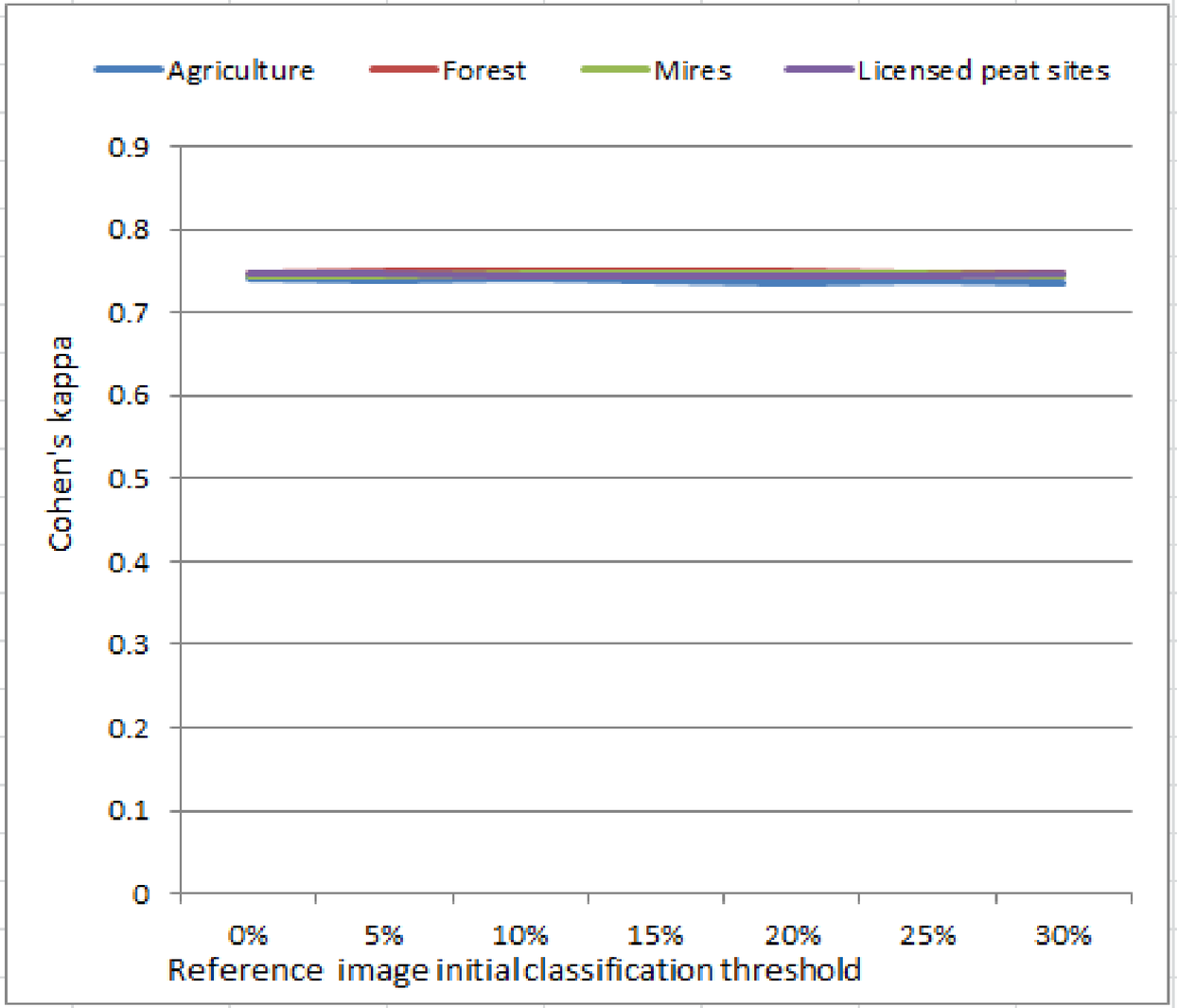
Reference image initial classification threshold


Agriculture
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Cohen's kappa
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20%
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Reference image initial classification threshold

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Conclusions

- The Dynland clustering algorithm can be applied to large images using the clustering (overleap) step for skipping pixels on both axes.

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Conclusions

- The Dynland clustering algorithm can be applied to large images using the clustering (overleap) step for skipping pixels on both axes.
  - Classification accuracy is decreasing gradually
  - It is not recommended to use a clustering step higher than 2
- The second reclassification approach is a preferable way for solving the missing reference problem
  - Target and supplementary image must be obtained in the same sensing conditions

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