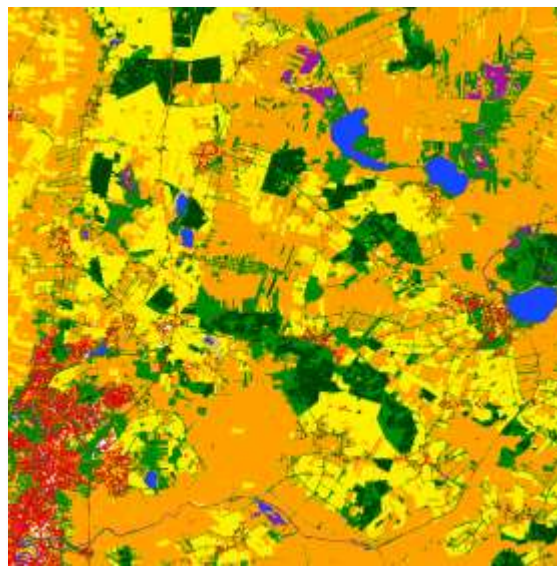




Global Classification approach based on Sentinel-2 (S2GLC - ESA)



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Ewa Kukawska¹, Michał Krupiński¹, Adam Włodarkiewicz¹, Ewa Bilaska¹,
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S2GLC - SENTINEL-2 GLOBAL LAND COVER



ESA project: Scientific Exploitation of Operational Missions (SEOM)
S2-4Sci Land and Water - Study 3: Classification

Development of classification methodology and strategy
for global mapping using Sentinel-2 images





S2GLC LEGEND

Existing Global Land Cover Databases:

[1]IGBP DIS (GLCC), [2]UMD (U. of Maryland), [3]GeoCover-LC, [4]GLC2000, [5]MCD12Q1, [6]GLCNMO, [7]CCI-LC, [8]GlobCover 2009, [9]FROM-GLC, [10]GlobeLand30, [11]GLC-SHARE

INSPIRE "Pure Land Cover Components", EAGLE concept (EAGLE Group concept),

CORINE LC, Land Cover Classification System (FAO)

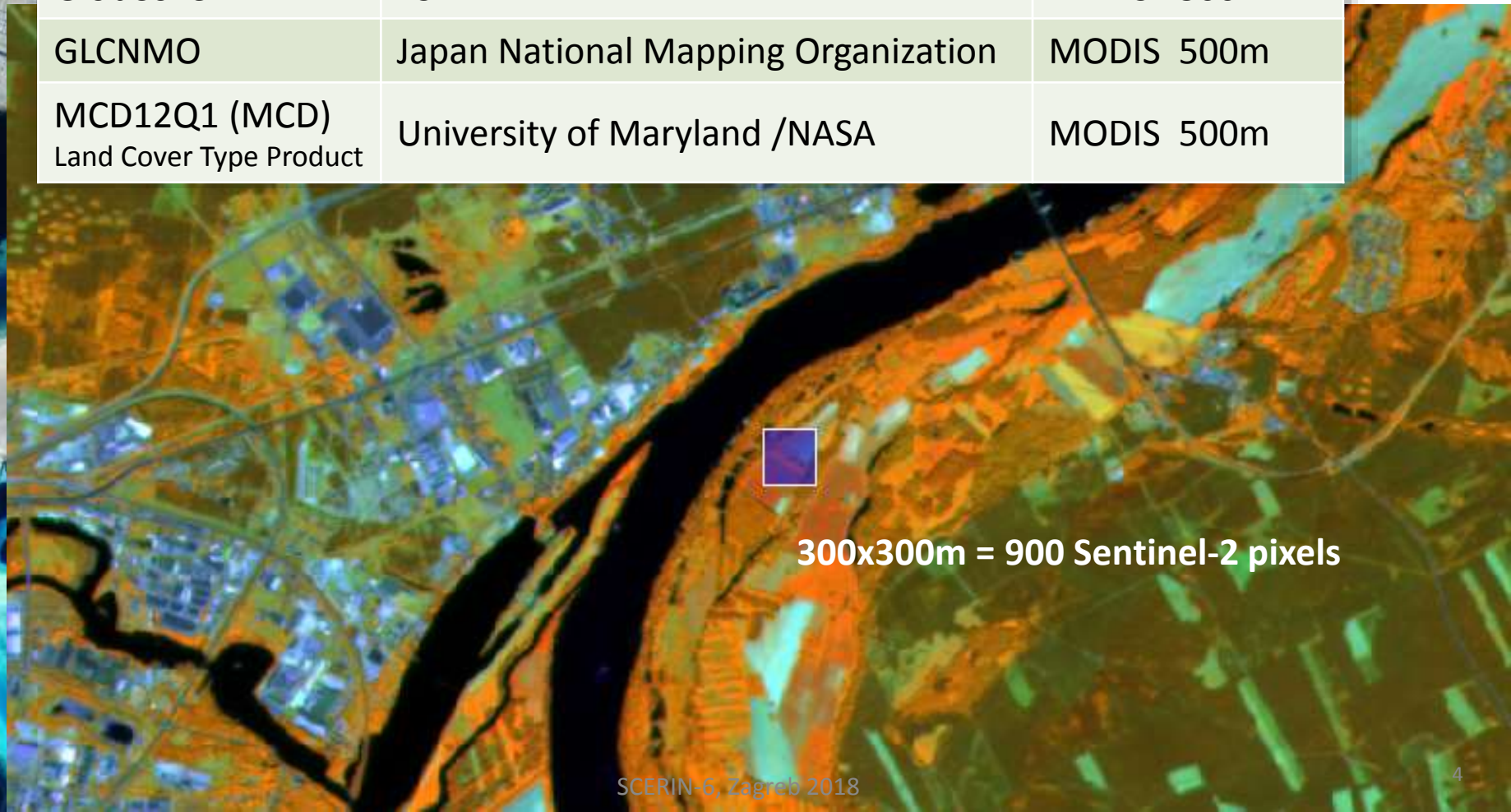
□ Hierarchical structure that can be modified

S2GLC Legend			Colour
Level 1	Level 2	Level 3	
1. Non-Vegetated surfaces	1. 1. Artificial surfaces and constructions	1. 1. 1. Artificial surfaces and constructions	Red
	1. 2. Natural material surfaces	1. 2. 1. Consolidated areas	Grey
		1. 2. 2. Un-Consolidated areas	Light Grey
2. Vegetated surfaces	2. 1. Woody vegetation	2. 1. 1. Evergreen broadleaf tree cover	Light Green
		2. 1. 2. Evergreen coniferous tree cover	Dark Green
		2. 1. 3. Deciduous broadleaf tree cover	Medium Green
		2. 1. 4. Deciduous coniferous tree cover	Bright Green
	2. 2. Low vegetation	2. 1. 6. Bush, shrub	Olive Green
		2. 2. 1. Grass, herbaceous vegetation	Orange
	2. 2. 3. Burnt areas	Brown	
3. Cultivated and managed areas	3. 1. Cultivated and managed areas	3. 1. 1. Cultivated and managed areas	Yellow
4. Inundated vegetation	4. 1. Inundated vegetation	4. 1. 1. Inundated vegetation	Purple
5. Water bodies	5. 1. Water bodies	5. 1. 1. Water bodies	Blue
6. Permanent snow covered surfaces	6. 1. Permanent snow covered surfaces	6. 1. 1. Permanent snow covered surfaces	Cyan
7. Unclassified surfaces	7. 1. Surfaces permanently covered by clouds	7. 1. 1. Surfaces permanently covered by clouds	White



Low resolution Global Land Cover Databases for training

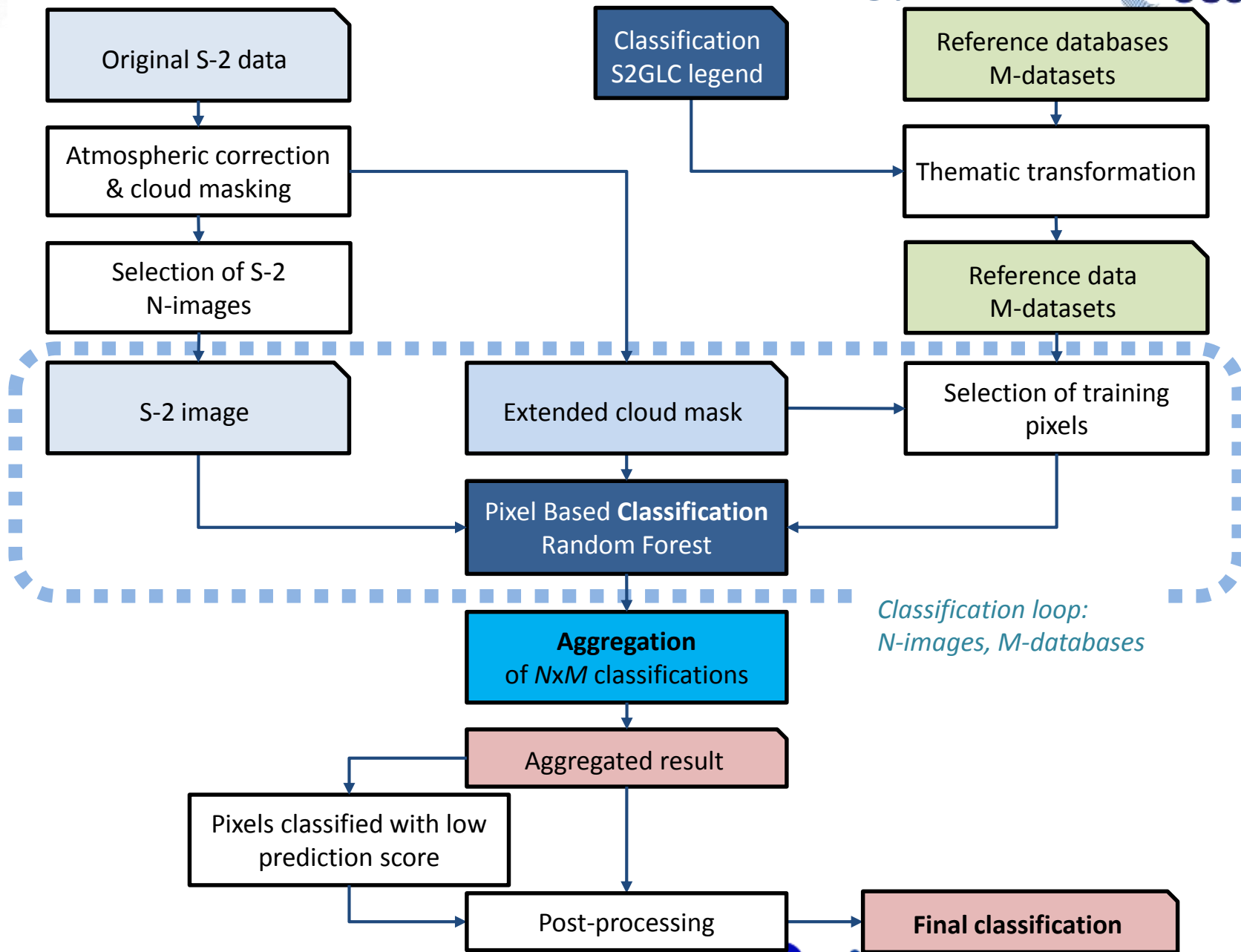
LR database	produced by	Satellite data
CCI LC	ESA Climate Change Initiative	MODIS 300m
GlobCover	ESA	MERIS 300m
GLCNMO	Japan National Mapping Organization	MODIS 500m
MCD12Q1 (MCD) Land Cover Type Product	University of Maryland /NASA	MODIS 500m



300x300m = 900 Sentinel-2 pixels



Global LC classification strategy



*Classification loop:
N-images, M-databases*



Time series 1, ..., 7	Classification result	Prediction score
Classification 1	Class 1	0.4
Classification 2	Class 2	0.6
Classification 3	Class 1	0.7
Classification 4	Class 3	0.4
Classification 5	Clouds	-
Classification 6	Class 3	0.7
Classification 7	Class 1	0.6



Estimation of a class label for a single pixel

Aggregation 1

DivByAll

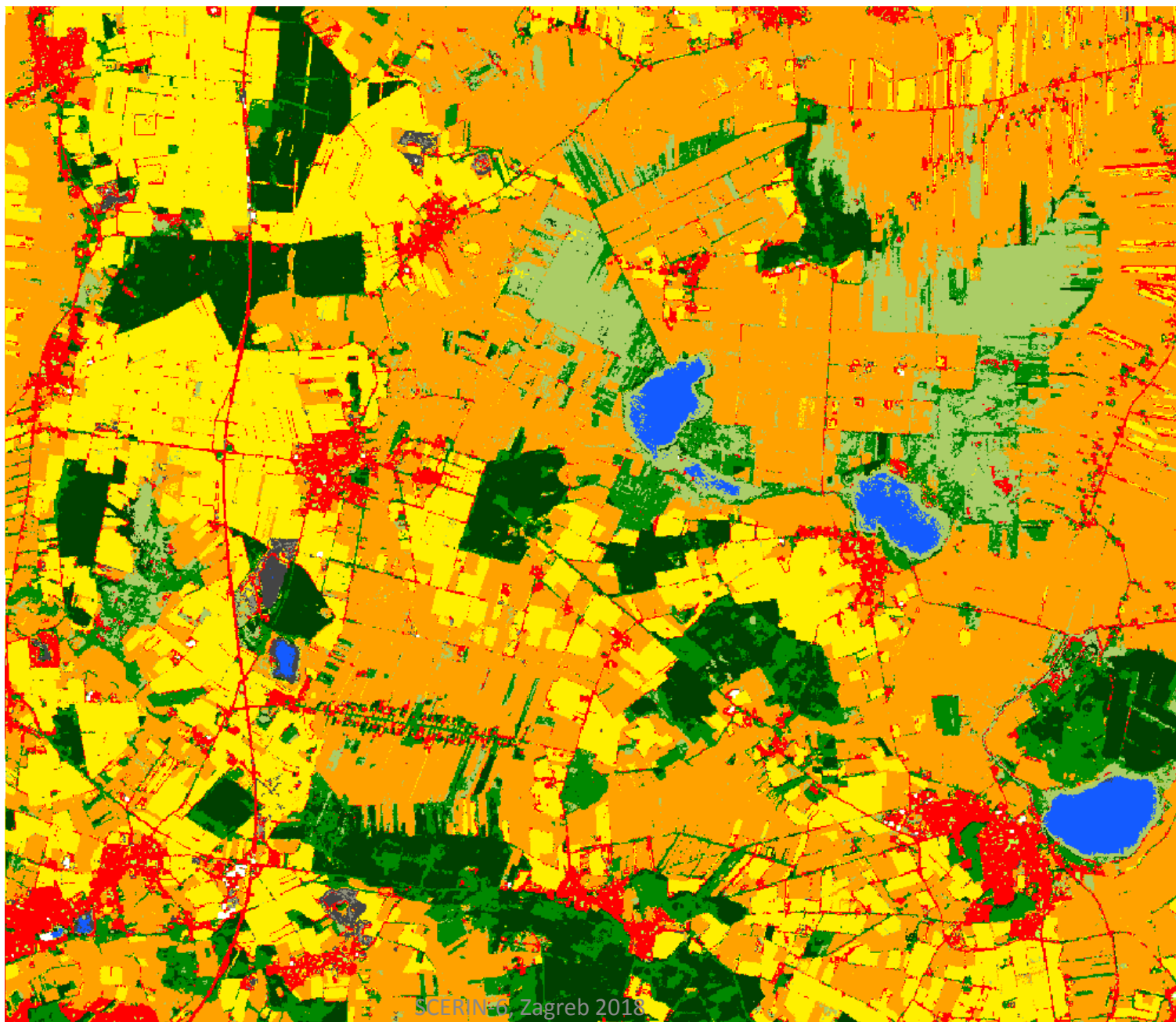
$$\text{Class 1} = (0.4 + 0.7 + 0.6) / 6 = 0.28$$

$$\text{Class 2} = 0.6 / 6 = 0.10$$

$$\text{Class 3} = (0.4 + 0.8) / 6 = 0.18$$

Aggregation results

Class 1

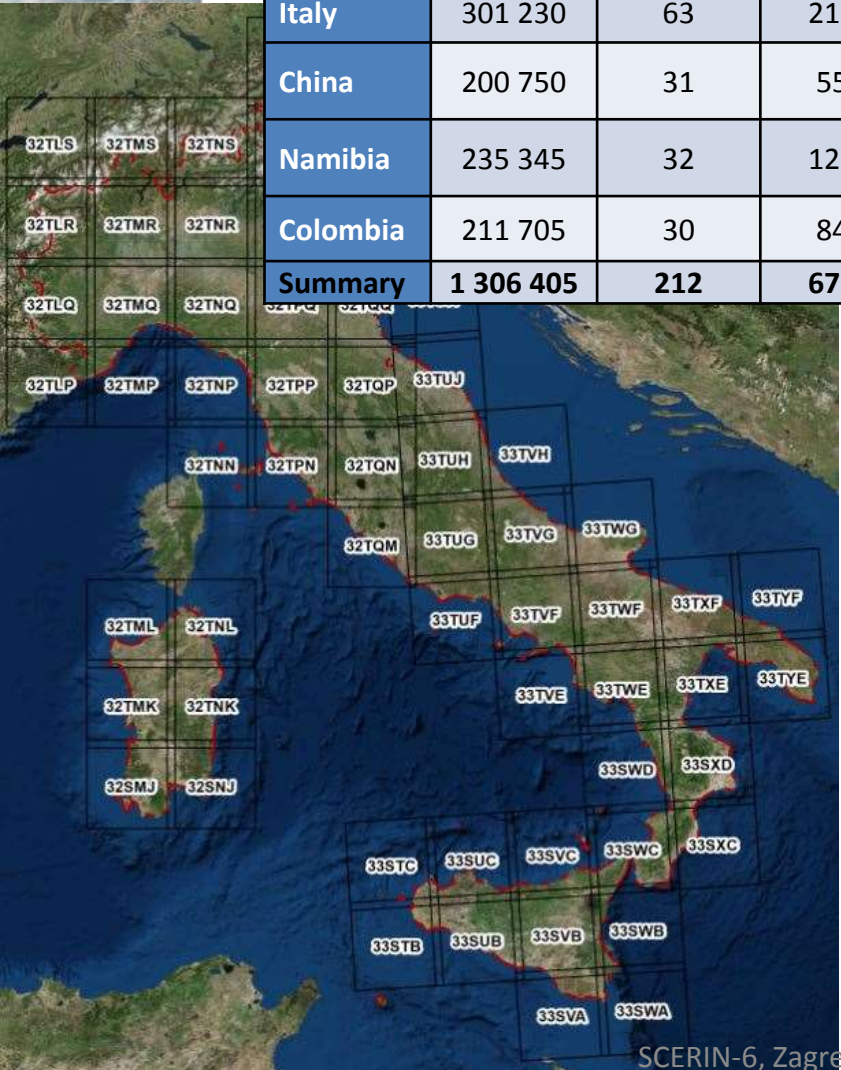




Processing Sentinel-2 tile by tile (110x110km)



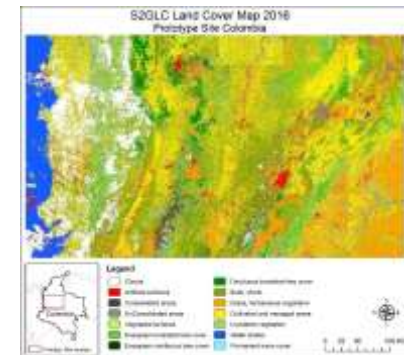
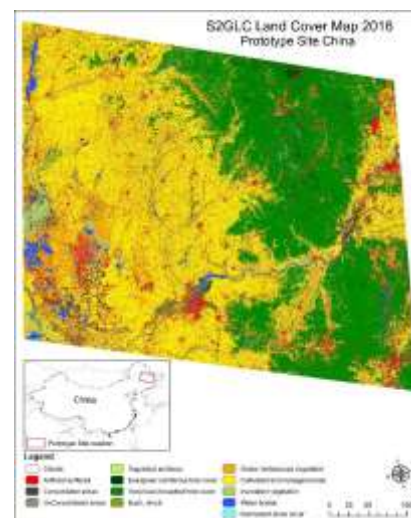
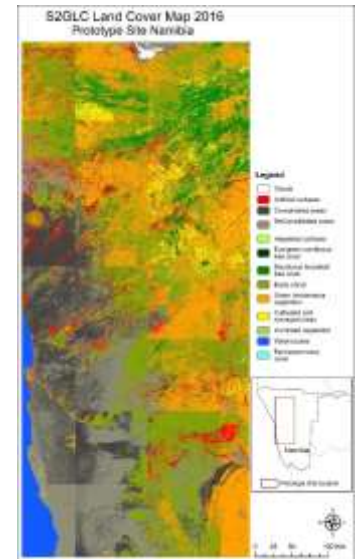
prototype site	Area [km ²]	Sentinel-2 images			Databases used for training			
		tiles	available (2016)	classified (per tile)	global	regional	Auxiliary	
Germany	357 375	56	1956	10	CCI LC, GlobeCover	CORINE LC	GUF	NDWI
Italy	301 230	63	2182	10	CCI LC, GlobeCover	CORINE LC	GUF	NDWI
China	200 750	31	551	6-10	CCI LC, GlobeCover, GlobeLand30		GUF	NDWI
Namibia	235 345	32	1228	10	CCI LC	LC Classification for Africa	GUF	NDWI
Colombia	211 705	30	846	3-10	CCI LC, GlobeCover	Colombian LC	GUF	NDWI
Summary	1 306 405	212	6763					





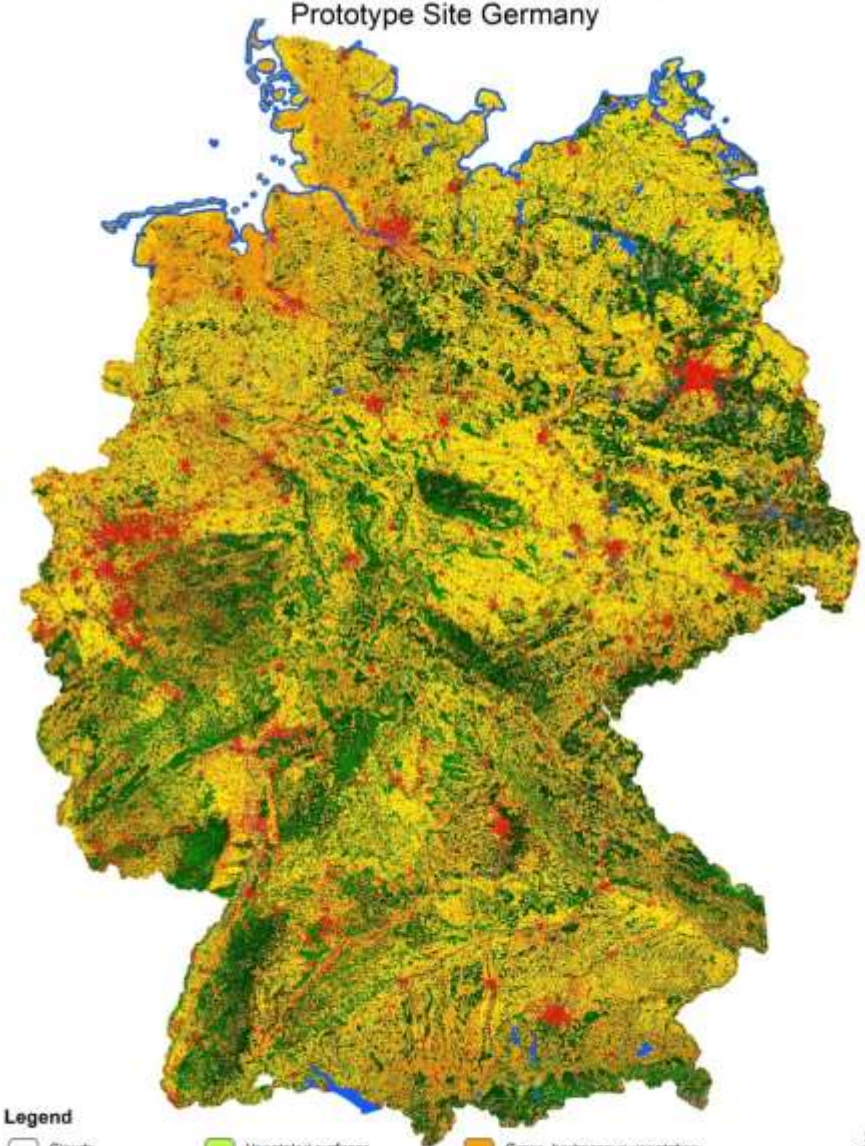
Classification results

Test site	Overall accuracy	Kappa coefficient	<i>CORINE LC</i> vs. LUCAS points
Germany	85.2	0.85	82.8
Italy	72.5	0.72	76.0
China	72.0	0.72	
Namibia	56.1	0.49	
Colombia	52.5	0.46	



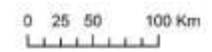


S2GLC Land Cover Map 2016 Prototype Site Germany



Legend

- | | | |
|----------------------|---------------------------------|------------------------------|
| Clouds | Vegetated surfaces | Grass, herbaceous vegetation |
| Artificial surfaces | Evergreen coniferous tree cover | Cultivated and managed areas |
| Consolidated areas | Deciduous broadleaf tree cover | Inundated vegetation |
| Unconsolidated areas | Bush, shrub | Water bodies |
| | | Permanent snow cover |



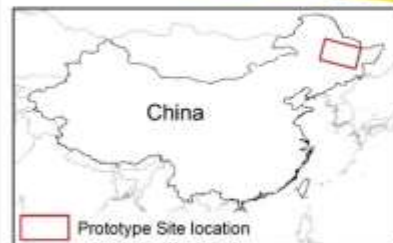
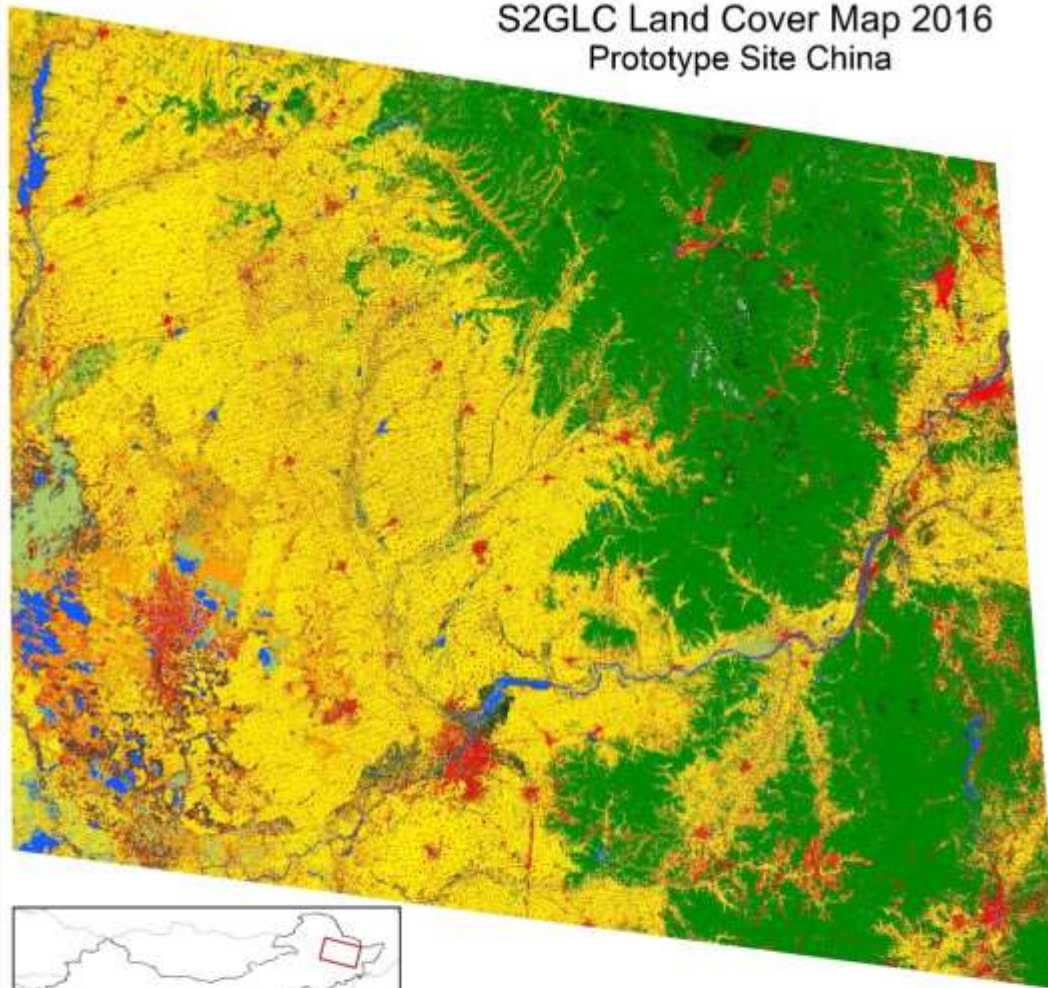


S2GLC Land Cover Map 2016 Prototype Site Italy



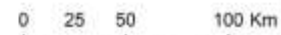


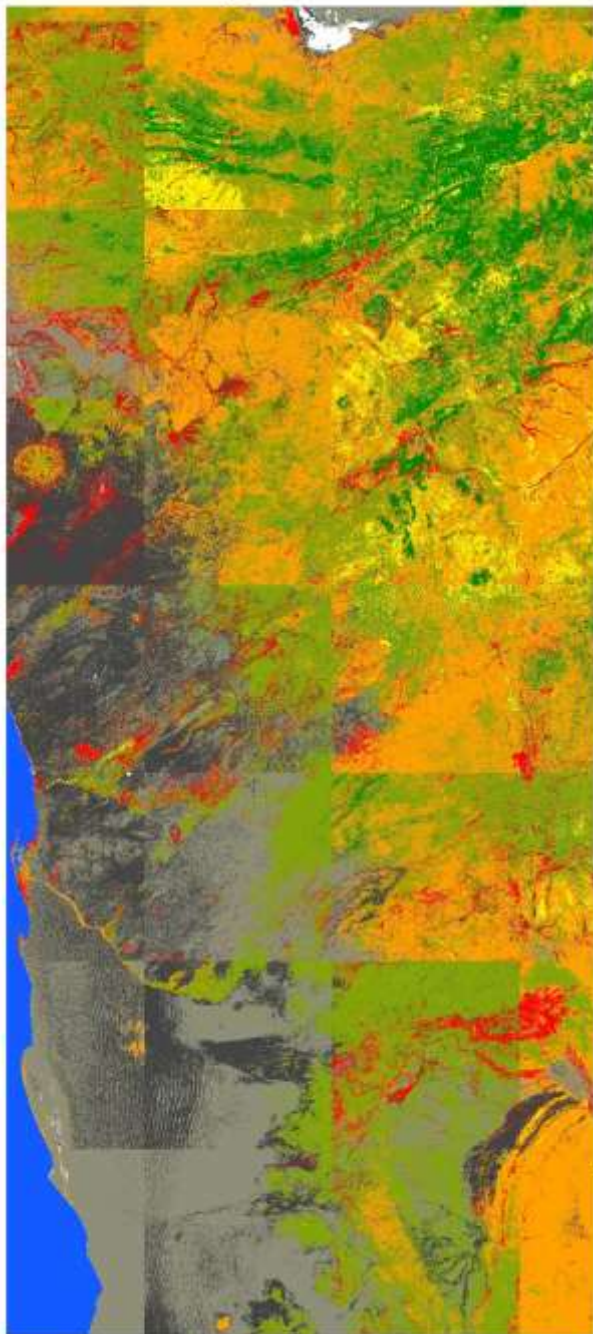
S2GLC Land Cover Map 2016 Prototype Site China



Legend

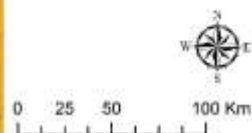
- | | | |
|----------------------|---------------------------------|------------------------------|
| Clouds | Vegetated surfaces | Grass, herbaceous vegetation |
| Artificial surfaces | Evergreen coniferous tree cover | Cultivated and managed areas |
| Consolidated areas | Deciduous broadleaf tree cover | Inundated vegetation |
| UnConsolidated areas | Bush, shrub | Water bodies |
| | | Permanent snow cover |

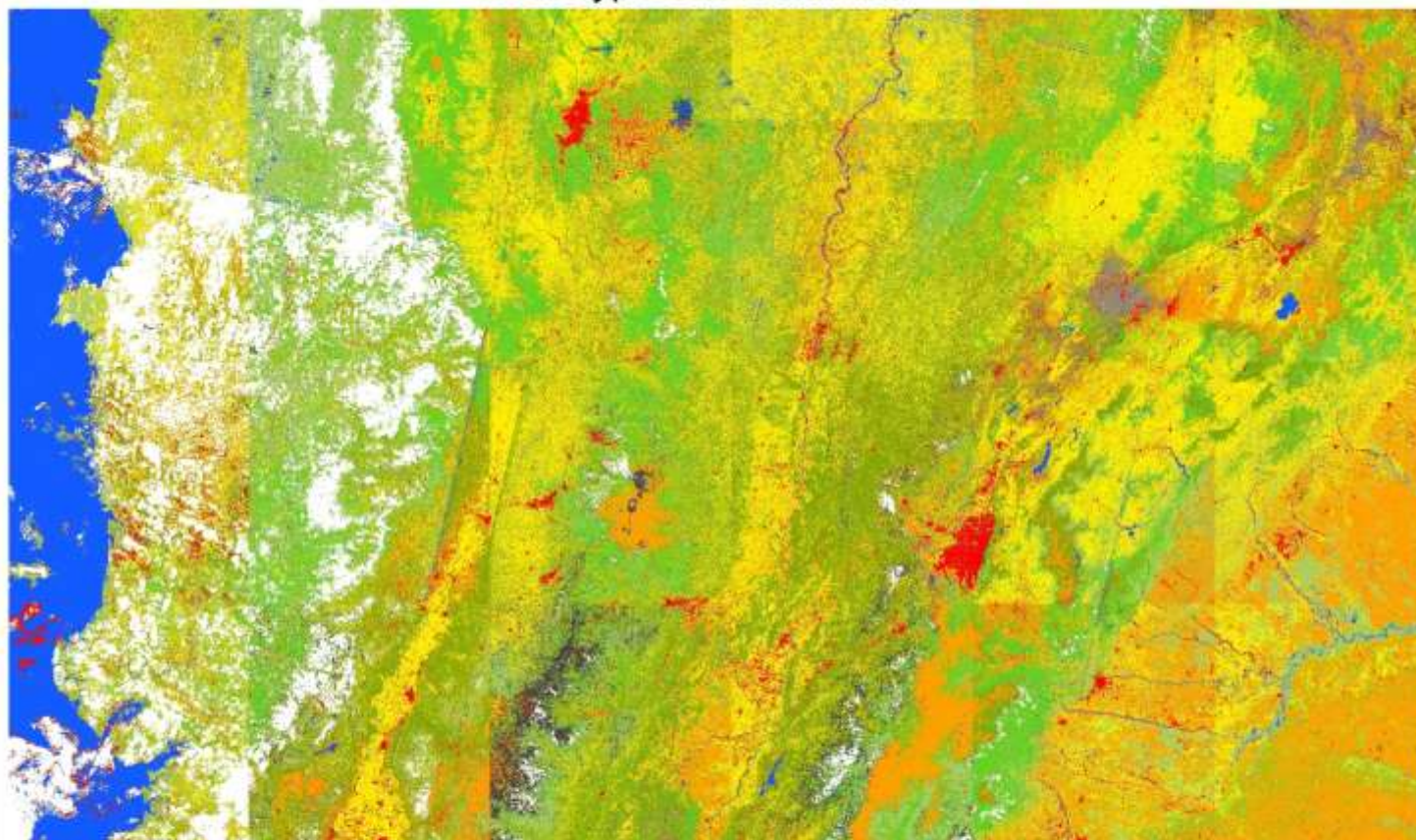




Legend

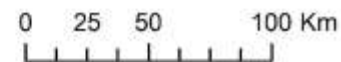
- Clouds
- Artificial surfaces
- Consolidated areas
- UnConsolidated areas
- Vegetated surfaces
- Evergreen coniferous tree cover
- Deciduous broadleaf tree cover
- Bush, shrub
- Grass, herbaceous vegetation
- Cultivated and managed areas
- Inundated vegetation
- Water bodies
- Permanent snow cover





Legend

- | | |
|--------------------------------|------------------------------|
| Clouds | Bush, shrub |
| Artificial surfaces | Grass, herbaceous vegetation |
| Consolidated areas | Cultivated and managed areas |
| UnConsolidated areas | Inundated vegetation |
| Vegetated surfaces | Water bodies |
| Evergreen broadleaf tree cover | Permanent snow cover |

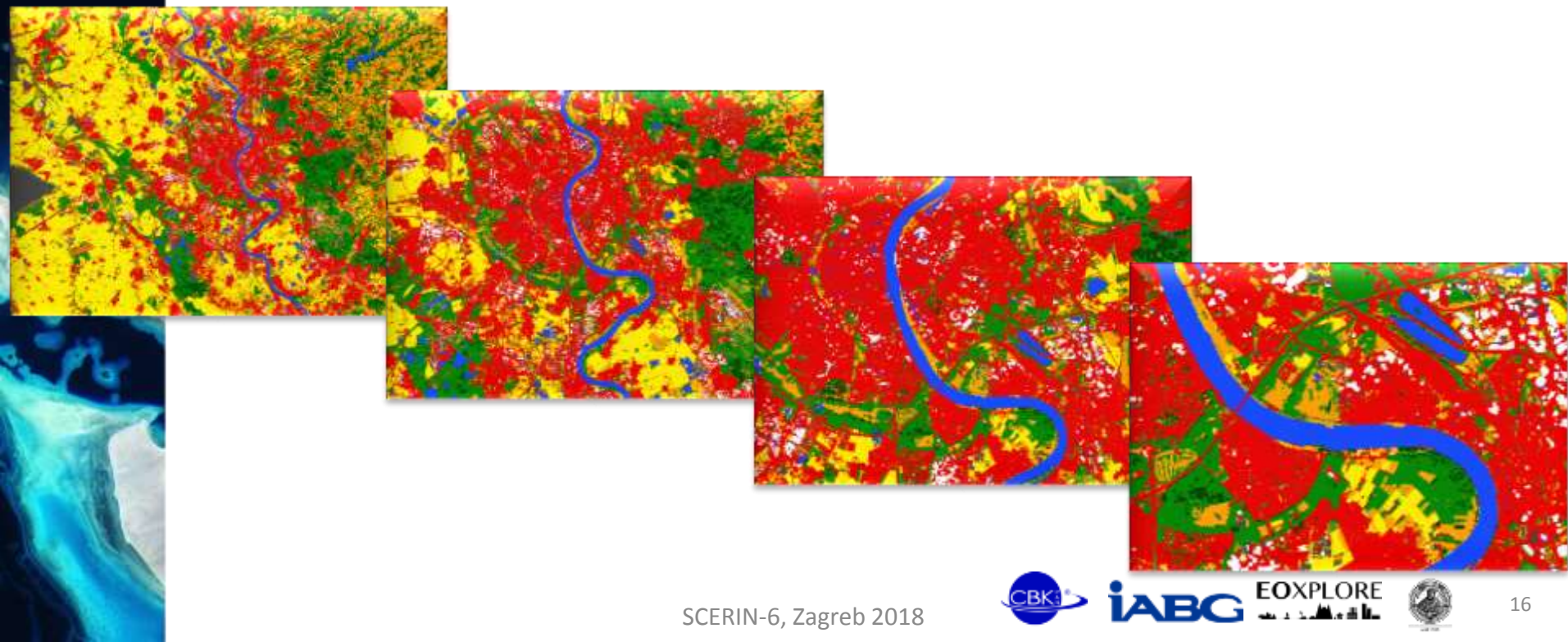




Conclusions

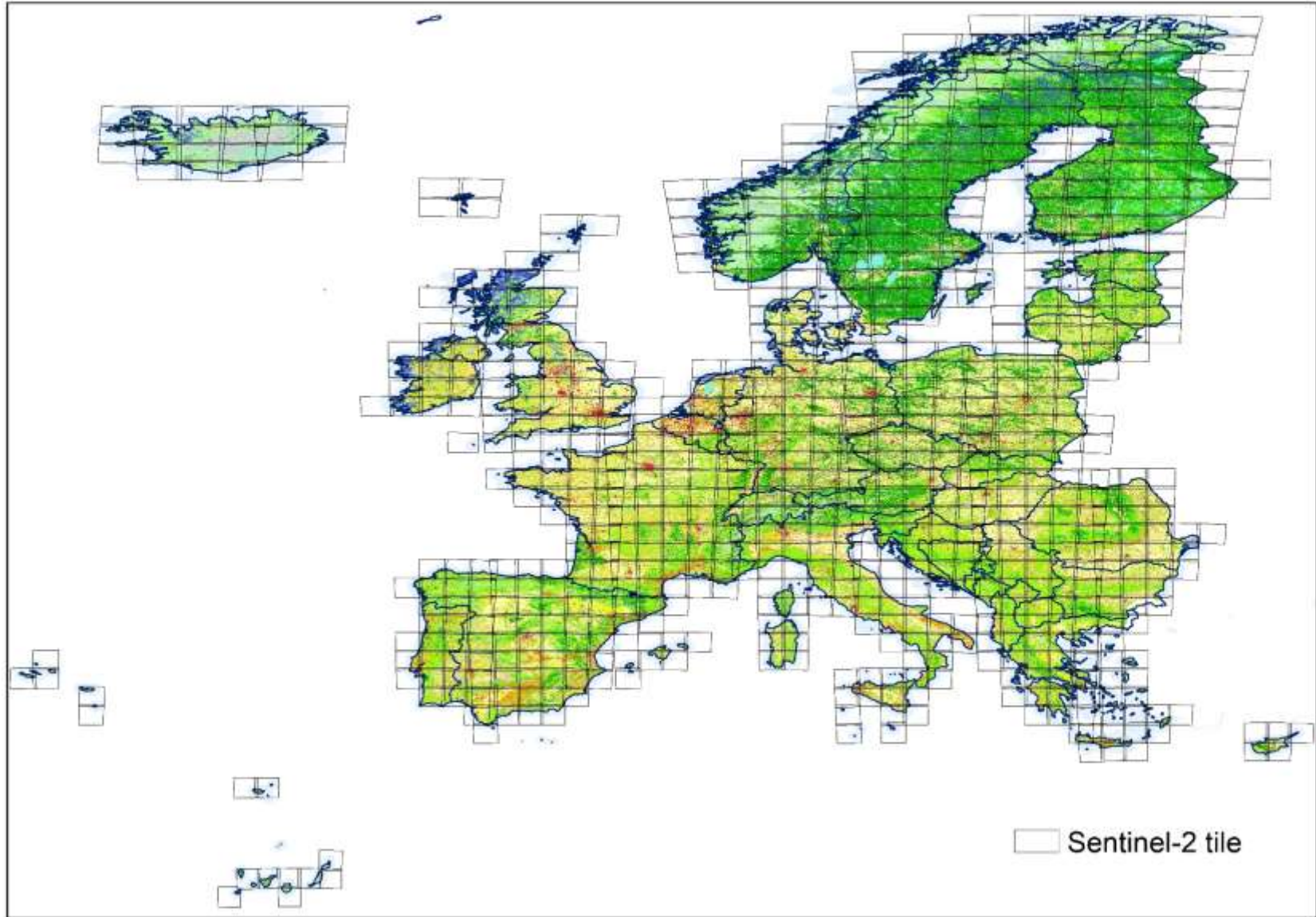
Aggregation advantages:

- ❑ Efficient alternative approach to analysis of multi-temporal image data
- ❑ Improvement of classification thematic accuracy
- ❑ Significant reduction of the amount of cloudy pixels at the final image
- ❑ Effective batch processing of large image series



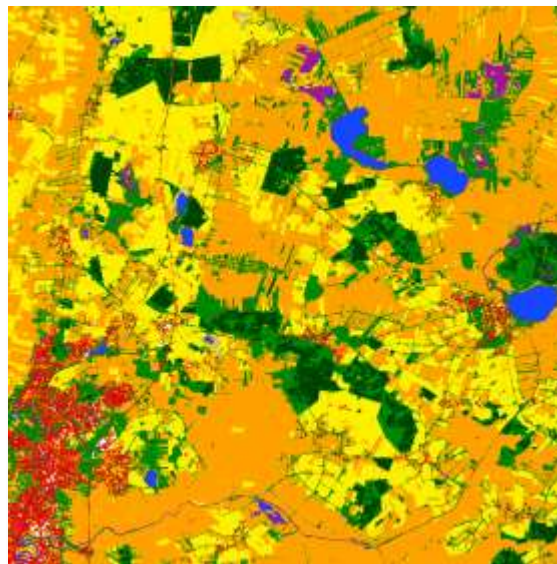


S2GLC – Extension for Europe





Global Classification approach based on Sentinel-2 (S2GLC - ESA)



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