Comparison of various types of land use and land cover data and example of their harmonization

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CTU in Prague

GISTAM 2021

Land Use

and

Land Cover

Land use corresponds to

the socio-economic description

i.e., functional dimension **of areas:**

areas used for residential**,** industrial **or** commercial purposes**, for** farming **or** forestry**, for** recreational **or** conservation purposes**, etc.**

European Environment Agency

Land Use
and
Land Cover

the arrangements**,** activities **and inputs people undertake in a certain land cover type to produce, change or maintain it.**

- "**grassland**" is a cover term,
- "**rangeland**" or "**tennis cou**rt" refer to the use of a grass cover;

Food and Agriculture Organization of the United Nations (FAO)

Land Use and Land Cover

Food and Agriculture Organization of the United Nations (FAO)

Land cover is the observed **(bio)physical cover on the earth's surface.**

it should be confined to the description **of vegetation and man-made features.**

Also, it is disputable whether **water surfaces** are real land cover.

However, in practice, the scientific community usually includes these features within the term *land cover.*

Land Use and Land Cover

Links with land cover are possible; it may be possible to infer land use from land cover and conversely.

But situations are often complicated and the link is not so evident.

Contrary to land cover, land use is difficult **to 'observe'.**

European Environment Agency

Land Use
or
Land Cover?

1st map of the Czech region dated 1518

Land Use
or
Land Cover?

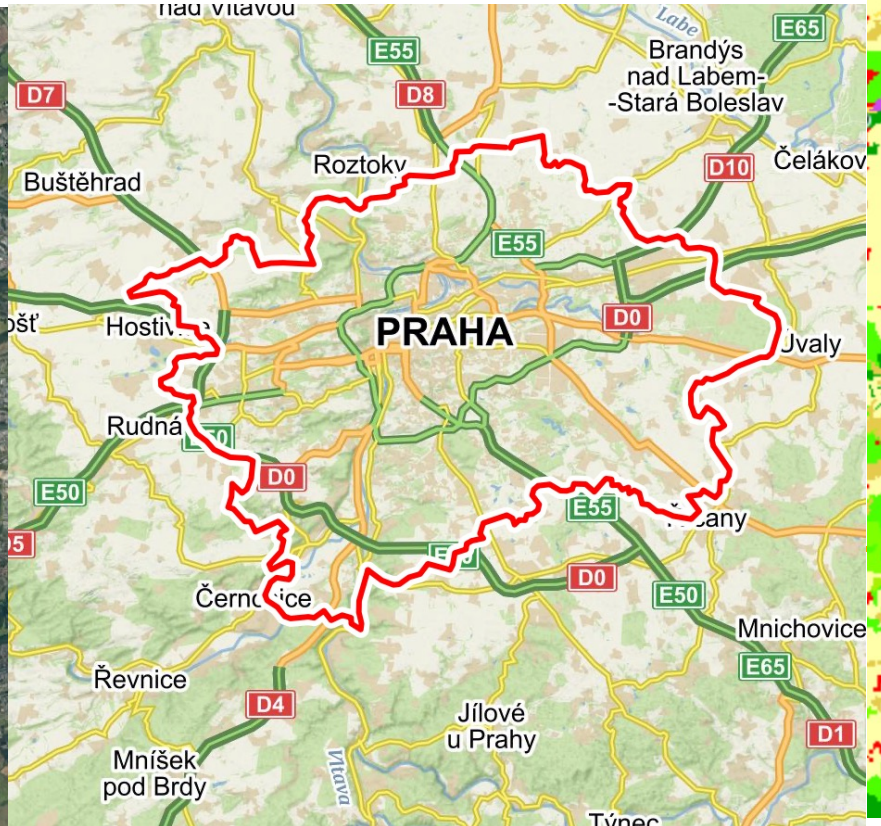
Land Use
or
Land Cover

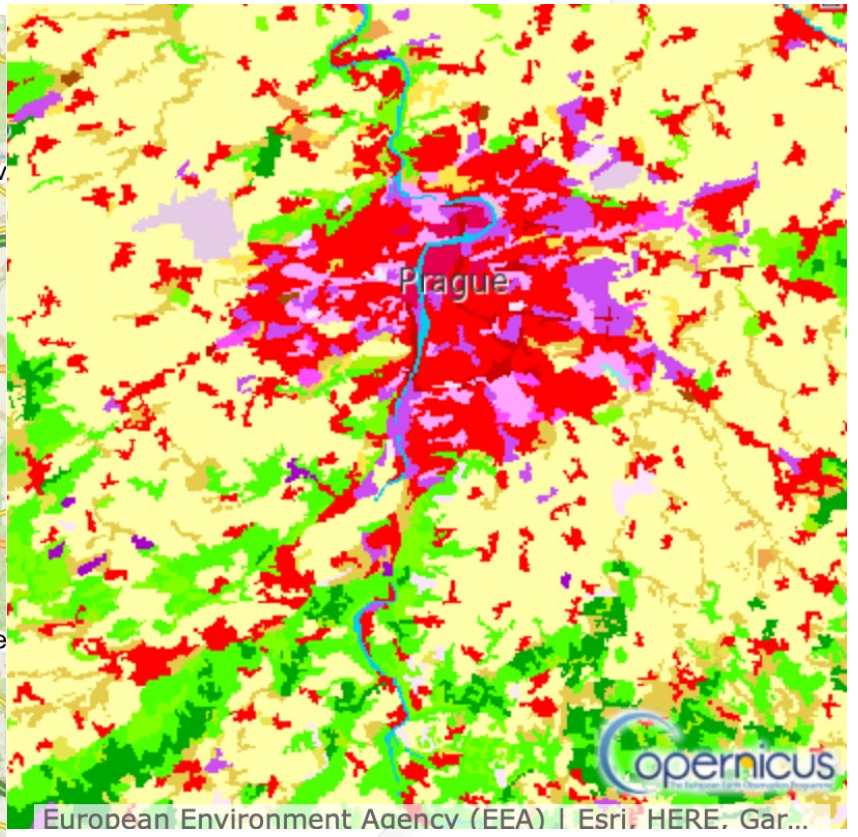
How did it start?

Thanks to photographs and satellite images

Land Use or Land Cover and when?

To be able to decide we have to have a look at existing land use land cover data





Land Use or Land Cover

To be able to decide we have to have a look at existing land use and land cover data

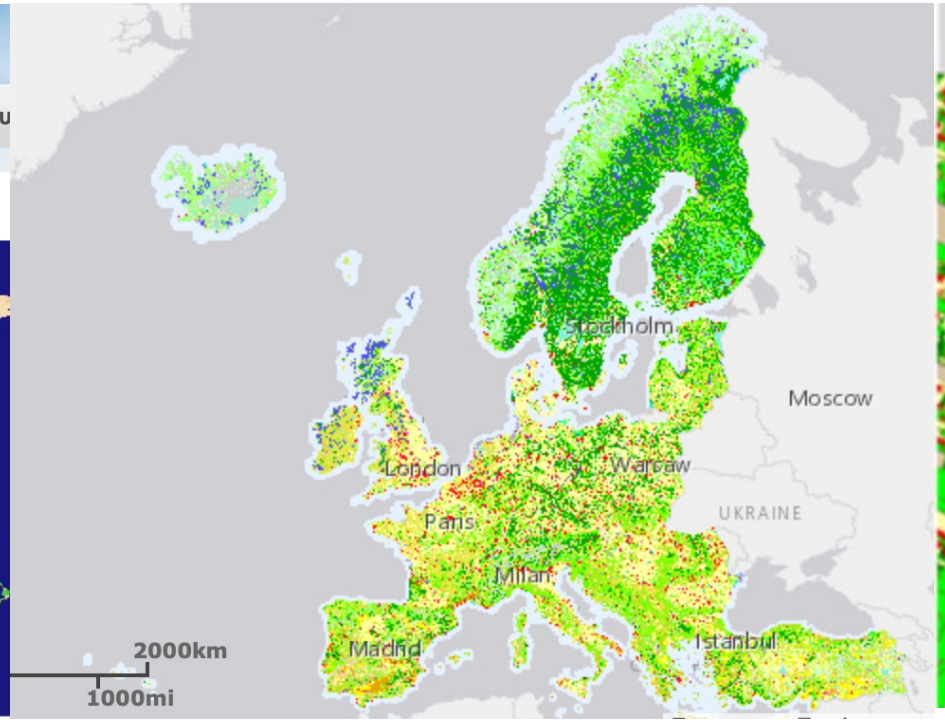
Do we separate them in the processed data?

Yes, if we use appropriate nomenclature

Spatial coverage

Global, Continental, National and Regional Land Cover products

[NASA Land Cover (2011)]



CORINE Land Cover 2018, Copernicus

LISA - Austria

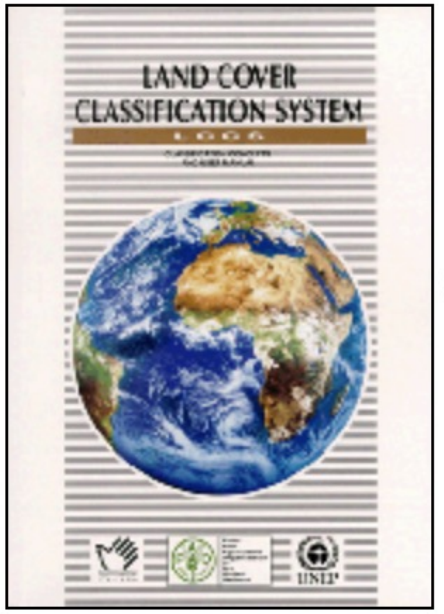
Spatial Coverage

Global data

LAND COVER NAME	MAINTAINER
CCI Land Cover (2017)	ESA
GlobeLand30 (2000, 2010)	National Geomatics Center of China
GLC - SHARE	Land and Water Division of FAO
GLC2000 (2000)	Joint Research Center (JRC)
NASA Land Cover (2011)	NASA
Land Cover (GLCNMO)	ISCGM, GSI of Japan
Copernicus Global Land Service	VITO

Global data

Product / Characteristics	ESA CCI LC	GlobeLand30	GLC - SHARE	GLC2000	NASA LC	Land Cover (GLCNMO)	CGLOPS-1 (VITO)
Thematic resolution (No. of classes)	22	10	11	23	17	20	23
Nomenclature model	LCCS	GlobeLand30	LCCS, FAO, SEEA	LCCS	IGBP	LCCS	LCCS
Spatial resolution / MMU	300m	30 m	1 km (source)	1 km (source) (source)	1 deg 0.5 deg 0.25 deg	500 m	100 m



GLOBELAND30

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

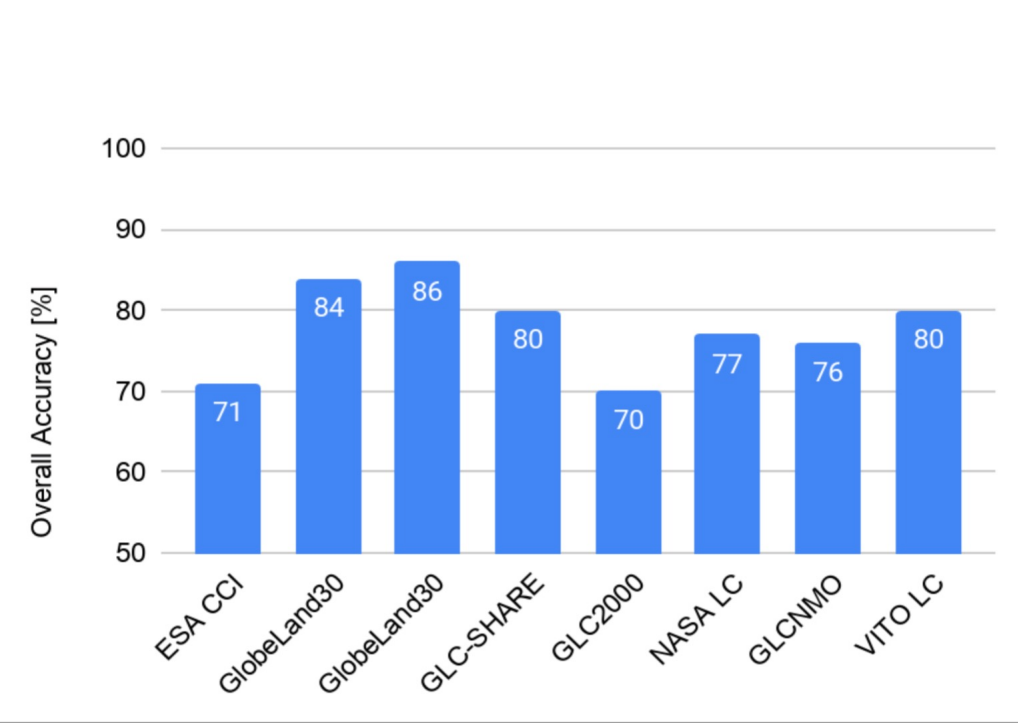
Nomenclature:

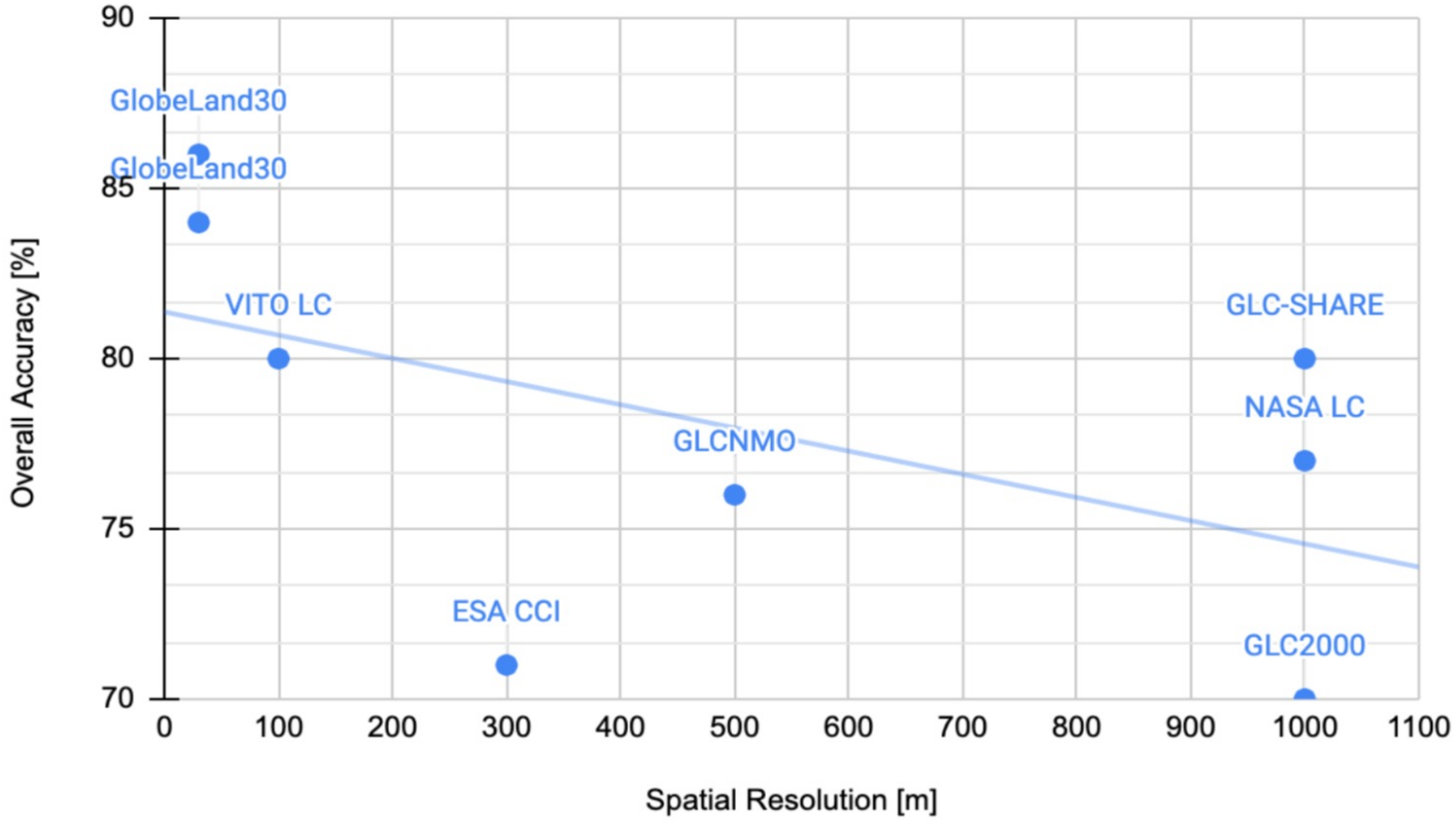
LCCS (FAO) http://www.fao.org/3/x0596e/x0596e00.htm

GlobeLand30 - http://www.globeland30.org

IGBP (International Geosphere-Biosphere Programme) - http://www.igbp.net

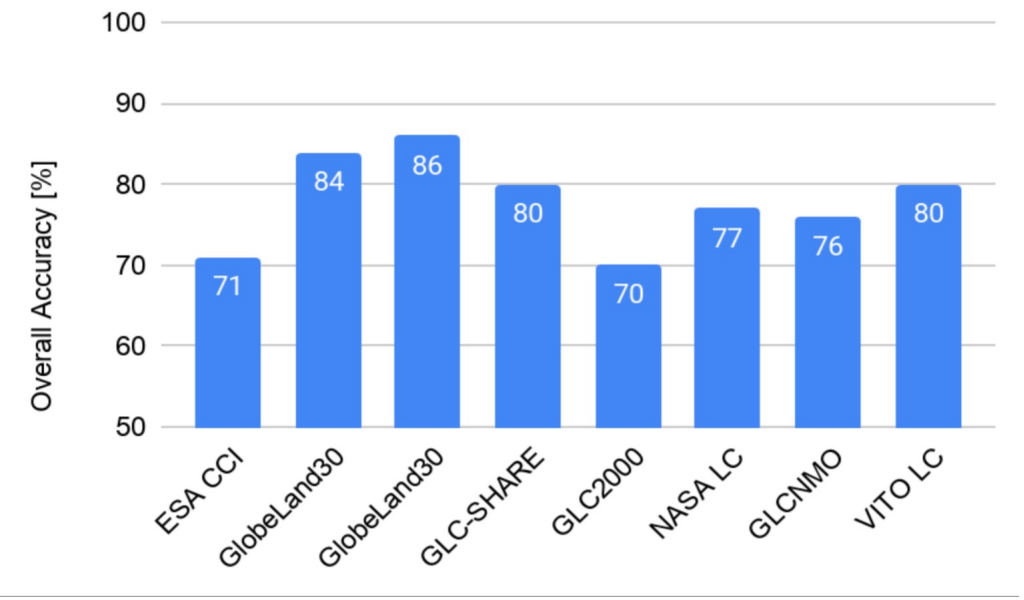
Global data - **spatial resolution** vs. overal accuracy





Global data accuracy 70 – 86 %

Global data - **thematic resolution** vs. **overal accuracy**



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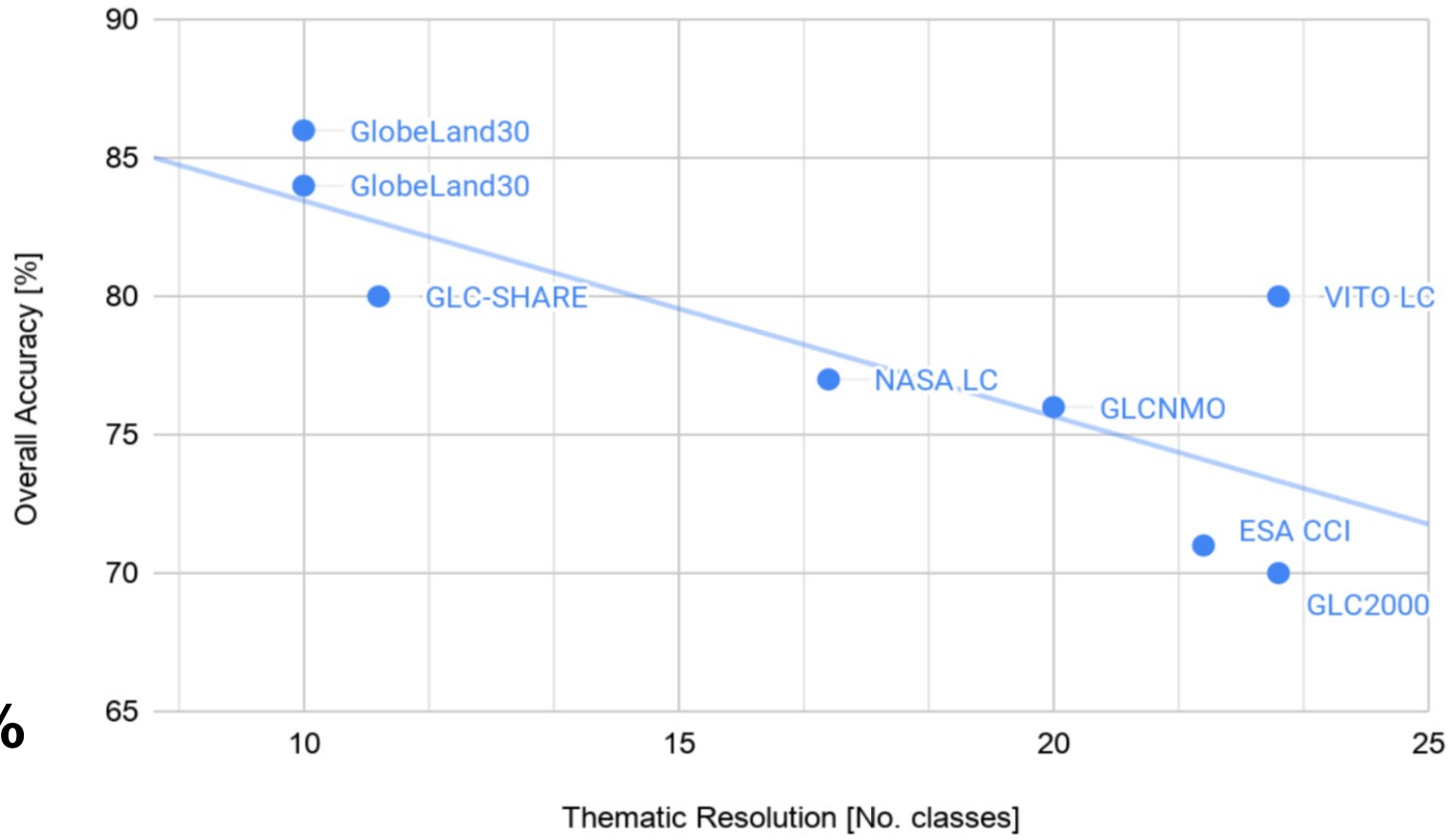


Spatial Coverage

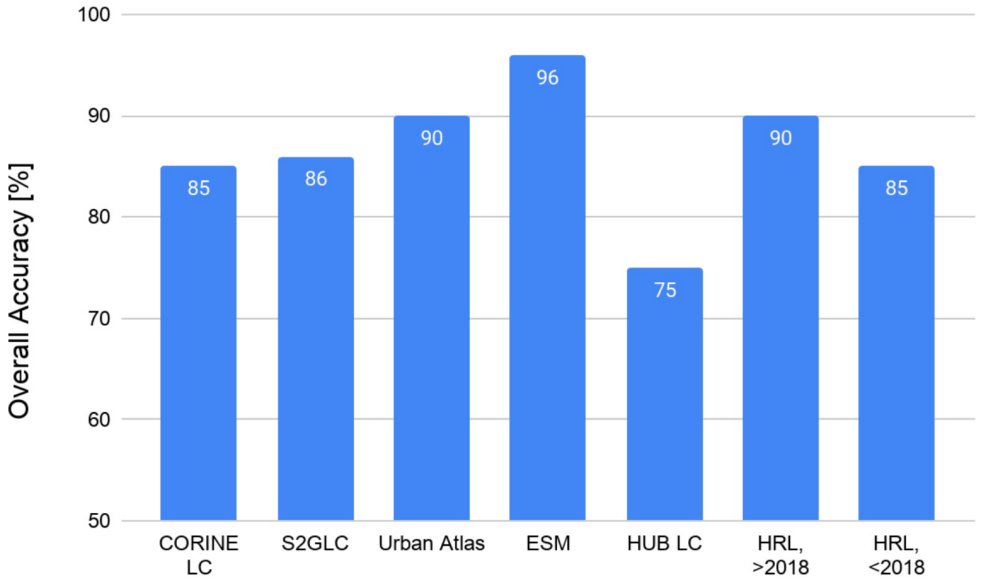
European continental data

Land Cover name	Maintainer
CORINE Land Cover (1990 -2018)	EEA (EU Copernicus)
European Settlement Map (2016, 17) Urban Atlas	EEA (EU Copernicus)
Land Cover Map of Europe 2017 (S2GLC, ESA)	EEA (EU Copernicus)
Pan-European land cover (30 m) map of 2015 (based on Landsat and LUCAS data)	Pflugmacher, Rabe, Peters, Hostert (Humbold University, Berlin)
High Resolution Layers	Copernicus

European data LC/LU

Product\ Characteristics	CORINE Land Cover (Copernicus)	Global Land Cover - Sentinel- 2 S2GLC (ESA)	Urban Atlas (Copernicus)	European Settlement Map (Copernicus)	Pan-European LC (Humboldt University of Berlin)	High Resolution Layers (HRL) (Copernicus)
Spatial coverage	Europe (EEA39)	Europe	Europe (EEA39) 319 FUAs	Europe	Europe	Pan-European
Thematic resolution (No. of classes)	44	13	27 (17 urban classes 10 rural classes)	1	12	5
Nomenclature model	CORINE (LC/LU)	CORINE	CORINE compatible	-	CORINE compatible	CORINE compatible
Spatial resolution (pixel size)		10 m		2 m/10 m/100 m	30 m	10 m (20 m before 2018)

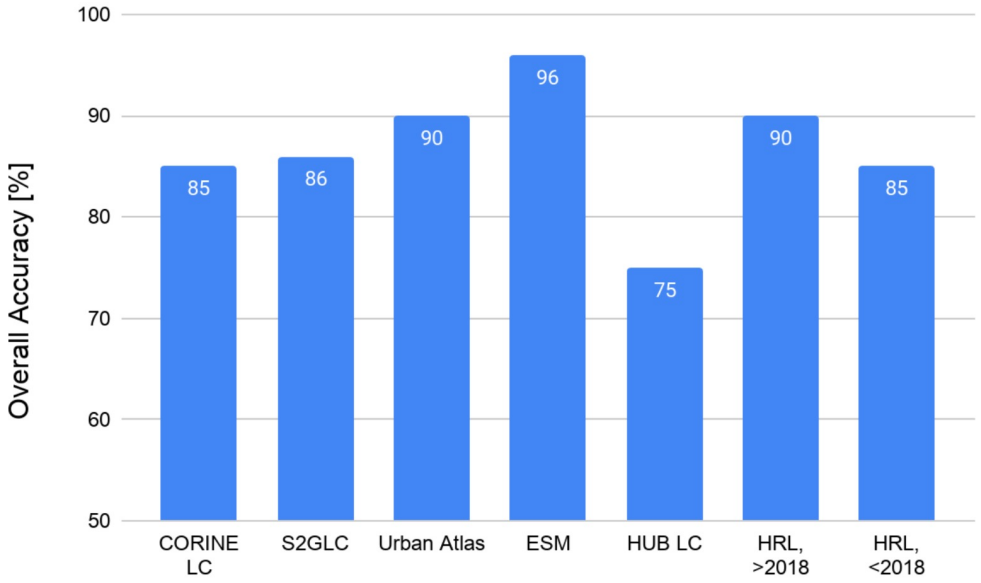
European data - **thematic resolution** vs. overal accuracy

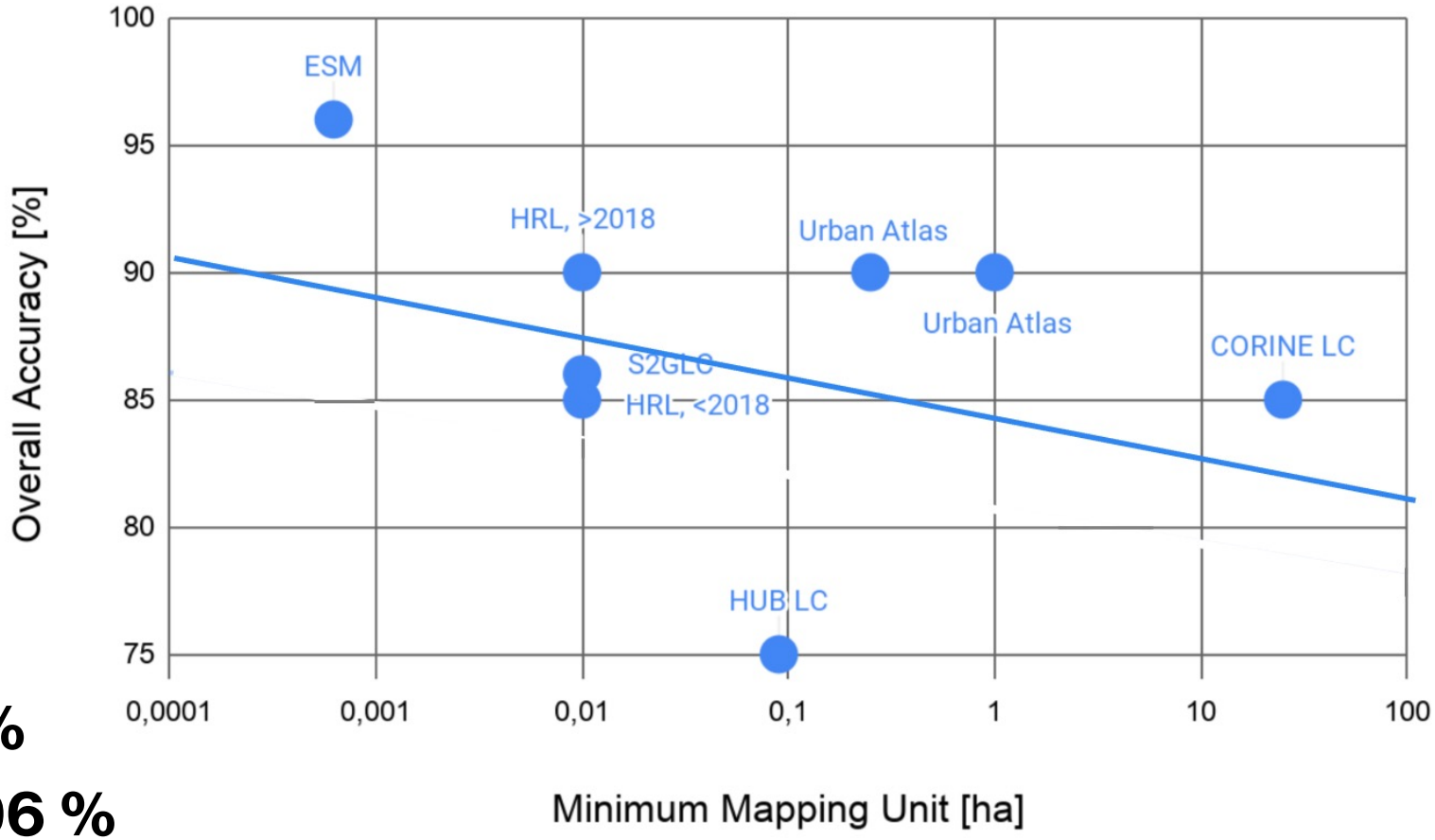


Global data accuracy 70 – 86 %

European data accuracy 75 – 96 %

European data - **spatial resolution** vs. overal accuracy





Global data accuracy 70 – 86 %

European data accuracy 75 – 96 %

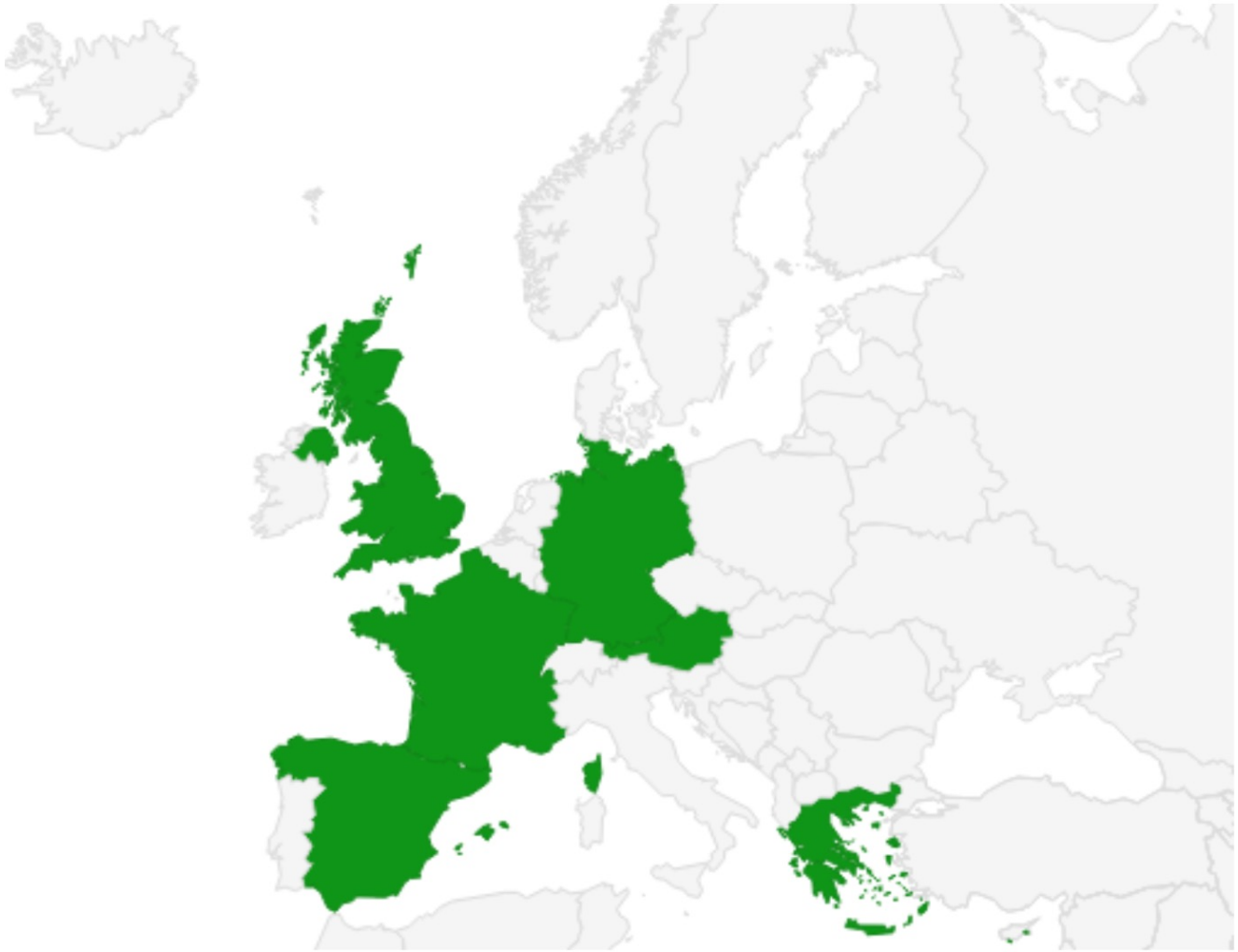
Spatial Coverage

national data

publicly available

Land Cover name	Maintainer
LISA	Austria, AT consortium
LandCover DE	Germany, DLR
SIOSE	Spain, National Reference Center on Land Cover and on Land Use and Spatial Planning
LGN (Dutch land use datasets from 1995 to 2018)	Netherlands, Wageningen Environmental Research
OSO Land Cover	France, Theia Data and Services centre
LC Greece	Greece, University of the Aegean
CLC50	Hungary, Institute of Geodesy, Cartography and Remote Sensing (FÖMI),

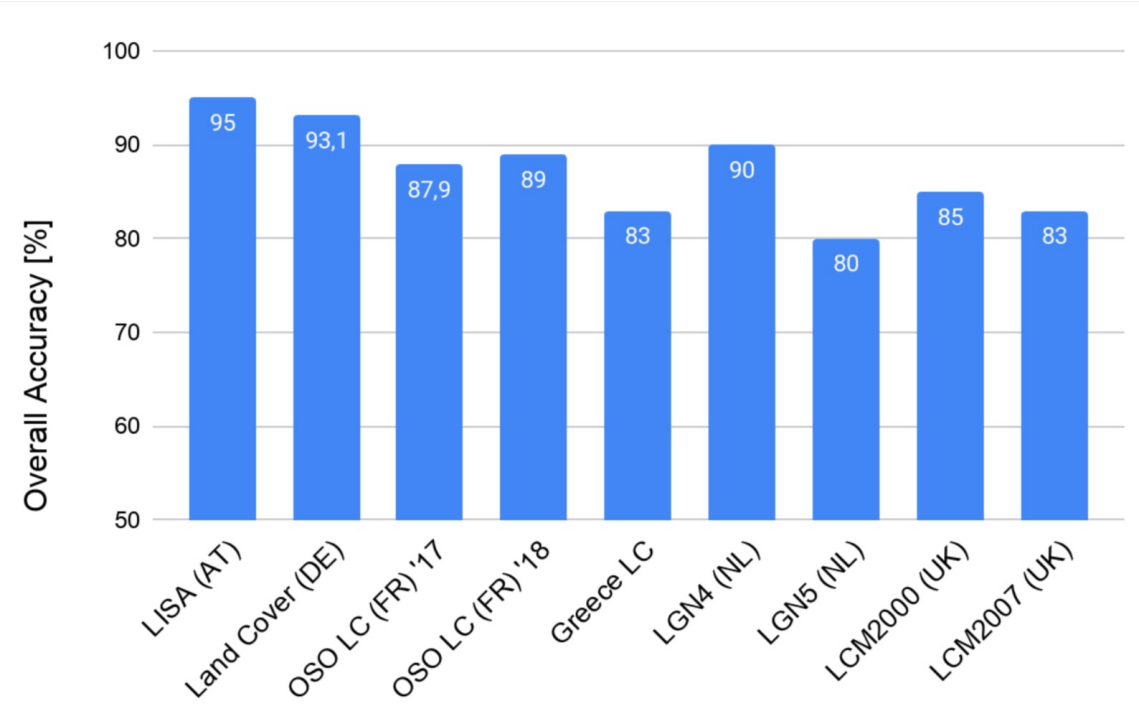
Map of publicly available European national data

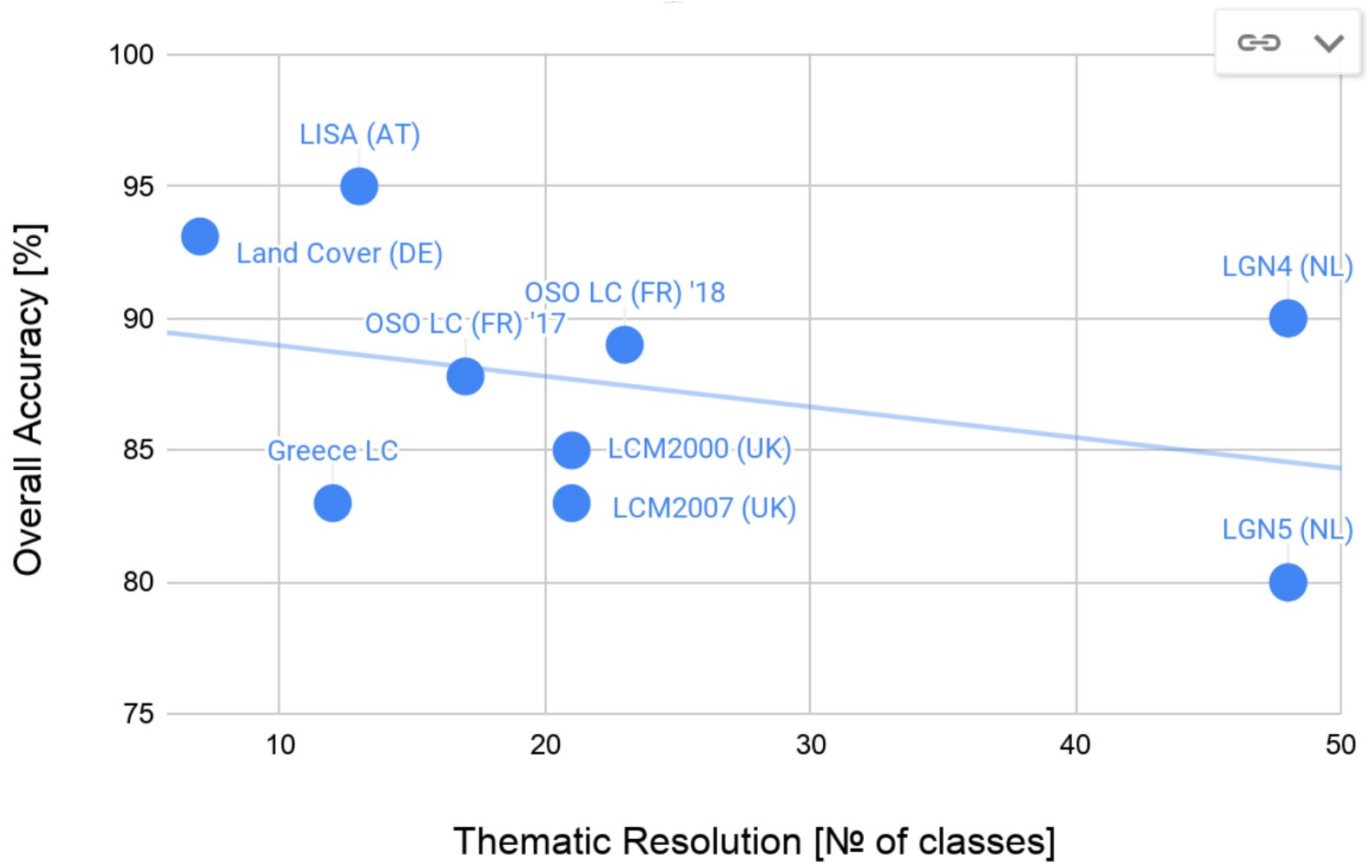


National Land Cover data – publicly available

Product / Characteristics	LISA	Land Cover DE	SIOSE	OSO LC	LC Greece	CLC50 HU	LGN	LCM2015
Spatial coverage	Austria	Germany	Spain	France	Greece	Hungary	The Netherlands	The UK
Thematic resolution (No. of classes)	13 and 12 attributes	7	20	23 (17 before 2018)	12	79	48 (39 before 2018)	21
Nomenclature model	CORINE compatible	CORINE	SIOSE	OSO LC	CORINE	CORINE level-3	LGN	JNCC Broad Habitats

National European data - **thematic resolution** vs. overal accuracy





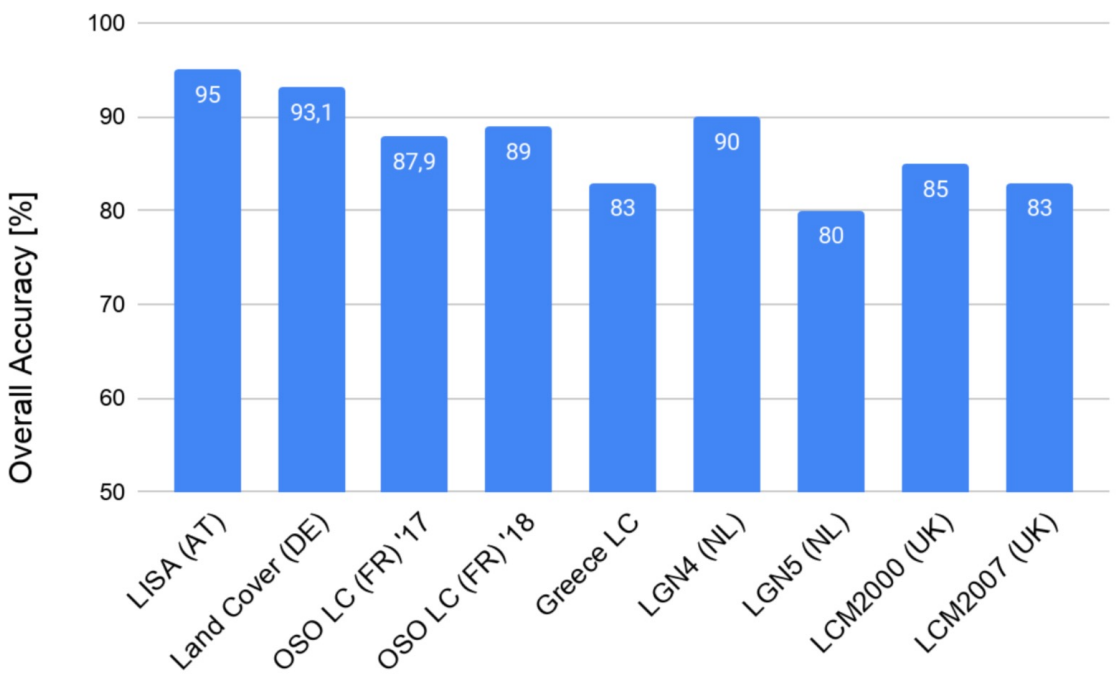
Global data accuracy 70 – 86 %

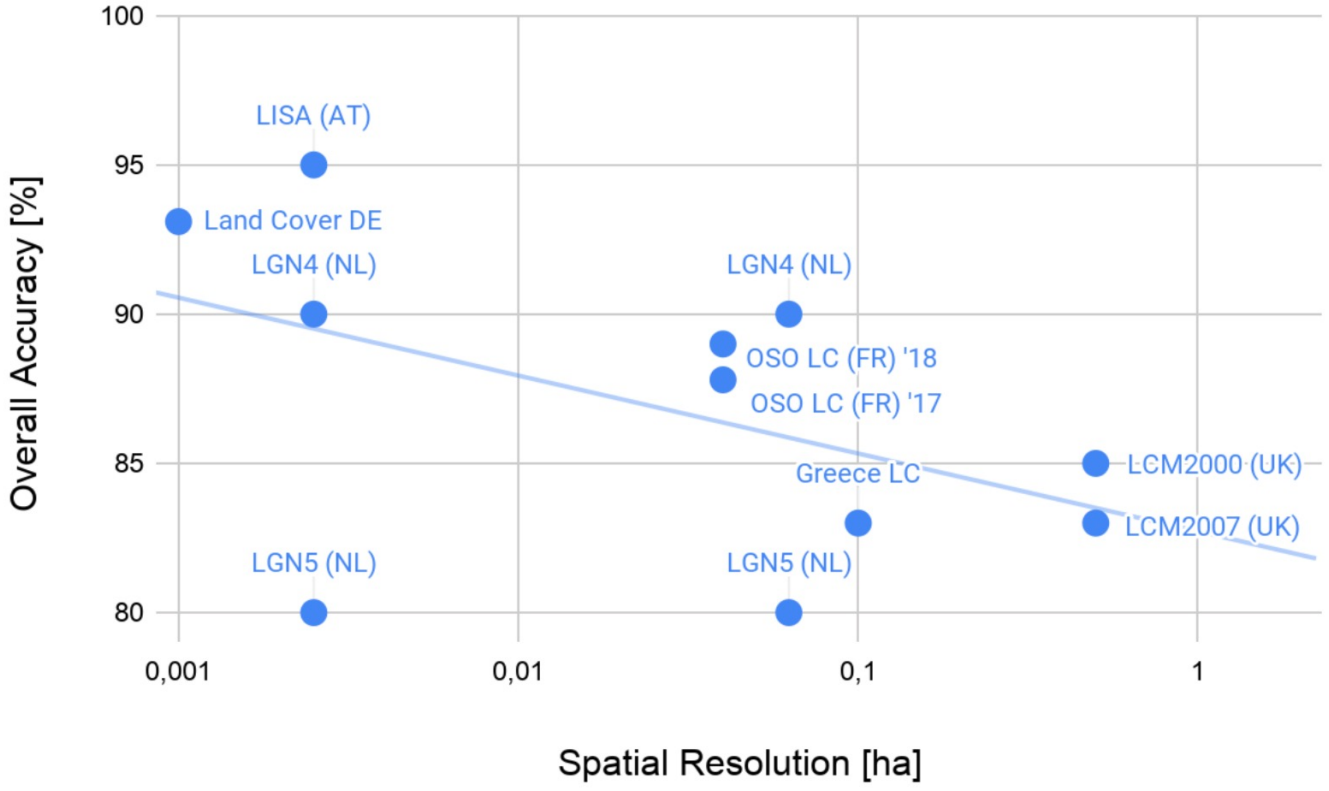
European data accuracy 75 – 96 %

National EU data accuracy 75 – 96 %

National European data

spatial resolution vs. **overal accuracy**





Global data accuracy 70 – 86 %

European data accuracy 75 – 96 %

National EU data accuracy 75 – 96 %

Conditions for good results of **land cover** **classification** of **remote sensing data**

Input data

- **remote sensing data – wide choice**
  - good quality
  - representative spectral information
  - appropriate spatial resolution
  - necessary temporal resolution
- **all other spatial data – which are available**

Method incl. **sample/training data**

Software

Open data used for the spatio-temporal data land cover/land use European model of the Geoharmonizer project

Land Cover Data
CORINE
Open street map
LUCAS

Satellite Data
Landsat data
Sentinel 2
VIIRS/Suomi NPP night light

Other data - timeless
DTM elevation **DTM slope**
Monthly Geometric Temperature
Global Surface Water Historical occurrence (1984-2019)

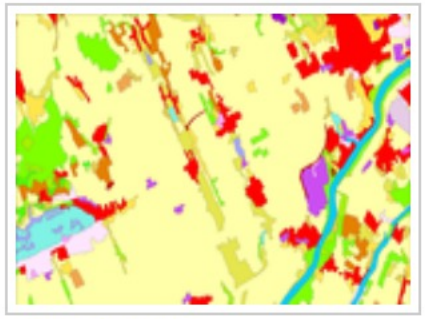
Applied Land Cover data

used to

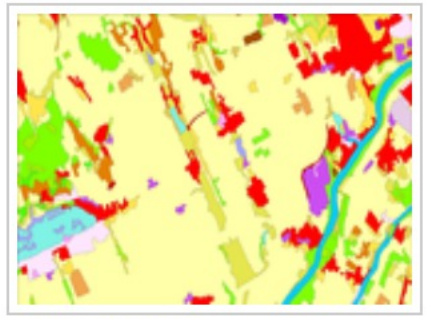
1) create a suitable nomenclature,
2) have training data
3) have data for validation

CORINE

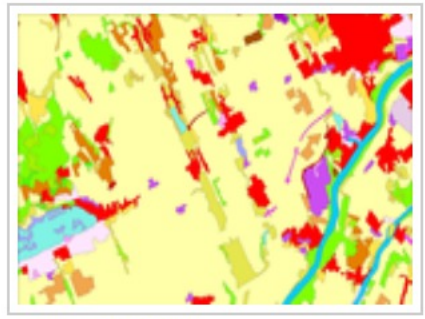
Year	Input data	Input Data Resolution	Participating Countries
CLC1990	Landsat-5 MSS/TM	50 m	27
CLC2000	Landsat-7 ETM	25 m	30
CLC2006	SPOT - 4/5 and ORS P6 LISS	25 m	38
CLC2012	IRS P6 LISS II and RapidEye	25 m	
CLC2018	Sentinel-2 imagery data; Landsat-8	10 m	39



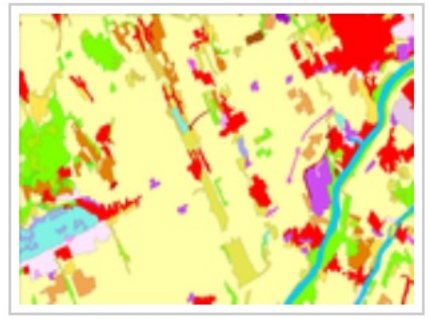
CLC 1990



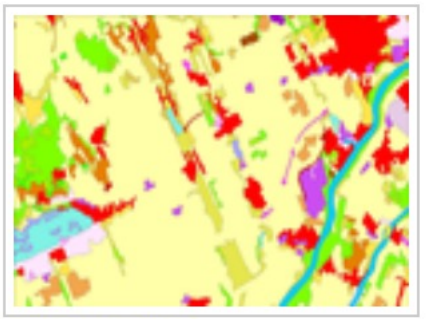
CLC 2000



CLC 2006



CLC 2012



CLC 2018

https://land.copernicus.eu/pan-european/corine-land-cover

CORINE clases

Artificial surfaces
Agricultural areas

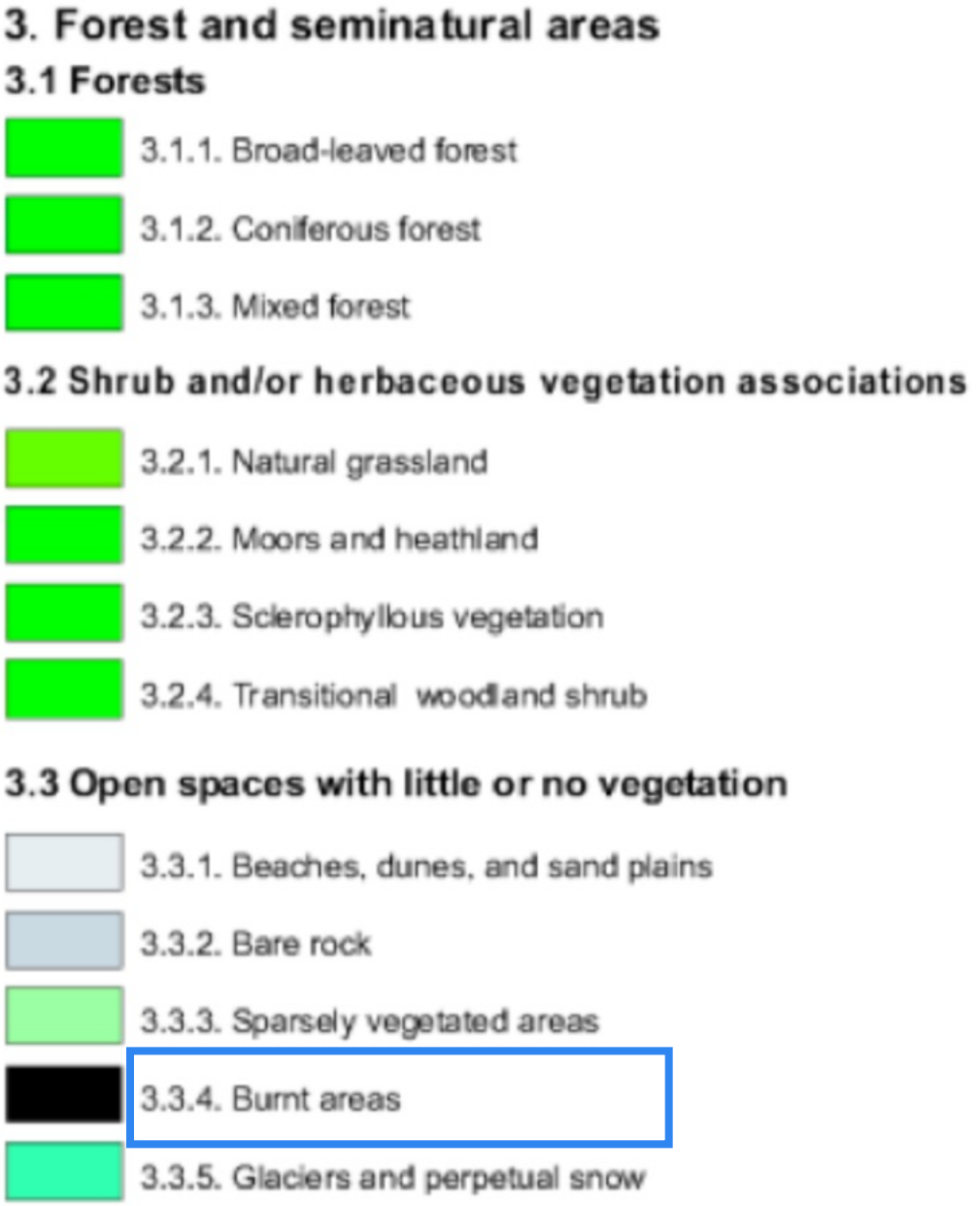
combination LU and LC

CORINE clases

Forest and seminatural areas

Wetlands

Water bodies



CORINE

Example of a **Land Use** class

1.1.2. Discontinuous urban fabric areas

1. 1. 2

1. 1. 2

1. 1. 2

CORINE - definition and determination of classes

Method:

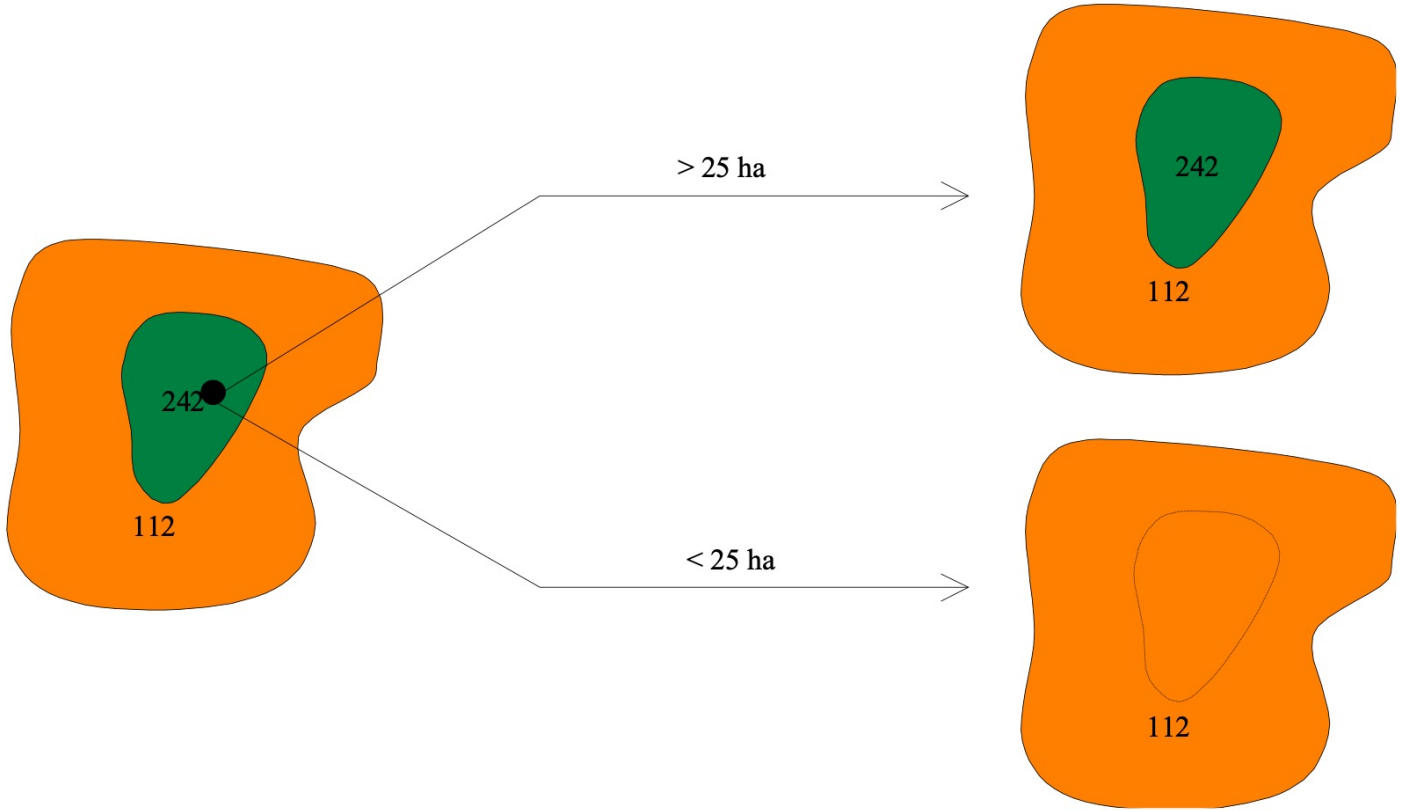
- visual interpretation using remote sensing data
- Manual vectorisation
- smallest mapped unit is 25 ha

Example:

- vegetated space surrounded by discontinuous urban fabric

1.1.2. discontinuous urban fabric areas

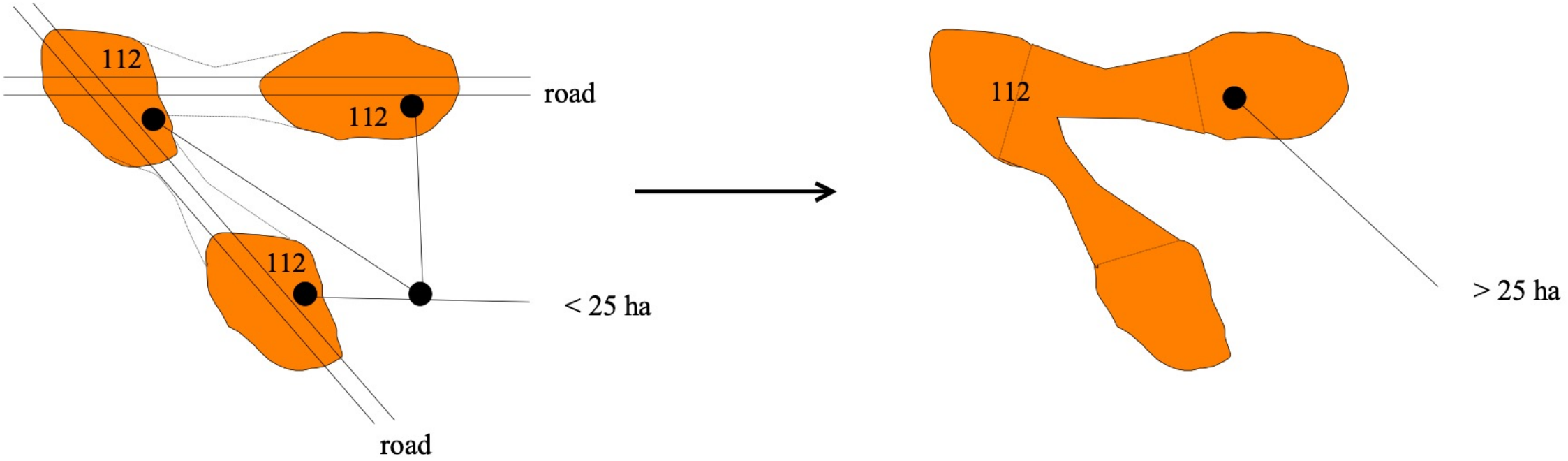
2.4.2. complex cultivation patterns



CORINE - definition and determination of classes

Example: 1.1.2. Discontinuous urban fabric areas

- grouped together if the distance < 300 m to reach **25 ha**
- exterior contour line leans on road network.



Open Street Map (OSM)

- The OSMs are an iterative ongoing work-in-progress.
- The aim is to produce maps which ***can*** **be relied upo**n, equally well, or better than other maps.

- OpenStreetMap is not a complete or accurate map of the world
- and should not be used in such a manner that deficiencies, omissions, inaccuracies or errors could result in death, loss or injury.

- The moneclature respects **keys and their values of individual countries**

- Disclaimer. .....**the maps might not be reliable**.

Open Street Map

etc.

Open Street Map

1. Primary features

1. 13.

1. 28.

Open Street Map

Primary features

1.29.1

Natural watercourses

Key	Value	Element	Description	Map rendering	Image	Count
waterway	river		The linear flow of a river, in flow direction.			2 314 1 515 943 21 903
waterway	riverbank		The water-covered area of a river			0 125 827 31 996
waterway	stream		A naturally-forming waterway that is too narrow to be classed as a river.			2 686 14 633 980 28 645
waterway	tidal_channel		A natural intertidal waterway in mangroves, salt marshes and tidal flats with water flow in the direction of the tide			1 3 846 6

Example of harmonization between

Open Street Map (222 tags in CR, e.g.) and **CORINE** (2nd level 15 classes)

CORINE

etc.

OSM

	11	12	13	14	21	22	23	24	31	32	33
	Urban f	Industrial,	Mine, dump	Artificial, non-	Arable land	Permanent c	Pastures	Heterogeneous	Forests	Scrub and/c	Open space
landuse											
allotments	0	0	0	1	0	0	0	0	0	0	0
basin	0	0	0	0	0	0	0	0	0	0	0
brownfield	0	0	1	0	0	0	0	0	0	0	0
cemetery	0	1	0	0	0	0	0	0	0	0	0
commercial	0	1	0	0	0	0	0	0	0	0	0
construction	0	0	1	0	0	0	0	0	0	0	0
farmland	0	0	0	0	0	0	0	1	0	0	0
farmyard	0	0	0	0	0	0	0	1	0	0	0
forest	0	0	0	0	0	0	0	0	1	0	0
garages	0	1	0	0	0	0	0	0	0	0	0
grass	0	0	0	0	0	0	1	0	0	0	0
greenfield	0	0	1	0	0	0	0	0	0	0	0
greenhouse_horticulture	0	0	0	0	1	0	0	0	0	0	0

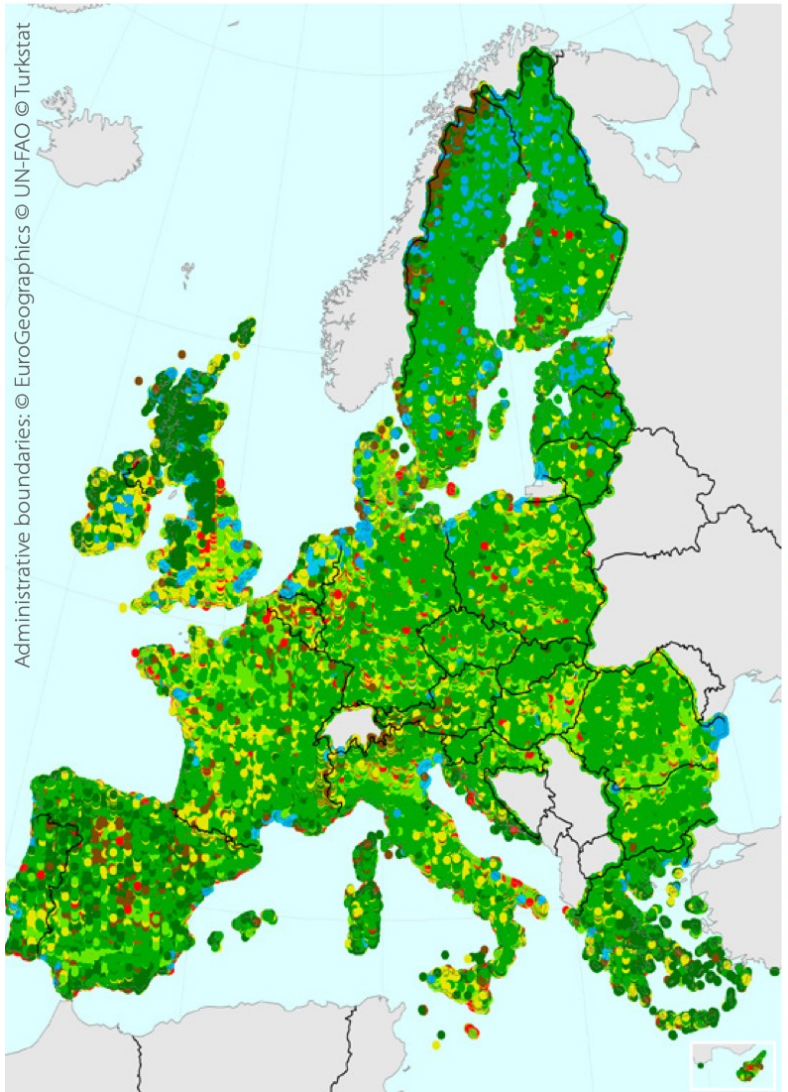
LUCAS
Land Use/Cover Area frame Survey

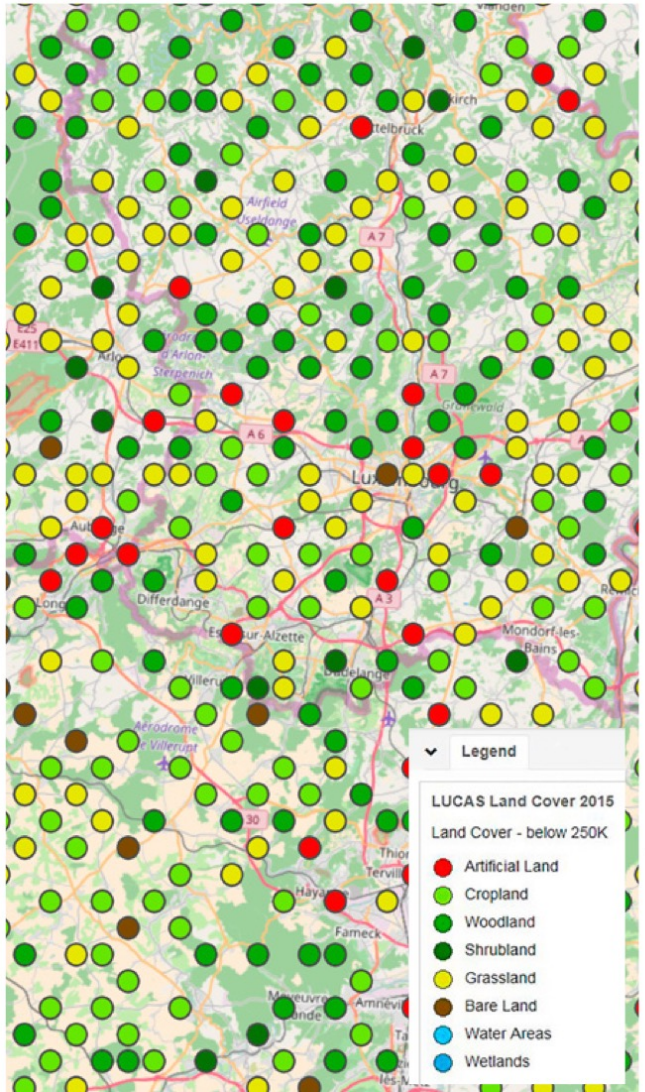
„Point data“at a systematic grid of 2 x 2 km

Years:
2005, 2009, 2012, 2015, 2018

2015 over 270 000 points;
2018 1 090 863 points

Method
- field observation and
- photo-interpretation





LUCAS

Land Cover

1st level
8 categories

2nd level
30 categories

3rd level
76 categories

Land cover			
A00	ARTIFICIAL LAND	**A10**	Roofed built-up areas
		A20	Artificial non-built up areas
		A30	Other artificial areas
B00	CROPLAND	**B10**	Cereals
		B20	Root crops
		B30	Non-permanent industrial crops
		B40	Dry pulses, vegetables and flowers
		B50	Fodder crops
		B70	Permanent crops: fruit trees
		B80	Other permanent crops
C00	WOODLAND	**C10**	Broadleaved woodland
		C20	Coniferous woodland
		C30	Mixed woodland
D00	SHRUBLAND	**D10**	Shrubland with sparse tree cover
		D20	Shrubland without tree cover
E00	GRASSLAND	**E10**	Grassland with sparse tree/shrub cover
		E20	Grassland without tree/shrub cover
		E30	Spontaneously re-vegetated surfaces
F00	BARE LAND AND LICHENS/MOSS	**F10**	Rocks and stones
		F20	Sand
		F30	Lichens and moss
		F40	Other bare soil
G00	WATER AREAS	**G10**	Inland water bodies
		G20	Inland running water
		G30	Transitional water bodies
		G40	Sea and ocean
		G50	Glaciers, permanent snow
H00	WETLANDS	**H10**	Inland wetlands
		H20	Coastal wetlands

Artificial land

Cropland

Woodland

Shrubland

Grassland

Bare land

Water areas

Wetlands

LUCAS

Land Cover Categories

3rd level 76 subclasses

Example of 3 levels of the Artificial Land

A00 ARTIFICIAL LAND

A10 BUILT-UP AREAS

A11 Buildings with one to three floors

A12 Buildings with more than three floors

A13 Greenhouses

A20 ARTIFICIAL NON-BUILT UP AREAS

A21 Non built-up area features

A22 Non built-up linear features

However, can we determine them from remote sensing data?

LUCAS

Land Use categories

4 sectors
33 subclasses

2 levels of Land Use in each sector

example of the secondary sector

U220 INDUSTRY AND MANUFACTURING

- U221 Manufacturing of food, beverages and tobacco products
- U222 Manufacturing of textile products
- U223 Coal, oil and metal processing
- U224 Production of Non-metal mineral goods
- U225 Chemical and allied industries and manufacturing
- U226 Machinery and equipment
- U227 Wood based products

primary sector

secondary sector

tertiary sector

other use

LUCAS

Land Use Categories

4 sectors
33 subclasses

3 Land Use Classification (LUCAS SU LU)

U100 Primary sector

U110 AGRICULTURE

U111 Agriculture (excluding fallow land and kitchen gardens)

Areas used for agricultural purposes (NACE Section A01) and field construction (e.g. agricultural land terracing, drainage, preparing rice paddies etc. - NACE 43.12 as far as related to agricultural activites).

This class includes the production of crop products and production of animal products. This class includes growing of crops in open fields as well as in greenhouses. The preparation of products for the primary markets is included here. These areas are normally harvested with use of agricultural machinery (exc. delicate crops).

This class includes

- A01.1 Growing of non-perennial crops
- Growing of cereals (except rice), leguminous crops and oil seeds

LUCAS

F00 BARE LAND AND LICHENS/MOSS

Land Cover **links to** **Land Use**

F10 ROCKS AND STONES

This class includes

- Inland rock cliffs
- Areas of rock outcrop and limestone parent
- Scree
- Block litter and mountain top debris
- Land covered with recent volcanic features

F10 ➢ U140	Scrapped or excavated areas for quarrying, mining purposes
F10 ➢ U21x	Rocky areas attached to energy production
F10 ➢ U22x	Rocky areas attached to industrial use
F10 ➢ U31x	Rocky areas attached to transport areas
F10 ➢ U330	Construction sites
F10 ➢ U34x	Rocky areas attached to commercial services
F10 ➢ U350	Rocky areas attached to community services
F10 ➢ U36x	Rocky areas used for recreational and leisure purposes
F10 ➢ U370	Rocky areas attached to residential areas
F10 ➢ U4x0	Rocky areas not used (inland rocks, top mountains)

LUCAS

Method of data collection

Each point from *in situ* equiped by 5 photos
Some points classified from aerial photos

Homogeneous land cover
Non-homogeneous land cover

Radius 1,5 m

homogeneous

Radius 20 m

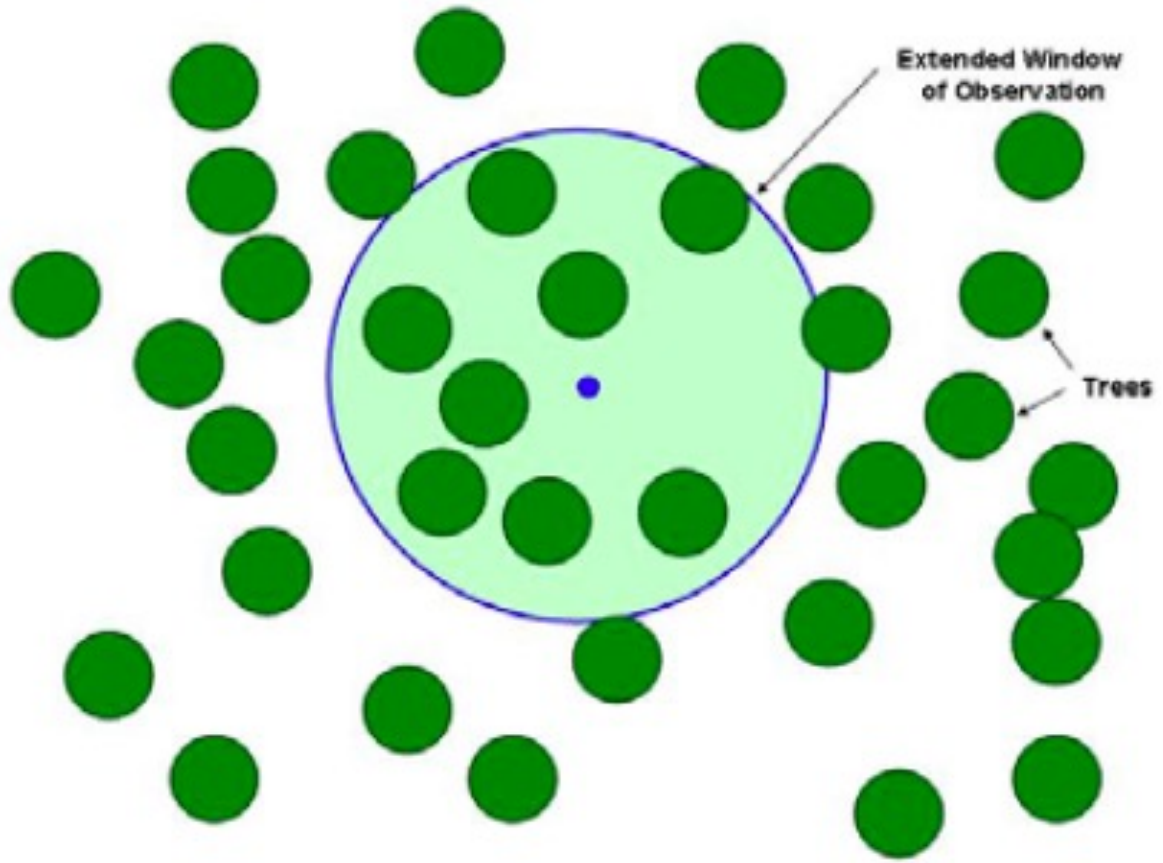
non-homogeneous

LUCAS

Method of data collection

Non-homogeneous land cover:
i.e., trees or shrubs interspersed with grassland,

Extended Window of Observation:
a radius of 20 meters, i.e., 0,13 ha



Conversion between

LUCAS (LC, 30 classes 2nd level) and CORINE (to 2nd level and 3rd level classes)

LUCAS 2nd level (LC2)	LC2 code	CORINE 2nd level code	CORINE 3rd level code	note
Roofed built-up areas	A10	11		
Artificial non-built up areas	A20	12	122	
Other artificial areas	A30			could be 122 or 132
Cereals	B10	21	211	contains rice
Root crops	B20	21	211	
Non-permanent industrial crops	B30	21	211	
Dry pulses, vegetables and flowers	B40	21	211	
Fodder crops	B50	21	211	possible pastures (23)
Permanent crops: fruit trees	B70	22	222	
Other permanent crops	B80	22		vineyards, olive groves, nurseries?
Broadleaved woodland	C10	31	311	
Coniferous woodland	C20	31	312	
Mixed woodland	C30	31	313	

etc.

Conversion between CORINE to LUCAS for the project

8 LUCAS classes

to 7 classes
to 10 classes

Land cover			
A00	ARTIFICIAL LAND	A10	Roofed built-up areas
		A20	Artificial non-built up areas
		A30	Other artificial areas
B00	CROPLAND	B10	Cereals
		B20	Root crops
		B30	Non-permanent industrial crops
		B40	Dry pulses, vegetables and flowers
		B50	Fodder crops
		B70	Permanent crops: fruit trees
		B80	Other permanent crops
C00	WOODLAND	C10	Broadleaved woodland
		C20	Coniferous woodland
		C30	Mixed woodland
D00	SHRUBLAND	D10	Shrubland with sparse tree cover
		D20	Shrubland without tree cover
E00	GRASSLAND	E10	Grassland with sparse tree/shrub cover
		E20	Grassland without tree/shrub cover
		E30	Spontaneously re-vegetated surfaces
F00	BARE LAND AND LICHENS/MOSS	F10	Rocks and stones
		F20	Sand
		F30	Lichens and moss
		F40	Other bare soil
G00	WATER AREAS	G10	Inland water bodies
		G20	Inland running water
		G30	Transitional water bodies
		G40	Sea and ocean
		G50	Glaciers, permanent snow
H00	WETLANDS	H10	Inland wetlands
		H20	Coastal wetlands

	CORINE with 7 classes		CORINE with 10 classes	
1	Artificial surface	1	Artificial	A10, A20
2	Agriculture	2	Cropland	B10, B40, B50
		3	Perenial crops	B70, B80
3	Forest	4	Forest	C10, C20, C30
		5	Shrubland	D20
		6	Grassland	E20, B50?
4	Bare	7	Barren	F00
5	Wetlands	8	Wetlands	H00
6	Water	9	Water	G10, G20, G40
7	Snow/Ice	10	Glaciers, permanent	G50

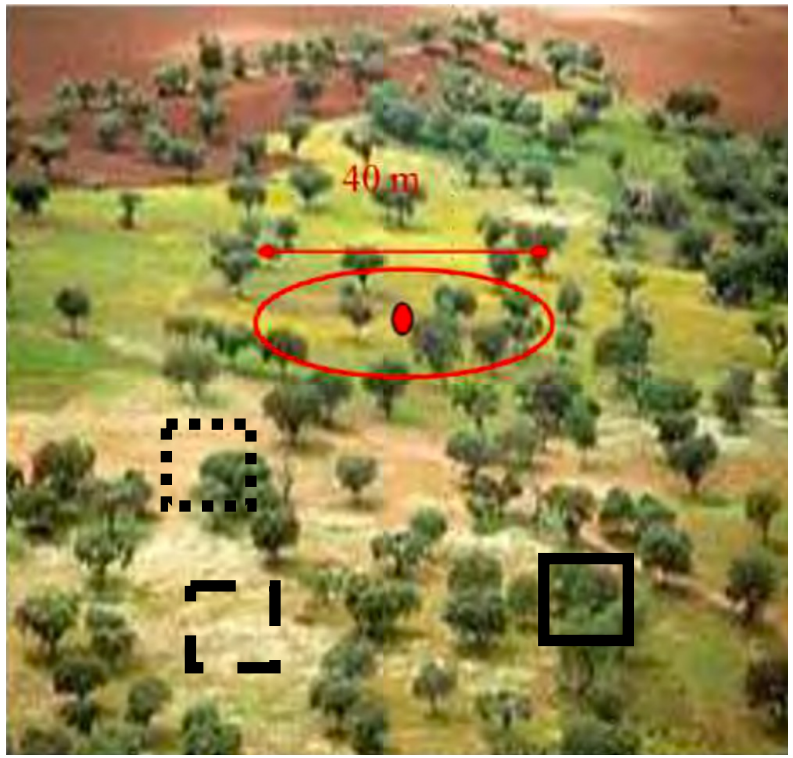
Adapted CORINE nomenclature and respective LUCAS one

7 classes		10 classes to LUCAS			to 21 classes to LUCAS			linkage to land use categories
1	Artificial surface	1	Artificial	A10, A20	1	Roofed buit-up areas	A11, A12	
					2	Artificial non-built up linear	A22	A30
					3	Mine, dump		A21
					4	Urban green	???	C10-*U370*, C21-*U370*, C22-*U370*, C23-*U370*, C31-*U370*, C32-*U370*, C33-*U370*, E20-*U370*
2	Agriculture	2	Cropland	B10, B40, B50	5	Cropland seasonal	B11, B12, B13, B14, B15, B16, B17, B18, B19, B21, B22, B23, B31, B32, B33, B34, B35, B36, B37, B41, B42, B43, B45	B11-*U111*, B12-*U111*, B13-*U111*, B14-*U111*, B15-*U111*, B16-*U111*, B17-*U111*, B18-*U111*, B19-*U111*, B21-*U111*, B22-*U111*, B23-*U111*, B30-*U111*, B32-*U111*, B33-*U111*, B34-U111, B35-U111, B36-*U111*, B37-*U111*, B37-*U111*, B41-*U111*, B42-*U111*, B43-*U111*, B45-*U111*
					6	Greenhouse	A13	
					7	Pastures	?B51, B52, B53, B55	B51-*U111*, B52-*U111*, B53-*U111*, B54-*U111*, B55-*U111*
							E10, E20	E10-*U111*, E10-*U31X*, E10-*U34X*, E10-*U350*, E10-*U36X*, E20-*U31x*, E20-*U34x*, E20-*U350*, E20-*U36x*
		3	Perenial crops	B70, B80	8	Perenial crops	B71, B72, B73, B74, B75, B76, B77, B81, B82, B83?, B84	B71-*U111*, B72-*U111*, B73-*U111*, B74-*U111*, B75-*U111*, B76-*U111*, B77-U111, B81-*U111*, B82-U111, B84-*U111*
3	Forest	4	Forest	C10, C20, C30	9	Forest Broadleaf	C10	C10-*U120*, C10-*U341*, C10-*U350*, C10-*U36x*
					10	Forest Coniferous	C21, C22, C23	C21-*U341*, C21-*U350*, C21-*U36x*, C22-*U341*, C22-*U350*, C22-*U36x*, C23-*U120*, C23-U341, C23-*U350*, C23-*U36x*
					11	Forest Mixed	C31, C32, C33	C31-*U120*, C31-*U341*, C31-*U350*, C31-*U36x*, C32-*U120*, C32-*U341*, C32-*U350*, C32-*U36x*, C33-*U341*, C33-U350, C33-*U36x*
					12	Cleaar-cuts/transitional wood		E10-*U120*, E20-*U120*
		5	Shrubland	D20	13	Shrubland	D20	D10	D20-*U111*, D20-*U112*, D20-*U420*
		6	Grassland	E20, B50?	14	Natural grassland	E20	E10, E30?	E20-*U410*, E20-*U420*
4	Bare	7	Barren	F00	15	Barren	F10, F20, F30->test	F40	
5	Wetlands	8	Wetlands	H00	16	Inland Wetlands	H11, H12	
					17	Coastal wetlands	H21, H22, H23	
6	Water	9	Water	G10, G20, G40	18	Water bodies	G11, G12	G30
					19	Water courses	G21, G22	
					20	Ocean	G40	
7	Snow/Ice	10	Glaciers, permanent	G50	21	Glaciers, permanent snow	G50	

Training data and validation data

LUCAS training data **controlled and "filtered"** by CORINE data and Urban Atlas

Validation by rasterised OpenStreet Map



Problem with non-homogeneous data:

- spectral signature space of trees
- spectral signature space of grass
- spectral signature space of tree and grass mixture

Training data and validation data

LUCAS training data need to be controlled and filtered by CORINE/Urban Atlas data

2006 (**A21** / **CLC** 111, 122, 123)

2012 (**E20** / **CLC 321**) change from 'Urban' to grassland'

CORINE versus Open Street Map vs. LUCAS

CORINE	OSM	LUCAS
polygons	**nodes** - defining points in space **ways** - defining linear features and **area boundaries** **relations** - sometimes used to explain how other elements work together	**Point data**
LU/LC	**LU/LC**	**LU and LC separate classifications**
3 level categories 1st 5 classes 2nd 15 classes 3rd 44 classes	29 Primary Features of the 1st hierarchy levels 2 levels of Primary Features Tags define classes (e.g. 222 tags of LU/LC in the CR)	**LC**: 8/30/76 categories **LU**: 4 sectors/16 classes/...
Updated CLC illustrated nomenclature guidelines, Kosztra, B. et al.	https://wiki.openstreetmap.org/wiki/Map_features	LUCAS 2018 (Land Use / Cover Area Frame Survey). E4 LUCAS ESTAT

Remote sensing data

Remote sensing satellite data

to create LC for 2000 - 2020

2000 -2019

Landsat data – Landsat 5 (TM), Landsat 7 (ETM+), Landsat 8 (OLI)

2015 - 2019

Sentinel-2

For both 4 seasons :

Winter: December 2 of previous year until March 20 of current year

Spring: March 21 until June 24 of current year

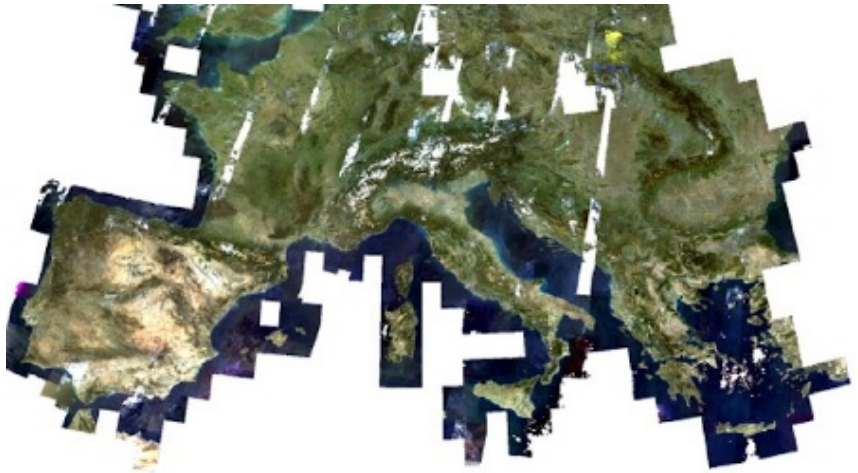
Summer: June 25 until September 12 of current year

Fall: September 13 until December 1 of current year

2012 - 2019

Night Light / VIIRS/NPP
Visible Infrared Imaging Radiometer Suite (VIIRS/NPP) is nighttime radiance product
Daily Gridded Day Night Band

Gap Filling for Landsat Mosaics



Where: clouds, shadows, non-existing data,

Method: based on
Landsat Analysis Ready Data (GLAD ARD)
developed by the Global Land Analysis and Discovery (GLAD)

However:
Data processed by GLAD method still comprise pixels with no values

Geoharmonizer project adapted the GLAD method

(*Landsat Analysis Ready Data for Global Land Cover and Land Cover Change Mapping*
*Peter Potapov *, Matthew C. Hansen , Indrani Kommareddy, Anil Kommareddy,*
Svetlana Turubanova, Amy Pickens, Bernard Adusei, Alexandra Tyukavina and Qing Ying)

Preprocessing: gap filling for Landsat mosaics

Long-Term Median Improvement

Pixels with gaps are filled in by the following option

9 priorities combined with 3 different window sizes

1st – 3rd priority = windows from **the same season**: *median value*
4th – 6th priority = windows from **fall and spring**: *average of medians*
7th – 9th priority = windows from **spring, summer and fall**: *median*

3 sizes of moving windows:

window 1: 8 neighboring periods - values from scenes 4 before and after
window 2: 16 neighboring periods – values from scenes 8 before and after
window 3: 24 neighboring periods – values from scenes 12 before and after

The 1st preference the same season with window 1

All the Landsat tiles were gapfilled generating 23,661,120 individual files

Other

spatial data layers

DTM - Elevation
(Timeless)

DTM - Slope
(Timeless)

Global Surface Water Freq.
(Timeless)

Monthly Geometric Temp.
(Timeless)

Soil Adjusted Vegetation Index

Normalized Burn Ratio

REI Riparian Ecosystem Index

Normalized Difference Water Index

NDVI

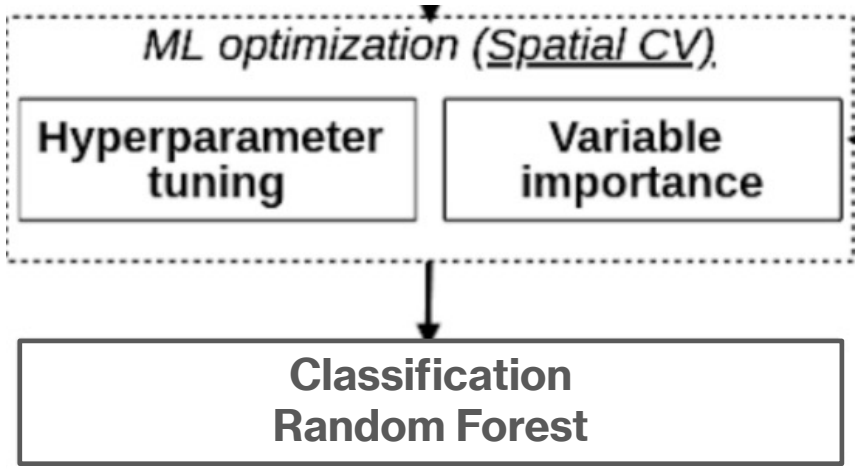
Global Surface Water

Value	Label
0	Not water
1	1% occurrence
100	100 % occurrence
255	No data

Global Surface Water
1984 – 2019 JRC: https://global-surface-water.appspot.com/download

Monthly Geometric Temperature
Spatio-temporal interpolation of daily temperatures for global land areas at 1km resolution
Milan Kilibarda et al
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2013JD020803

Classification

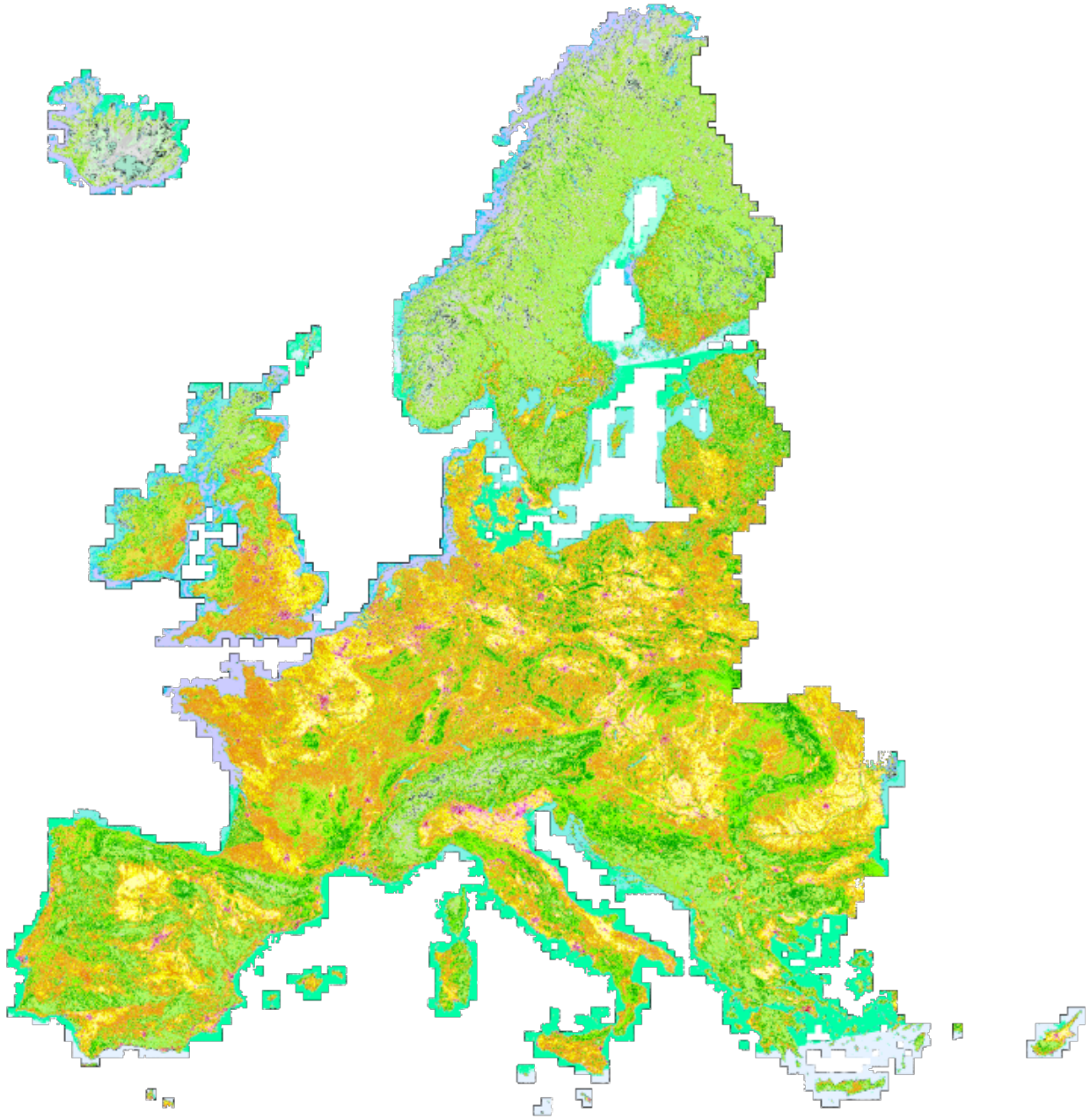


178 covariates

111-Urban fabric
122-Road and rail networks and associated land
123-Port areas
124-Airports
131-Mineral extraction sites
132-Dump sites
133-Construction sites
141 Green urban areas
211-Non-irrigated arable land
212-Permanently irrigated arable land
213-Rice fields
221-Vineyards
222-Fruit trees and berry plantations
223-Olive groves
231-Pastures
311-Broad-leaved forest
312-Coniferous forest
321-Natural grasslands
322-Moors and heathland
323-Sclerophyllous vegetation
324-Transitional woodland-shrub
331-Beaches, dunes, sands
332-Bare rocks
333-Sparsely vegetated areas
334-Burnt areas
335-Glaciers and perpetual snow
411-Inland wetlands
421-Maritime wetlands
511-Water courses
512-Water bodies
521-Coastal lagoons
522-Estuaries
523-Sea and ocean

Unclassified CORINE classes:

112 Discontinuos urban fabric
121 Industrial or commercial units
142 Sport and leisure activities
24 Heterogenous agricultural areas
313 Mixed forest
412 Peat bogs
422 Salines
423 Inertidal flats



Preliminary result – classes with various user‘s/producer‘s accuracies

Conclusion

Land Cover classification and harmonization is a complex problem due to:

1) Existing detailed namenclatures

a. which are a combination of **LU** and **LC**

b. and therefore the class definitions do not respect spectral feature space

b. where many classes in one nomenclature comprise more classes of the other nomenclature

We need to have a harmonized nomenclatures to convert one **LC** data to another not only for the new harmonized **LC** layers but for their **calculation** on one side and for their **validation** on the other side.

2) Atmospheric conditions – even though gap filling methods are able to replace non-existing data, the training phase uses many pixels where the spectral values is a combination spectral values even of all seasons.

Geoharmonizer: EU-wide automated mapping system for harmonization of Open Data based on FOSS4G and Machine Learning

https://opendatascience.eu/geoharmonizer-project/

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