IIASA International Institute for Applied Systems Analysis www.iiasa.ac.at

Lessons learned from building a training data set for land cover mapping at 10m

esa

WorldCover

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vito remote sensing

WAGENINGEN UNIVERSITY & RESEARCH

living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

Background

- High quality training data is a critical input for land cover/ land use mapping
- New requirements:
  - Very high resolution mapping
  - More thematic details
  - Change detections
- Different sources of training data available:
  - on-ground observations and
  - visually interpreted very high resolution images.
  - existing land cover/land use maps
  - automatic generation

Copernicus Global Land Service
Providing bio-geophysical products of global land surface
Copernicus
Europe's eyes on Earth

RELEASE OF THE 10 M WORLDCOVER MAP

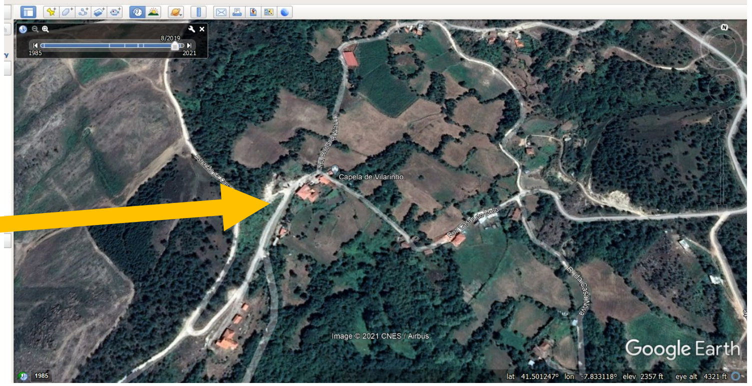
Esri Land Cover
Sentinel-2 10-Meter Land Use/Land Cover

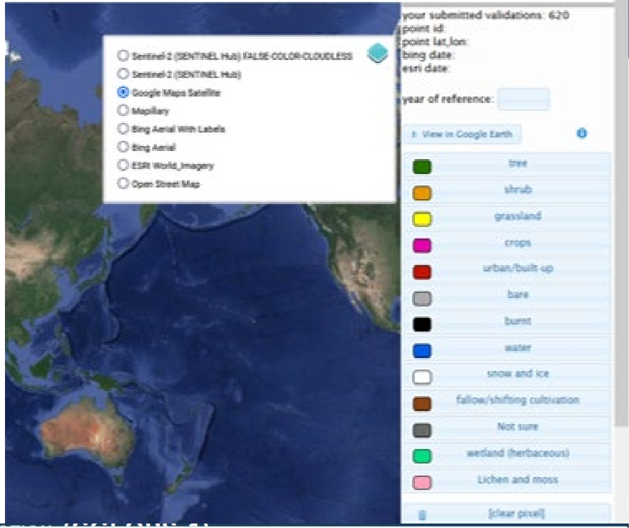
Challenges

- Unknown quality
  - Geolocation errors
  - Thematic errors
  - Timestamp
  - Not clear definitions
- Spatial distribution of data – overfitting issue
- Translation from one legend to another
- Translation of point observations into pixels
- Lack of data
- Access to data

Geo-Wiki tool box

- Very high resolution (VHR) imagery from Google maps, Microsoft Bing, and ESRI
- Google Earth VHR historical images
- Planet time series of images
- Sentinel-2 time-series in False color
- Street level images from Google and Mappilary
- NDVI time series derived from Landsat, Proba-V and MODIS data


1985
8/2019
2021
Capela de Vilarinho
Image © 2021 CNES / Airbus
Google Earth
lat 41.501247° lon -7.833118° elev 2357 ft eye alt 4321 ft


○ Sentinel-2 (SENTINEL Hub) FALSE-COLOR-CLOUDLESS
○ Sentinel-2 (SENTINEL Hub)
● Google Maps Satellite
○ Mapillary
○ Bing Aerial With Labels
○ Bing Aerial
○ ESRI World_Imagery
○ Open Street Map

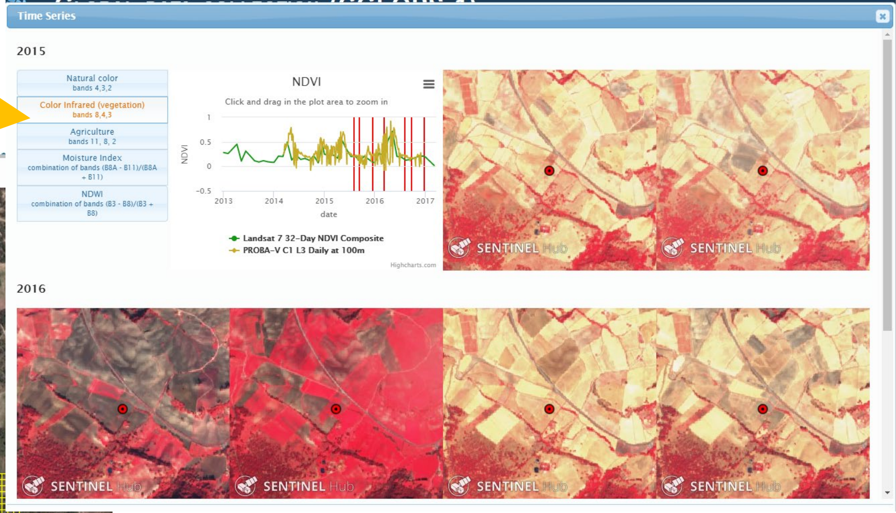
your submitted validations: 620
point id:
point lat_lon:
bing date:
esri date:

year of reference:

View in Google Earth

🟩	tree
🟧	shrub
🟨	grassland
🟪	crops
🟥	urban/built-up
⬜	bare
⬛	burnt
🟦	water
⬜	snow and ice
🟫	fallow/shifting cultivation
⬛	Not sure
🟩	wetland (herbaceous)
🟪	Lichen and moss

[clear pixel]


Time Series

2015

Natural color
bands 4,3,2

Color Infrared (vegetation)
bands 8,4,3

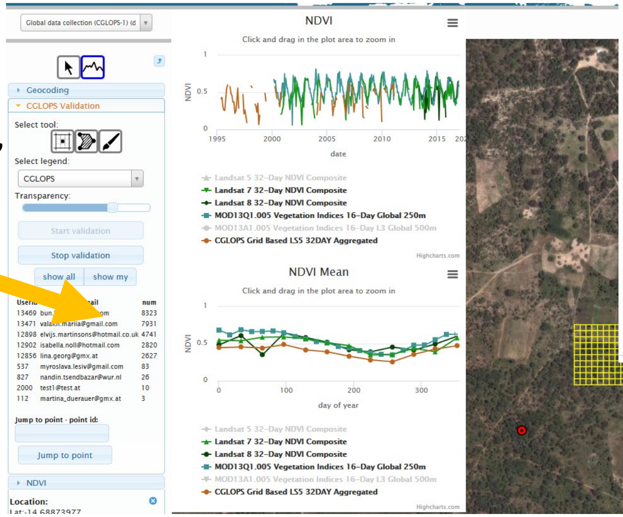
Agriculture
bands 11, 8, 2

Moisture Index
combination of bands (B8A - B11)/(B8A + B11)

NDWI
combination of bands (B3 - B8)/(B3 + B8)

NDVI
Click and drag in the plot area to zoom in
NDVI
1
0.5
0
-0.5
2013
2014
2015
2016
2017
date
Landsat 7 32-Day NDVI Composite
PROBA-V C1 L3 Daily at 100m
Highcharts.com
SENTINEL Hub

2016


Global data collection (CGLOPS-1) (d

Geocoding

CGLOPS Validation

Select tool:

Select legend: CGLOPS

Transparency:

Start validation

Stop validation

show all | show my

Useri	ail	num
13469	bun.[illegible]om	8323
13471	vala[illegible].mariia@gmail.com	7931
12898	elvijs.martinsons@hotmail.co.uk	4741
12902	isabella.noll@hotmail.com	2820
12856	lina.georg@gmx.at	2627
537	myroslava.lesiv@gmail.com	83
827	nandin.tsendbazar@wur.nl	26
2000	test1@test.at	10
112	martina_duerauer@gmx.at	3

Jump to point - point id:

Jump to point

NDVI

Location:
Lat:-14.68873977

NDVI
Click and drag in the plot area to zoom in
NDVI
1
0.5
0
1995
2000
2005
2010
2015
202
date
Landsat 5 32-Day NDVI Composite
Landsat 7 32-Day NDVI Composite
Landsat 8 32-Day NDVI Composite
MOD13Q1.005 Vegetation Indices 16-Day Global 250m
MOD13A1.005 Vegetation Indices 16-Day L3 Global 500m
CGLOPS Grid Based LS5 32DAY Aggregated
Highcharts.com
NDVI Mean
Click and drag in the plot area to zoom in
NDVI
1
0.5
0
0
100
200
300
day of year
Landsat 5 32-Day NDVI Composite
Landsat 7 32-Day NDVI Composite
Landsat 8 32-Day NDVI Composite
MOD13Q1.005 Vegetation Indices 16-Day Global 250m
MOD13A1.005 Vegetation Indices 16-Day L3 Global 500m
CGLOPS Grid Based LS5 32DAY Aggregated
Highcharts.com

Funded by the Horizon 2020 Framework Programme of the European Union

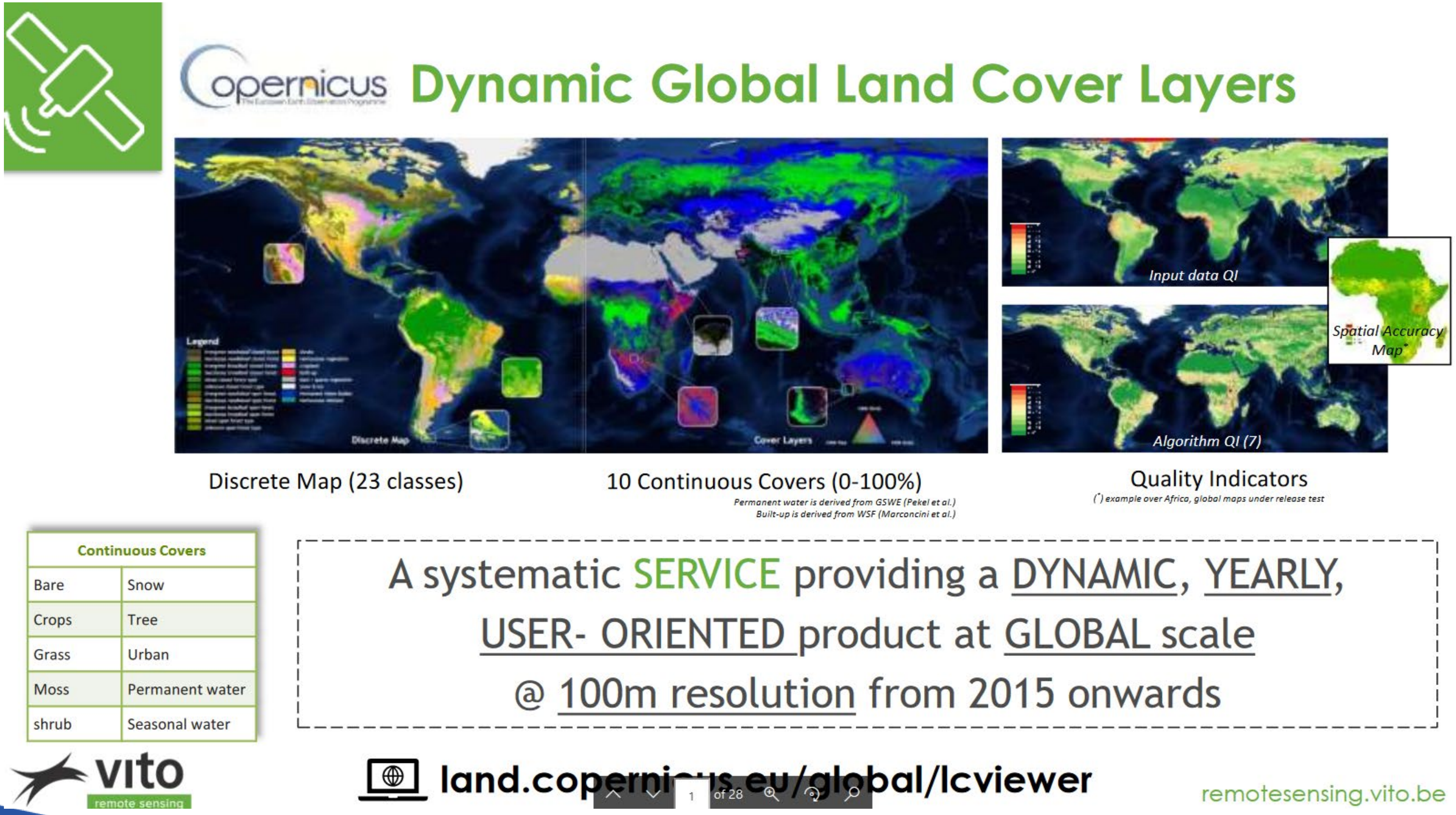
Concept of a multipurpose data set

Global Land Cover at 100m (JRC)

copernicus
Europe's eyes on Earth

World Cover at 10m (ESA)

Copernicus Global Land Cover 2015-2019 PROBA-V 100m



Copernicus Dynamic Global Land Cover Layers

Discrete Map (23 classes)

10 Continuous Covers (0-100%)

Permanent water is derived from GSWE (Pekel et al.)
Built-up is derived from WSF (Marconcini et al.)

Quality Indicators

(*) example over Africa, global maps under release test

Continuous Covers	
Bare	Snow
Crops	Tree
Grass	Urban
Moss	Permanent water
shrub	Seasonal water

A systematic SERVICE providing a DYNAMIC, YEARLY,
USER- ORIENTED product at GLOBAL scale
@ 100m resolution from 2015 onwards

vito remote sensing

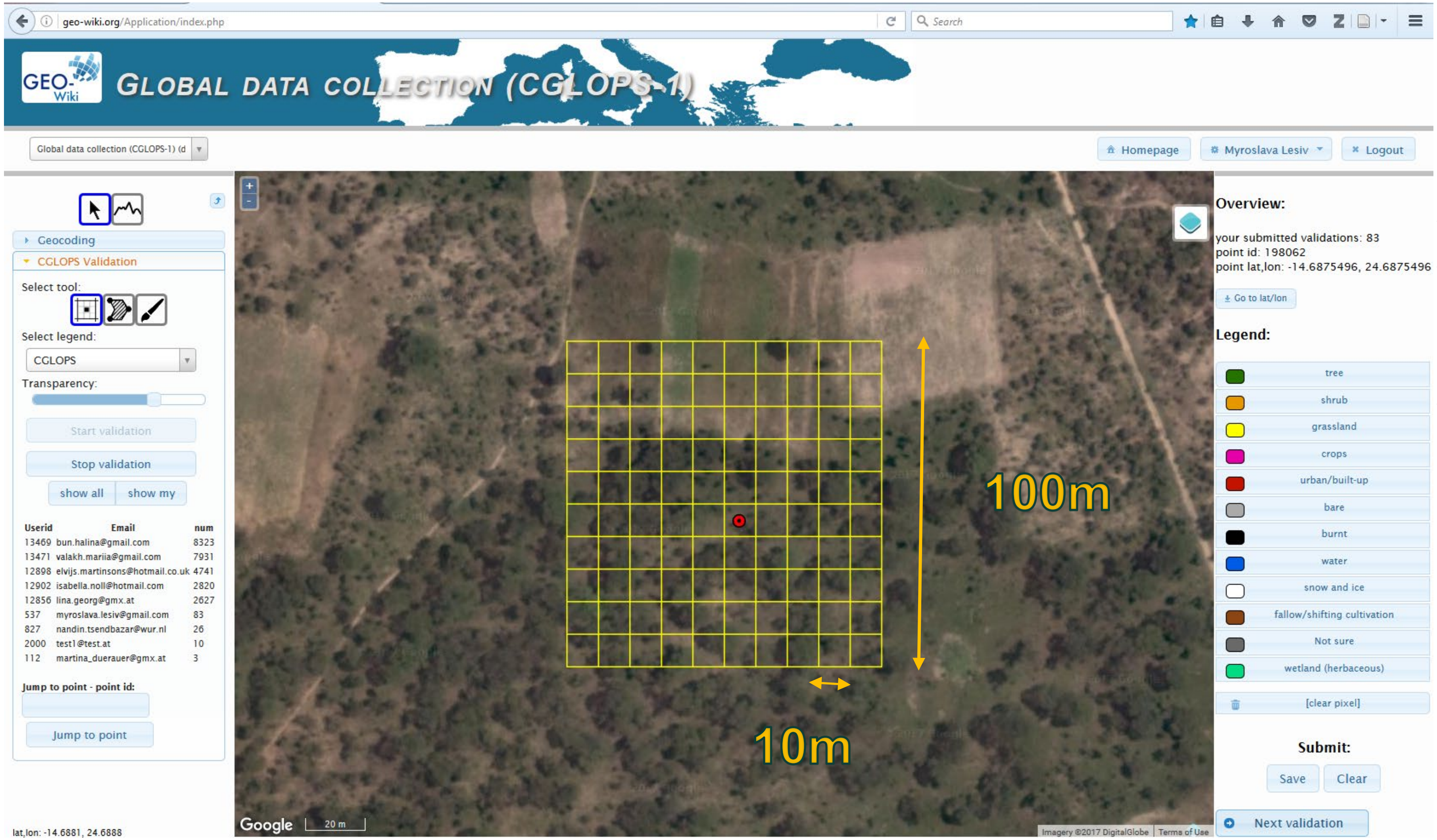
land.copernicus.eu/global/lcviewer

remotesensing.vito.be

25th May. 2022

Lesiv et al., 2022 LPS

Geo-wiki app



Userid	Email	num
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13471	valakh.mariia@gmail.com	7931
12898	elvijs.martinsons@hotmail.co.uk	4741
12902	isabella.noll@hotmail.com	2820
12856	lina.georg@gmx.at	2627
537	myroslava.lesiv@gmail.com	83
827	nandin.tsendbazar@wur.nl	26
2000	test1@test.at	10
112	martina_duerauer@gmx.at	3

lat,lon: -14.6881, 24.6888

Overview:

your submitted validations: 83
point id: 198062
point lat,lon: -14.6875496, 24.6875496

Legend:

- 🟩 tree
- 🟧 shrub
- 🟨 grassland
- 🟪 crops
- 🟥 urban/built-up
- ⬜ bare
- ⬛ burnt
- 🟦 water
- ⬜ snow and ice
- 🟫 fallow/shifting cultivation
- ⬛ Not sure
- 🟩 wetland (herbaceous)

- Fractions at 100m
- Easy translation to discrete land cover classes
- Training data at 10m

Data collection workflow

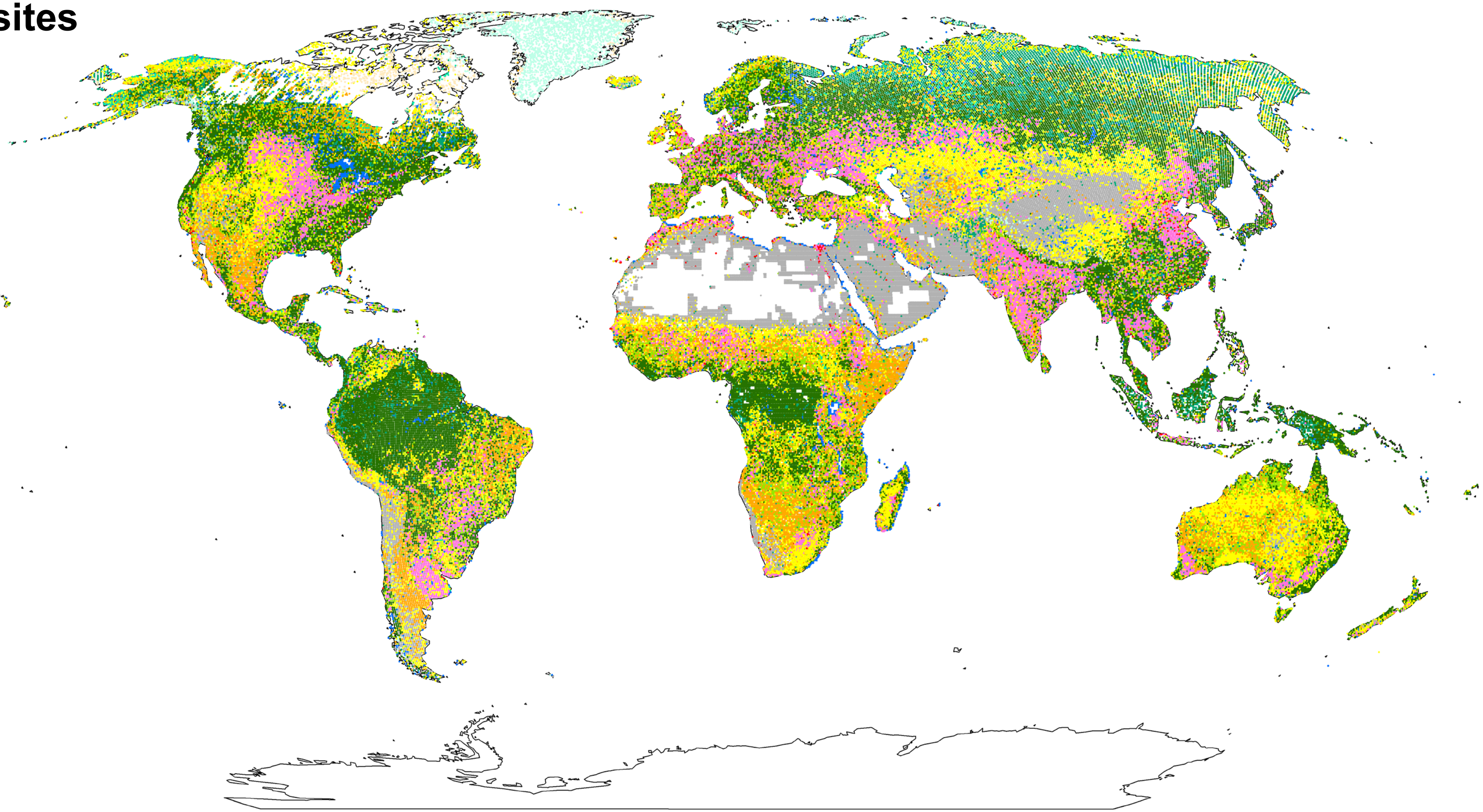
- Initial Geo-wiki training
  - Interface, tools, per class examples
- Weekly online seminars to check quality
  - discuss difficult locations
  - randomly revisit some classifications
    - Target <5 % of mistakes
- Comparison with regional products
  - Revise disagreeing locations
- Removing land cover class outliers based on spectral information
  - homogeneous pixels

Distribution of reference data 2015

~180 000 sample sites
by 20 experts

Sampling design:

- systematic
- uncertainty hotspots



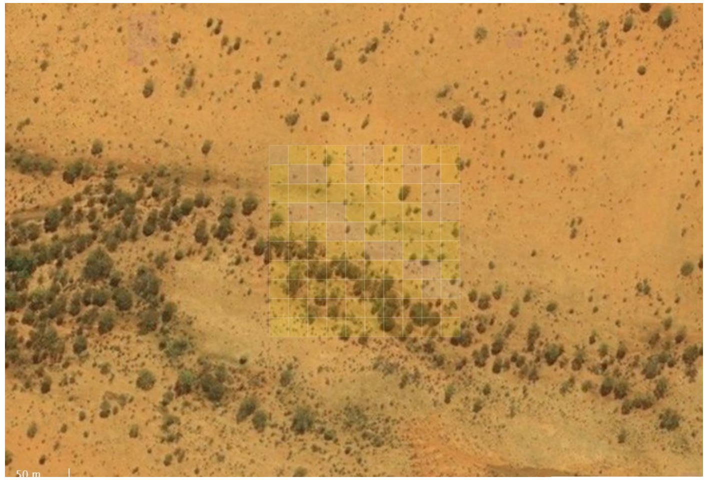
ESA World Cover 2020/2021 at 10m Sentinel 1 and Sentinel 2

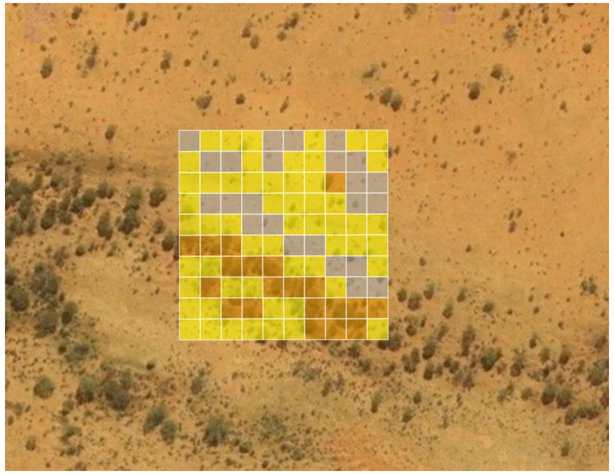
180 K (at 100m) pixels ~ 18 Millions (at 10m)

Issues:

- geolocation errors of the underlying images used for visual interpretations
- land cover/land use changes that happened after 2015
- Correct fractions at 100m ~misclassifications at 10m

Landscape in Australia





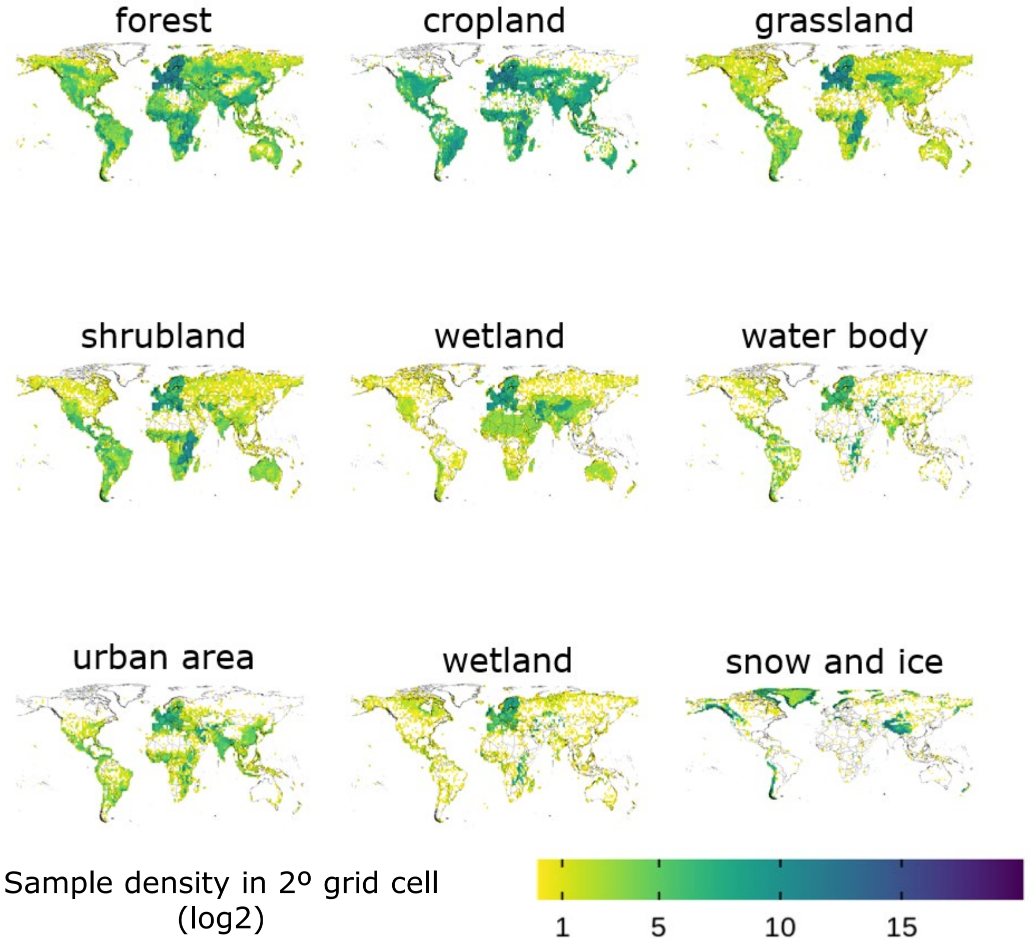
Training data optimization

- Geolocation errors of labels?
    - subset only those pixels that are surrounded by pixels with the same label
- Land cover changes ? –
    - subset sample sites of potential changes by running BFAST model and revising these sites
    - Set of rules based on spectral information
- Misclassifications at 10m resolution?
    - Set of rules based on spectral information

Lessons learned

- Having subpixel information about land cover is important for better defining classes at pixel level
- Homogeneous areas - it would be more convenient to label patches/segments rather than pixels
- There are always uncertainties associated with human labeling therefore additional data filtering is needed
  - E.g. taking into account spectral information
- The presented data will be made of open access

Collection of existing reference data sets


forest

cropland

grassland

shrubland

wetland

water body

urban area

wetland

snow and ice

~ 7 million samples

years: 1951-2020

spatial units: 10-5000 m

Sources:
LUCAS – Land use and land cover survey
GLIMS
Ramsar
GHS Urban Center Database
Global Croplands
JECAM
PRdataGO
…

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Macroecology and Society
A research group of iDiv

Thank you!

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