

Unbiased statistics from Earth Observation : Dos, don'ts and challenges

DGINS 2021

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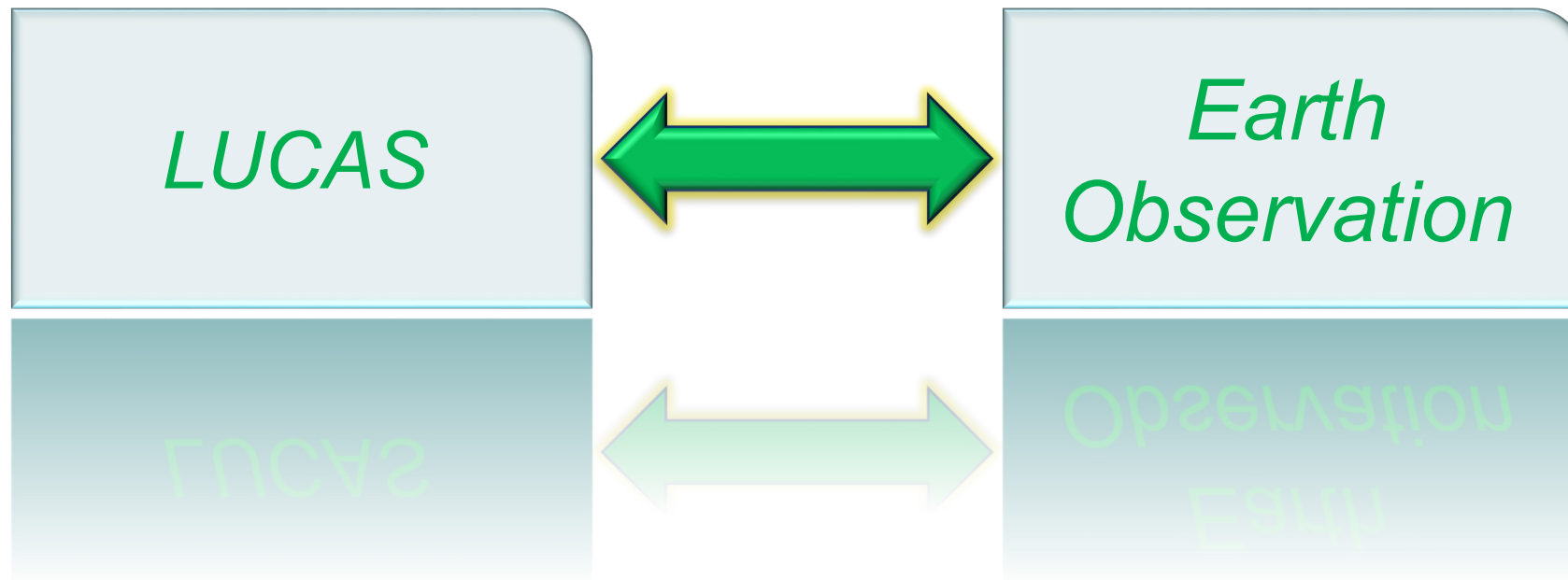
Content

- LUCAS (Land Use and land Cover Area Survey) and Earth Observation
- Results of the Eurostat study EO4Statistics

Part I – LUCAS and Earth Observation

LUCAS and Earth Observation

A Mutual Beneficial Relation



LUCAS and Earth Observation

How LUCAS uses EO

- LUCAS survey and sample design
- Orthophotos (ground documents)
- Office Photointerpretation
- Post processing (QC)
- LUCAS Landscape Feature Module

How LUCAS contributes to EO

- LC/LU Reference database - Validation of EO statistics
- LUCAS Copernicus Module

LUCAS Viewer

Interactive photo viewer within Eurostat's statistical atlas
<http://ec.europa.eu/eurostat/web/lucas/lucas-photo-viewer>

The LUCAS
country, 1



> LUCAS (land use/cover) 2015

> Background maps

▼ LUCAS - land use/cover survey 2015

1 LUCAS Land Cover 2015

LUCAS Land Use 2015

> Typologies, regions and cities

▼ Legend Layer

LUCAS Land Cover 2015

Land Cover - above 5M

- Artificial Land
- Cropland
- Woodland
- Shrubland
- Grassland
- Bare Land
- Water Areas
- Wetlands

Point ID: 40462980



Photos taken from a distance of 16 m

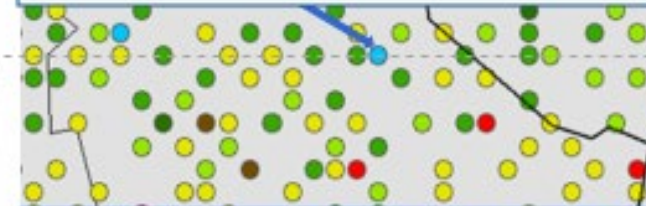
First land cover: G26 - Inland running water

First land use: U313 - Water transport

Survey date: 26/04/2012

NUTS region: LU00

Area size (ha): area >= 10 ha

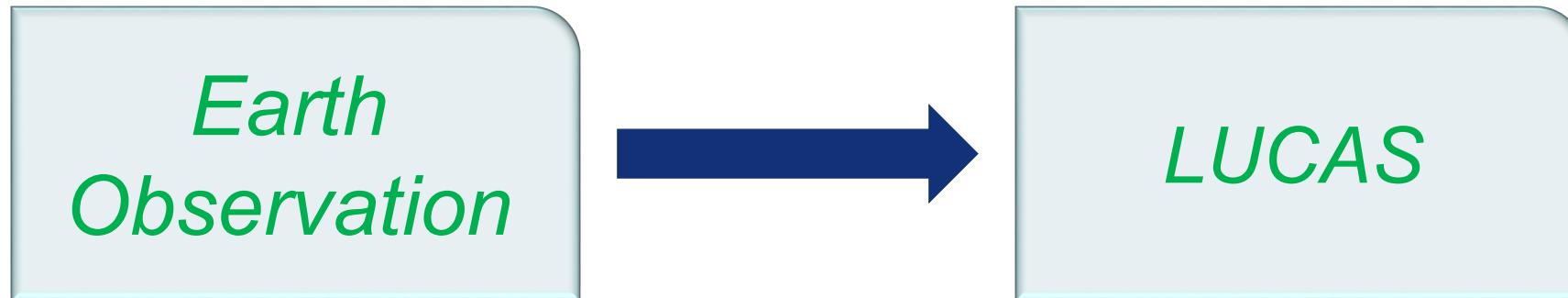


LUCAS viewer

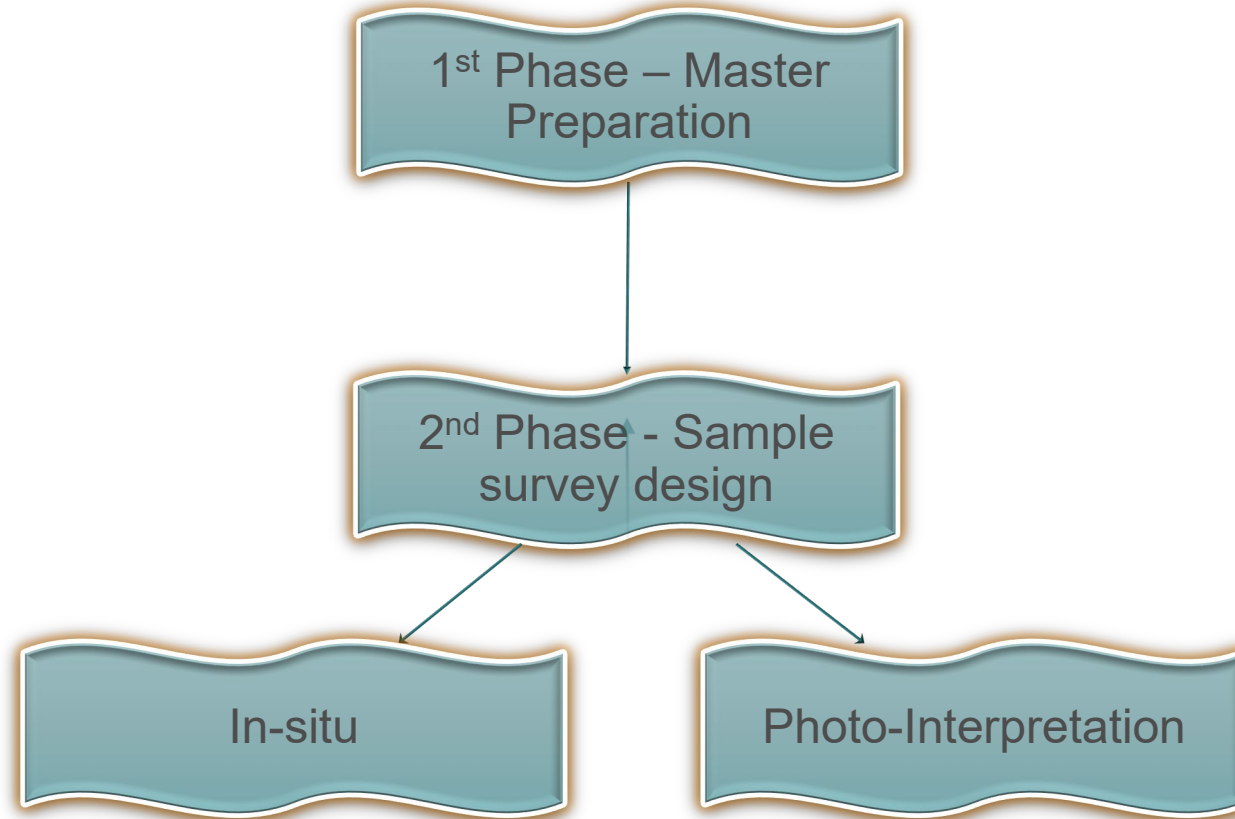


land

Earth Observation for LUCAS




LUCAS Survey Design



LUCAS Data Collection



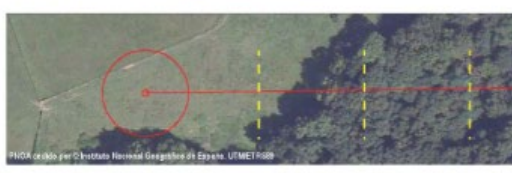
- Ground Documents based on Orthophotos for:
 - Field visit
 - Photointerpretation in the field
 - PI the office
 - Quality Control

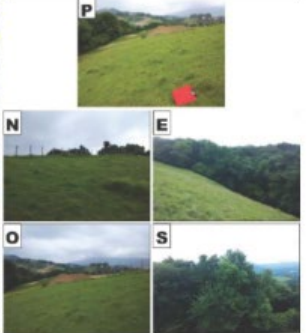
eurostat  Encuesta sobre Cubiertas y Usos del Suelo Mediante Marco de Áreas
LUCAS 2018 - ESPAÑA 336 823 22

Provincia: Guipúzcoa Región Biogeográfica: Atlántico
Coordenadas WGS84: Lat (°): 43,331695 Long (°): -1,773875 Altitud: 67 (m)

A. Técnico: **M1**
7. Fecha:
8. Hora inicio: 9. Hora fin:
Ubicación GPS del coche:
11. Lat (°):
12/13. Long (°):
14. GPS: WGS84 ☐ Prob c/ señal ☐
Ubicación GPS del punto:
17. Lat (°):
18/19. Long (°):
15. Altitud: (m) (16) Precisión (m)
20. Distancia GPS: (m)
21. Distancia calculada: (m)
☐ Punto extensión PI ☐ Punto Ex-ante PI
☐ Suelo ☐ Densidad ☐ Bio ☐ H Org.
☒ Copernicus ☐ Pastizal ☐ Erosion
(500) Acceso al punto:

Punto Panel (Datos de la campaña anterior)
Fecha: 09/06/2015
Distancia al punto (m): 1
Lat(°): 43,3317 Long (°): -1,773837
Tipo de observación: En campo punto visible <100m
Dirección de observación: En el punto
Cubierta del suelo (LC1-2): E20-8
Uso del suelo (LU1-2): U111-8

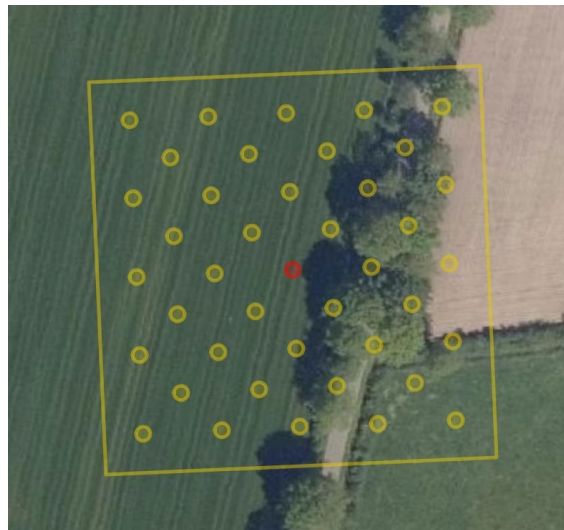
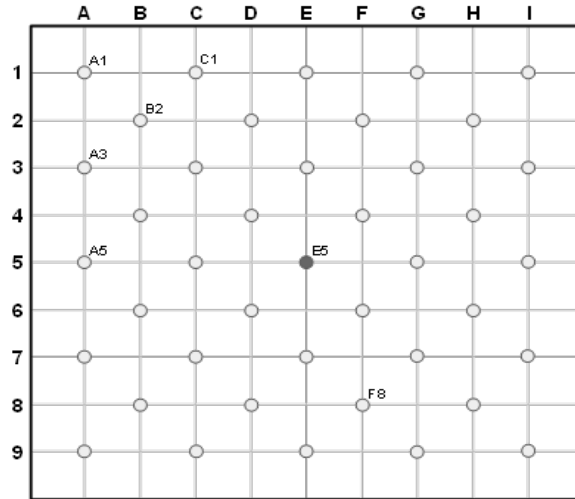






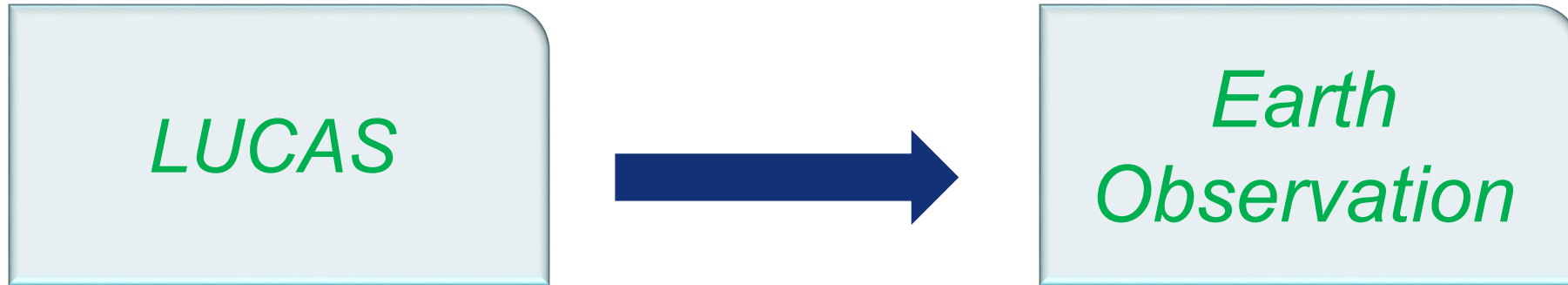
Landscape Features Module

Small fragments of natural or semi-natural vegetation in agricultural landscape

- 100x100m (1 ha)
- grid of 41 sub-points centered on a LUCAS point.
- presence of landscape features into two – stages.
 - PI using orthophotos.
 - in-situ visit to ratify



LUCAS for EO

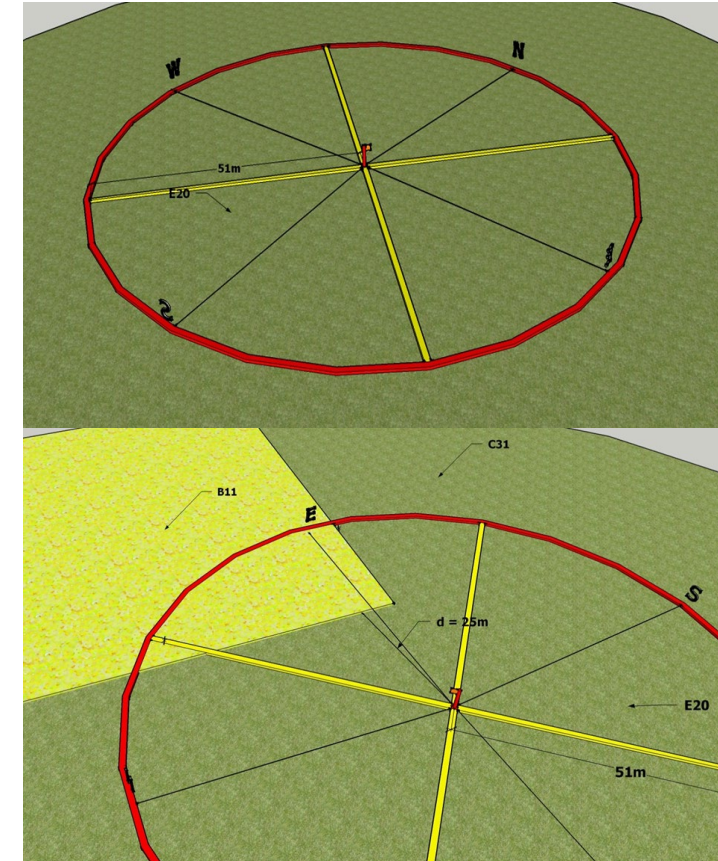


Reference Data

- EO information is based on images and maps
- Requires validation from reliable sources
- LUCAS: EU harmonized ground truth

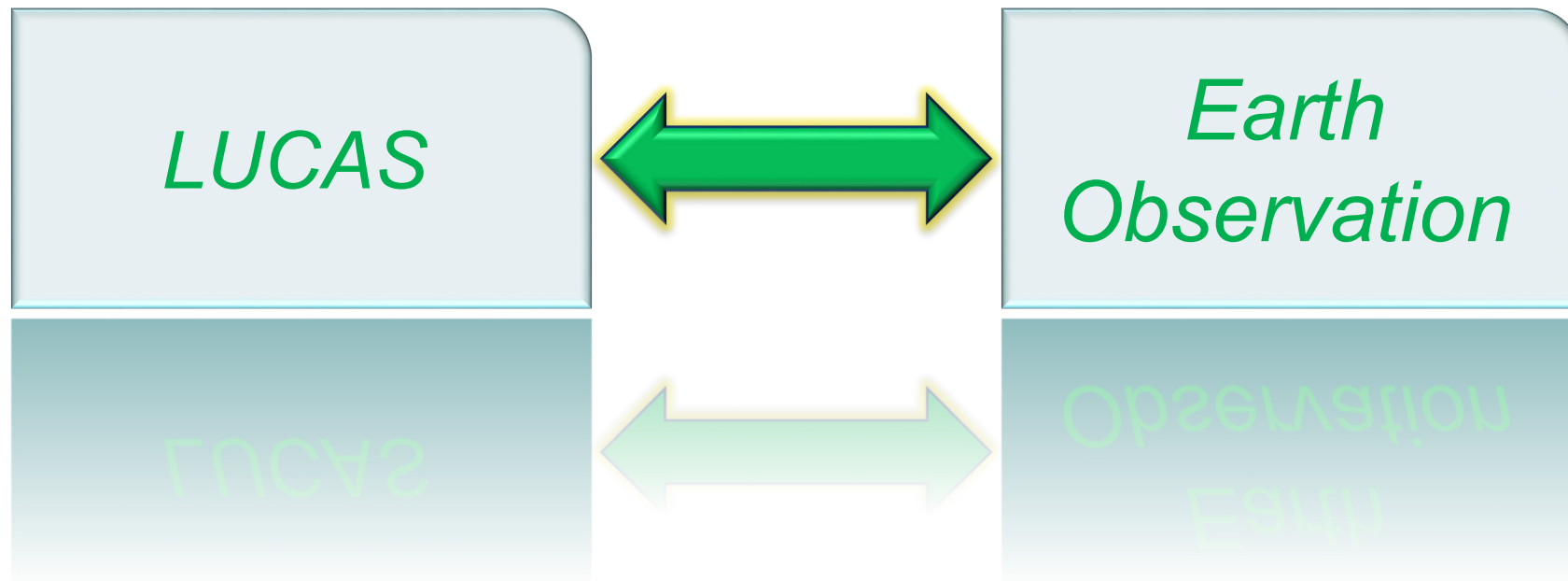
LUCAS 4 Copernicus Module

- From 2018 tailored
- Information on LC from the point is extended into the 4 cardinal directions.
- This allows recreating polygons with homogenous LC.
- 75% of total LUCAS 2022 field points (150.000 points)
- Mainly for validation of Copernicus products.



LUCAS and Earth Observation


A Complementary Relation between Friends

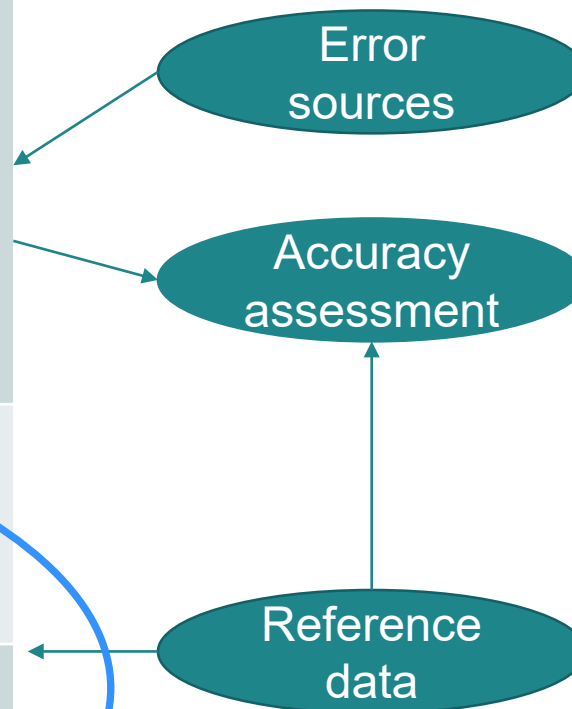


Part II

Results of the Eurostat study EO4Statistics

Trusted statistics from Earth observation

		Biased area estimation	Unbiased area estimation
1	Classified EO products	<ul style="list-style-type: none"> Sensing and cartographic as "simplification" implies inevitable technical errors. => with impacts on micro-level Those error ranges cannot be predicted but can be assessed with adequate reference data.  <p>⇒ Examples for mixed signatures</p> <p>Varying classification of shadows, ...</p>	
2	Area estimates	Pixel counting	Different estimators (regression, stratified, calibration...)
3	Reliability	Not possible	Based on estimator used



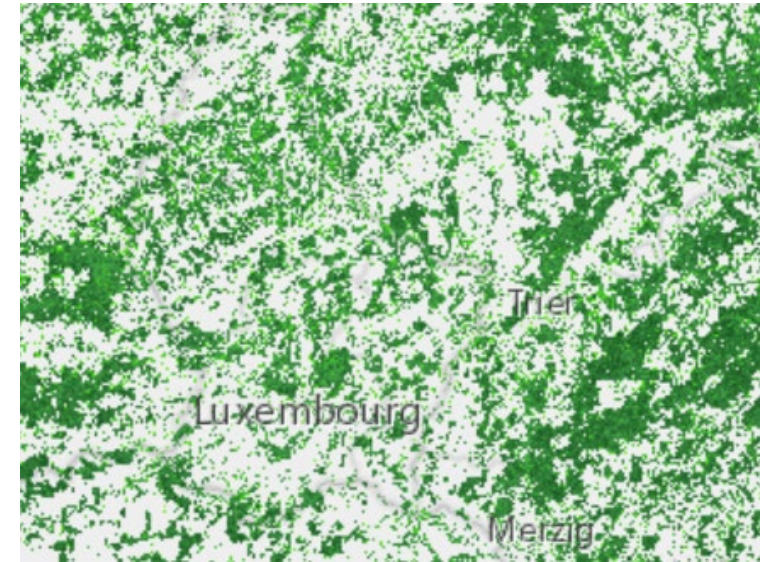
EO4Statistics study

EFTAS Gmbh, Muenster (D)

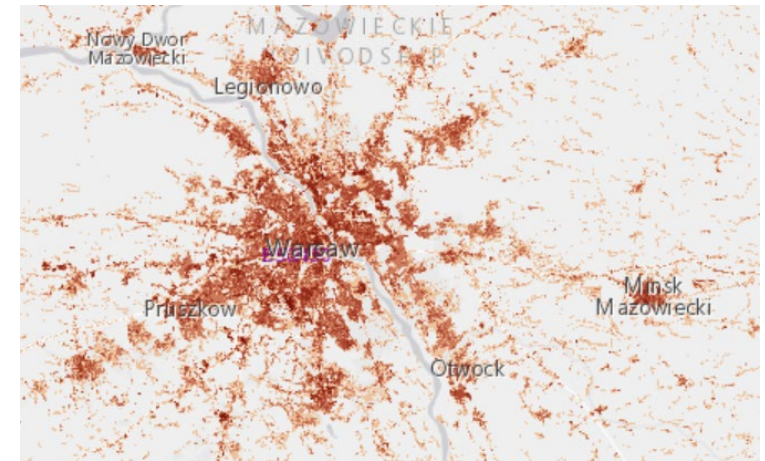
- Copernicus HRL Forest & Change (2015, 2018)
- Copernicus HRL Imperviousness & Change (2015, 2018)
- Reference Area: selected countries & NUTS 2

Questions:

- Do unbiased statistics confirm results from pixel counting?
- How reliable are the statistics?

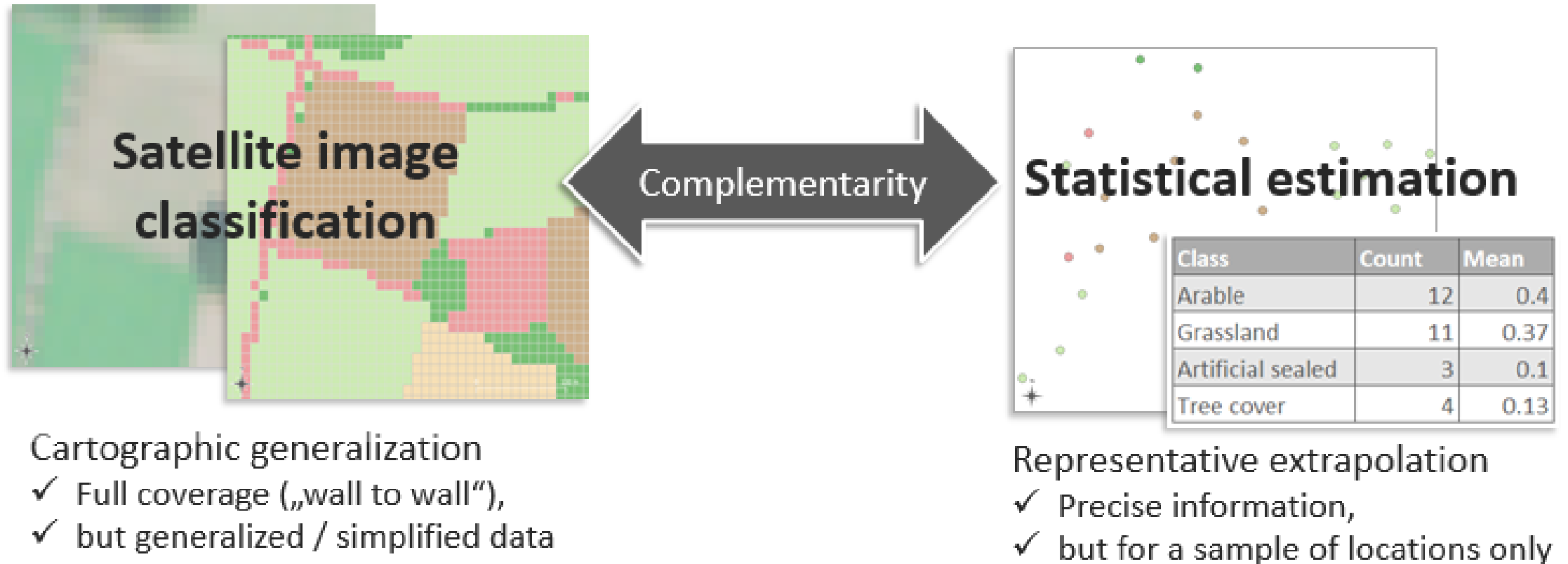


Copernicus HRL Tree Cover Density 2018



Copernicus HRL Imperviousness 2015

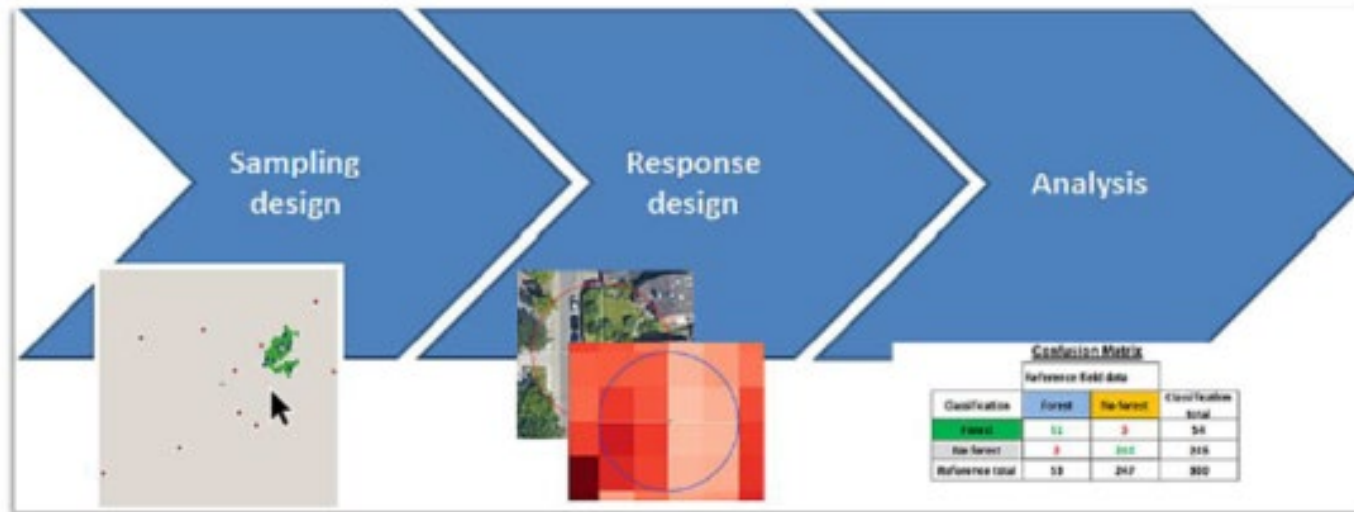
Complementarity: EO & reference data



Approach for unbiased estimation

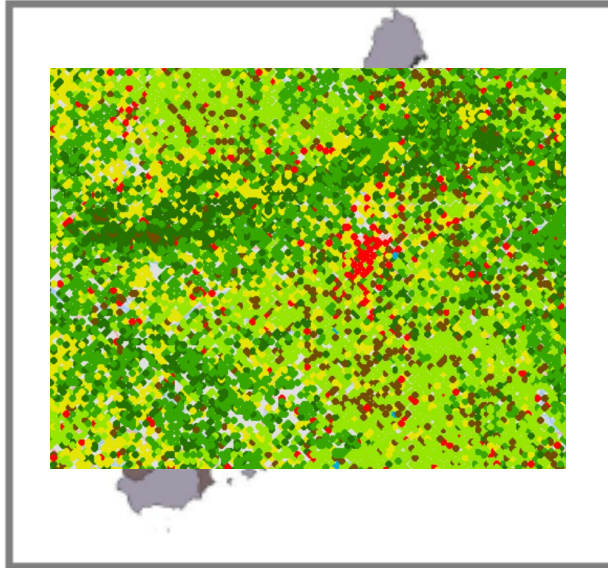
Sample based estimation of area

- Sample design: adequate **probabilistic sample**
- Response design: matching EO data and **reference data** (spatial, temporal, thematic)
- Analysis: suitable **estimator** for area and uncertainty



Reference data

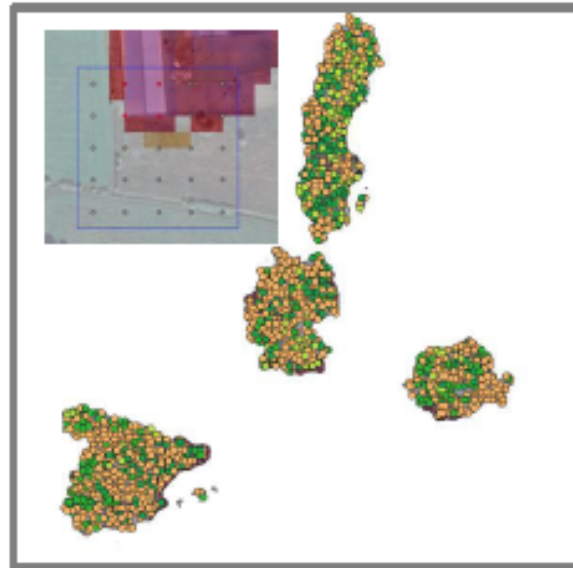
LUCAS 2015 /2018



Point sample 3m

Assessment for:
FTY - Country & NUTS2 level
IMD - Country & NUTS2 level

EEA validation data 2015/2018



100x100m pixel sample

Assessment for:
FTY - Country
IMD - Country

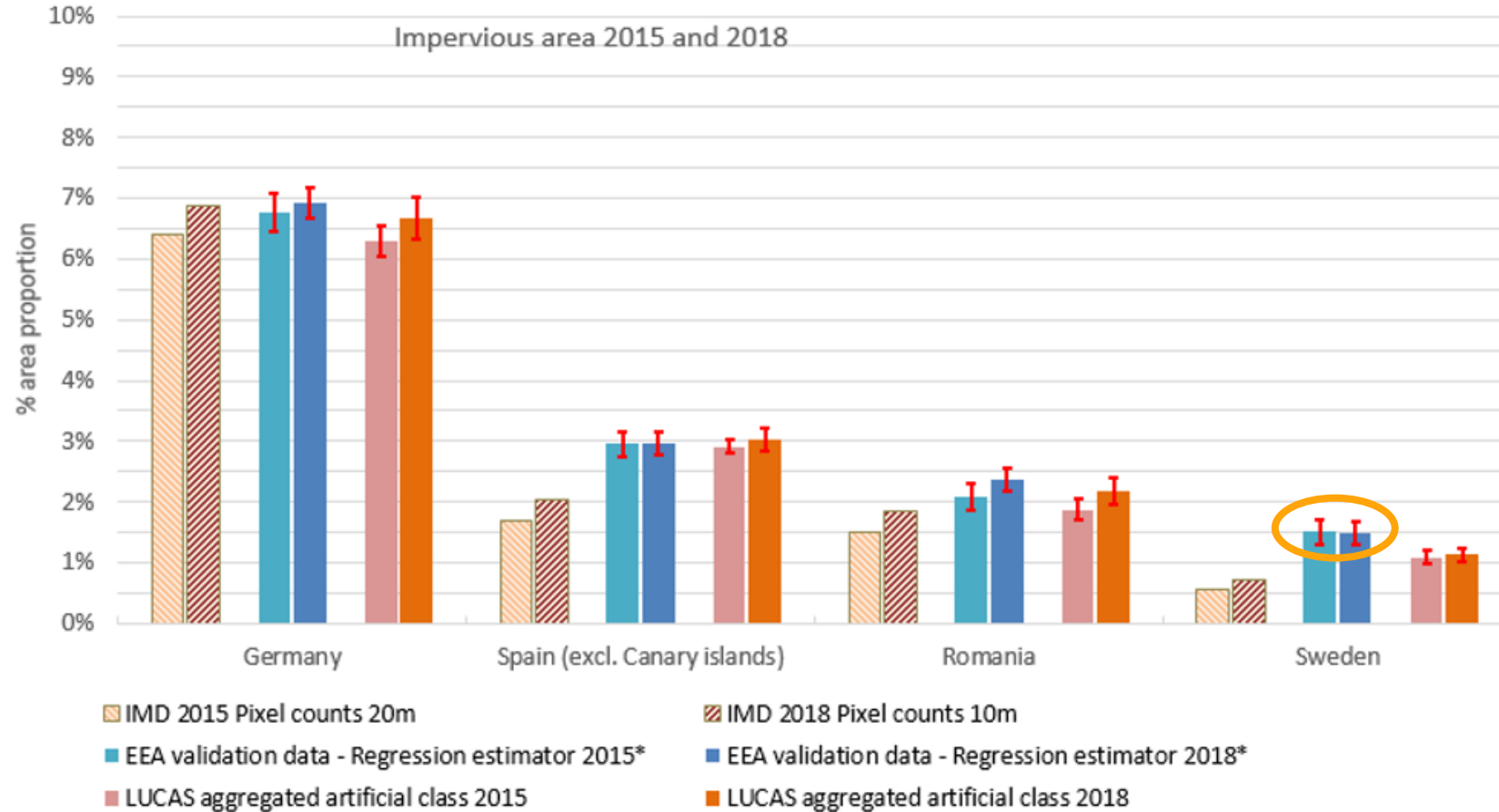
EO-4-statistics data



Pixel 10m / 20m sample

Assessment for:
FTY – selected NUTS2
IMD – selected NUTS2
TCCM – Country & NUTS2
IMCC – NUTS2

Imperviousness: Pixel counting vs unbiased statistics



*Estimates include Canary islands
Error indication shows the 95% confidence interval

Do unbiased statistics confirm results from pixel counting?

How reliable are the statistics?

Main findings

- Complementarity of LUCAS & EO
- Trusted statistics from EO: assessment of reliability
- Standardised protocols, tools, training
- Infrastructure: Reference data
 - Planning adequate of reference data
 - LUCAS & Copernicus

Thank you



[Overview - Land cover/use statistics - Eurostat \(europa.eu\)](https://ec.europa.eu/eurostat/web/lucas/overview)
<https://ec.europa.eu/eurostat/web/lucas/overview>



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