

# StatEO

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## From Sentinel to national Land Cover mapping to Ecosystem Accounting: *A roadmap for integrating Earth Observation data into official statistics for Environmental-Economic Accounting in Austria*

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Statistics Austria

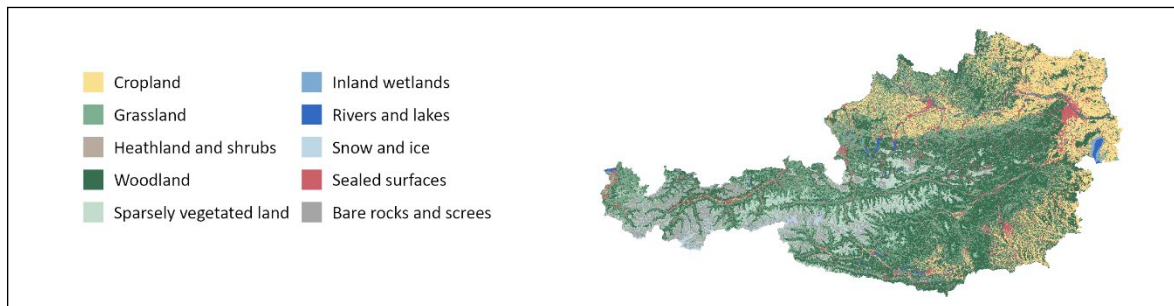
# STATeo: Earth Observation for Land Cover Statistics in Austria



# STATEo Landcover: Background

- Providing **analysis-ready Sentinel data**: Acquisition and preparation of required large-scale EO data
- Producing nation-wide **spatially explicit land cover data** using Sentinel data, topographic data, (various in-situ data) and Machine Learning algorithms
- Land cover data **time-series from 2019 onwards** (2019-2023 Eurostat Grant, 2024ff. follow-up)
- **Integration into statistical products** and applications – incl. Ecosystem Accounting
- Follow-up: Focusing on **methodological improvements**

Quality improvement and assurance | Workflow automation | Metadata



Co-funded by the  
European Union



STATEo V1 (2019) results from the Grant project 2020-AT-GEOS

# STATEo Landcover: Methodology

## Nomenclature:

- Focusing on Land Cover (not Land Use) -> feasible using 10x10m EO data
- Harmonization with EU ecosystem typology (Level 1), CLMS CLC+/HR Layers - (EAGLE)

## Accuracy:

- Grant projects: 80-90% (biased), Revision in progress...
- Defined metrics: Error Matrix; Overall Accuracy; User's & Producers Accuracy per class; Standard errors & variance (total and per class); Confidence Interval (95%-CI for OA, UA, PA per class)

## Labeling:

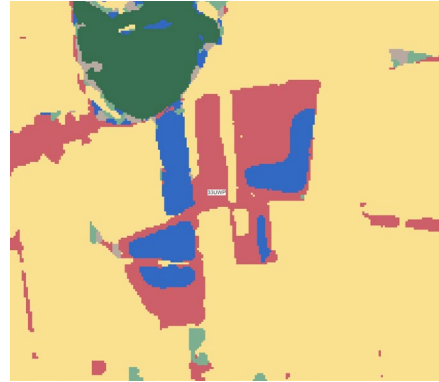
### Grant projects:

- Using in-situ data from (1) Digital Cadastral Map and (2) Land Parcel Identification Data
- Up to 800K sampling points (trained on 2019-2022 ref. years)

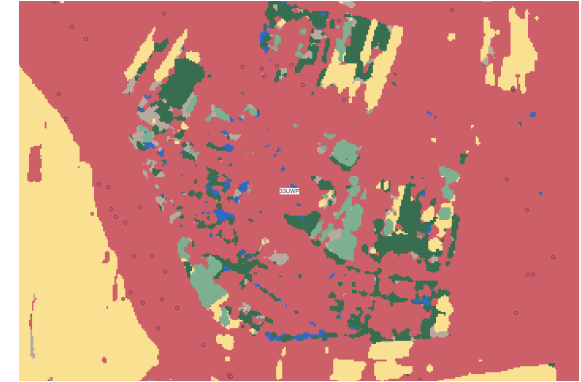
### Revision: Manual labeling

- ~ 1000 labels/class depending on LC share of classes to generalize model
- Stratification across AT on 25x25km raster

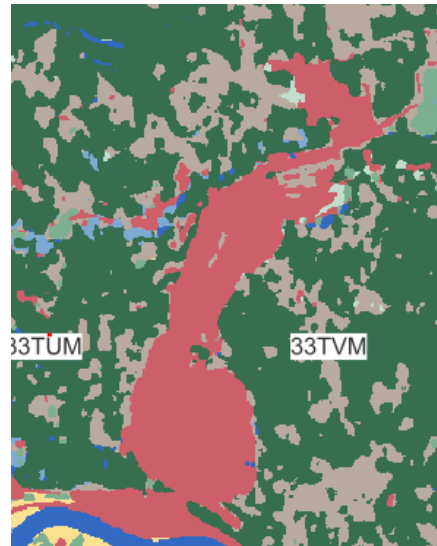
# STATEo Landcover: In-situ/Training data investigation



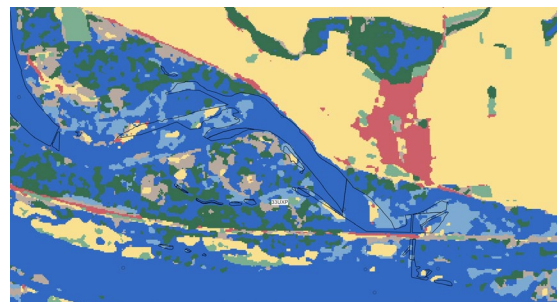
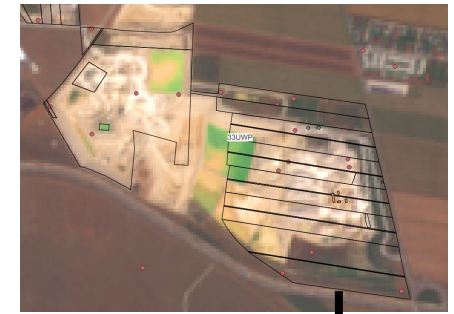
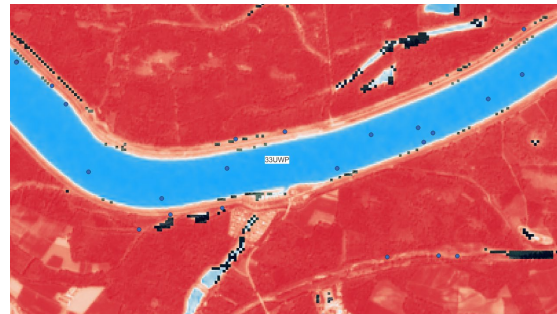
Mining areas  $\neq$  sealed surfaces



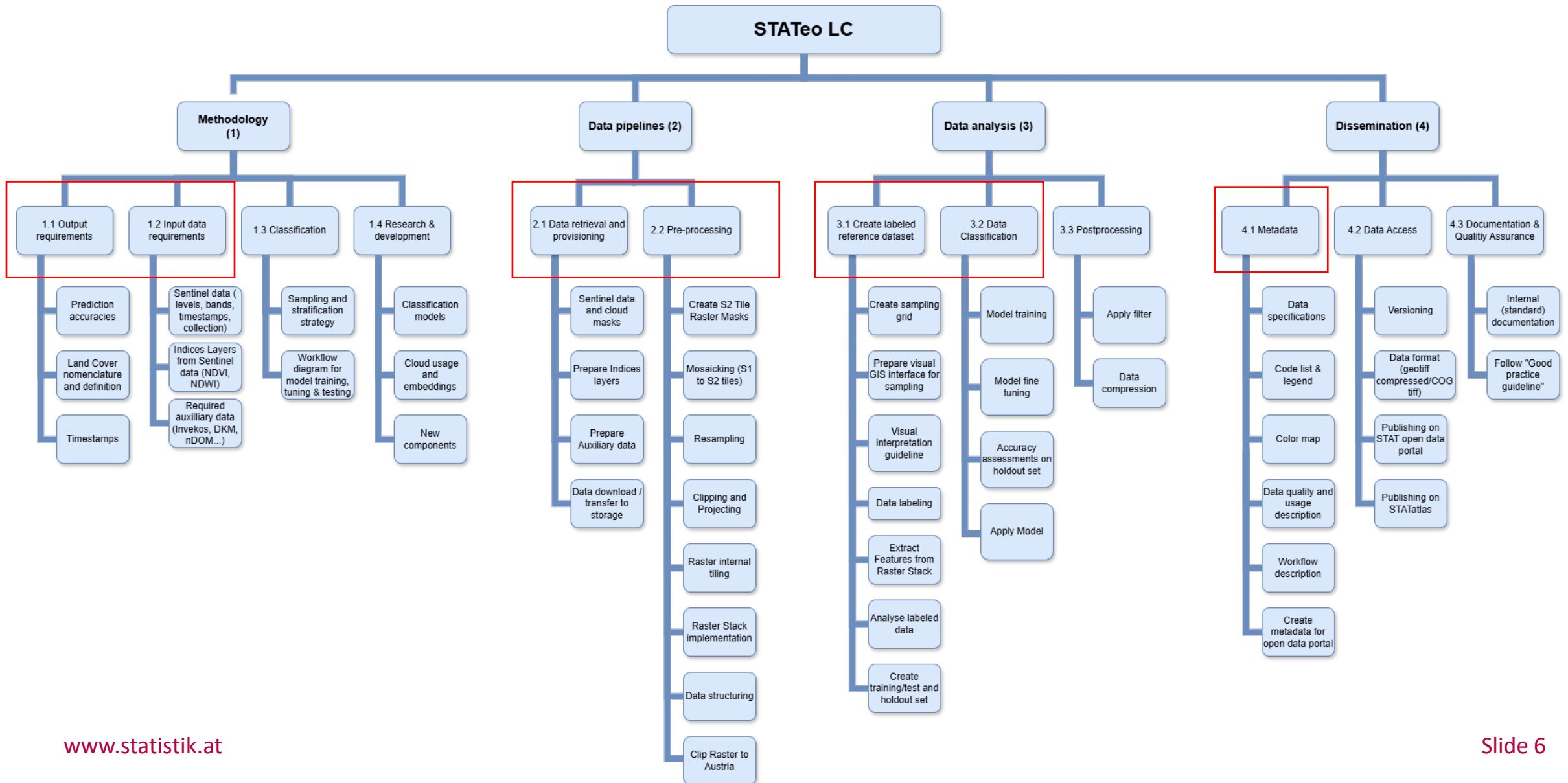
Land use  $\neq$  Land cover



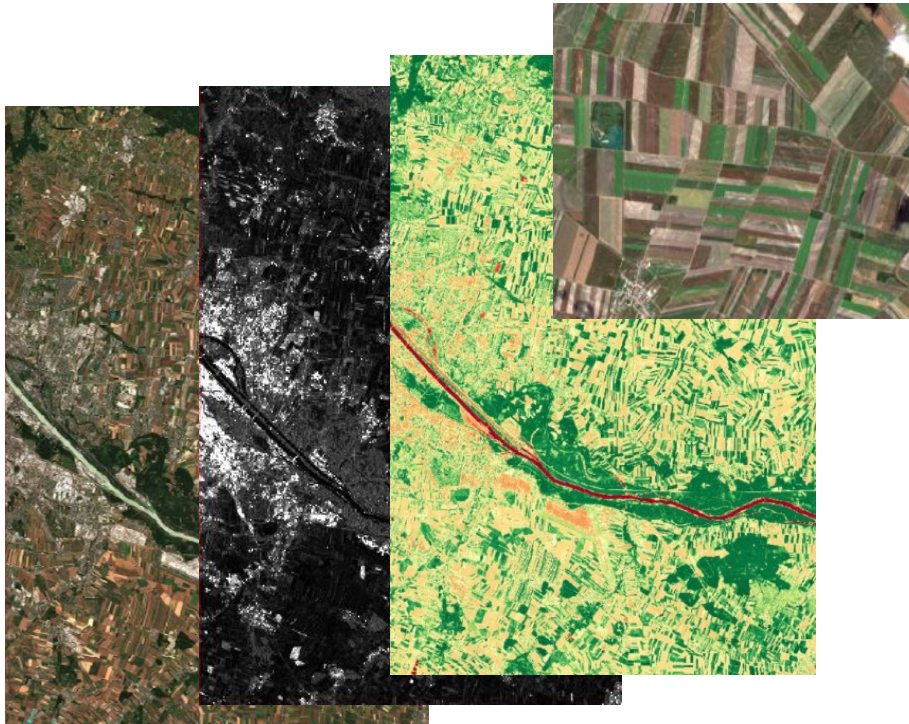
Label misplacements due to Cadaster polygon boundaries




# STATEo Landcover Revision: Project-view



# STATeo Landcover: Data



Data	Attributes	Time stamps
<b>ESA Sentinel-1</b>	Sentinel-1 GRD monthly mosaic (CDSE)	2024-03 until 2024-10
<b>ESA Sentinel-2</b>	L2A Bi-monthly composite (all bands except B01 and B10) Incl. cloud mask	2024-03 until 2024-10
<b>ESA Sentinel-2</b>	Bi-monthly composites: <ul style="list-style-type: none"> <li>• NDVI (Normalized Difference Vegetation Index)</li> <li>• NDWI (Normalized Difference Water Index)</li> <li>• BASI (Bare Soil Index)</li> </ul>	2024-03 until 2024-10
<b>Digital Elevation Model (Mapping Agency / TU Vienna / EODC)</b>	10 m spatial resolution (Derived via ALS (Airborne Laser Scanning)) <ul style="list-style-type: none"> <li>• DTM</li> <li>• Slope</li> <li>• nDSM (normalized DSM)</li> </ul>	2015 – 2024 (updated by federal states irregularly)
<b>Data for labeling:</b>		
<b>ESA Sentinel-2</b> <b>Digital Elevation Model</b> <b>Aerial Imagery</b>	<ul style="list-style-type: none"> <li>• S2 TCC</li> <li>• NDVI</li> <li>• NDWI</li> <li>• BSI</li> <li>• DTM</li> <li>• WMS DOPs (Digital Orthophotos)</li> </ul>	



# Towards Integration of EO Data and Official Statistics: Ecosystem Accounting

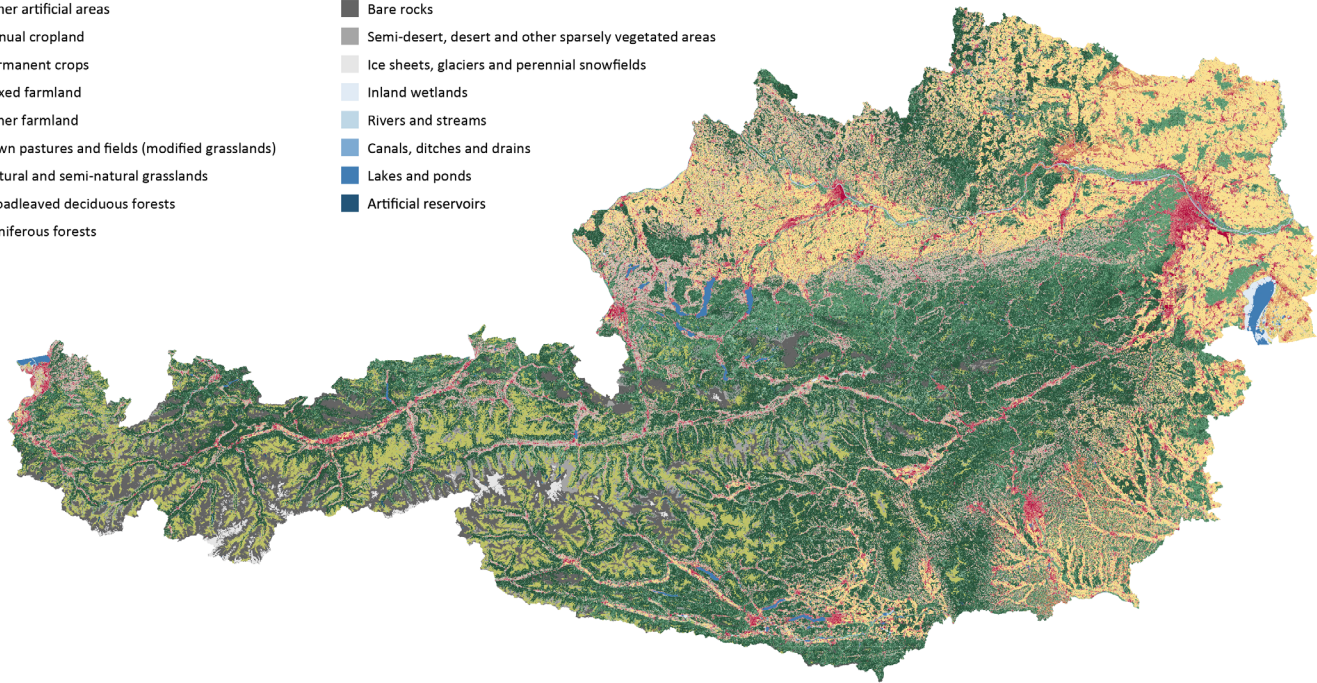
# AT Ecosystem Extent Map 2021

STATeo Landcover input data

## Ecosystem Extent Map 2021 Grid Units



- Continuous and discontinuous settlement area
- Infrastructure
- Urban greenspace
- Other artificial areas
- Annual cropland
- Permanent crops
- Mixed farmland
- Other farmland
- Sown pastures and fields (modified grasslands)
- Natural and semi-natural grasslands
- Broadleaved deciduous forests
- Coniferous forests
- Mixed forests
- Transitional forest and woodland shrub
- Scrub and heathland
- Bare rocks
- Semi-desert, desert and other sparsely vegetated areas
- Ice sheets, glaciers and perennial snowfields
- Inland wetlands
- Rivers and streams
- Canals, ditches and drains
- Lakes and ponds
- Artificial reservoirs



Statistics Austria: STATeo Land Cover, 2021. Agricultural Marketing Austria: IACS, 2021.  
Federal Forest Office: Tree species map, 2021. Environment Agency Austria: WISA, 2021.  
Federal Office of Metrology and Surveying: Digital cadastral map, 2021. Digital terrain model, 2015.

0 25 50 km

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Compiled on 9 September 2025.

EU ecosystem typology: level 1	EU ecosystem typology: level 2
1. Settlements and other artificial areas	1.1 Continuous settlement area 1.2 Discontinuous settlement area 1.3 Infrastructure and industrial areas 1.4 Urban greenspace 1.5 Other artificial areas
2. Cropland	2.1 Annual cropland 2.2 Rice fields 2.3 Permanent crops 2.4 Agro-forestry areas 2.5 Mixed farmland 2.6 Other farmland
3. Grassland	3.1 Sown pastures and other grass (modified grasslands) 3.2 Natural and semi-natural grasslands
4. Forest and woodland	4.1 Broadleaved deciduous forest 4.2 Coniferous forests 4.3 Broadleaved evergreen forests 4.4 Mixed forests 4.5 Transitional forest and woodland shrub 4.6 Plantations
5. Heathland and shrub	5.1 Tundra 5.2 Heathland and (sub-)alpine shrub 5.3 Sclerophyllous vegetation
6. Sparsely vegetated ecosystems	6.1 Bare rocks 6.2 (Semi-)desert and other sparsely vegetated areas 6.3 Ice sheets glaciers and perennial snow fields
7. Inland wetlands	7.1 Inland marshes on mineral soils 7.2 Mires, bogs and fens
8. Rivers and canals	8.1 Rivers and streams 8.2 Canals, ditches and drains
9. Lakes and reservoirs	9.1 Lakes and ponds 9.2 Artificial reservoirs

Ecosystem Extent map 2021, Data compilation: Sylvia Gierlinger, Florian Hochfellner; Mapping: Maria Wurster (part of the Grant project 2021-AT-EGD)

# AT Ecosystem Extent map: Data sources and -structure

2021

1. Base-Layer: **STATEo**
2. Settlement, bare rocks and screes, glaciers, sparsely vegetated (BEV Cadaster)
3. Agriculture (IACS/InVeKoS)
4. Correction of pastures: Bare rocks and screes & sparsely vegetated (CLC+)
5. Tree species map (BFW Austrian forest inventory)
6. Wetlands (BEV Cadaster)
7. Rivers/Lakes (BEV Cadaster, UBA WISA)
8. Road infrastructure, dump sites (BEV Cadaster)
9. Correction of sealed areas in mountainous regions (CLC+)

2024 (tbd.)

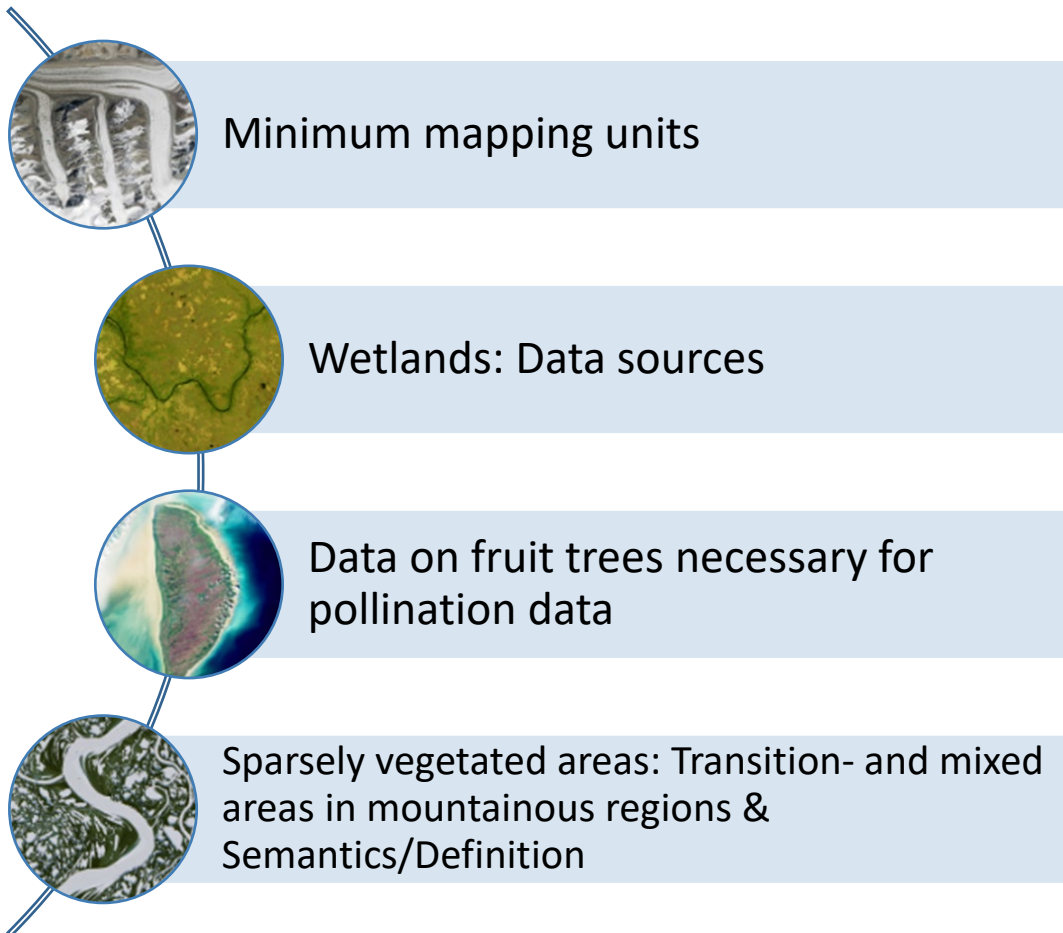
1. Base-Layer: **STATEo / CLC+**
2. Agriculture (IACS/InVeKoS)
3. Correction of pastures: Bare rocks and screes & sparsely vegetated (STATEo/CLC+)
4. Tree species map (BFW Austrian forest inventory)
5. Glasshouses (OSM)
6. Settlement areas (UBA ÖROK Soil sealing)
7. Cemeteries (BEV Cadaster)
8. Wetlands (BEV Cadaster, STATEo)
9. Rivers/Lakes (BEV DLM)



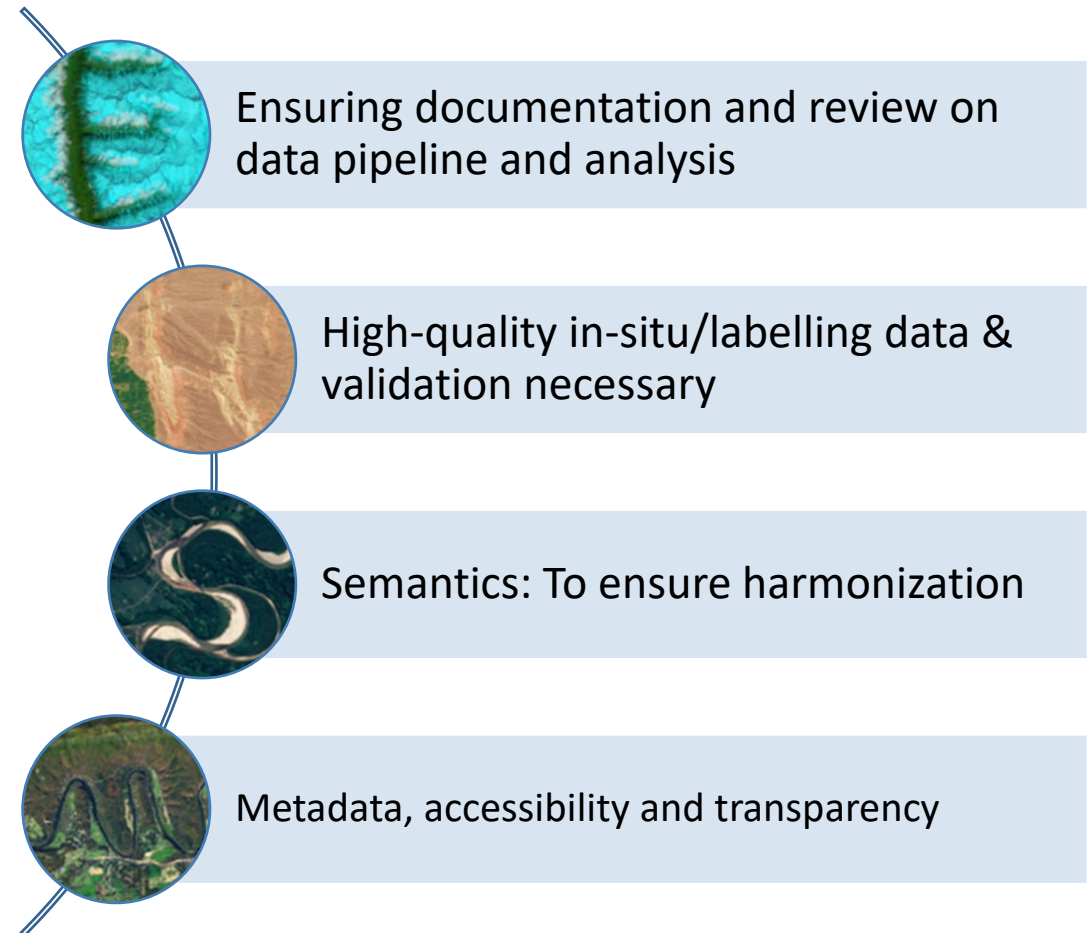
# STATeo and Ecosystem Accounting: Lessons learned and next steps

# Lessons learned and next steps

## Ecosystem Accounting



## STATEo Landcover



# Recommendations

Copernicus **Products to be harmonized with relevant policies** incl. Ecosystem Accounting, Nature Restoration Regulation etc. (available timeliness, resolution and granularity)



Statistical **requirements to be harmonized with relevant available EO data & products** (available timeliness, resolution and granularity)

Promoting EO-Data uptake and concepts in **domain-specific working groups** for statistics

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