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Completing the picture: Satellite-based mapping of agricultural land-use to gap-fill the Austria IACS geodatabase

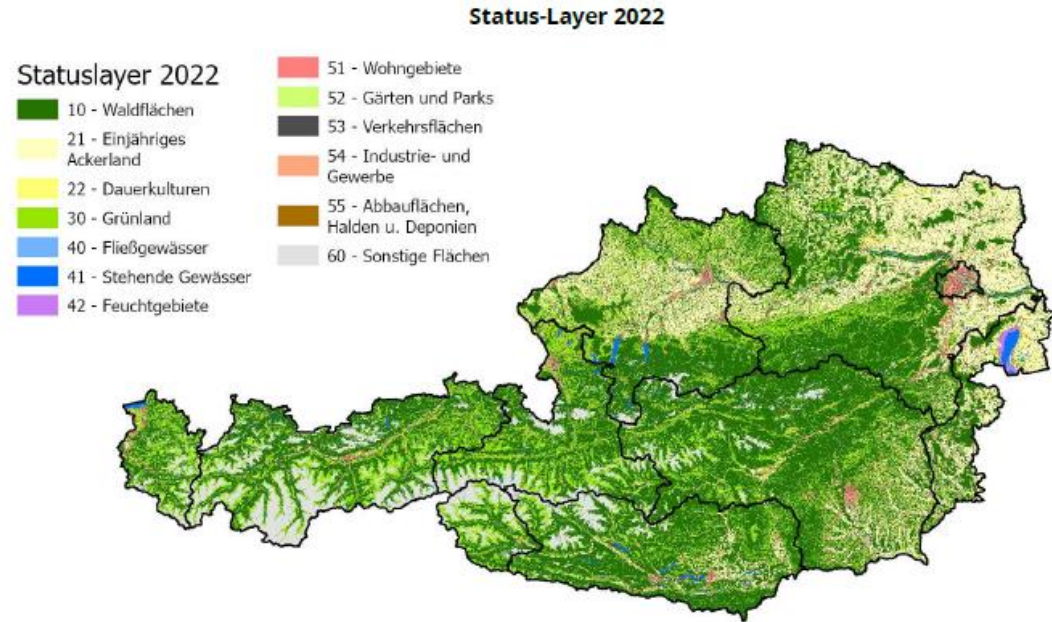
Sebastian Böck, Environment Agency Austria,

2nd Conference on EO4MRV | Copenhagen | 8 October 2025



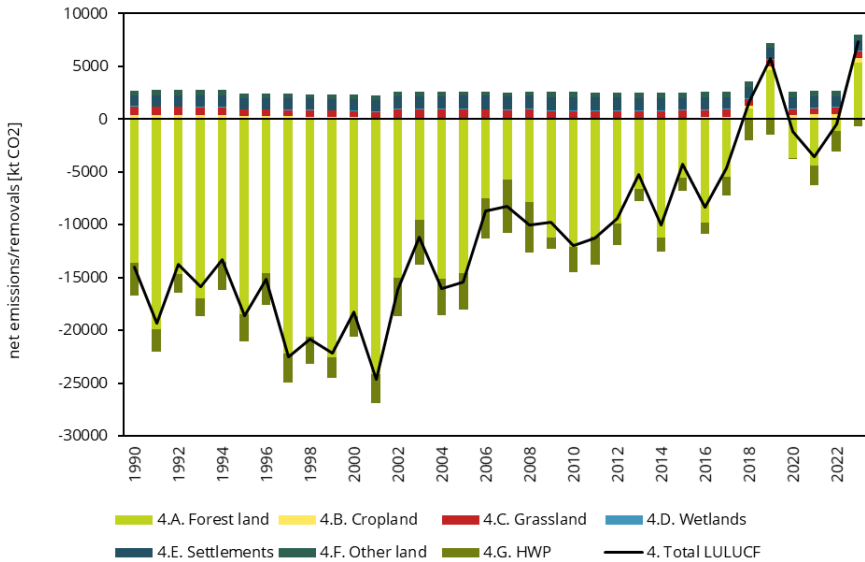
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- IACS Geo-databases for Croplands and Grasslands and *Completeness* issues
- Gap-filling approaches:
 - *Phantom fields*
 - *Croplands and Grasslands outside of IACS LPIS*
- Comparison with CLMS data



LULUCF and Austrian System for Land Representation

Austrian LULUCF GHG Emissions/Removals 1990-2023



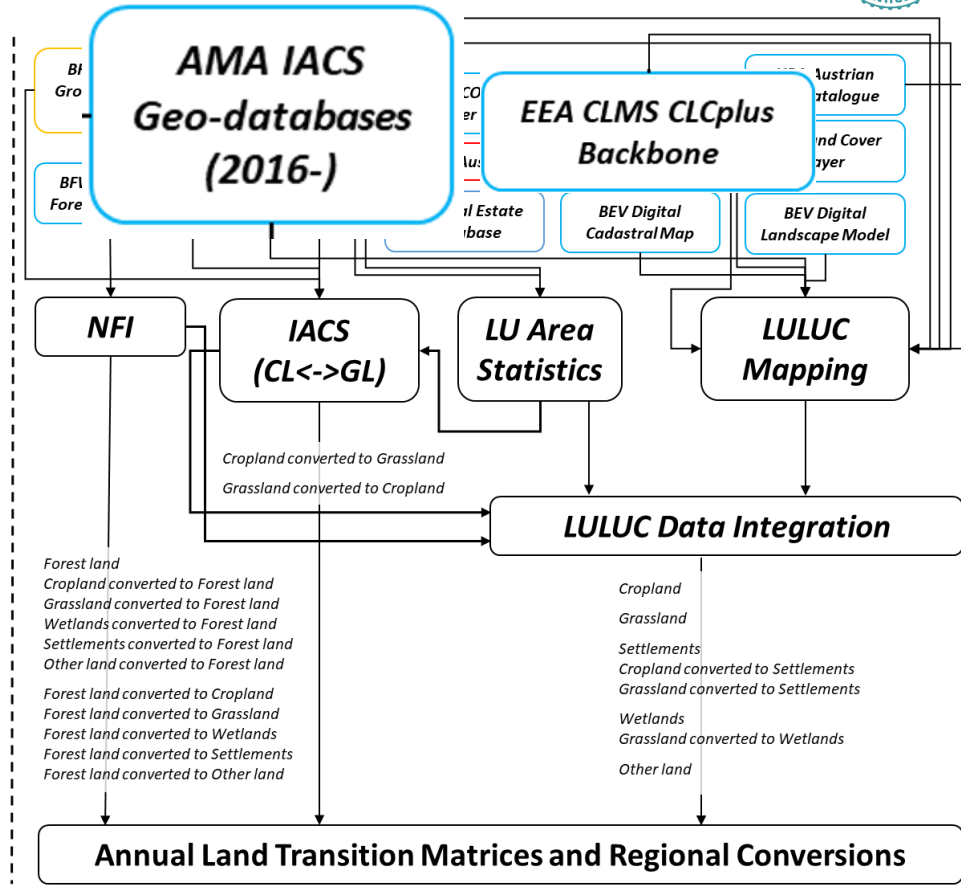
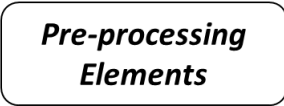
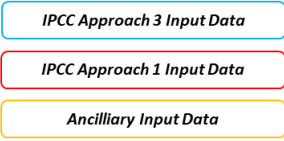
- LULUCF significant contributor to the GHG balance of Austria
- 1990: Net sink of 13.8 Mt CO₂eq (17% offset of the national total emissions without LULUCF)
- 2023: Net source of 7.5 Mt CO₂eq (11% addition to the national total emissions without LULUCF)
- Forest land dominant driver of sector level and trend
- Large interannual variations, declining sink strength over last two decades

Land-use and land-use change activity data used for LULUCF derived from a system that integrates spatially-explicit information from various sources

Austrian System for Land Representation

- EU LULUCF Regulation (2023/839) requires inter alia the use of approach 3 geographically-explicit land-use conversion data according to the IPCC 2006 Guidelines
- In the last years, work has been ongoing to further develop the land monitoring system for LULUCF
- Particular focus on the mapping of Croplands and Grasslands

Legend:



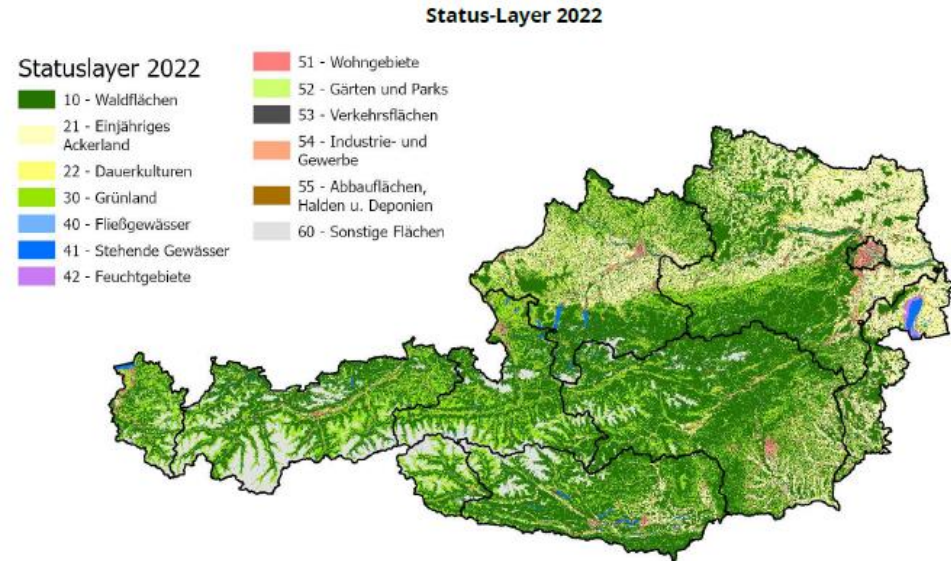
IACS Geo-databases for Croplands and Grasslands

Mapping Cropland and Grassland areas

- Largely based on the AMA IACS LPIS and GSAA datasets:
 - LPIS Reference Parcels
 - GSAA Fields (Feldstücke)
 - GSAA Plots (Schläge)
- IACS geo-databases contain spatially-explicit information on agricultural practises that are updated annually and subject to central QA/QC; however, the GSAA cover the fields for which subsidy payments are made

Gaps in the GSAA derived data:

- **Phantom fields** for which subsidy applications are not made every year
- **Croplands and Grasslands outside of IACS LPIS**, which are not actively managed for agriculture

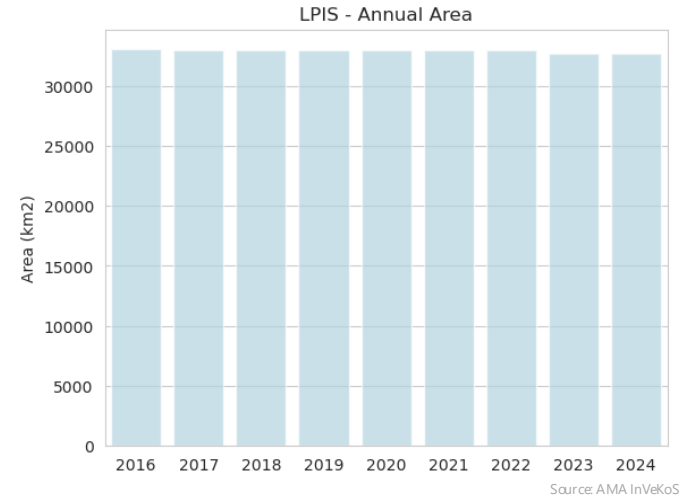
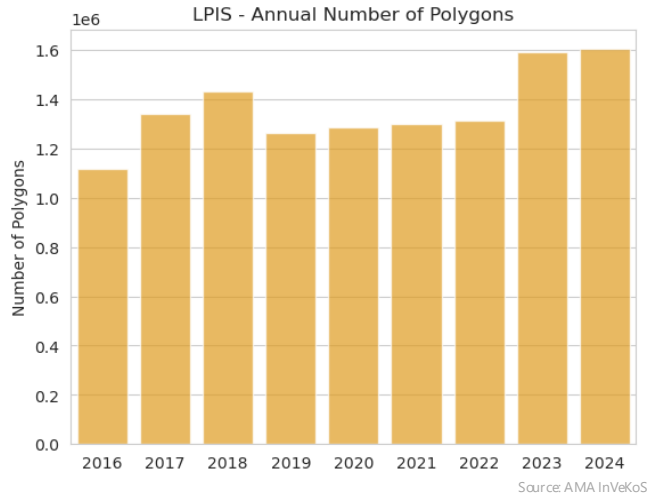


Overview IACS LPIS and GSAA datasets

Integrated Administration and Control System (IACS)

- ***Land Parcel Information System (LPIS)*** provides stable information on **reference parcels** to identify *all agricultural land* (in theory) and the maximum eligible area

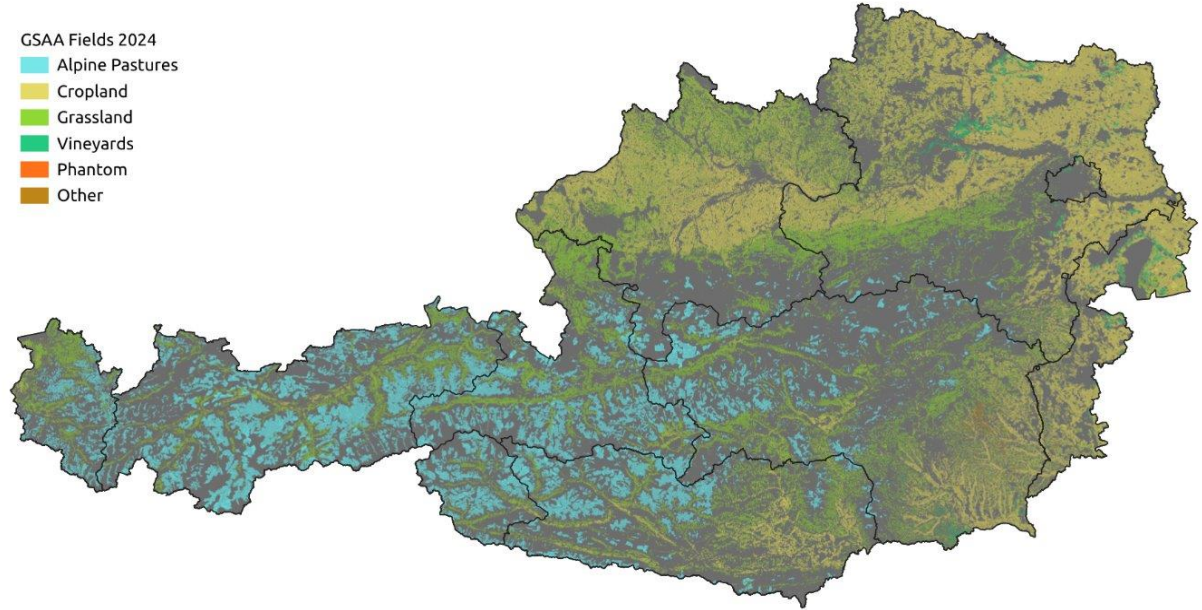
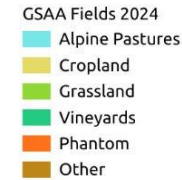
~ 1/3rd of the national area



Overview IACS LPIS and GSAA datasets

Integrated Administration and Control System (IACS)

- ***Geospatial Aid Application (GSAA)*** data consist of boundaries and areas collected annually through ***beneficiary declarations***
- Granular information on ***fields*** and ***plots*** (crop group or crop type)
- ***Substantial inter-annual variation!***

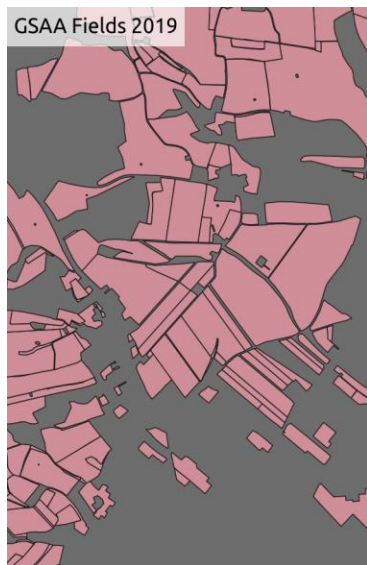
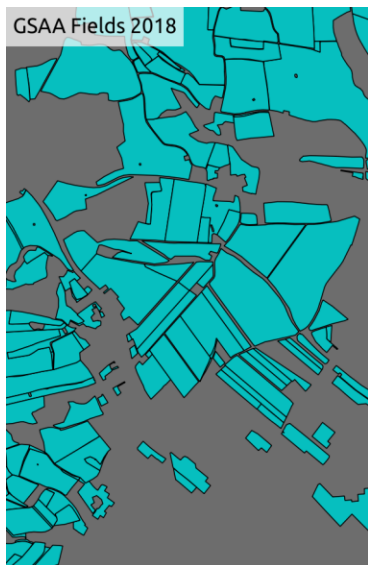


Source: AMA InVeKoS

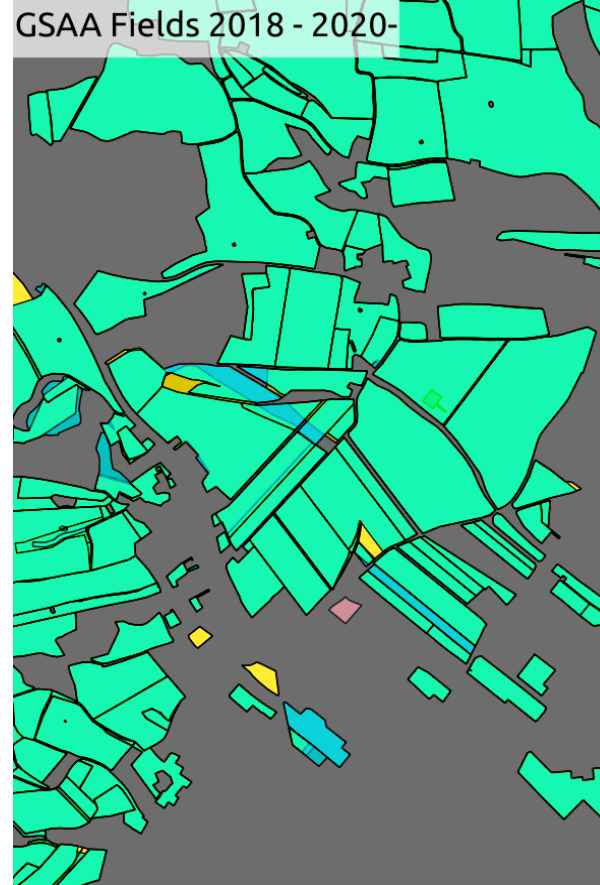
Gap-filling IACS geo-databases

Phantom fields

- GSAA geometries change from one year to another, i.e. polygons
 - Appear, disappear, split, merge, reshape...
 - Data cleaning is required (despite *central QA/QC*)



Source: AMA InVeKoS



- **Timeseries of GSAA fields** is established by iteratively identifying areas present in...
 - ... *year i and $i+1$* ('stable')
 - ... *year i , but not year $i+1$* ('loss')
 - ... *year $i+1$, but not year i* ('gain')



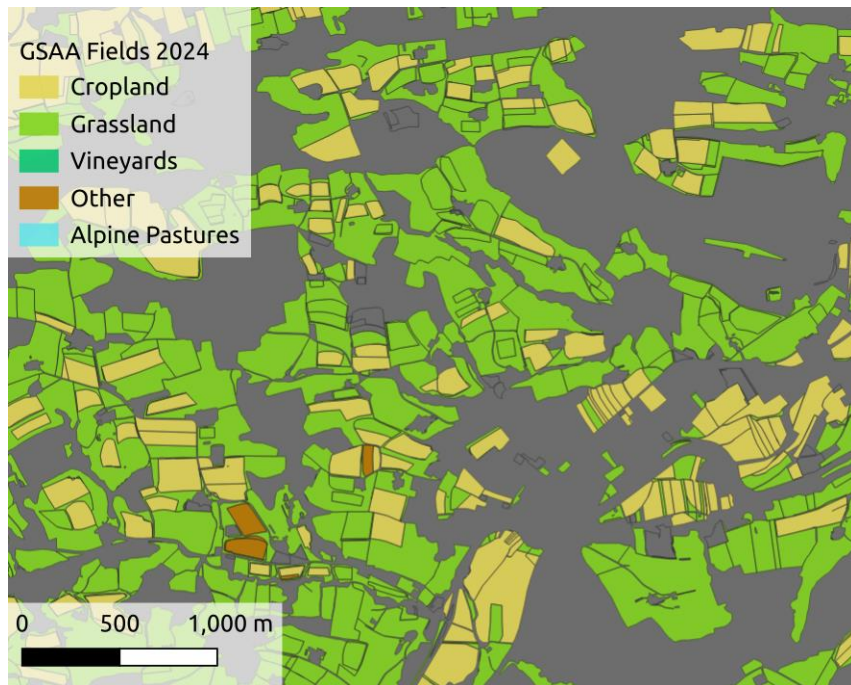
- **Gap-filling** is performed using the most proximate value (in time) - after clipping the Phantom geometries with LPIS coverage of the respective year
- Currently, unbounded preceding and following years are taken into account (as long as the Phantom field is within the LPIS!), which assumes regular updates by the data custodian

Phantom fields

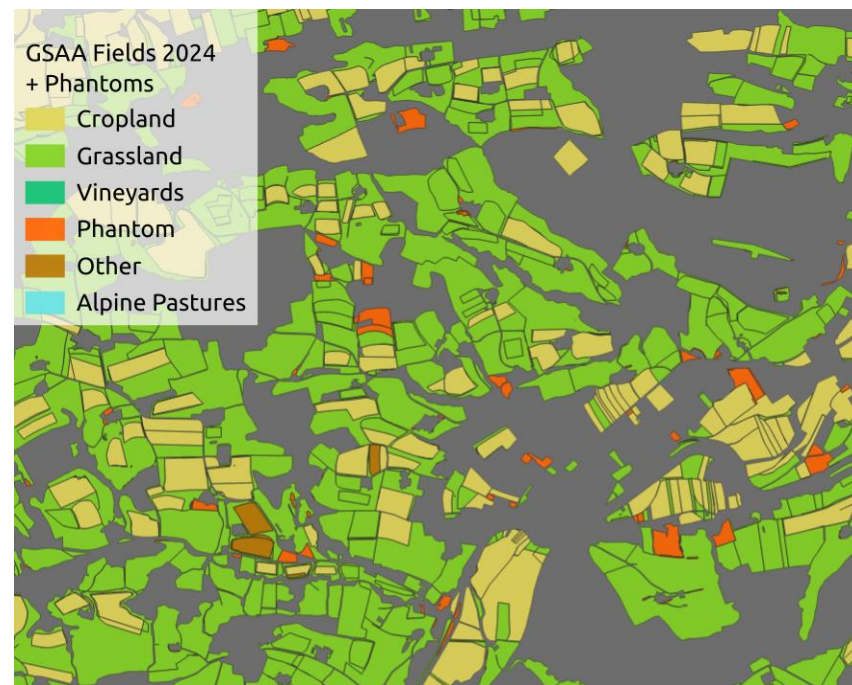
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37946464	A	A	A	A	A	A	A	A	A	A	19864.1
37946465	A	A	A	A	G	G	G	G	G	G	10229.5
37946466	A	A	A	A	A	A	A	A	A	A	1468.8
37946467	A	A	A	A	A	A	A	A	A	A	1487.9
37946468	A	A	A	A	A	A	A	A	A	A	23481.0
37946469	X	X	X	X	A	A	A	A	A	A	7119.7
37946470	A	A	A	A	A	A	A	A	A	A	1308.7
37946471	G	G	G	G	G	G	G	G	G	G	2623.2
37946472	A	A	WI	WI	WI	WI	WI	WI	WI	WI	2969.2
.
.
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Phantom fields gap-filling

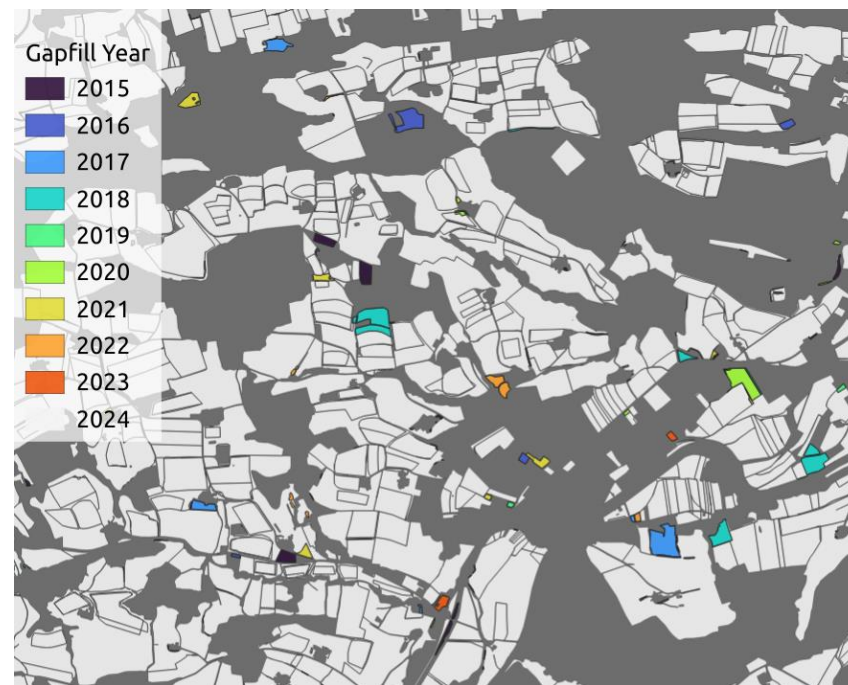


Source: AMA InVeKoS

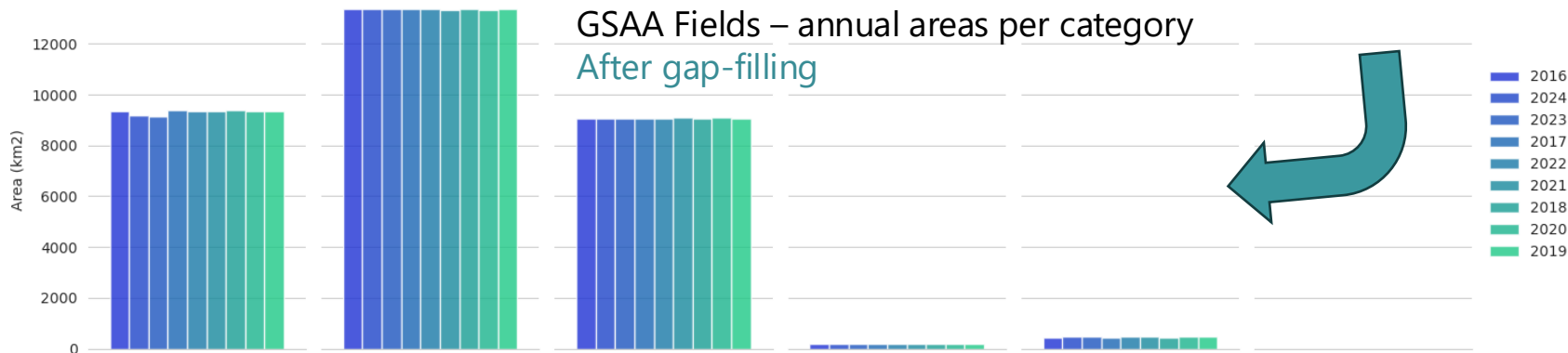
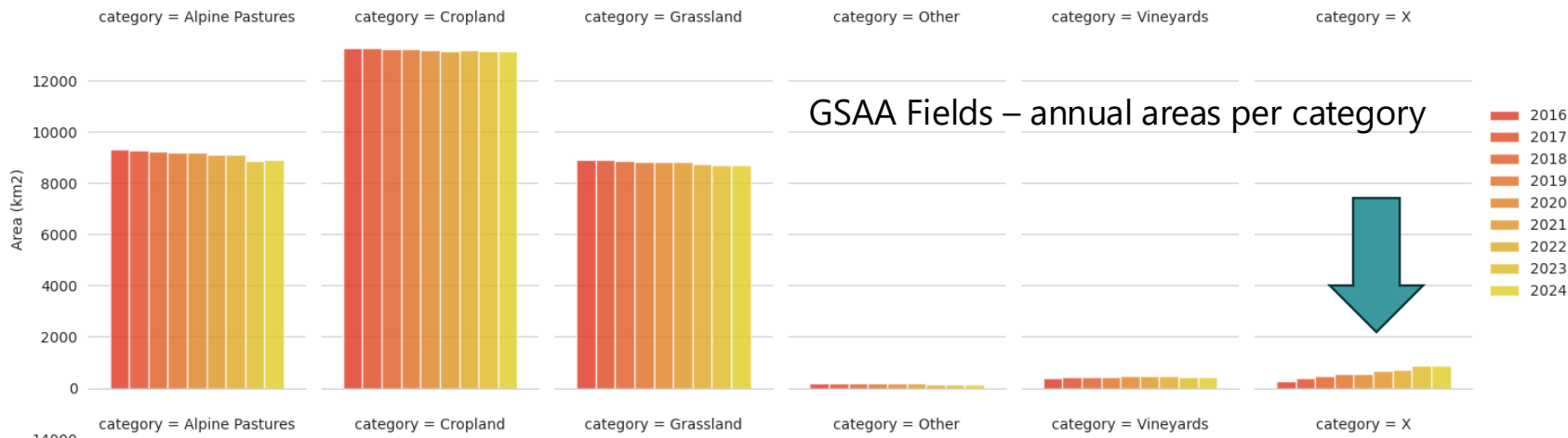


Source: AMA InVeKoS

Phantom fields gap-filling



Phantom fields gap-filling

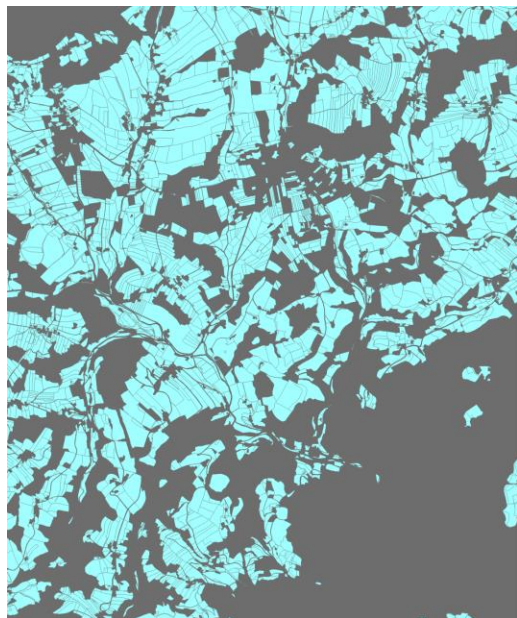


Detecting managed agricultural land beyond LPIS

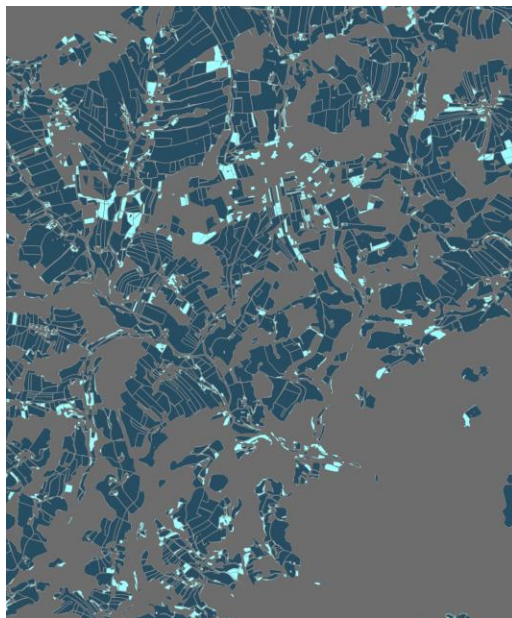
Croplands and Grasslands outside of LPIS

A population of candidate geometries derived from BEV Digital Cadastral Map

- ***“Fields, Meadows, or Pastures”, “Shrubbery”, and “Permanent Crops and Commercial Gardens”*** →

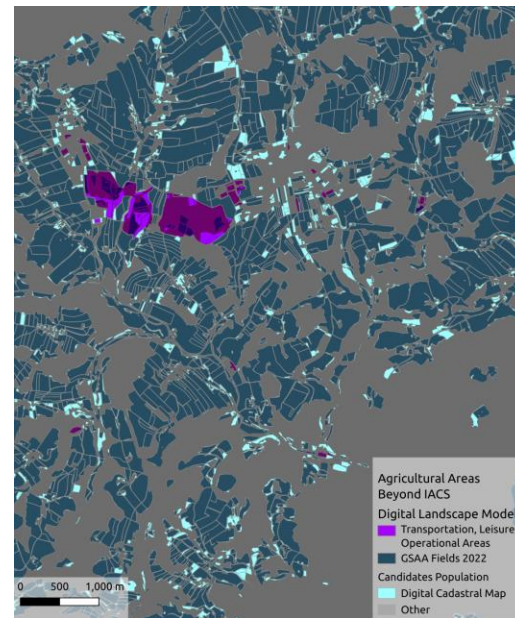


Erase GSAA Fields →



Remove BEV Digital Landscape Model

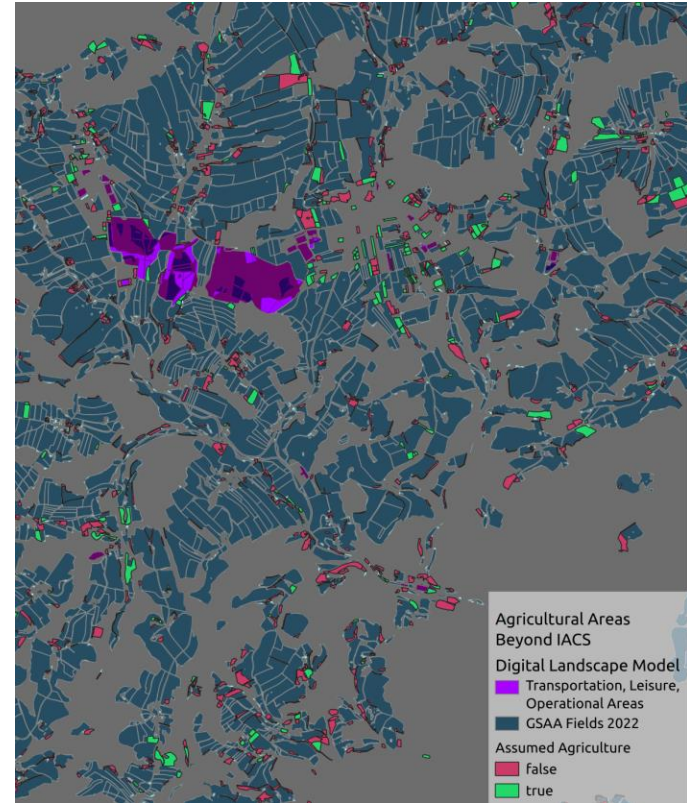
- ***“Transportation Areas”,***
- ***“Operational Areas”,***
- ***“Leisure Areas”***



Source: BEV Digital Cadastral Map, BEV Digital Landscape Model, AMA InVeKoS

CLC+ backbone proportions are extracted over remaining polygon portions of the candidate geometries:

- ***If predominantly permanent or periodically herbaceous*** - assumed agricultural land
- ***If predominantly permanent herbaceous***, further analysis with high resolution land-cover data from aerial photography to single out gardens
- Using this approach, for 2022 an additional ~2.380km² of potential agricultural land outside LPIS is found, of which about **800km²** are classified as **Grassland**, **215km²** as **Cropland**.

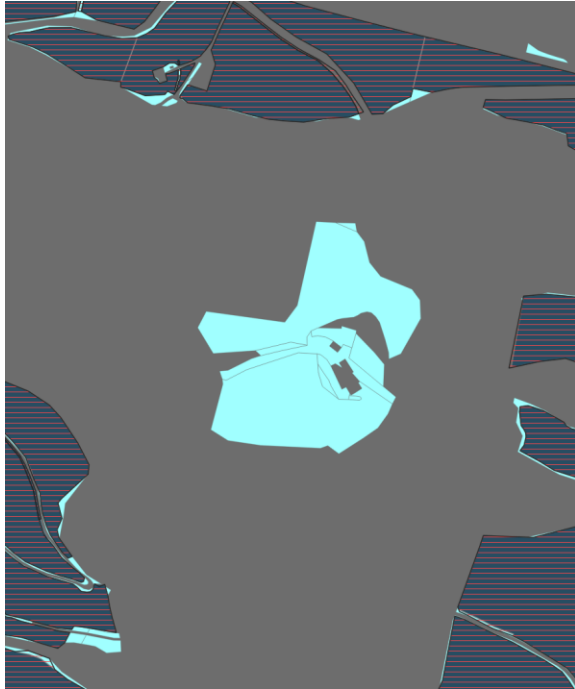


Source BEV Digital Cadastral Map, BEV Digital Landscape Model, AMA InVeKoS

Comparison with CLMS HRL Croplands and Grassland

CLMS HRL Croplands and Grassland Comparisons

CL / GL outside of IACS LPIS



Source: AMA InVeKoS

HRL Grasslands Herbaceous



Source: Copernicus Land Monitoring Service

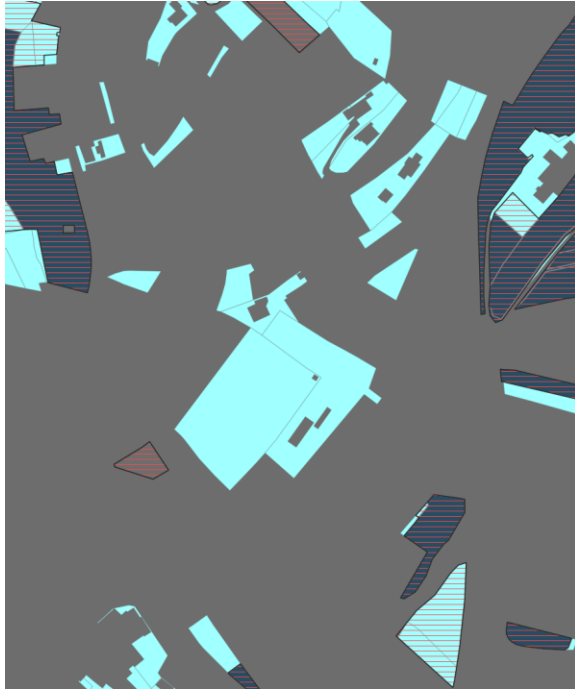
Google Maps



Source: Google Maps

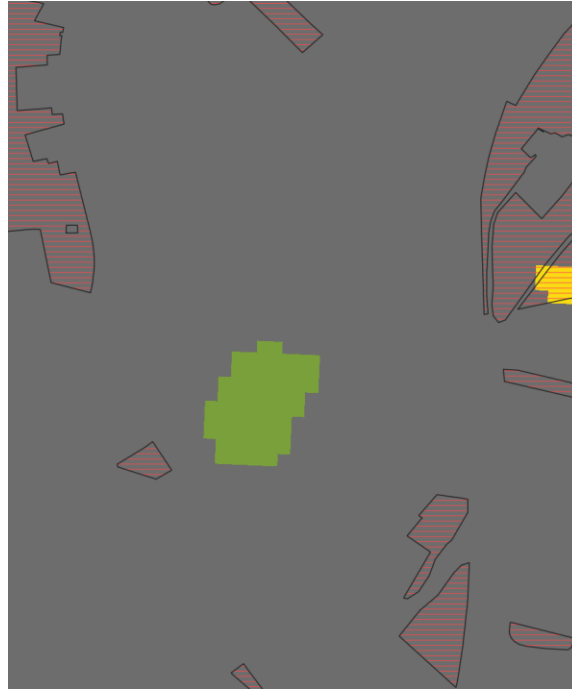
CLMS HRL Croplands and Grassland Comparisons

CL / GL outside of IACS LPIS



Source: AMA InVeKoS

HRL Grasslands Herbaceous



Source: Copernicus Land Monitoring Service

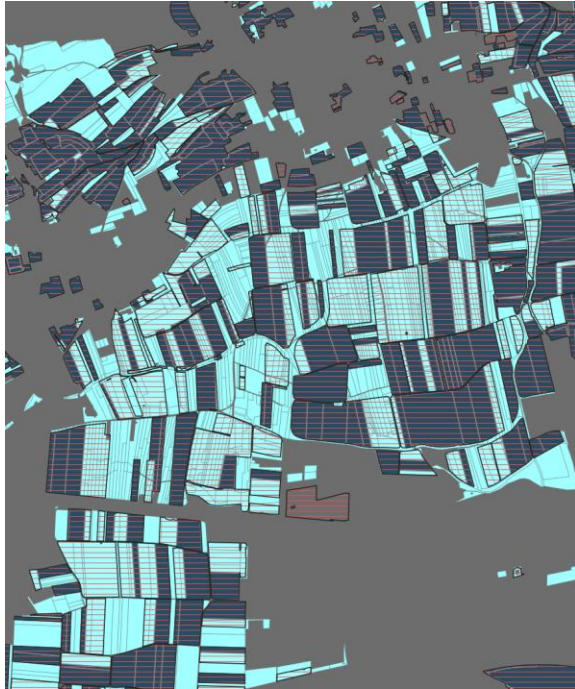
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Source: Google Maps

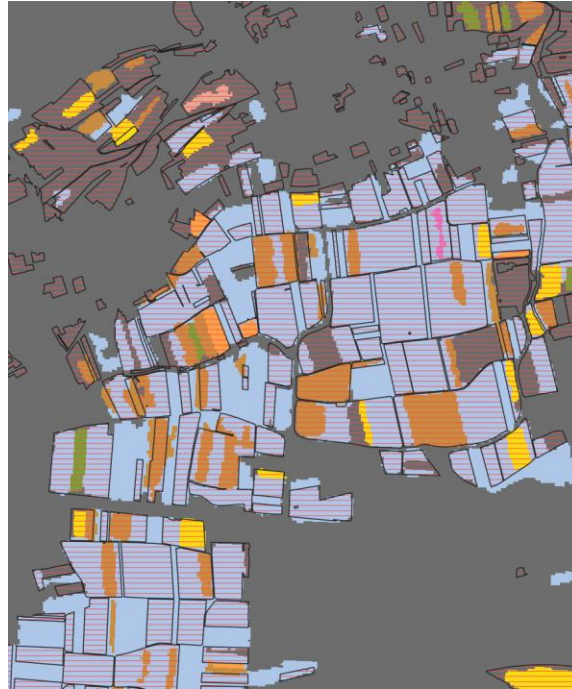
CLMS HRL Croplands and Grassland Comparisons

CL / GL outside of IACS LPIS



Source AMA InVeKoS

HRL Croplands – Crop Types



Source Copernicus Land Monitoring Service

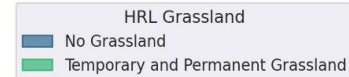
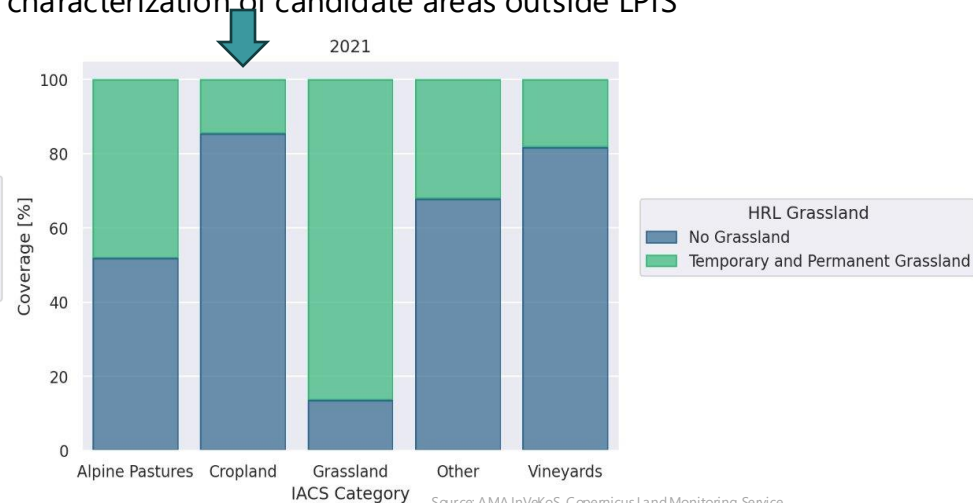
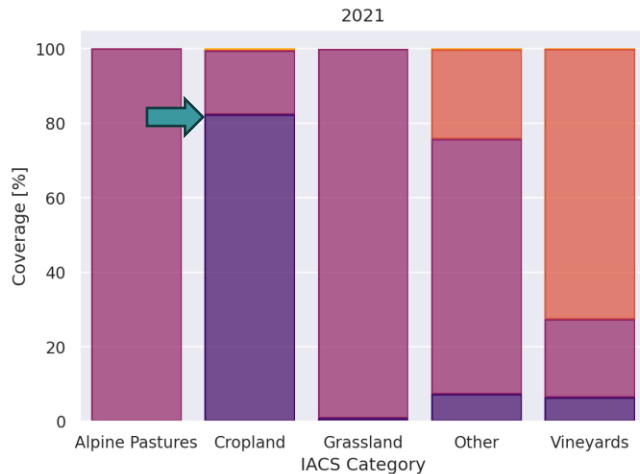
Google Maps



Source: Google Maps

CLMS HRL Croplands / Grassland Comparisons with GSAA fields

- Comparison of HRL Croplands and Herbaceous cover over GSAA Fields data
- Both layers in combination cover GSAA Cropland very well
- HRL Grassland appears to moderately underestimate GSAA Grassland
- Potential to reliably identify agricultural outside LPIS still needs to be explored – LU vs LC
- HRL Layers promising replacement for CLC+ Backbone for characterization of candidate areas outside LPIS



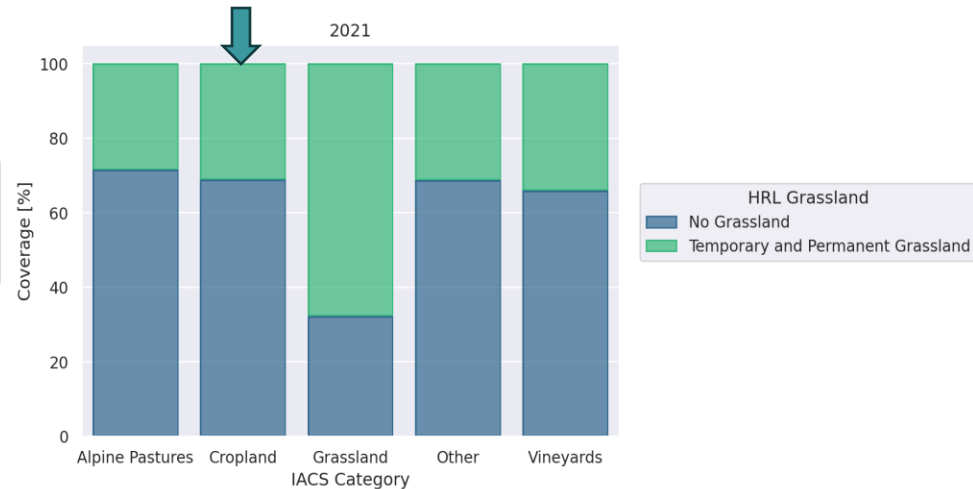
GSAA Fields prior to gap-filling

CLMS HRL Croplands / Grassland Comparisons with GSAA fields

- Looking at gap-filled polygons only shows larger deviations
- Could indicate land-use change in Phantom fields, but further analysis is needed



Gap-fill polygons only



Concluding Remarks

- Although IACS LPIS and GSAA data already cover the vast majority of agricultural land in Austria, gap-filling helps dampen inter-annual fluctuations and fill in the blanks
- Incorporation of CLMS HRL Croplands and Grassland data into the gap-filling and detection of agricultural land beyond LPIS could further improve the effectiveness to differentiate between Cropland and Grassland
- More timely availability of CLMS products would alleviate the burden of developing in-house EO solutions, especially when data gaps are spatially scattered and relatively small in extent
- The derived agricultural mask is used for other applications as well, i.e. in the OEROK land-take, land-use and soil sealing monitoring

Contact & Information

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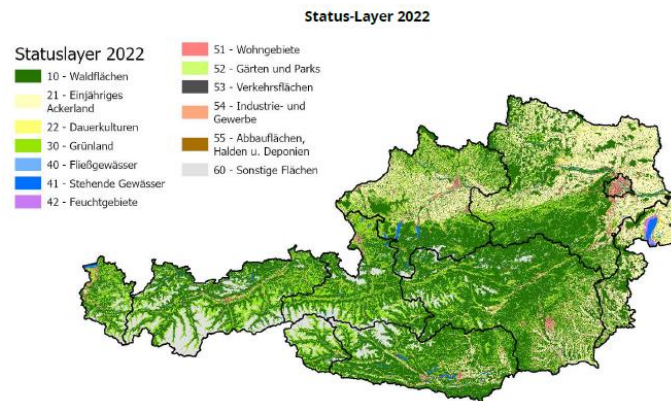
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*Completing the picture:
Satellite-based mapping of
agricultural land-use to gap-fill
the Austria IACS geodatabase*

Copenhagen, 08.10.2025