

3. IACS for land-use tracking in LULUCF inventories:
data characteristics, methodological considerations and country approaches

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A. What do IPCC guidelines require?

IPCC land-use classification framework

Every managed land area must be assigned to a unique IPCC land-use category.



Forest Land (FL)
Woody vegetation consistent with national Forest Land threshold



Cropland (CL)
Cropped land, rice fields, agroforestry systems under FL thresholds



Grassland (GL)
Wild/recreational/agricultural/sylvi-pastoral grassland that is not FL/CL

Examples of agricultural land that can require further **national allocation rules** to fit specific context:

- Land under opportunistic or rotational cropping/grazing/fallow practices
- Agroforestry systems
- Orchards
- Woody crops
- Wooded grassland



Wetland (WL)
Peat extraction, land covered or saturated by water for all or part of the year that is not FL/CL/GL



Settlements (SL)
Transportation infrastructure and human settlements of any size that are not FL/CL/GL/WL



Other Land (OL)
Bare soil, rock, ice and all areas that are not FL/CL/GL/WL/SL

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Land remaining / Land converted

Inventory must track changes between land-use categories over time.

APPROACH 1

	Area (ha)
FL	…
CL	…
GL	…
WL	…
SL	…
OL	…

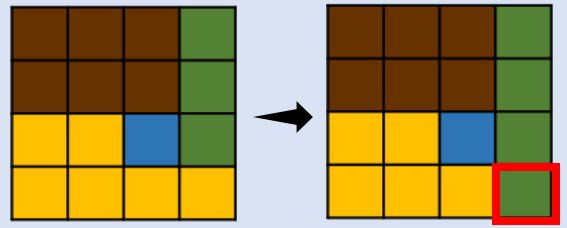
How much land is in each land-use category?

APPROACH 2

↱	FL	CL	GL	WL	SL	OL
FL	…	…	…	…	…	…
CL	…	…	…	…	…	…
GL	…	…	…	…	…	…
WL	…	…	…	…	…	…
SL	…	…	…	…	…	…
OL	…	…	…	…	…	…

How much land converts between land-use categories ?

APPROACH 3



Where do land-use conversions take place ?

Governance Regulation requires geographically-explicit land-use monitoring

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B. What can IACS offer?

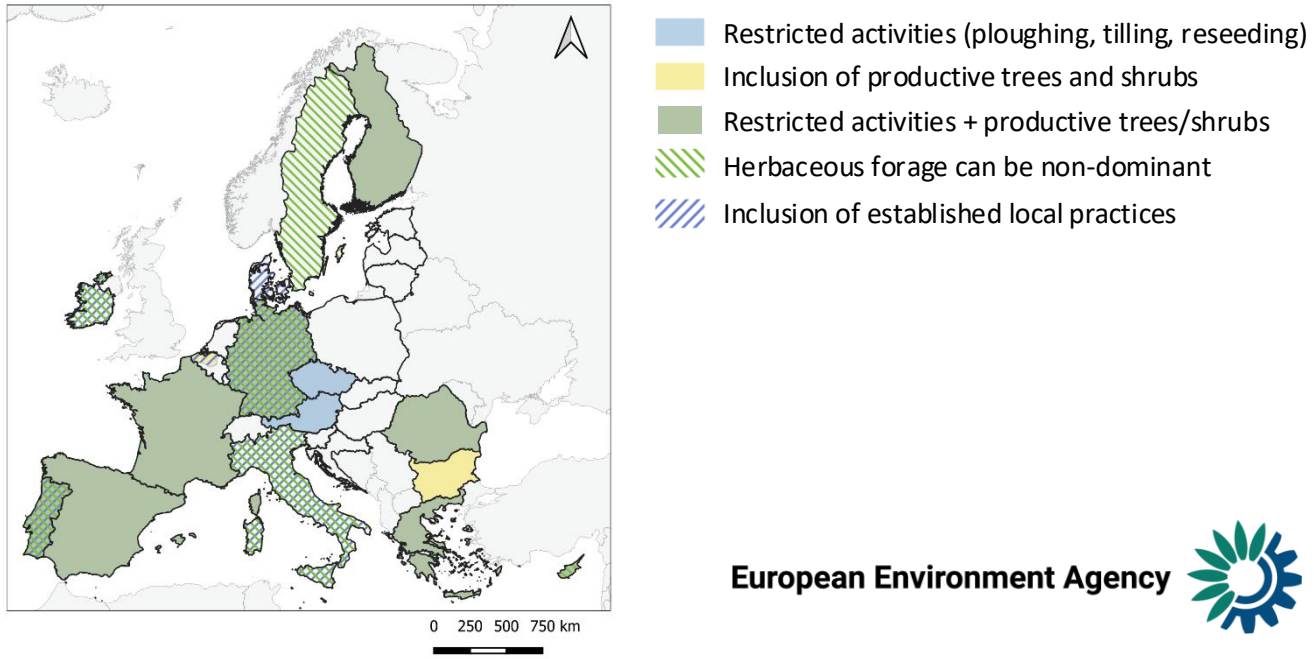
Where can we find land-use information in IACS? (1/2)



Reference parcel (LPIS)

- Broad land-use categories primarily determined by land cover characteristics
- Since 2023, reference parcels must regulatory distinguish CAP's agricultural land types (Regulation (EU) 2022/1172, Art. 2(7)(b)):
  - Arable land
  - Permanent crops
  - Permanent grassland

→ those categories must be defined in national CAP Strategic Plans



National specifications added to the general CAP definition of permanent grassland
(data source: European Commission: Directorate-General for Agriculture and Rural Development, ECORYS, Agrosynergy, METIS, Chartier, O. et al. (eds), Mapping and analysis of CAP strategic plans – Assessment of joint efforts for 2023-2027, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2762/71556)

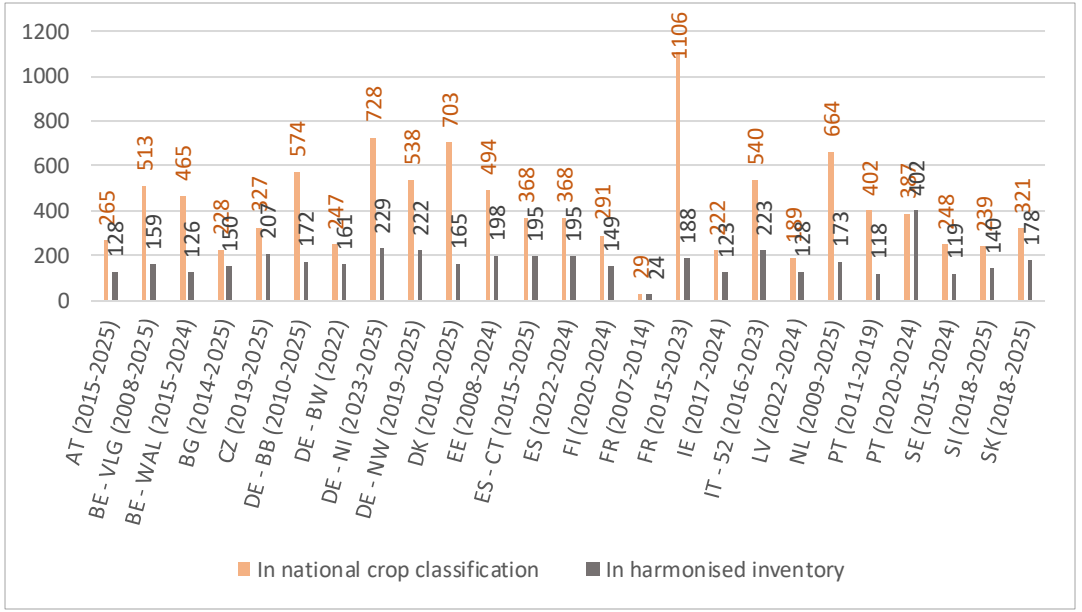
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Where can we find land-use information in IACS? (2/2)



Agricultural parcel (GSA)

- Crop type (declared use)
- Since 2023, must be provided at the agricultural parcel level (Regulation (EU) 2022/1173, Art. 8(3)) - although already provided by most aid application systems to support CAP specific payments



Number of different crop types per country over the entire time series

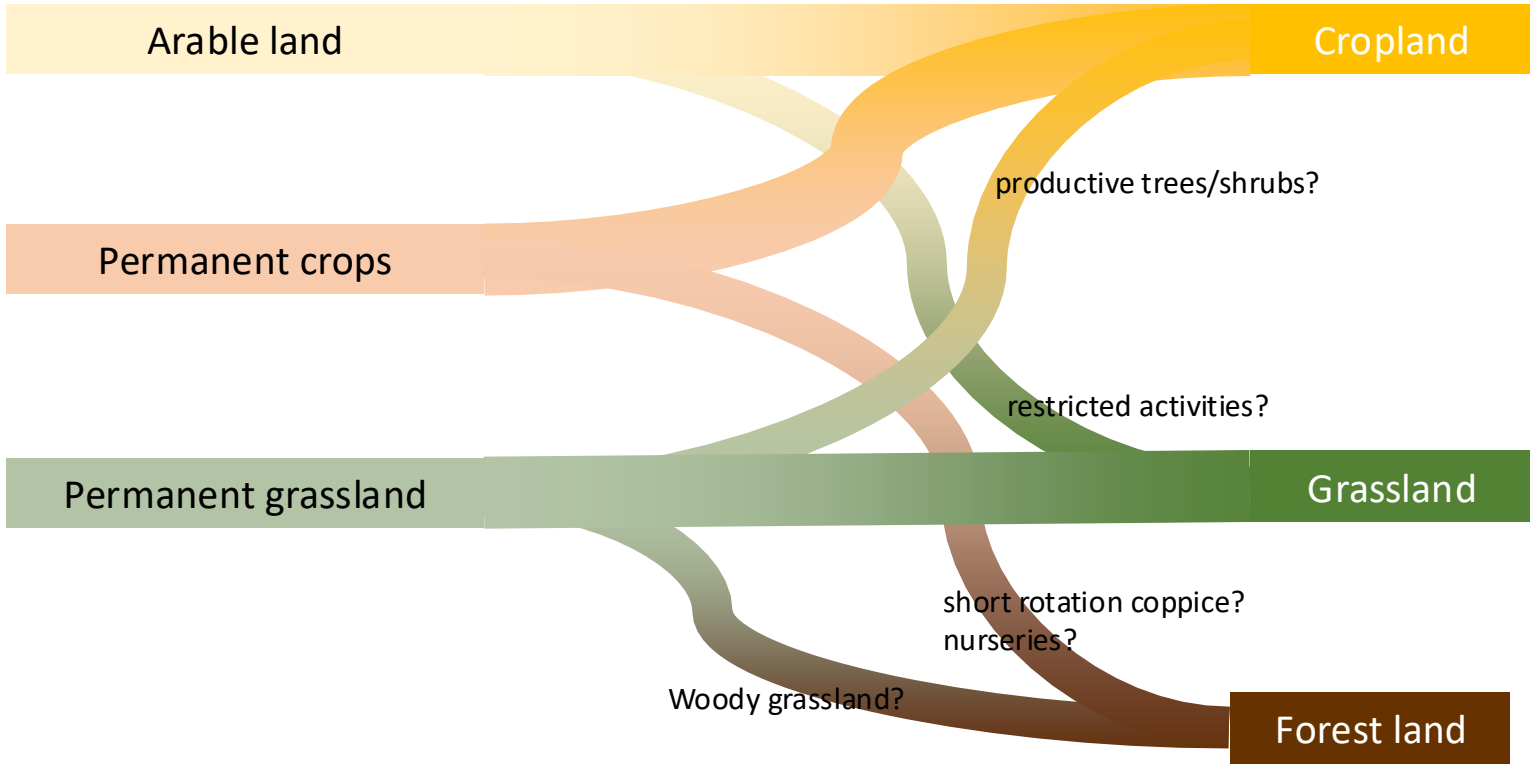
(data sources: Europe-LAND project, Version 1,3, February 18, 2026; EuroCrops project Version, Version v11, 2024)

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How can CAP agricultural land types can map onto IPCC categories ?

CAP land types do not directly translate into IPPC land use

➡ Need to carry out a national specific mapping exercise before building time series



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How can CAP agricultural land types can map onto IPCC categories ?

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Original object code	Original object name (Danish)	Original object name (English)	LULC category code	LULC category name
1	Vårbyg	Spring barley	15	Cropland
2	Vårhvede	Spring wheat	15	Cropland
3	Vårhavre	Spring oat	15	Cropland
4	Blanding af vårsåede arter	Mixture of spring cereals	15	Cropland
5	Majs til modenhed	Maize to maturity	15	Cropland
6	Vårhvede, brødhvede	Spring wheat, near cereal	15	Cropland
7	Korn + bælgsæd under 50% bælgsæd	Cereal/pulse, max. 50% pulse	15	Cropland
8	Vårspelt	Spring spelt	15	Cropland
		...		
801	Skov i IKKE skovblok	Forest outside forest blocks	13	Forest
900	Øvrige afgrøder	Other cop	15	Cropland
901	Naturarealer efter driftsloven	Nature areas according to farming law	16	Grassland
902	Naturlignende arealer	Nature like areas	16	Grassland
903	Lysåbne arealer i skov	Open nature in protected forest	16	Grassland
		...		

Extract of the Appendix "Applied object types from field parcel maps and agricultural registers from 2008 to 2020 and aggregation to LULC categories for the years 2012 to 2020
(Levin, G. et Gyldenkærne, S. 2022)

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Completeness of IACS data for LULUCF inventory needs

- **IACS data provide valuable agricultural information, but do not represent all IPCC managed cropland and grassland.**
- **IACS records rarely cover all inventory years (1970/1990-present).**

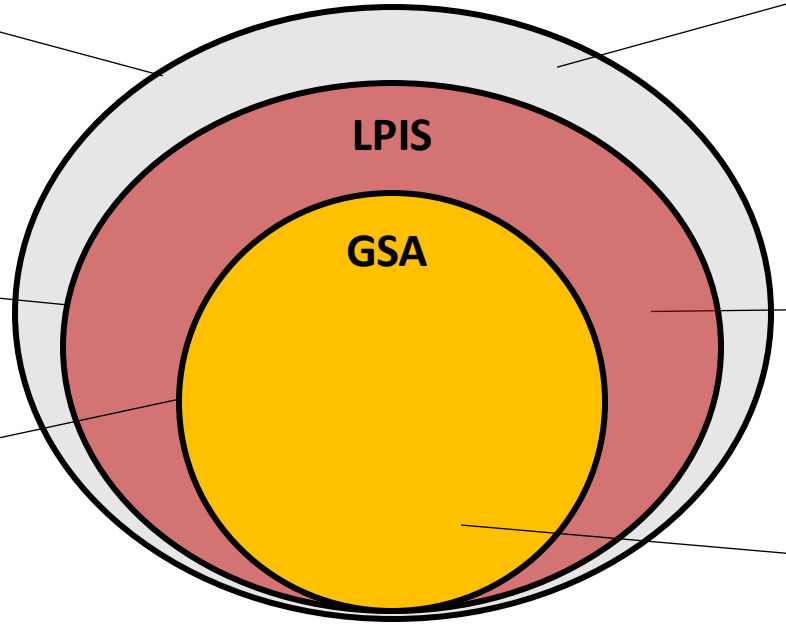
➡ Need to identify potential gaps and needed complementary data before building time series

Semantic relation between the IACS and LULUCF data content *

IPCC Cropland and Grassland categories

Maximum eligible agricultural area by CAP (LPIS)

Annually declared agricultural area by farmer (GSA)



- Some areas used for agricultural purposes can be excluded from CAP eligibility but consider as CL/GL by IPCC
- Natural Grassland with no agricultural activity
- …

Agricultural land – not declared in a X year

Agricultural land – declared in a X year

*schematic view

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Consistency of IACS data for LULUCF inventory needs

IACS is long-established and structured, but the characteristics of the data evolve over time.

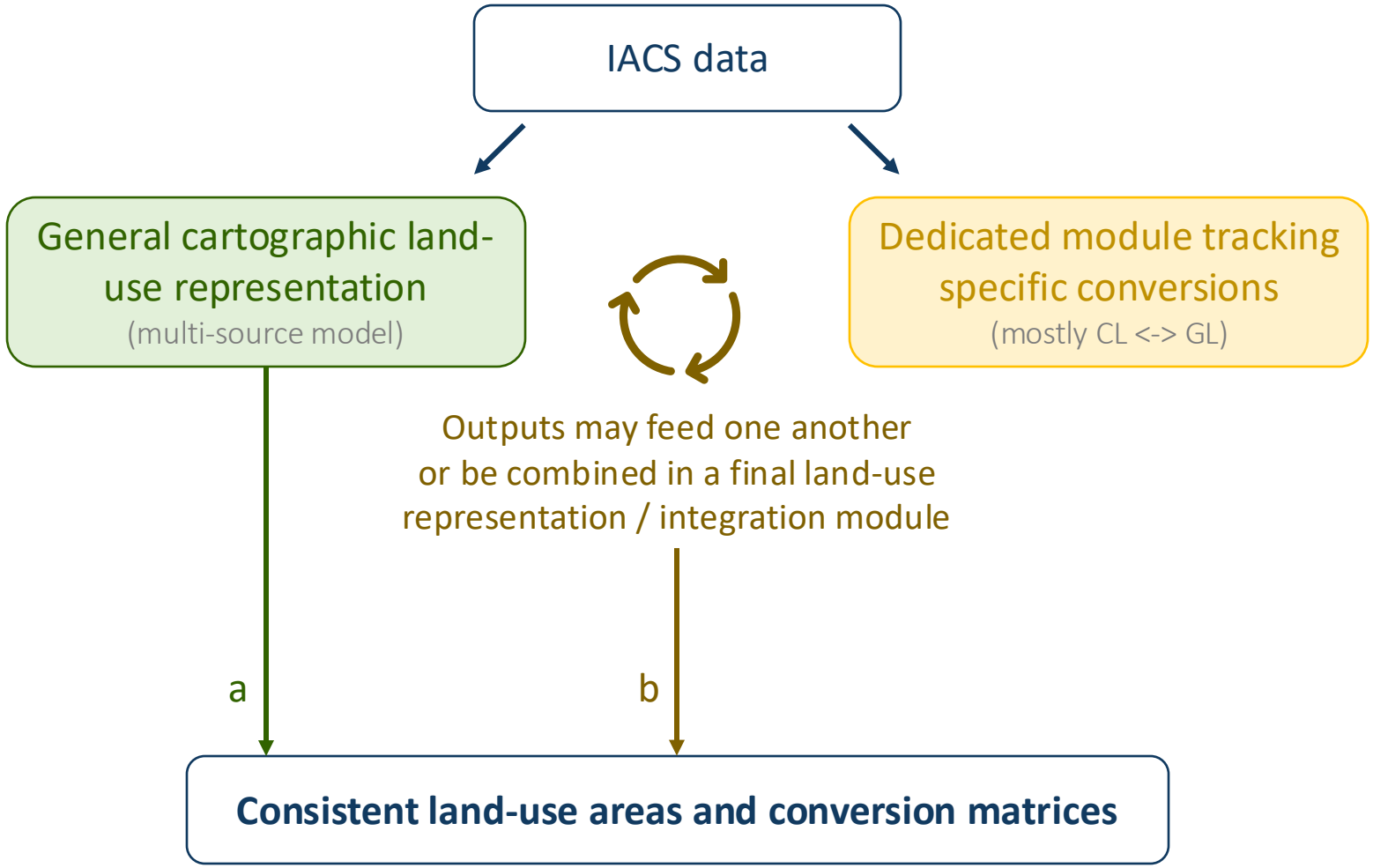
➡ Need to harmonise data before building time series

SOURCES OF TEMPORAL VARIABILITY

Policy and definitions	Spatial representation	Attributes and format
• Agricultural land categories • Eligibility rules	• Mapping resolution • LPIS reference parcel types	• Tabular to geospatial declarative data • Crop types

C. Examples of countries' use of IACS data

From IACS data to LUC matrices: different integration pathways



Three example countries, three starting points

FRANCE

LAND REPRESENTATION

A general land-use product based on centroids of a 50 x 50 m grid
+ 5 complementary modules directly feeding the general product of which a “crop rotation” module

IACS DATA AVAILABLE TO COMPILERS

- 2007-2014: LPIS available with a “farmer’s block” reference parcel type
- From 2015: LPIS available with an “agricultural parcel” reference parcel type

INTEGRATION OF IACS

2015+ LPIS are used to:

- Inform land use (not land use change) of certain centroids of the general land-use product within a hierarchy of geographical datasets
- Refine crop rotation for centroids identified as having an agricultural use in the general land-use product

- France 2025 NID
- Citepa, 2026. Modèle de suivi des terres haute résolution

AUSTRIA

LAND REPRESENTATION

Four pre-processing modules including a module providing biennial 5 x 5 m land-use maps over 2016-2022 and a module specifically tracking CL↔GL conversions
+ a final non cartographic integration module

IACS DATA AVAILABLE TO COMPILERS

- 2002-2015: declaration data available in a tabular format and attached to cadastral parcel ID
- From 2016: GSA data available
- In 2016, LPIS reference parcel type has moved from “cadastral parcel” to “physical blocks”

INTEGRATION OF IACS

- GSA data contribute to the biennial land-use maps over 2016-2022 within a hierarchy of geographical datasets
- Declarative data (tabular and geographical) are used in a dedicated module to compute CL↔GL conversion percentages

- Austria 2025 NID (particularly Annex 5.2)

DENMARK

LAND REPRESENTATION

25 x 25 m raster land-use maps obtained by the combination of 8 thematic layers by hierarchy:

- Before 2012, LU maps are produced for 3 reference year (1990, 2005 and 2011)
- From 2012: LU maps are produced annually

IACS DATA AVAILABLE TO COMPILERS

- LPIS – with a “physical block” parcel type – available from 1998
- GSA data available from 2010
- Declarative data available in a tabular format from 1998 to 2010

INTEGRATION OF IACS

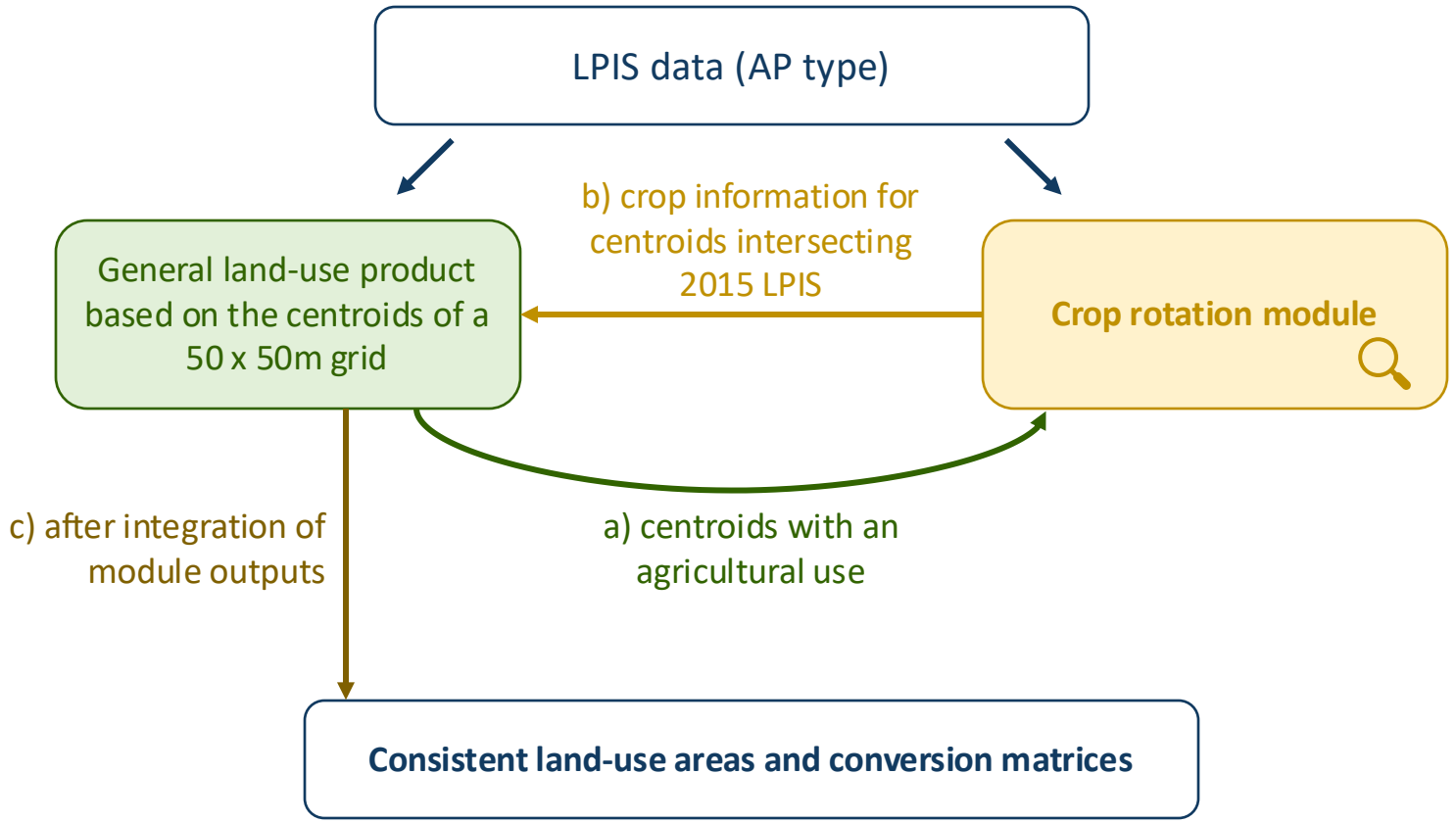
- IACS data are the main data source for the thematic layer “Cropland / Grassland”, with LPIS and declarative data having a complementary role
- IACS can supply or filter geometries for other thematic layers (forest or wetland layers)

- Denmark 2025 NID
- Levin, G. et al., 2014
- Levin, G. et Gyldenkærne, S. 2022

Four methodological questions to keep in mind

1. How to tell a land-use conversions from a crop rotation?
2. How to cover years with no IACS data available?
3. When using declaration data, how to treat “missing” parcels?
4. How to bridge format changes?

Ex 1: France – IACS integration strategy

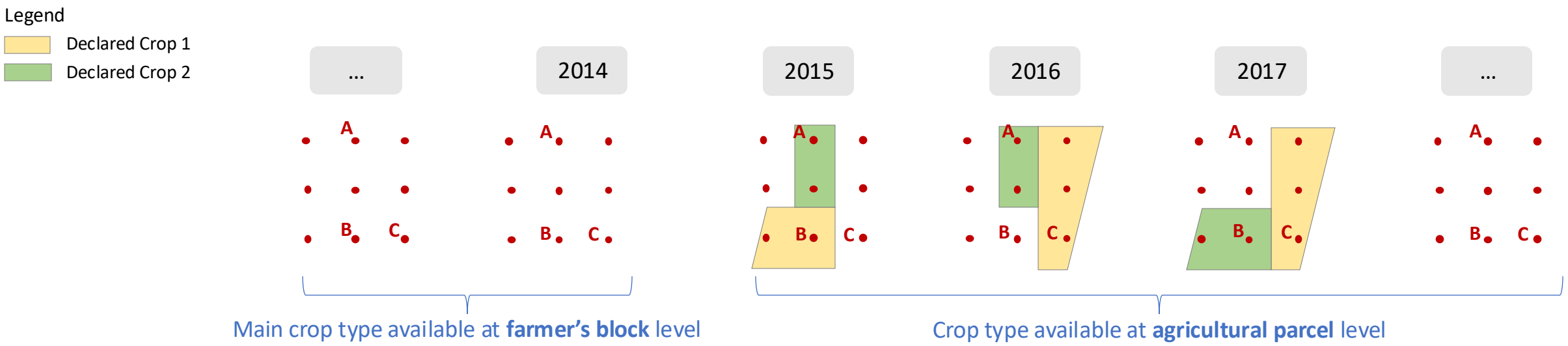




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Ex 1: France

How to bridge format changes?

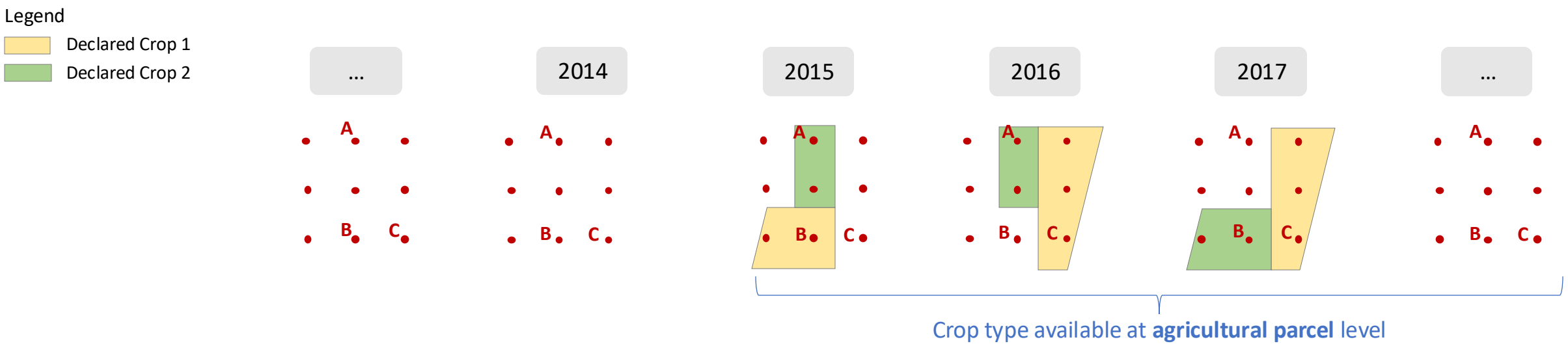


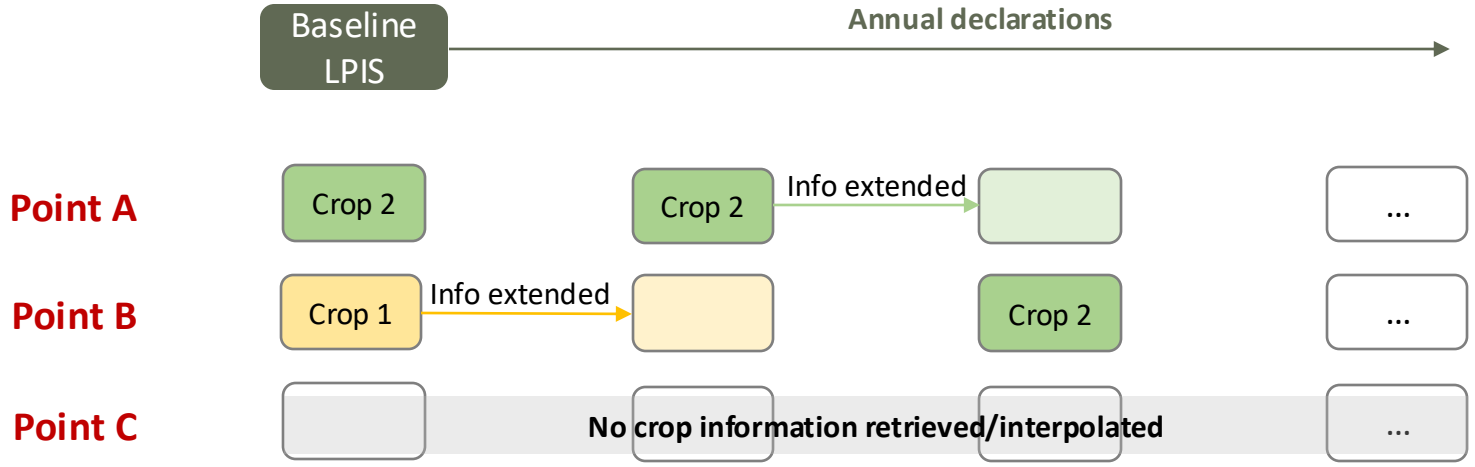
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Ex 1: France

When using declaration data, how to treat “missing” parcels?

How to bridge format changes?



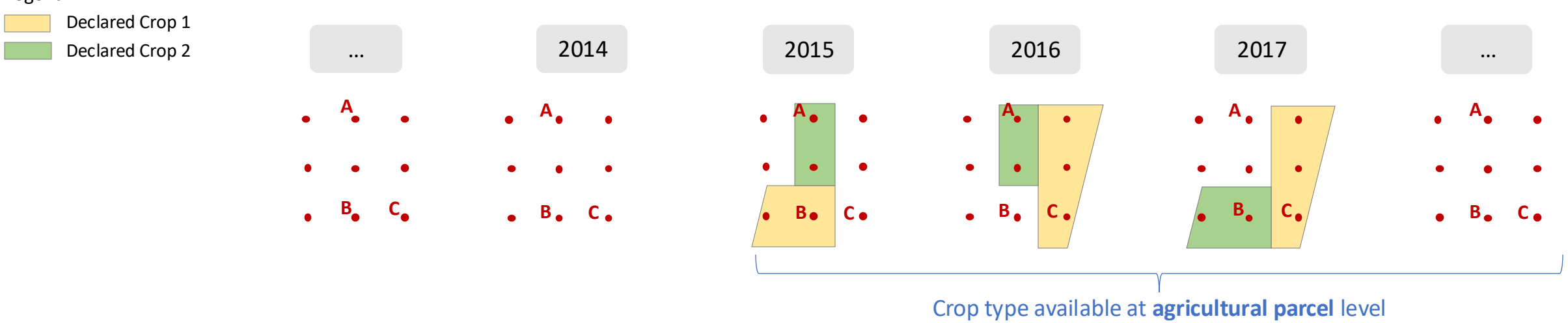


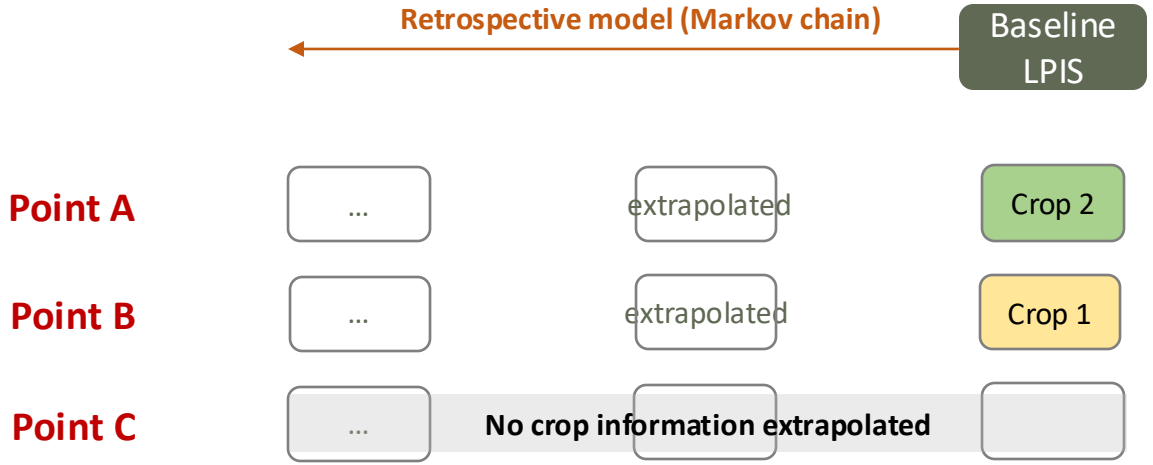
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Ex 1: France

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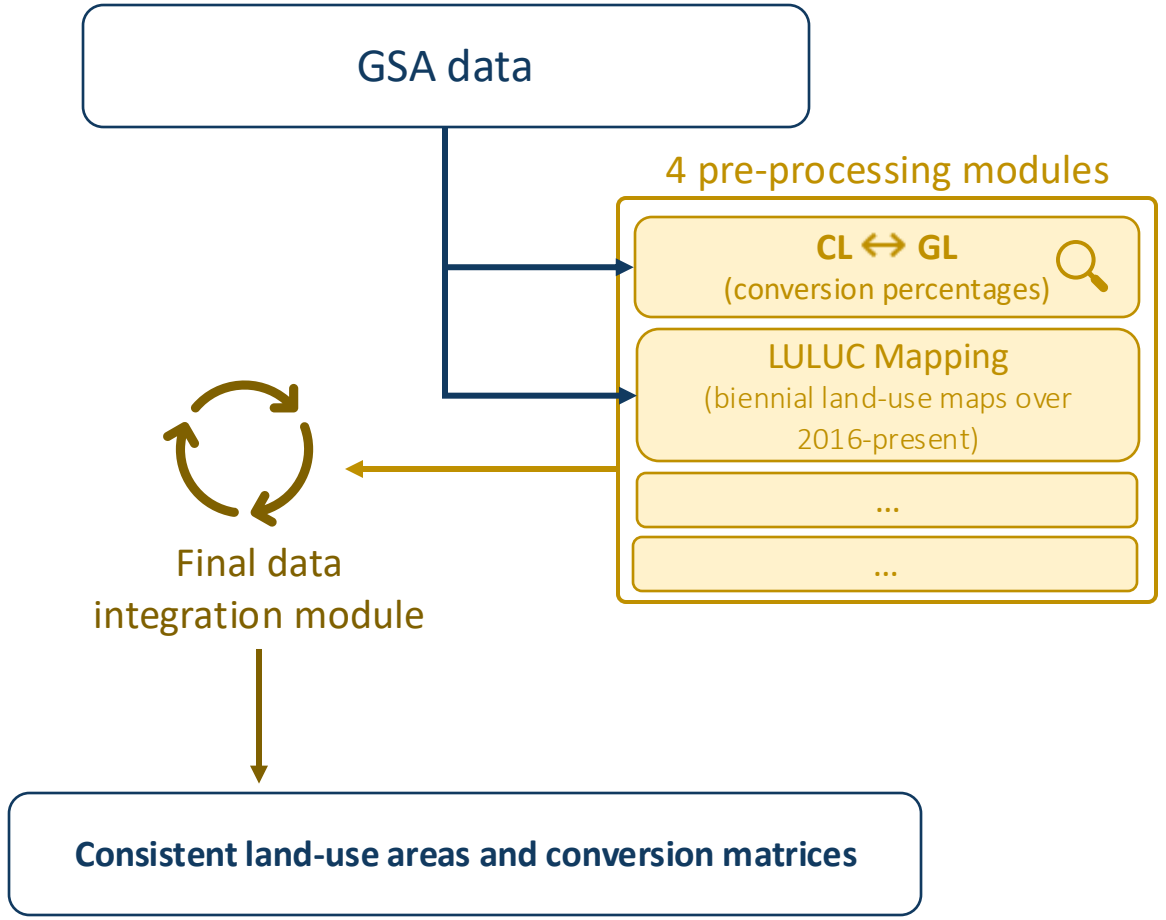




Markov chain trained on corrected LPIS available from 2015 onwards and calibrated to agricultural census available at the level of small agricultural regions over 1970-present

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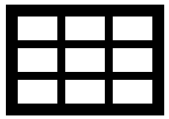
Ex 2: Austria – IACS integration strategy



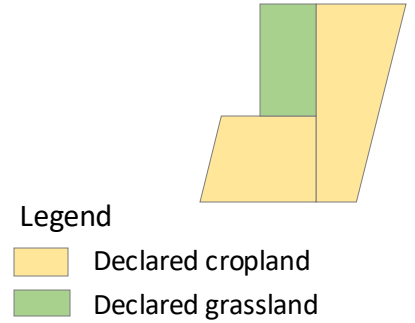
Ex 2: Austria

How to bridge format changes?

2002-2015
Declared agricultural areas in a tabular format by cadastral parcel



2016+
GSA data



Ex 2: Austria

How to bridge format changes?

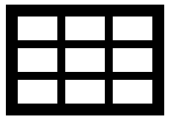
2002-2015
Declared agricultural areas in a tabular format by **cadastral parcel**

×

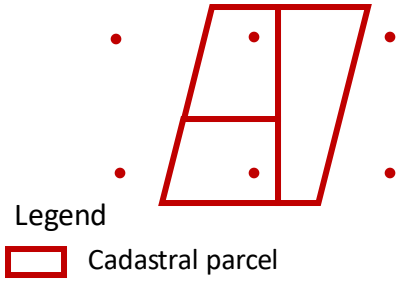
Cadastral parcel ID retrieved at **sampling points**

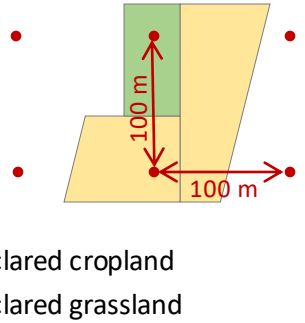
×

2016+
Sampling of **GSA data** based on a 100 x 100 m grid



Filter criteria :
stability of the cadastral parcel, LU information available for each year, relatively homogeneous LU





Reconstruction of a land-use series at the level of sampling points over 2002-present (partly incomplete)

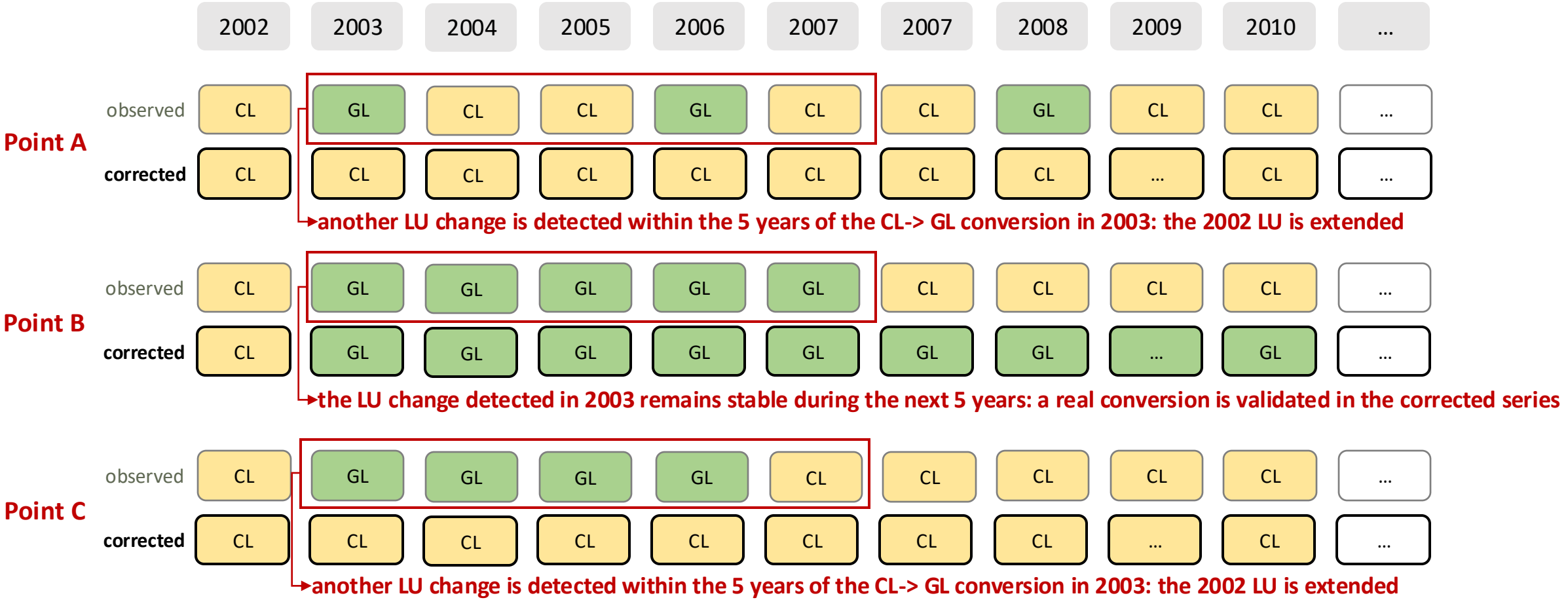
Source of incompleteness:
- Undeclared parcels
- Filter applied to 2002-2015 data

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Ex 2: Austria

How to tell a land-use conversions from a crop rotations?

Short-term changes are checked using the next 5 years: a land-use change is validated when it lasts at least 5 consecutive years.



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Ex 2: Austria

When using declaration data, how to treat “missing” parcels?

How to bridge format changes?

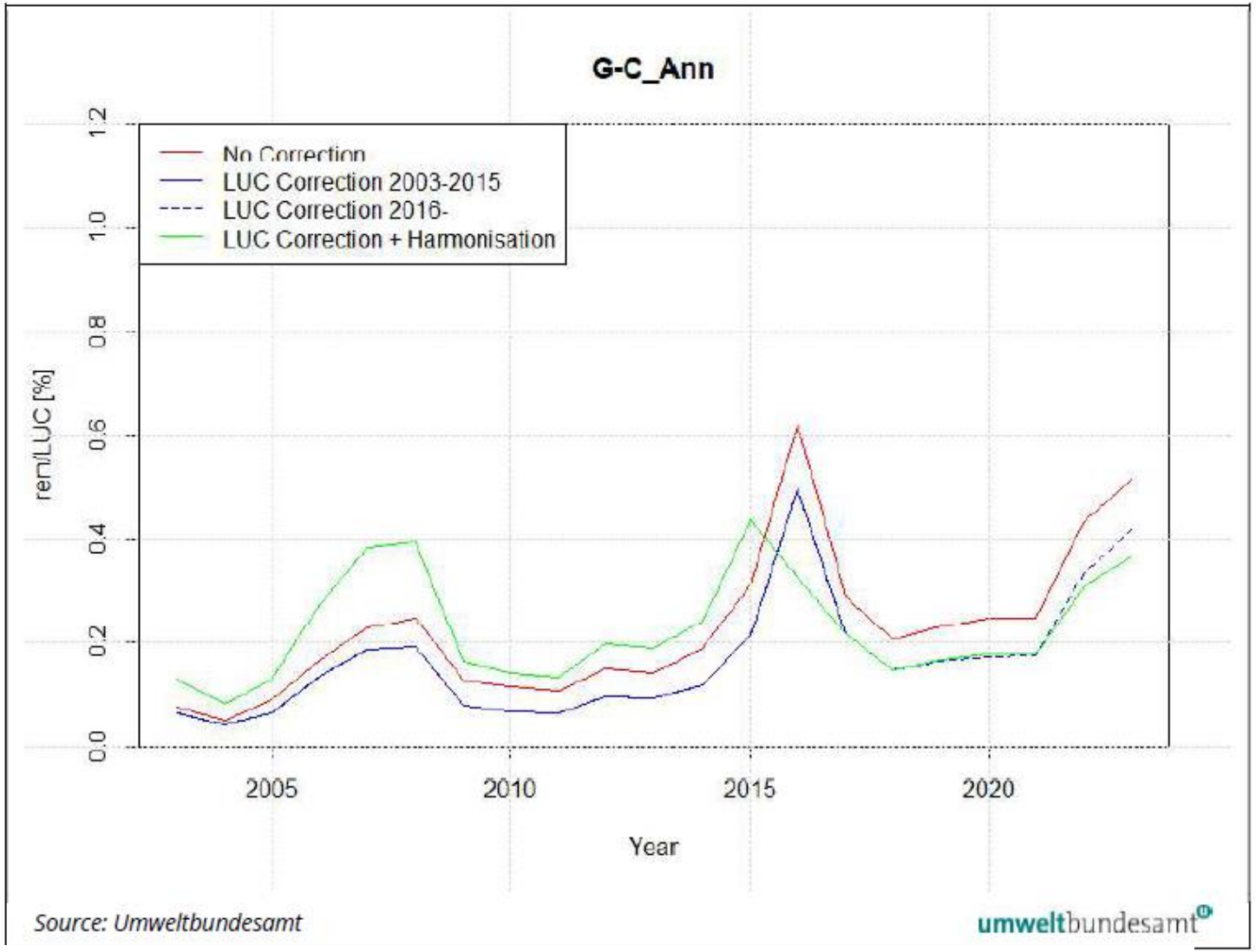


Figure 7: Grassland converted to annual Cropland as a percentage of total Cropland area. The different lines illustrate the adjusments according to the above correction and harmonisation steps

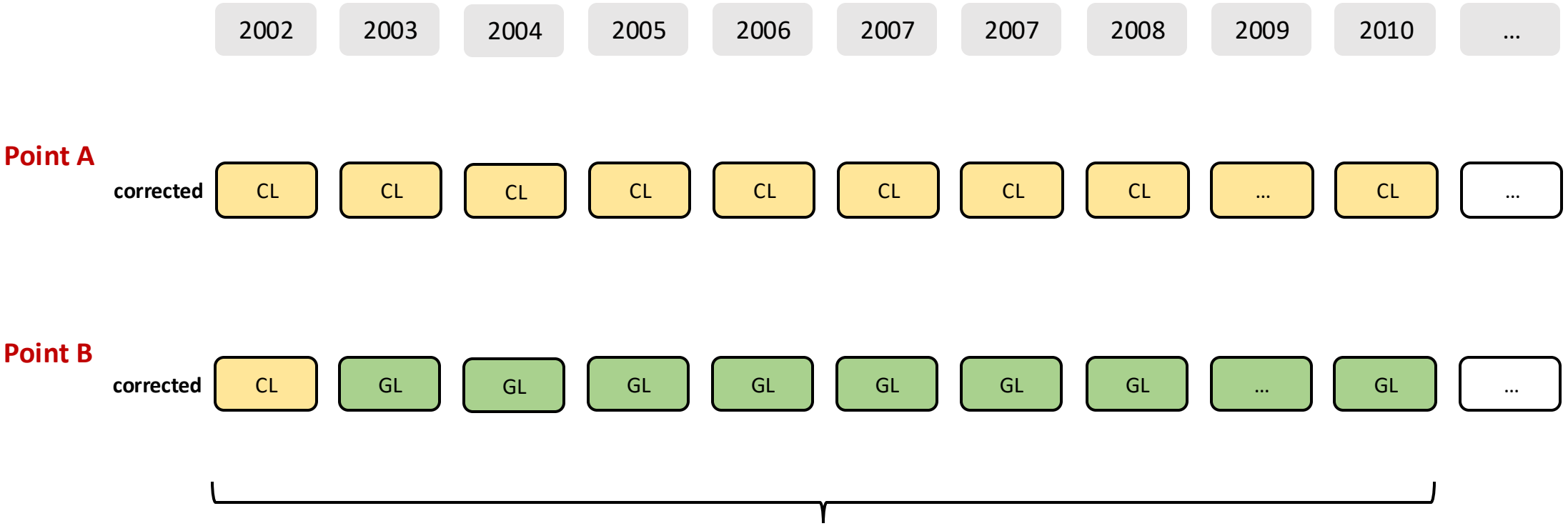
(Austria 2025 NID, Annex 5.2)

→ the module computes annual conversion percentages of the total sampled CL area, not converted areas

→ statistical treatment to adjust the two periods (2002-2015 & 2016-present)

Ex 2: Austria

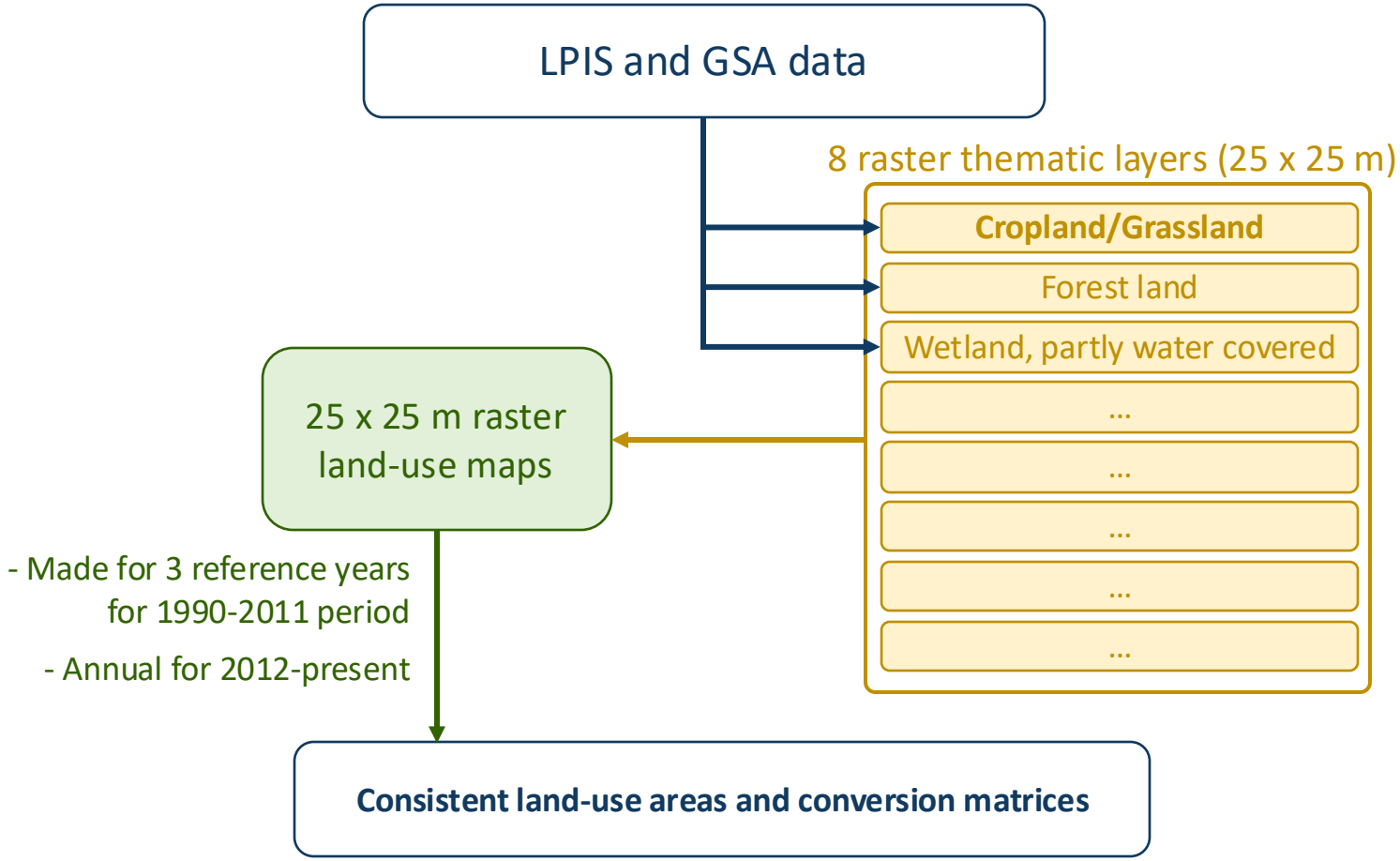
How to cover years with no IACS data available?



The mean annual conversion percentages over 2002-2010 is computed from the corrected series.

The value is extrapolated over the 1970-2001 as a constant estimate.

Ex 3: Denmark – IACS integration strategy



The fully spatially-explicit method implemented for the **CL/GL thematic layer** requires to use LPIS and declaration data in a complementary way to spatially disaggregate land-use information :

- to create the **1990, 2005, 2011 reference maps**
- to fully **apply a 5-year rule over the 2012-present period** to distinguish crop rotations from CL/GL conversions

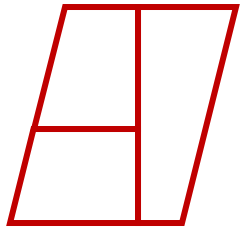
Ex 3: Denmark – 1990-2011 method

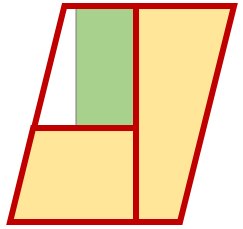
How to bridge format changes?

LPIS reference parcels

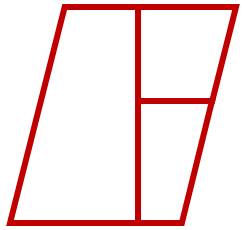
Declaration data

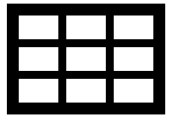
2011



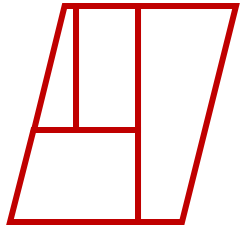


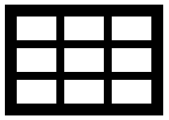
2005





1998





1998 is used as a proxy for 1990

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Ex 3: Denmark – 1990-2011 method

How to cover years with no IACS data available?

How to bridge format changes?

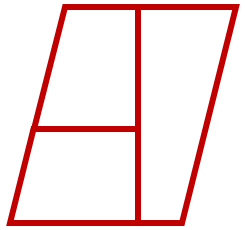
LPIS reference parcels

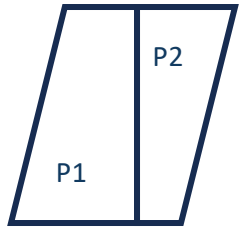
Aggregated reference parcels (stable spatial units)

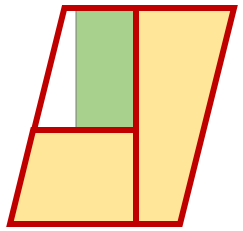
Declaration data

Spatial disaggregation

2011





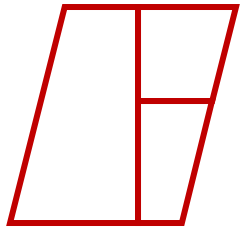


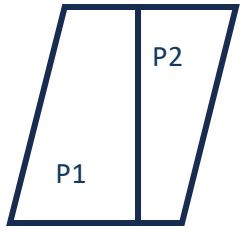
% total surf.

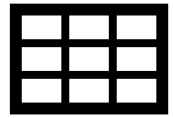
P1	CL	60
	GL	40
P2	CL	100

Declared agricultural area in 2011 is assumed to be agricultural in 2005 and 1998

2005

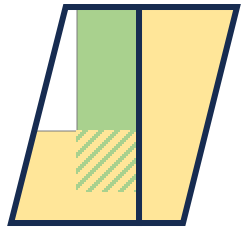




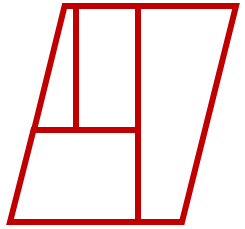


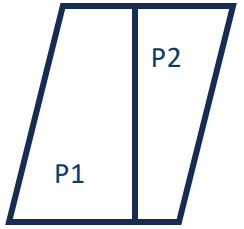
% total surf.

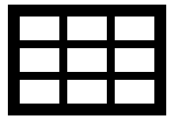
P1	CL	40
	GL	60
P2	CL	100



1998







% total surf.

P1	CL	70
	GL	30
P2	CL	100



Legend

- Declared Cropland
- Declared Grassland
- Reference parcel boundary
- GL converted to CL

1998 is used as a proxy for 1990

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Ex 3: Denmark – 2012-present method

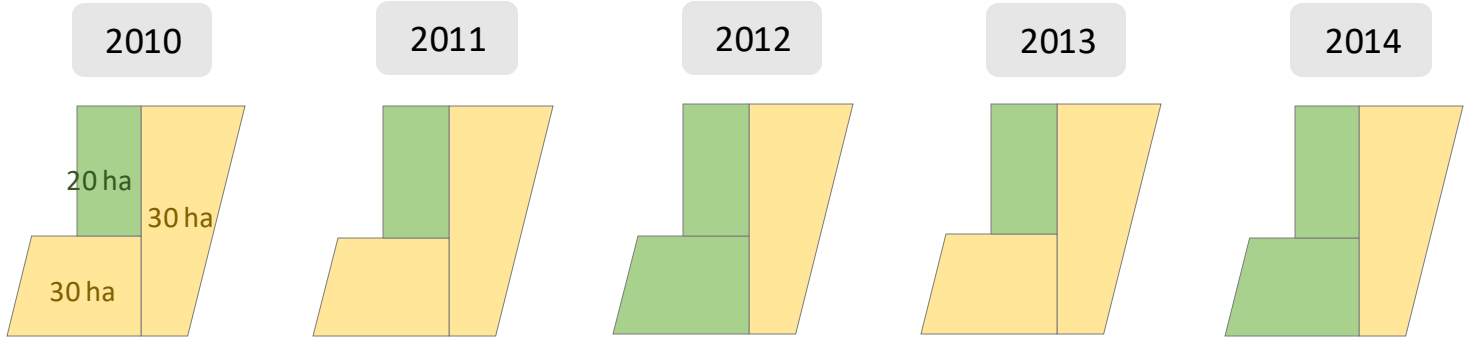
How to tell a land-use conversions from a crop rotations?

Short-term changes are checked using the last 5 years: GL must have remained GL over the last 5 consecutive years to be classified as such.

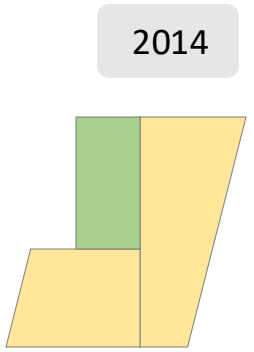
Legend

- Declared Cropland
- Declared Grassland
- Reference parcel boundary
- GL converted to CL

Declaration data



Final land use



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Ex 3: Denmark – 2012-present method

How to tell a land-use conversions from a crop rotations?

How to bridge format changes?

Short-term changes are checked using the last 5 years: GL must have remained GL over the last 5 consecutive years to be classified as such.

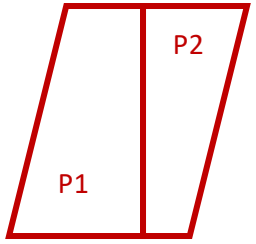
Legend

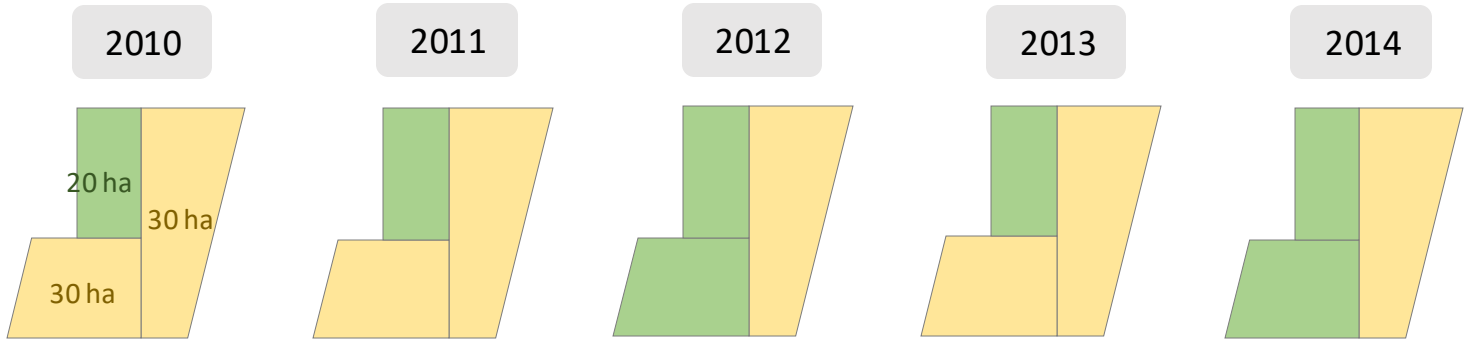
- Declared Cropland
- Declared Grassland
- Reference parcel boundary
- GL converted to CL

Declaration data

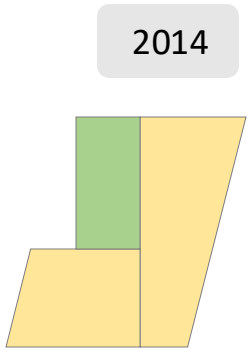
		Surf (ha)
P1	CL	10
	GL	40
P2	CL	30

Reference parcel





Final land use



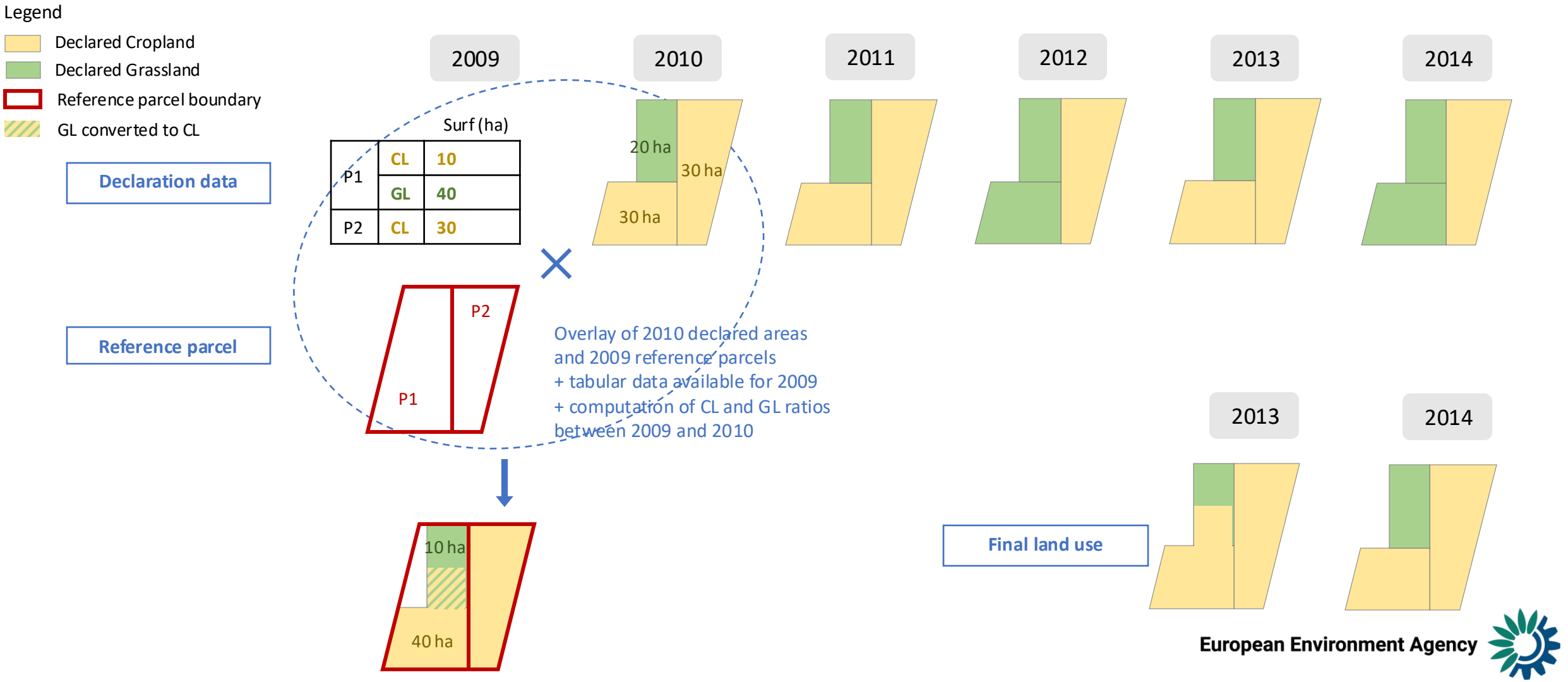
European Environment Agency

Ex 3: Denmark – 2012-present method

How to tell a land-use conversions from a crop rotations?

How to bridge format changes?

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Four methodological questions - Synthesis

	FRANCE	AUSTRIA	DENMARK
Conversion or rotation?	No 5-year rule (the crop type is used as such at the finest resolution available)	5-year rule: land-use change is checked using the 5 following years (classification of crop types as annual crops, perennial crops or grassland)	5-year rule: land-use change is checked using the 5 past years (classification of crop types as cropland or grassland)
Years without IACS use?	1970-2007 – Extrapolation of the crop types using a Markov model as long as the use remains agricultural in the general land-use product	1970-2001 – Extrapolation of the mean of the oldest computed conversion percentages backwards	1990-1998 – Use of the earliest data available
Missing parcels?	The previous crop type information is carried out forward as long as the use remains agricultural in the general land-use product	Percentages conversions are computed from the partially incomplete time series (and not areas)	?
Data format changes?	Only the latest and most detailed format is used + extrapolation via Markov chain	External data sources (cadastral layer + geographical sampling points) are used to join tabular and spatial geographical declaration data	Construction of a layer of stable spatial units to compare data over the period 1990-2011 + spatial disaggregation method


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Thank you!