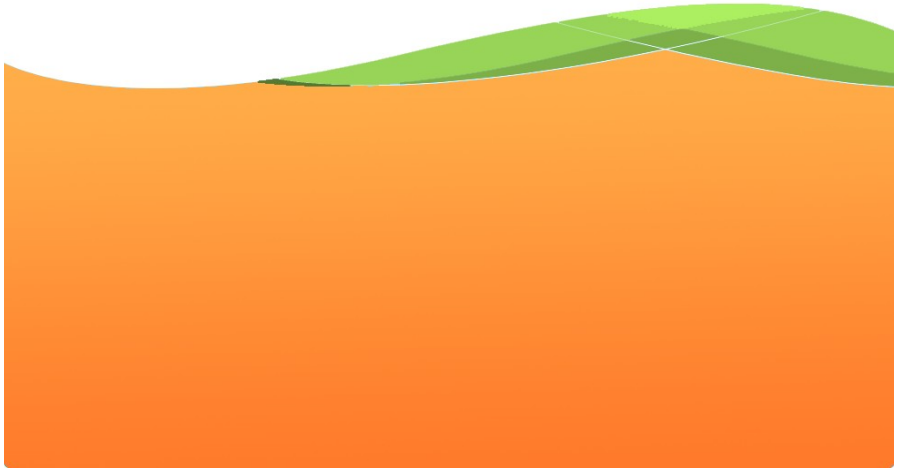
GIO-land



European Environment Agency

opernicus

Copernicus Initial Operations Land: Services, current status and ideas for validation

Gyorgy.Buttner@eea.europa.eu

Land Products Validation and Evolution Workshop 28-30 January 201
– ESRIN, Frascati, Italy

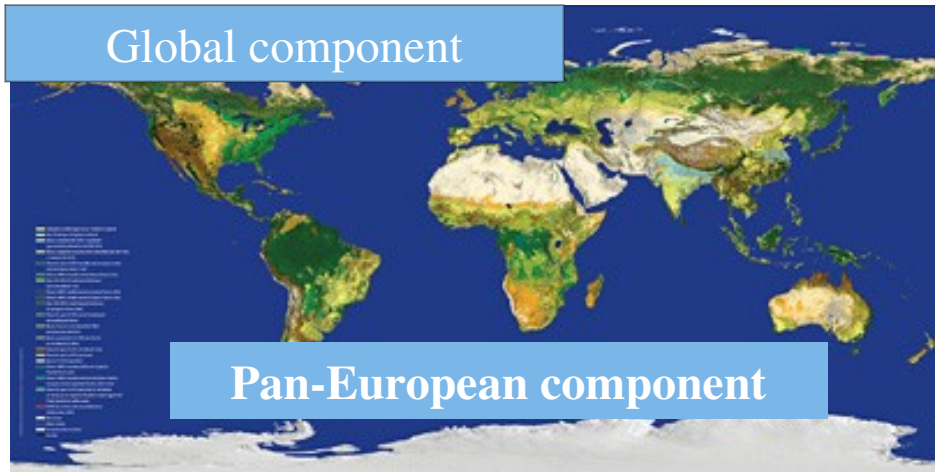
Outline

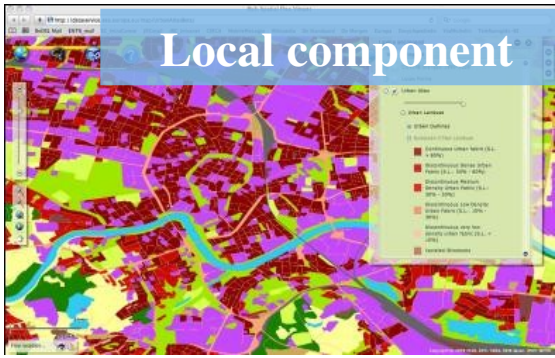
Copernicus Initial Operations land

- Continental component
- Satellite imagery
- High Resolution Layers (new)
- CLC2012
- Progress and examples
- Ideas for validation

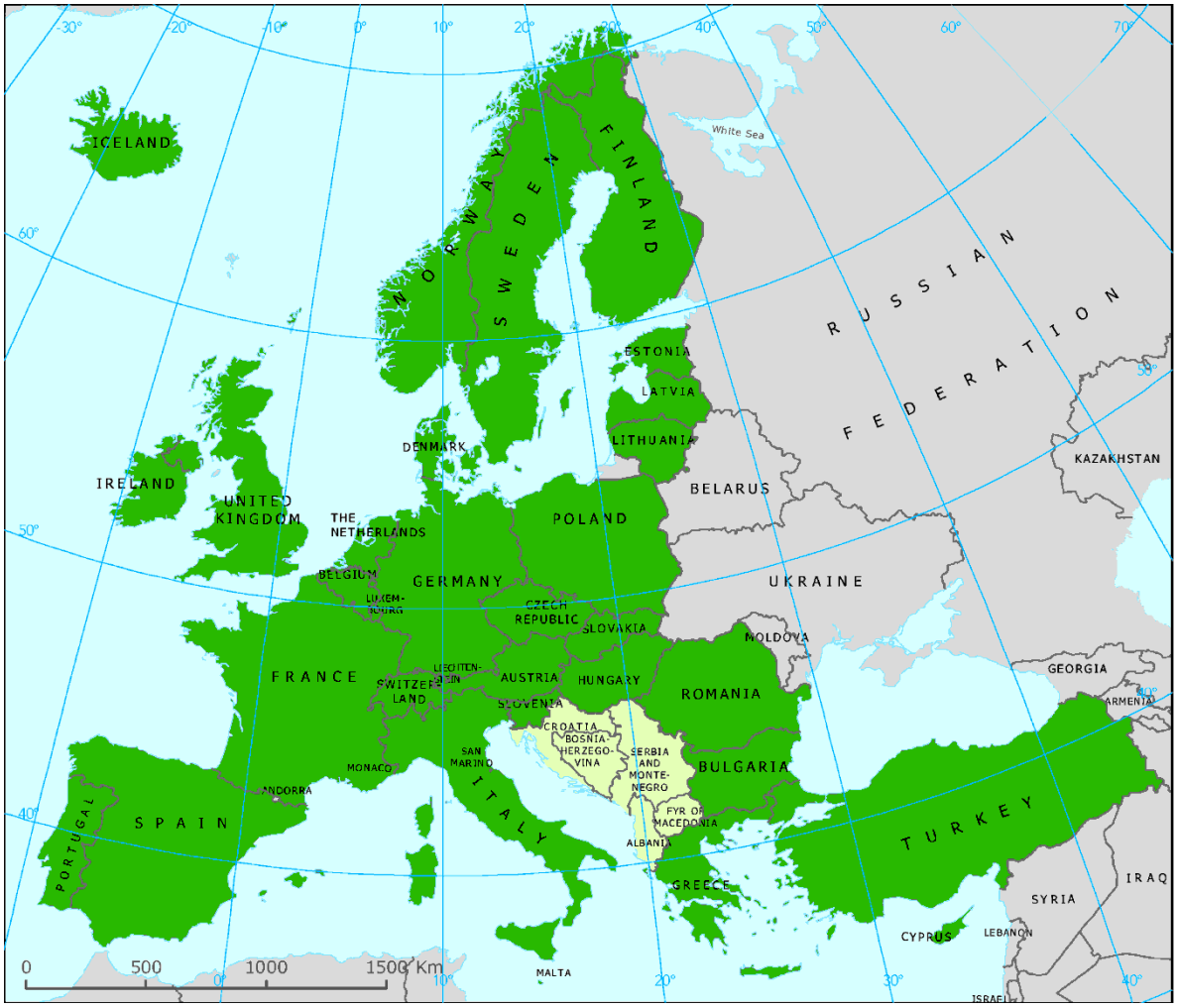
Copernicus Initial Operations land (GIO land) components

- **Global** → JRC
  bio-physical parameters (Essential Climate Variables (ECVs), food security (Africa) etc.)
- **Continental** → EEA
  pan-European products (CLC 2012, five HRLs: imperviousness, forest, grassland, wetland, water). HR satellite image mosaic
- **Local** → EEA
  zooming on 'hot spots': urban atlas, riparian areas
- **Dissemination** + archiving + cataloguing → EEA
- Improve **access to in-situ** data → EEA





Copernicus Initial Operations land Geographical coverage



EEA member countries

- Member countries
- Collaborating countries

- 6M km2
- 39 countries (**EEA39**)
  - EU28
  - additional 5 EEA MS
  - 6 cooperating countries

Satellite images from ESA DWH used in GIO land (Pan-EU and local)

	type	coverage	primary application
MR	IRS AWiFS (60 m, monthly March-to-Oct composites)	continental (several coverages)	• HRL grassland • HRL wetland • HRL water
HR	**IRS/Resourcesat LISS III,** SPOT 4/5 (20m) **RapidEye** (5m, 20m)	continental	• HRL imperviousness • HRL forest • HRL grassland • HRL wetland • HRL water • CLC 2012 update
VHR	SPOT-5, Formosat, EROS-A/B, Ikonos, GeoEye, QuickBird, Wordview-1/2	continental	• UA 2012 update • Riparian Areas • HRL Forest

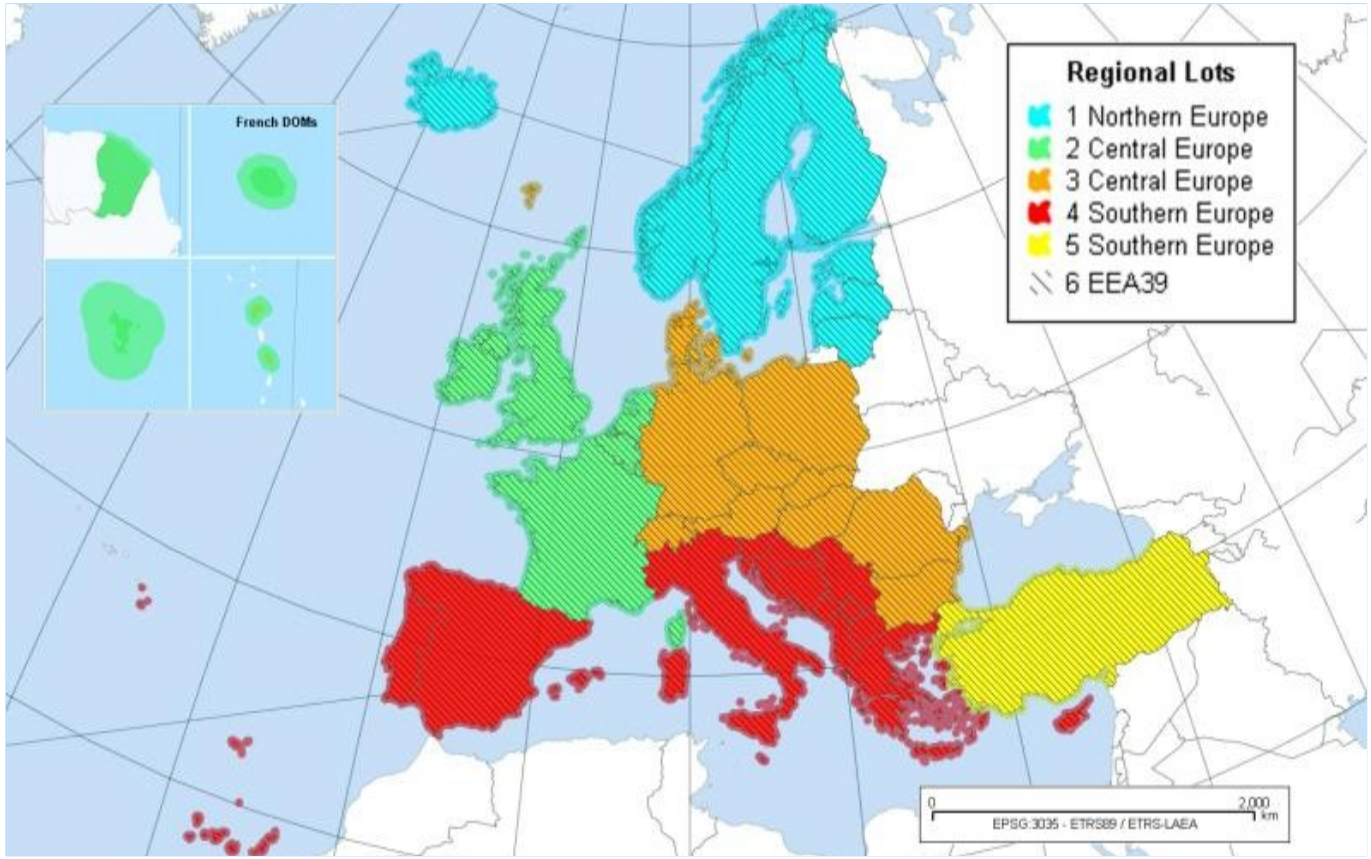
Workflow: HRL production

European Environment Agency

technical coordination, QA/QC, contracting, grants, administration

HRL production

Work distributed in 6 lots



- **Harmonisation** required to ensure coherence and homogeneity of the products.
- Initial statistical assessment of **streamlining** results required before full production mode.

Degree of Imperviousness

definition

- **Produced** using automatic derivation based on calibrated **NDVI**.
- Intermediate product: no MMU (20m x 20m), minimum mapping width: 20m
- Degree of imperviousness is **expressed in %** (1-100).
- Final product: 100m x 100m degree of imperviousness - will be validated
- The only HRL having produced before for Europe (2006, 2009)



Tree cover density, Forest type

definition

Tree cover density

- Automatic classification of HR imagery; training sites from calibrated VHR imagery.
- Intermediate product: no MMU (20m x 20m), minimum mapping width: 20m
- Tree Cover Density range: 1-100%
- Final product: 100m x 100m tree cover density - will be validated

Forest type

- Intermediate product (20m x 20m): derived from **Tree Cover Density ≥10%**, **MMU = 0.5 ha** (FAO); minimum mapping width = 20m; 2 dominant leaf type classes: broadleaved and coniferous
- Final product (100m x 100m): will be validated; **3 forest classes**. Non-forestry trees are excluded (trees used for agriculture and urban context).

Permanent grassland

definition

- **HR images of three reference years** (2006, 2009, 2012) are used to detect the permanent presence of grassland.
- Intermediate product: no MMU (20m x 20m), minimum mapping width: 20m; **binary map** (grassland / no grassland)
- Final product: 100m x 100m – will be validated. **Occurrences of permanent grassland** under **agricultural use** (0-100%). Grassland in urban context, airports and sport and recreation areas are excluded.

Wetland

definition

- Areas covered **temporarily by surface water** during the reference year (2012) are mapped by **AWiFS monthly** time series and HR imagery.
- Intermediate product: no MMU (20m x 20m), minimum mapping width: 20m; **binary map** (wetland / no wetland)
- Final product: 100m x 100m - will be validated **occurrences of wetland** (0-100%)

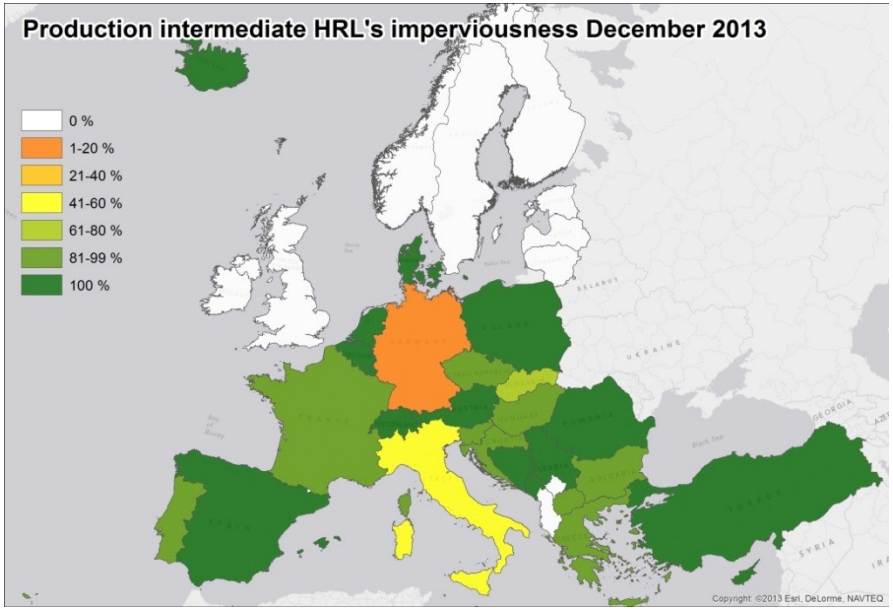
Water bodies

definition

- High resolution images of three reference years (2006, 2009, 2012) are used to detect the **permanent presence of surface water**.
- Intermediate product: no MMU (20m x 20m); minimum mapping width: 20m; **binary map** (water / no water)
- Final product: 100m x 100m - will be validated **occurrences of water** (0-100%)

Pan-European continental component

Imperviousness Forest (2 layers)



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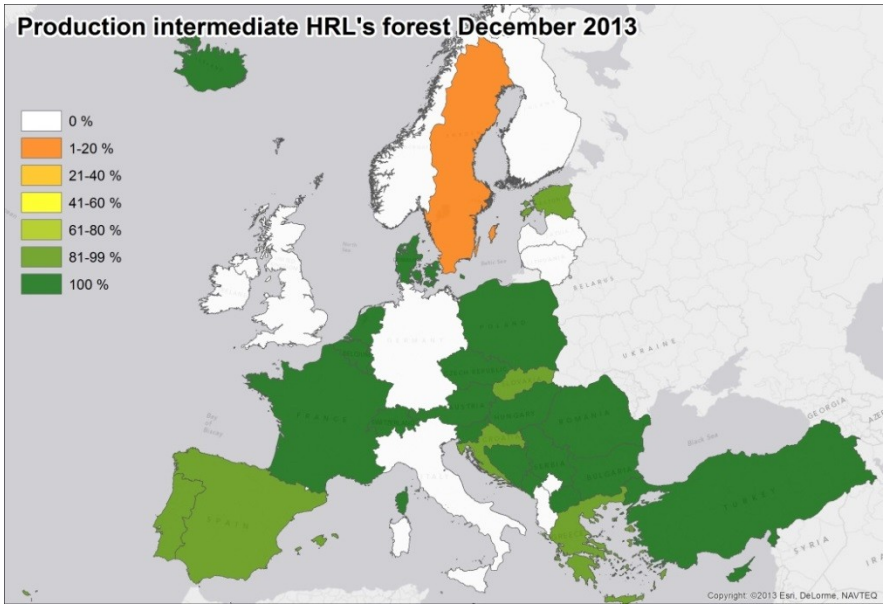
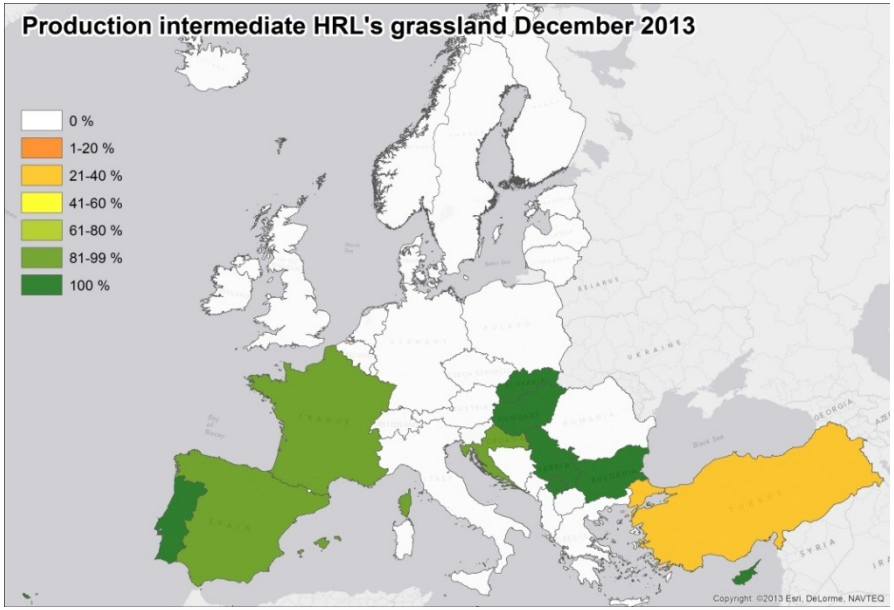


First step in validation: semantic checking of all deliverables by ETC-SIA

Pan-European continental component

Grassland Wetland & water



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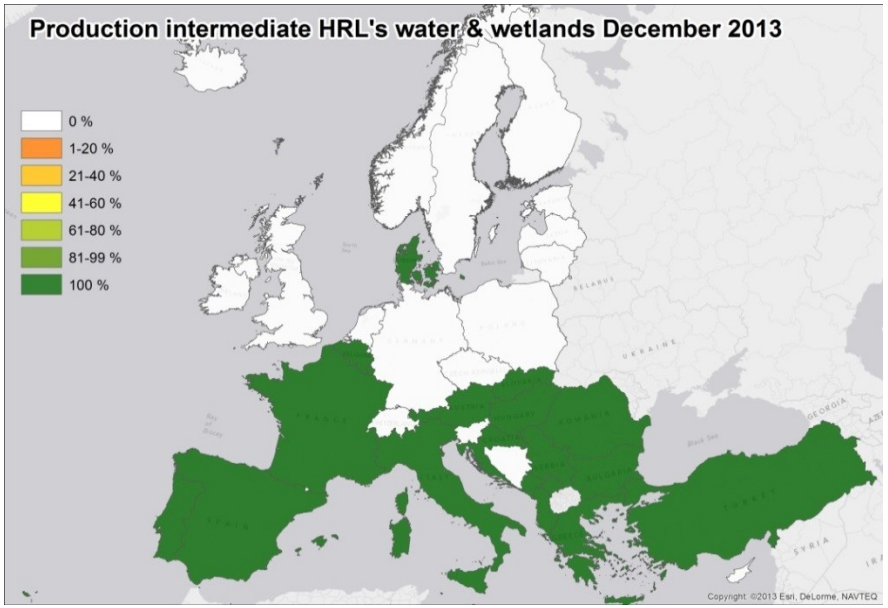
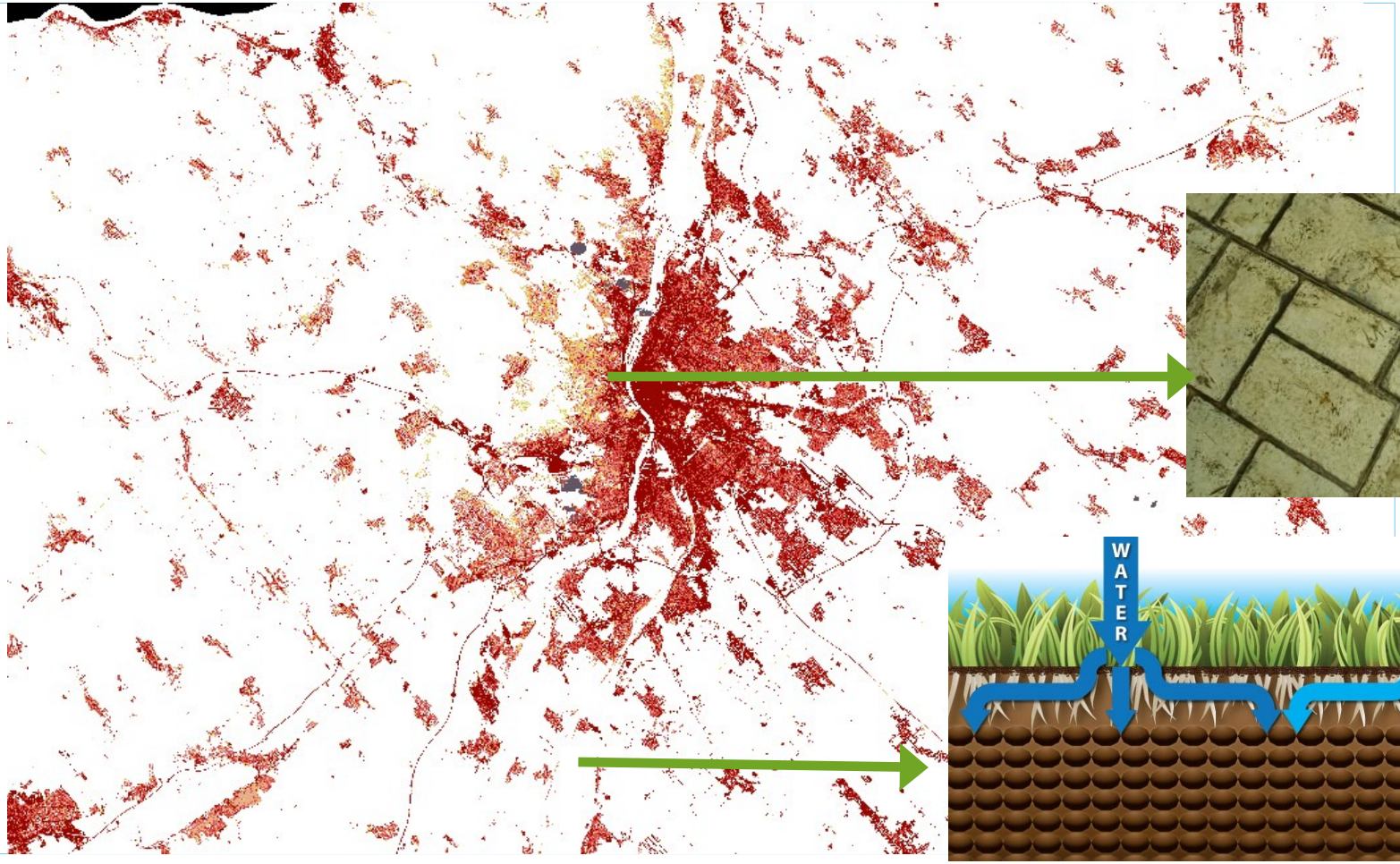


First step in validation: semantic checking of all deliverables by ETC-SIA

Degree of imperviousness

HRL example

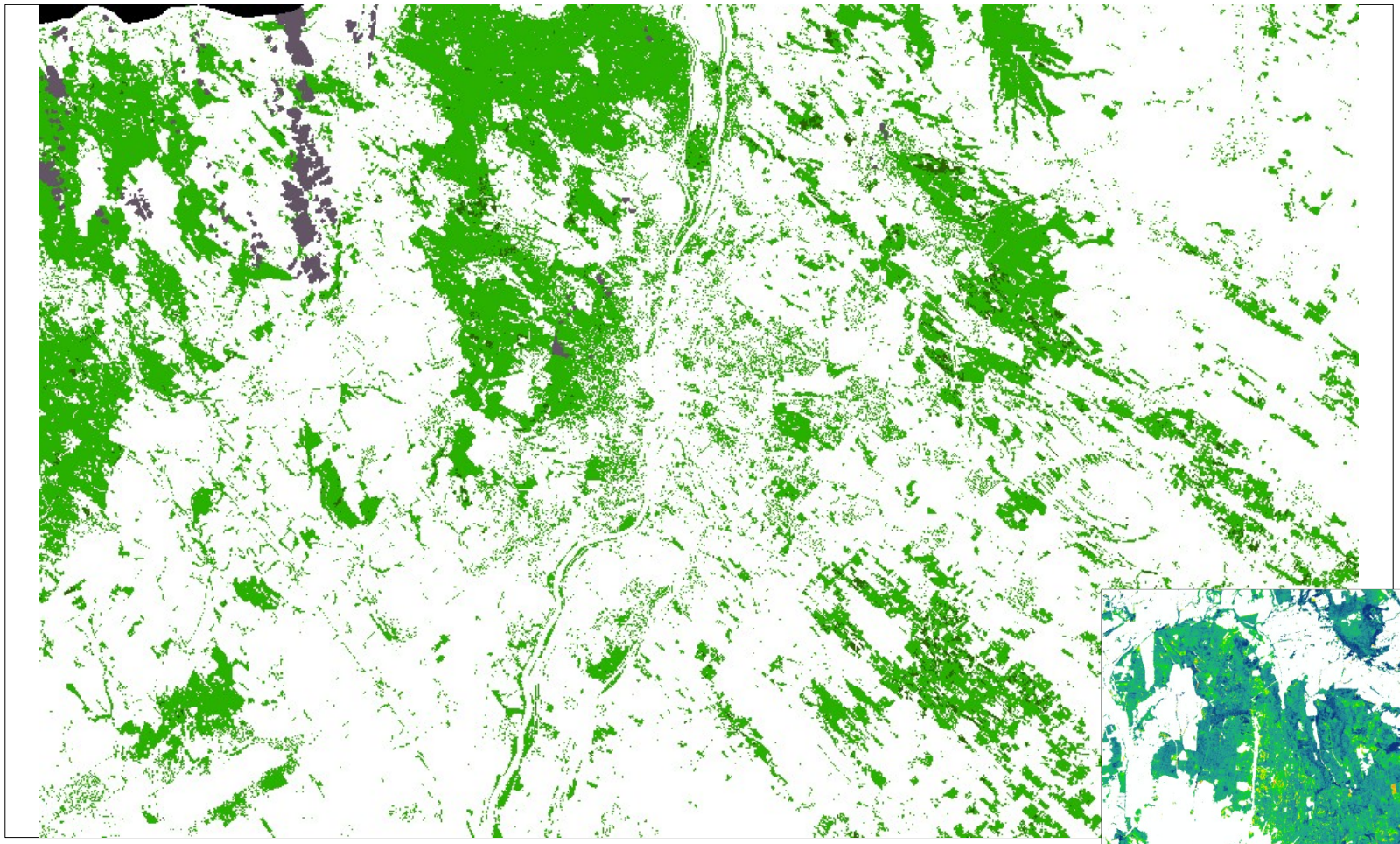


Budapest, HU

European Environment Agency

Tree cover density, Forest type

HRL example

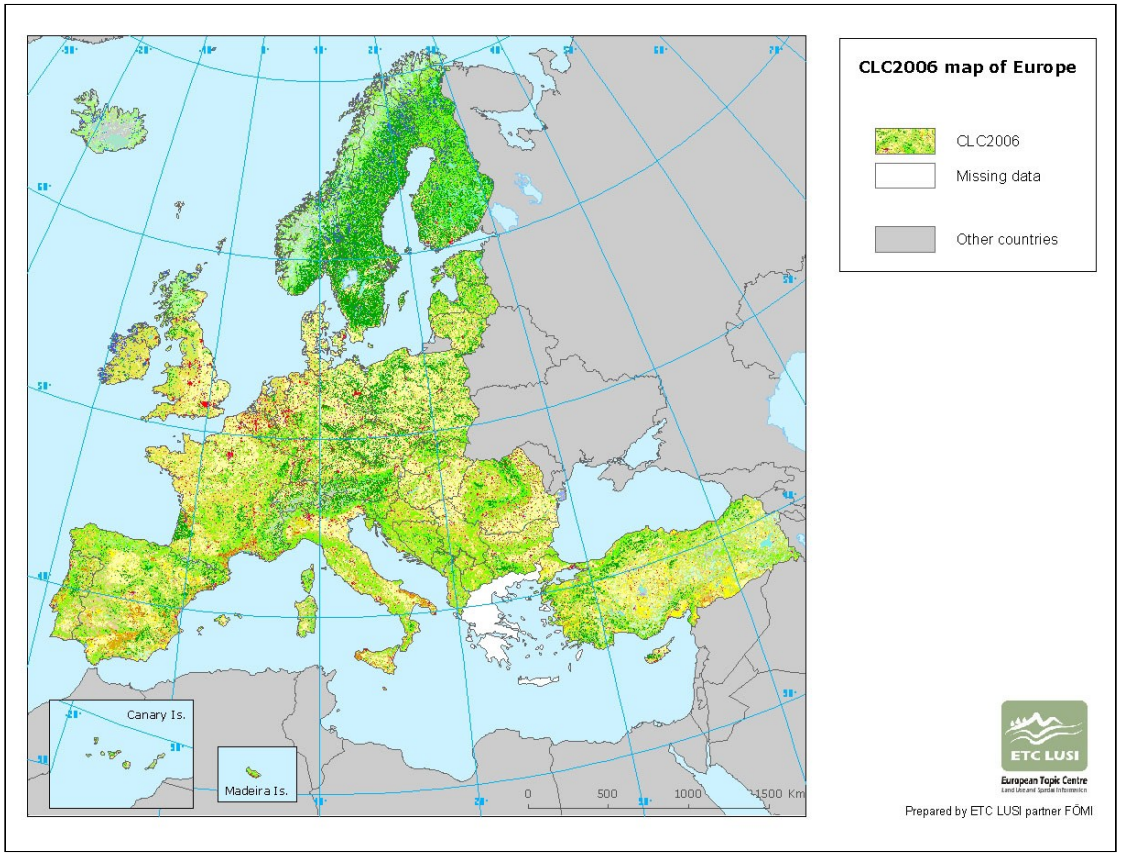


Around Budapest, HU

European Environment Agency

Pan-European Continental Component

CORINE Land Cover



Mapping surface features of Europe at medium scale based on (mostly) physical characteristics

Minimum mapping unit: 25 ha

MMU change mapping: 5 ha

Minimum mapping width = 100 m

Nomenclature: 3 levels, 44 level-3 classes in Europe

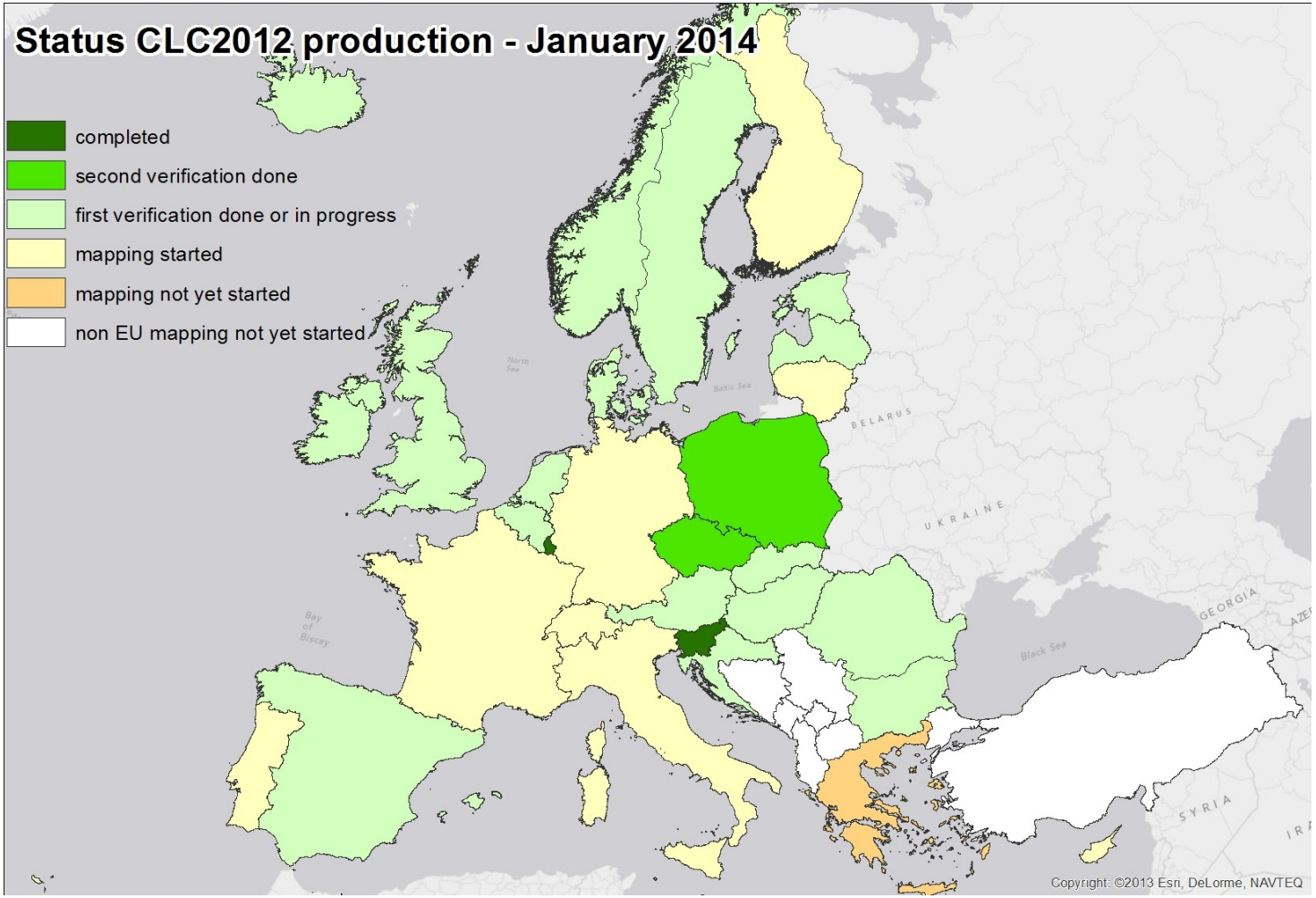
Long heritage: CLC1990, CLC2000, CLC2006, **CLC2012**

National Teams (bottom-up), simple workflow

CLC-changes2006,2012 are mapped;

CLC2012 = CLC2006+CLC-Changes

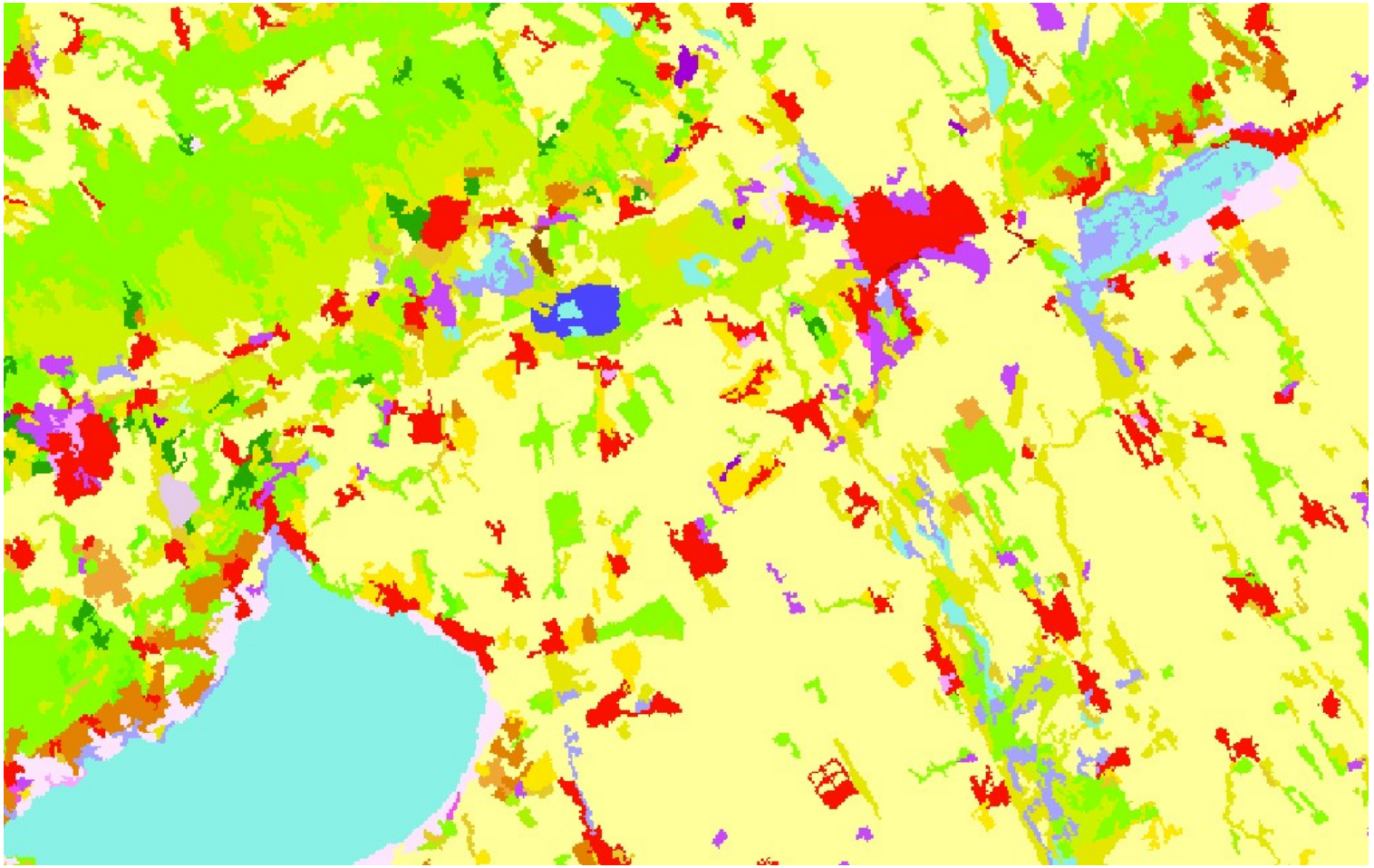
CLC status – January 2014



Progress is followed-up by 2 verifications in each country by EEA & ETC-SIA.

European Environment Agency

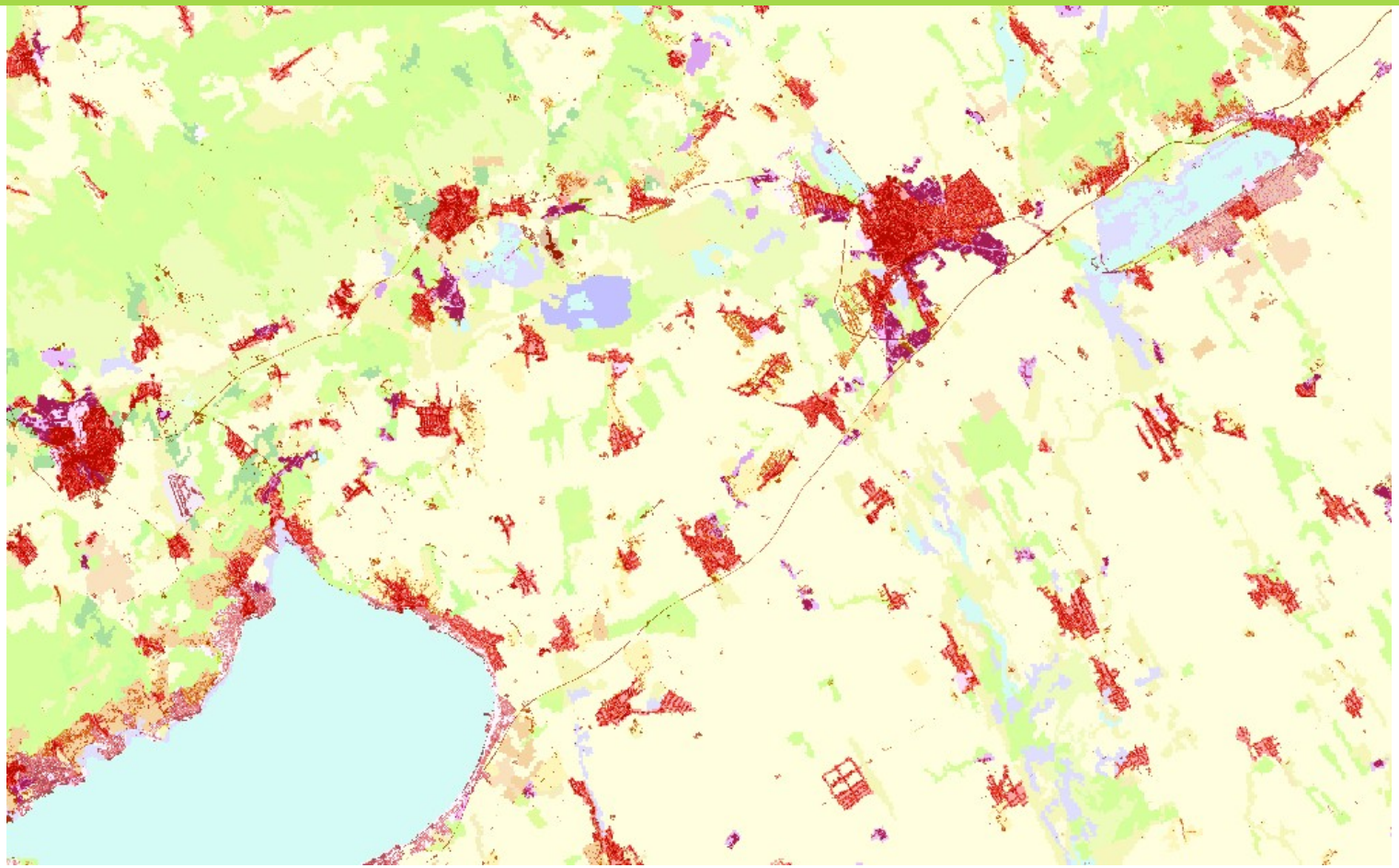
CORINE Land cover map



Lake Balaton (HU)

CLC + degree of imperviousness

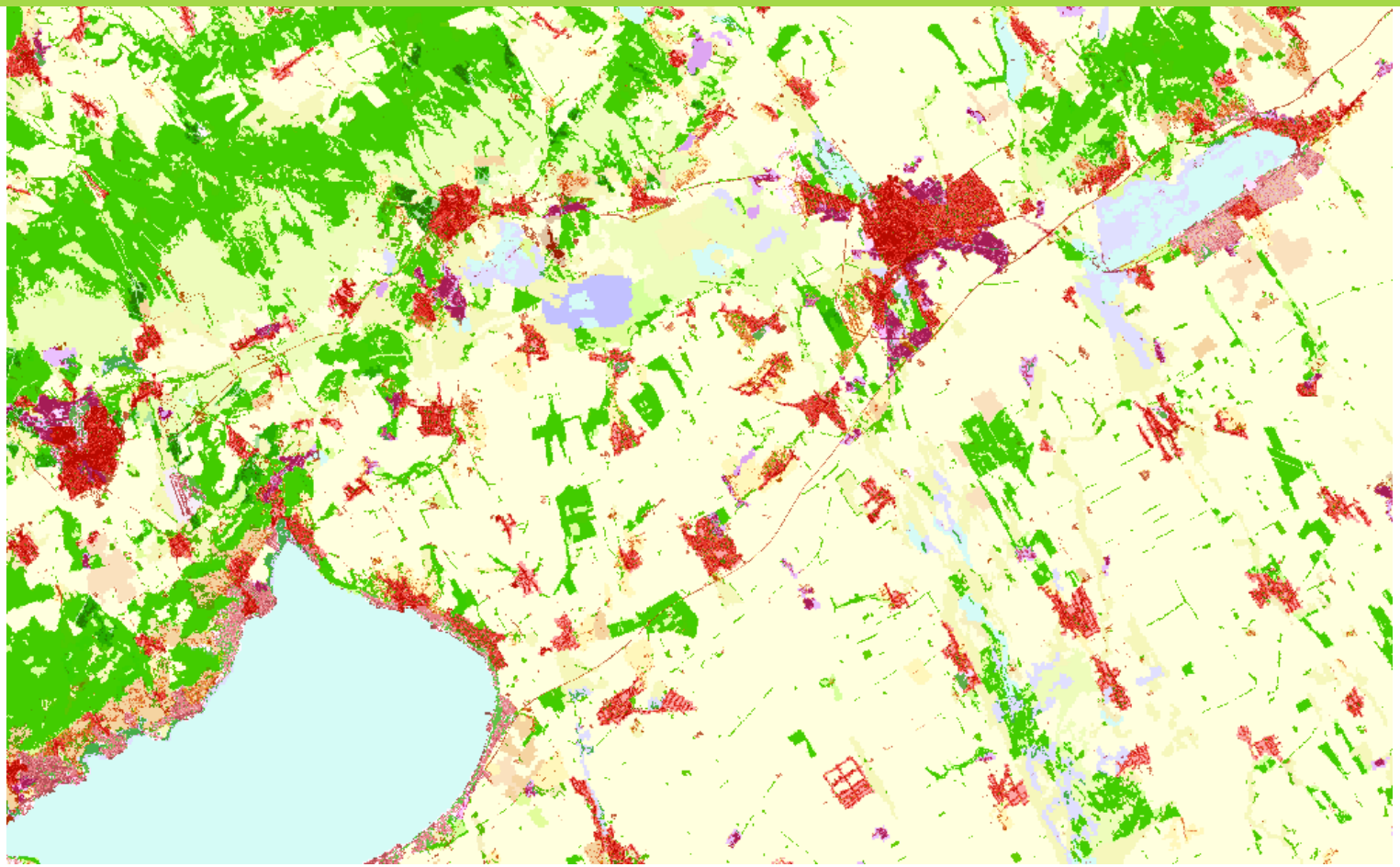
Integrating CLC and HRLs



Lake Balaton (HU)

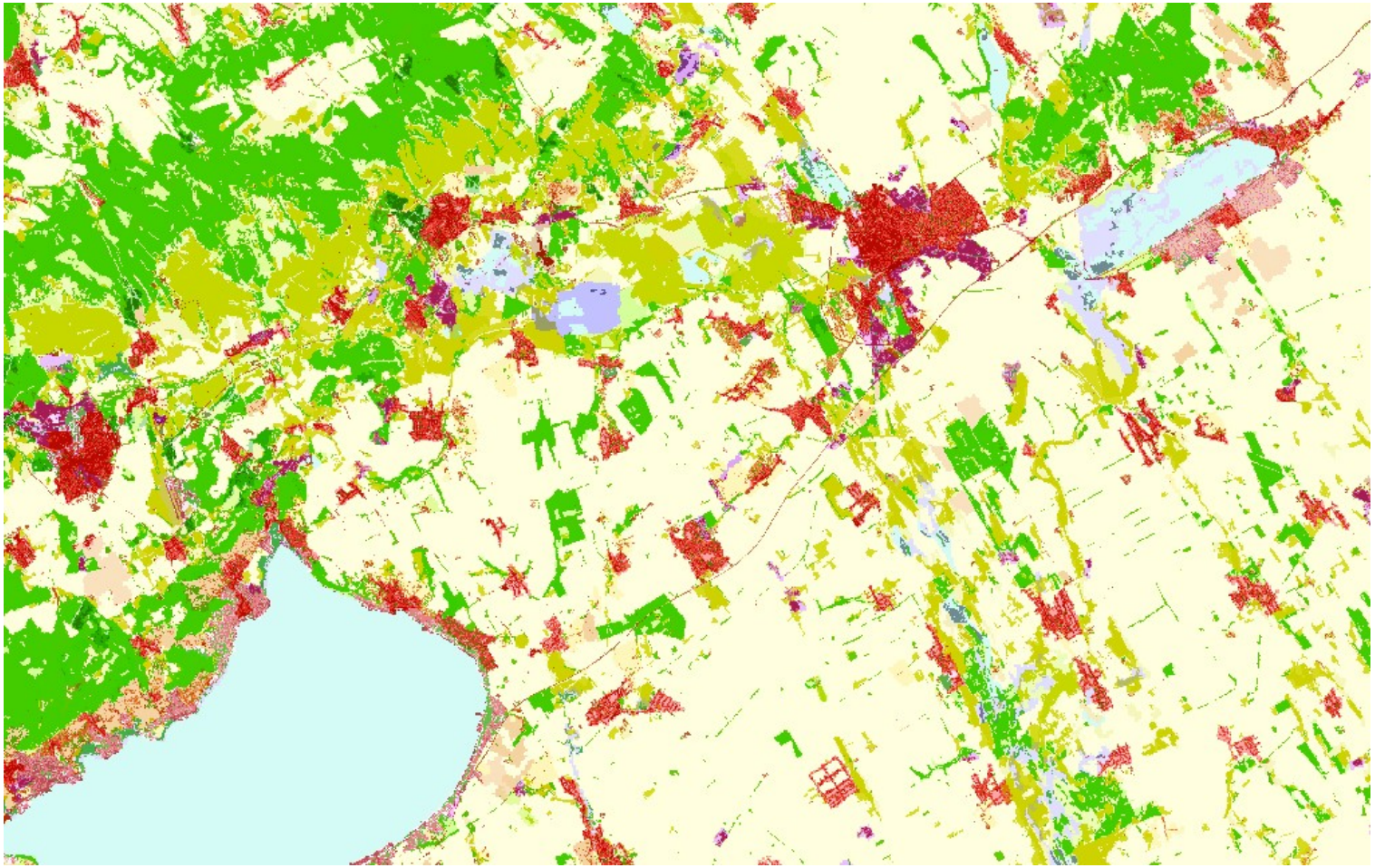
CLC + Imperviousness + Forest type

Integrating CLC and HRLs



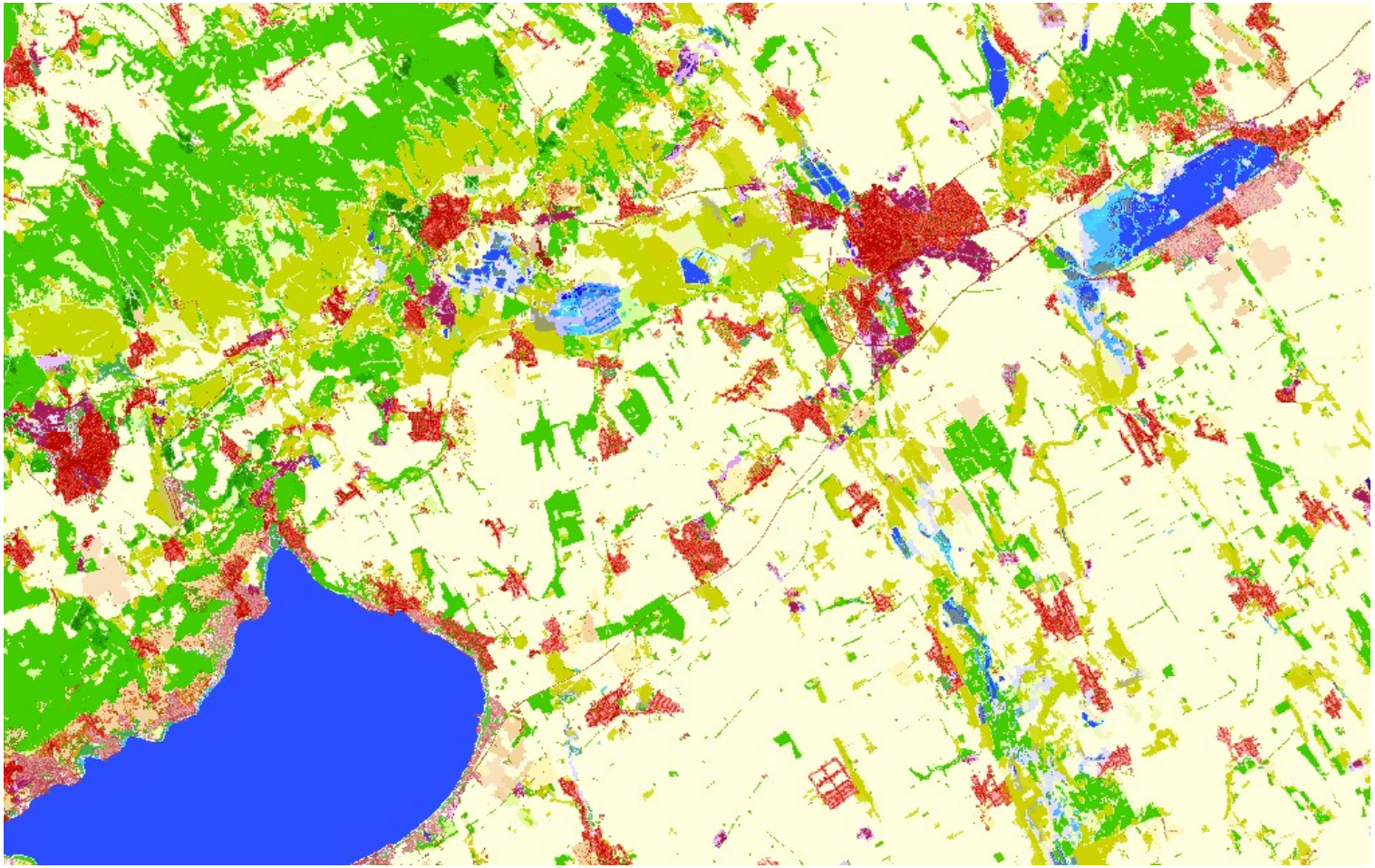
Lake Balaton (HU)

CLC + Imperviousness + Forest type + Grasslands



Integrating CLC and HRLs: Lake Balaton (HU)

CLC + Imperviousness + Forest type + Grasslands + Wetlands + Water



Integrating CLC and HRLS: Lake Balaton (HU)

GIO land HRLs
final products to validate

Product (100m x 100m)	Year	Classification (100m grid cells)	Type of product
Degree of Imperviousness	2012	Occurrence (0 – 100%) of imperviousness	Density layer
Tree cover density	2012	Occurrence (0 – 100%) of tree cover	Density layer
Forest type	2012	Broadleaved or coniferous (plus non-forest)	Map layer (3 classes)
Permanent grassland	2006 – 2009 – 2012	Occurrence (0-100%) of permanent grassland in Δ=4%	Pseudo density layer
Wetlands	2006 – 2009 – 2012	Occurrence (0-100%) of permanent wetland in Δ=4%	Pseudo density layer
Permanent water bodies	2006 – 2009 – 2012	Occurrence (0-100%) of permanent water in Δ=4%	Pseudo density layer

Aims of the validation

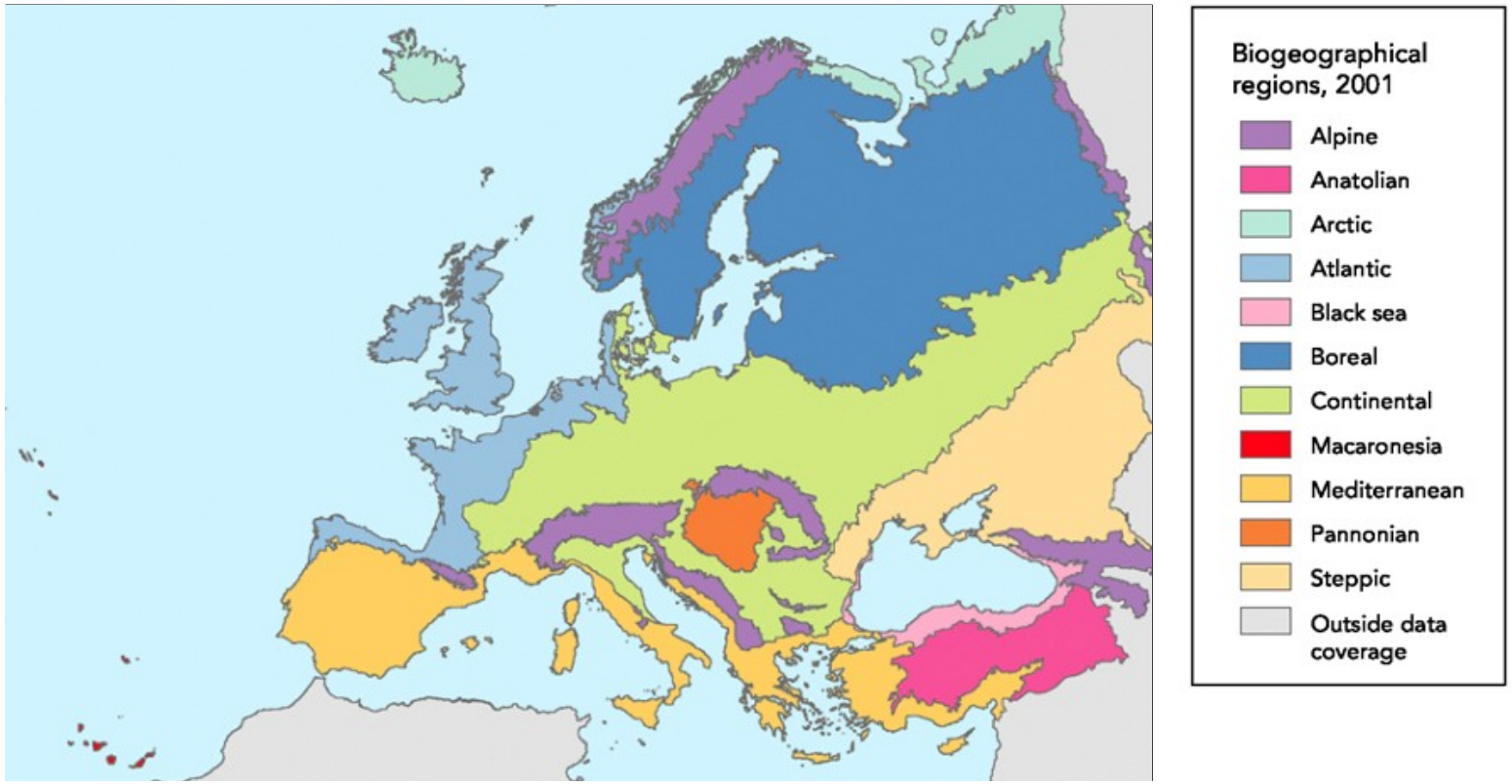
- To derive an **independent estimation** of the **accuracy** of the **European products** by using higher resolution information
- To inform **users** about the accuracy of final products
- No feedback to improve production
- ..but influence **planning of next update**
- Enable to assess validity of change detection in time series

Main questions
Planning is on the way

- What is the best approach for **stratification**?
- The primary goal is to validate **map products.** However, at least 2 **density products:** imperviousness and tree cover density have to be validated to check their calibration.
- We need to derive **commission** as well as **omission** error for maps. But how to estimate omission error for a class with low percentage of occurence?
- **How much samples** we need for a representative validation?
- What are the **independent, higher resolution data** to support validation?

Stratification for validation

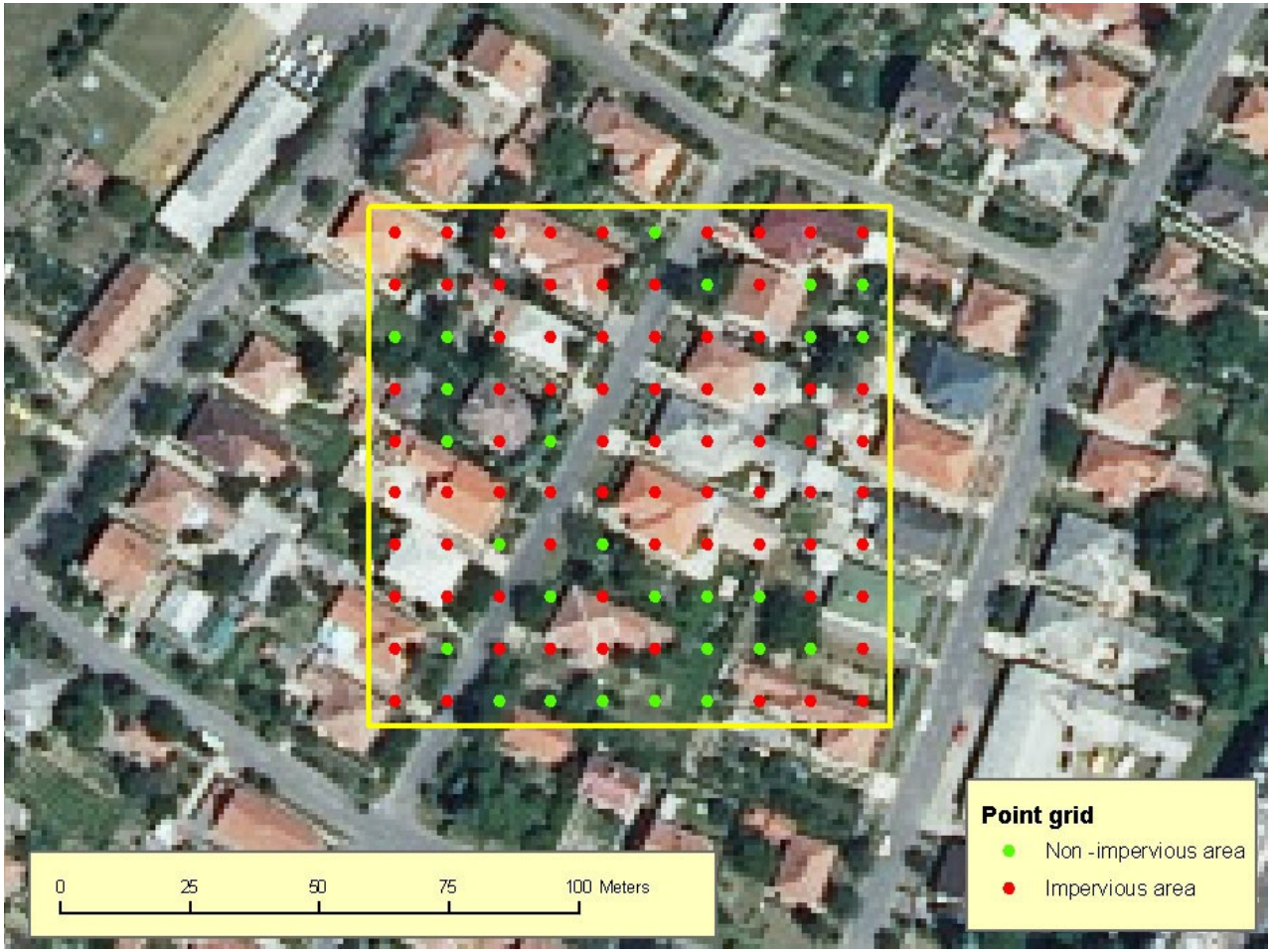
An example



- Bio-geographical regions of Europe can be used for stratification
- Separate results should be derived for each strata

Validation of HR density layers

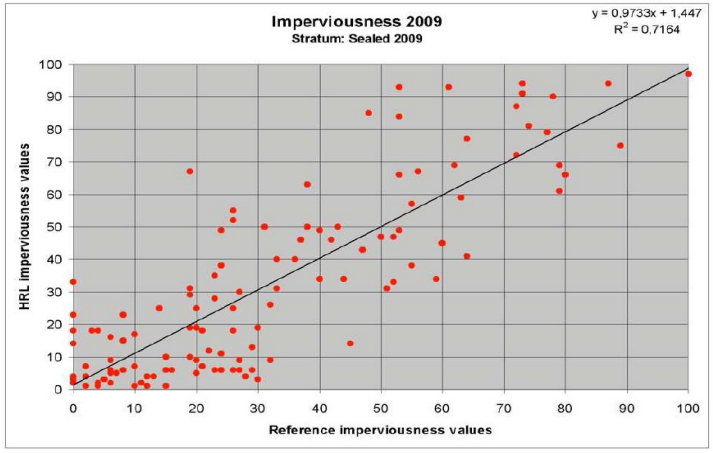
Independent estimation of densities

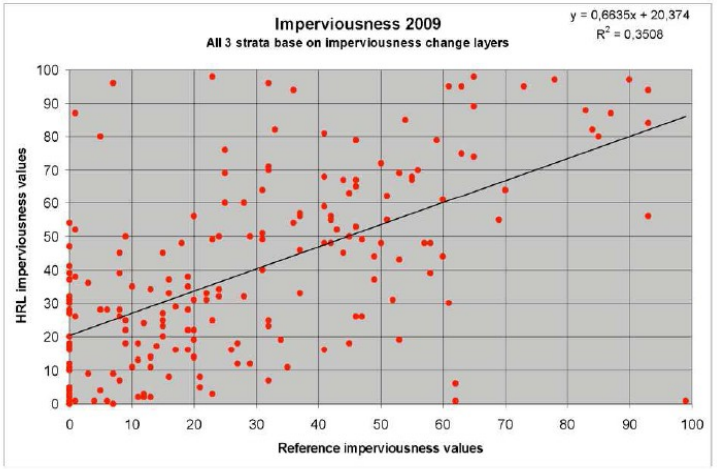


- *Random sampling inside the density layer.*
- *Counting the number of impervious points inside the 100x100 m grid cell on a **VHR image**, the degree of imperviousness in the sample cell is estimated*

Validation of HR density layers
Scatter plots

- Scatter-plot provides the overall view about the agreement between product and reference densities.
- Parameters of the linear trend-line fitted on samples provide information about the calibration.
- Correlation values provide information about the average deviation of sample values from the fitted trend-line .



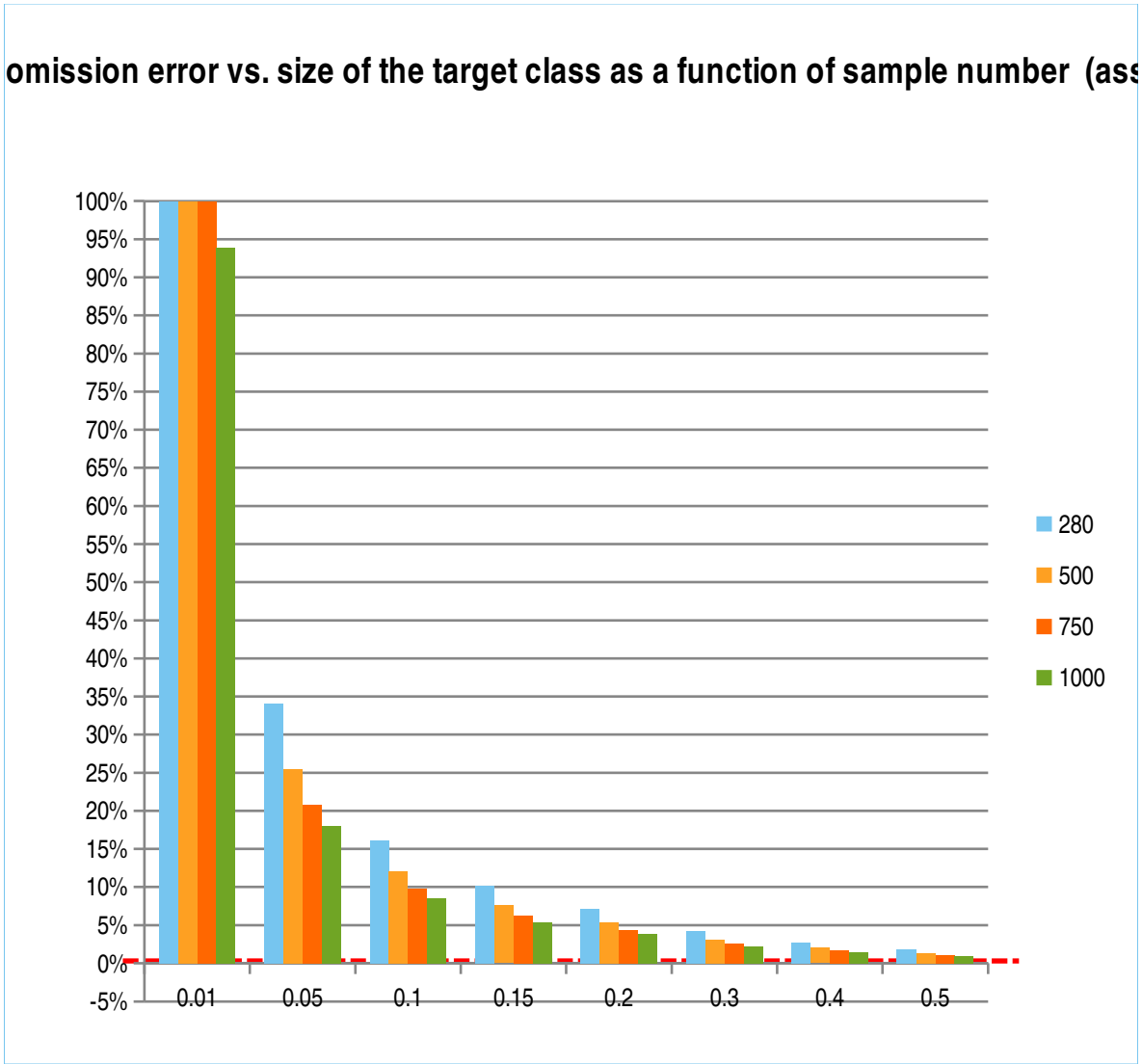


Validation of HR map layers

Built-up, Forest type, Grassland, Wetland, Water

- **Samples** are to be selected **random**ly to check **commission** as well as **omission** errors.
- Locations should be **blindly** interpreted (i.e. without using the HRL) based on an independent HR imagery.
- The interpreted value will be compared with the HRL value (produced by the SP).
- **Contingency matrix** and **omission** and **commission** error rates are derived.
- **Commission** error can be estimated with acceptable accuracy using relatively **few samples.**
- Estimating **omission error** with acceptable accuracy/ confidence is difficult, if the target class has low percentage of occurrence. What kind of **stratification** can be applied?

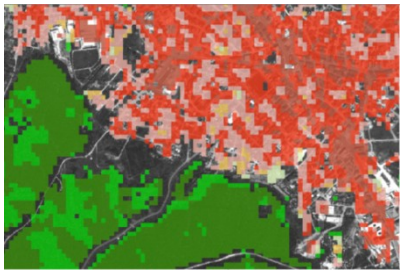
Number of samples, representativity

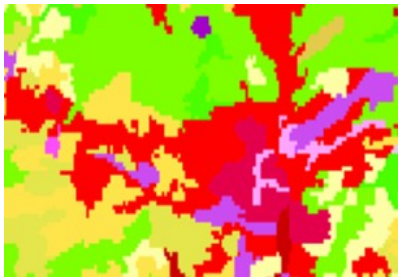


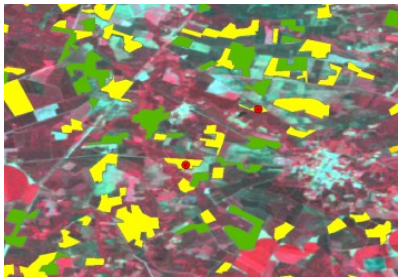
- Sample number should be realistic regarding work load (e.g. max.1000/ HRL/ stratum)
- Estimating omission error is realistic without stratification for target class with size >15-20 %.
- Very large uncertainty for small HRL target class; => stratification!

Software tool for Land Cover and Land Cover Change validation

- LACOVAL tool developed by GeoVille group (www.geoville.com, lacoval@geoville.com)
- Funded by ESA
- Capable to validate density layers, map layers and change-map layers
- On-line version (basic, free), off-line version (expert tool)
- Functionality:
  - Sample generation
  - Support to sample interpretation
  - Validation report generation







Validation data
Independent, higher resolution

Not easy to find suitable validation data, especially for multi-year products (CLC-Changes, grassland, wetland, water)

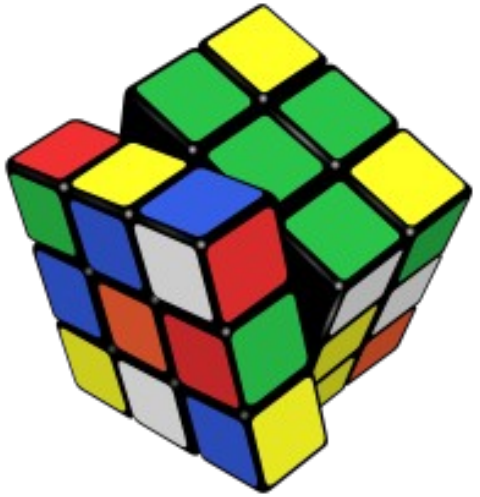
- **National orthophoto** (39 countries): wide access is not realistic
- **Google Earth:** hi-res coverage is not available everywhere; acquisition date is sometimes not correct
- **Eurostat LUCAS 2012/2006:** LU/LC codes and field photographs; applicable to validate map products; EU27 coverage only, sampling focused on agriculture
- **VHR data in DWH** (2011-2013): full coverage, but lots of wintertime images

Pan-European continental component: challenges

- Getting **39 countries** on board (GA,…)
  - Participation of non-EU countries …
- **Satellite image acquisition** remains a bottleneck (meteorology, improper acquisition windows)
- **Keep timing** in a complex production process: to reduce elapsed time between image acquisition and service to < 1 year.
- Designing a **meaningful European validation** for the HRLs and the CLC is a delicate issue.

Copernicus Initial Operations land Continental Component

- Continued production of CORINE Land Cover and HRL Imperviousness.
- New continental HR layers: forests, grassland, wetlands, water bodies.
- Difficulties to have reliable reference data against which to validate. Methodological challenge to validate low occurrence classes.
- Results expected from mid 2014. Freely accessible, validated source of LC information for Europe, which underpins a broad range of EC policies and complements national data.
- Bring Copernicus land services to a fully operational status



Thanks for your attention !

Contact

- Webpage Copernicus: http://land.copernicus.eu
- GIO land at EEA: http://www.eea.europa.eu/themes/landuse/gio-land/gio-land

György Büttner
Senior advisor
Copernicus land services
European Environment Agency
Gyorgy.Buttner@eea.europa.eu