

# LIFE CROLIS: Croatian approach to historic land cover changes

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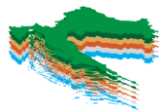


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# LIFE CROLIS PROJECT

**PROJECT GOAL** - developing Croatia's first harmonized, multi-scale land monitoring system, by integrating land-use and land-cover data from national sources and Sentinel satellite observations.

The system will support sustainable spatial and economic planning, LULUCF reporting, and greenhouse-gas mitigation actions in Croatia's land-use sector.

**C1 – CROLIS data concept & model** - based on legislation, reporting needs, available data sources.

**C2 – Sample-based system for historic LC and LU** - using aerial photogrammetric images from 1968–2020, classified into IPCC/LULUCF land categories.

**C3 – Mapping of LC and LU** - whole territory of Croatia, two data models; LC is based mainly on annual satellite images, while LU uses data from state and public institutions.

**C4 – CROLIS database & service implementation**

**C5 – Capacity building for CROLIS reporting**

**C6 – Sustainability of CROLIS**



# CROLIS historic LC changes - input data



## C.2 SAMPLE BASED SYSTEM FOR HISTORIC LC AND LU

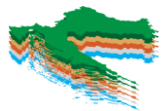


2020.

### Input data:

- 1968. – State orthophoto
- 1990. – SPOT satellite images
- 2000. – State orthophoto
- 2010. – State orthophoto
- 2020. – State orthophoto





# CROLIS historic sampling design and visual interpretation manual



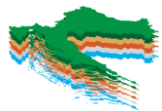
## C.2 SAMPLE BASED SYSTEM FOR HISTORIC LC AND LU

- Sub-Action 1: **Derivation of a sampling design for visual interpretation**
  - Initially - a standard 100x100 m, and later **500x500 m, regular grid** was proposed
- Sub-Action 2: **Preparatory data management and guidelines**
  - Preparation of orthophotos and satellite images
  - **Interpretation manuals for LC and LU** - guidelines for standardizing the visual interpretation
  - CROLIS historic LC categories:
    - Woodland Surfaces
    - Agricultural Surfaces (Periodically, Permanent)
    - Grassy Surfaces
    - Water Bodies Surfaces
    - Artificial Surfaces
    - Bare Soil Surfaces

### Testing phase

- Testing interpretation of LC and LU classes with available historic data
- Testing the approach in 3 small test areas (main representative landscapes)
- The initial grid sample consisted of 12,600 points
- **Project time and resource constraints - initial grid sampling design cannot be implemented**
- Alternative sampling design needed.



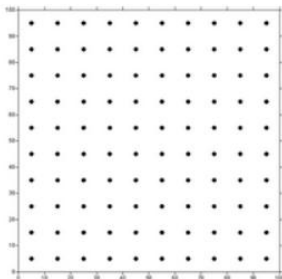


# Alternative CROLIS historic sampling design

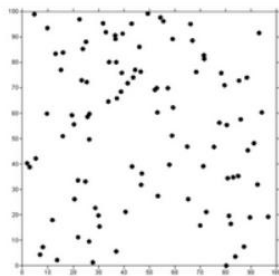
## Initial sample design

- 500x500 m grid sample of size 12,600
- Continental region of Croatia

Example of a regular grid sample



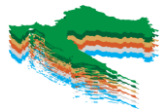
Example of a uniform random sample



## Alternative sample design

- An alternative two-phase approach
  - incorporate reliable data from credible Croatian sources
  - sampling can be reduced in well-documented stable areas and concentrated on unknown or low-information areas.
- Construction of an **a priori map** based on credible sources and available data — Croatian Forests, Croatian Waters, Paying Agency for Agriculture, Fisheries and Rural Development, Copernicus CLC backbone, etc.
- **Stratified (importance) sampling** based on the a priori map with uniform spatial sampling within each layer - **500 m exclusion radius** (where possible).
- Sample size 28,400

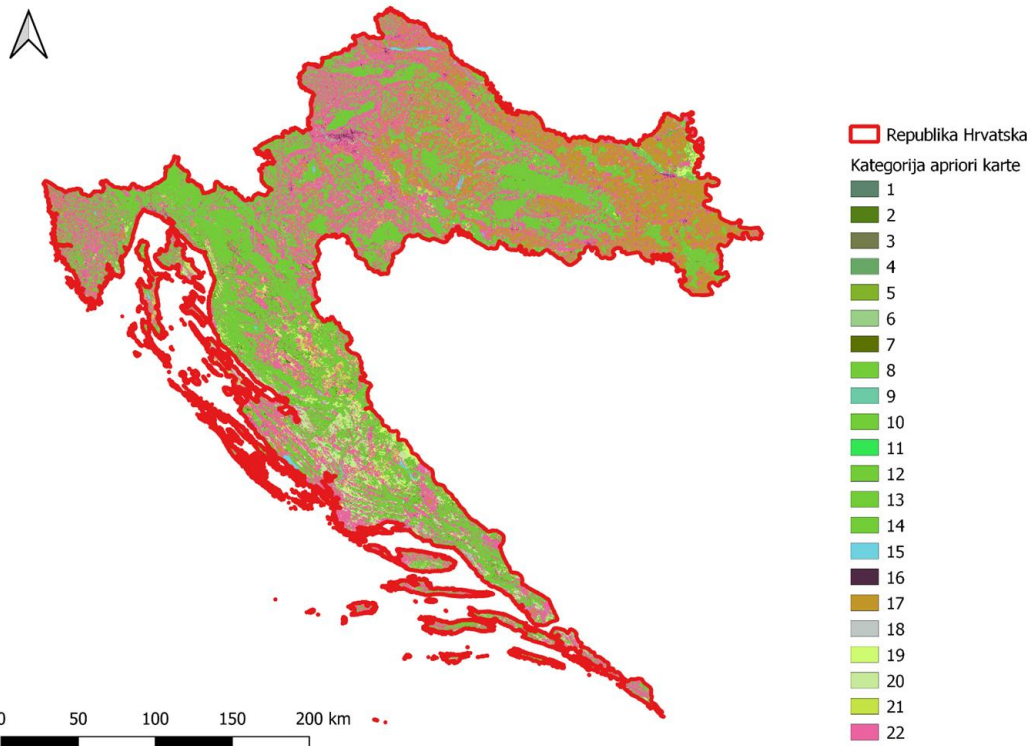




# CROLIS historic LULUCF model



A priori map



Category	Priority	Area (ha)
Deforestation_2000	1	489.43
2010	2	3,011.48
2020	3	869.31
Afforestation_reforestation_1990	4	203.11
2000	5	2,474.75
2010	6	25,156.64
2020	7	29,041.80
Woodland Surfaces by ES	8	2,016,107.33
Private Woodland Surfaces Fond data from 2010	9	7,944.03
Overlay HS and Private Forests 2010	10	108,807.18
Private Woodland Surfaces Fond Analysis 2020	11	7,068.08
Overlay HS and Private Forests 2020	12	224,227.36
Nacionalni parkovi NP S. Velebit	13	44,835.47
	14	9,056.89
Water Bodies Surfaces	15	70,750.52
Artificial Surfaces	16	19,472.48
Agricultural Surfaces	17	62,420.91
Grassland Surfaces	18	70,018.33
Grassy Surfaces by ES	19	106,987.81
Grassy Surfaces	20	117,345.38
Grassy Surfaces ARKOD	21	134,694.02
Other	22	1,905,807.46

Goal: identify no change (permanent) layers within each LC category to be omitted from further sampling;

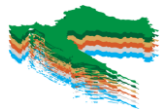
Initial a priori map was tested on the regular grid initial sample.

Analysis based on the results of the accuracy assessment for multi-class data (confusion matrix analysis, Sensitivity, Precision).

Construction of the map in several iterations, each tested on an additional sample;

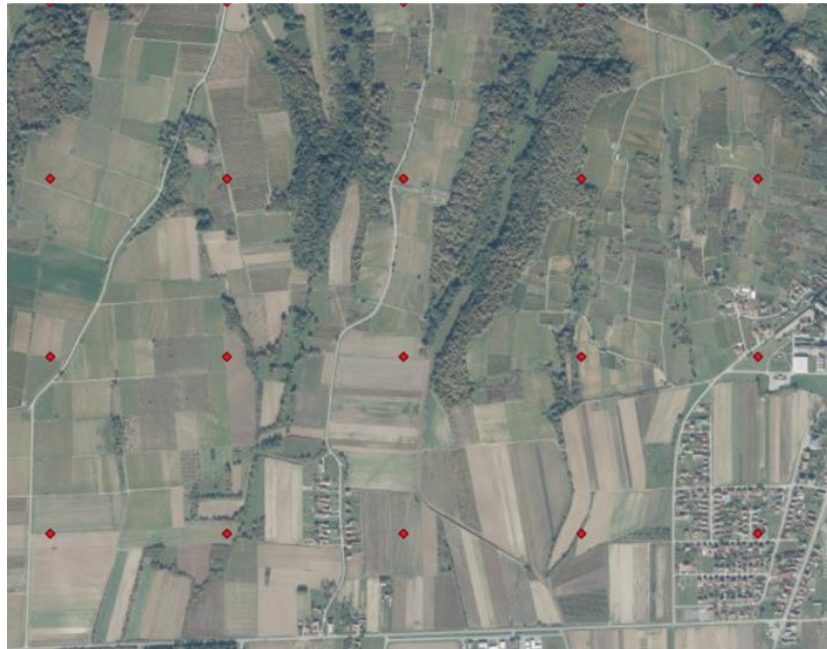
Final version of map: 22 layers.





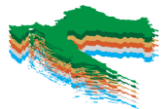
# CROLIS historic LULUCF model

Grid sample – 12898 points in total



Initial grid sample





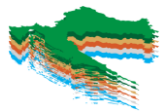
# CROLIS historic LULUCF model

Random sample – 28414 points in total



Stratified random uniform sample





# CROLIS historic LULUCF model



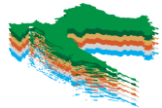
New LC category

New LC category via CROLIS a priori map:

**Woodland Surfaces – Se=51%, PPV=77%**

- Layers A8, A10, A12, A13, and A14 were labeled as ***no-change Woodland Surfaces***;
- Layers constructed using Croatian Forests data - official data on LU Woodland Surfaces;
- These layers do not cover approximately 49% of data observed as unchanged Woodland Surfaces;
- The majority of this data belongs to layer A22 (*Not Assigned*);
- **Construction of a new category *Grassland with woody* – representing forest-like surfaces outside of the domain of Croatian Forests data.**





# CROLIS historic LULUCF model

CROLIS sample analysis

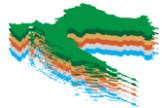
## Main weighting principle

- with importance sampling it is necessary to design weights at the layer level;
- each interpreted point represents the appropriate share of the total layer area.

## Two-phase sampling - weight selection:

- dataset combines two fundamentally different sampling phases (with possible high heterogeneity);
- two extreme weight selection options:
  - not distinguishing between two samples - overrepresentation of the grid sample;
  - weight selection for each sample - diminished valuable information from the grid sample.
- **Proposed choice:** use a combination of the two extreme weight selections from previous points (depending on the regional bias of the first phase grid sample) and the sensitivity analysis.
- Regional bias - 3 regions in total (Continental, Alpine, Mediterranean)
  - assessing the grid sample representation of the Continental region, possibly allocate additional grid samples in other two regions (2000 points left).





# Thank you for your attention!

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