

# Progress on the development of land cover and land use layers for reporting purposes in the LULUCF sector

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REPUBLIKA HRVATSKA  
Ministarstvo zaštite okoliša  
i zelene tranzicije



AGENCIJA ZA  
PLAĆANJA U  
POLJOPRIVREDI,  
RIBARSTVU I  
RURALNOM  
RAZVOJU

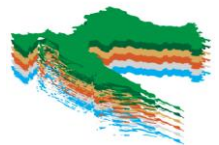


REPUBLIKA HRVATSKA  
Državna geodetska uprava



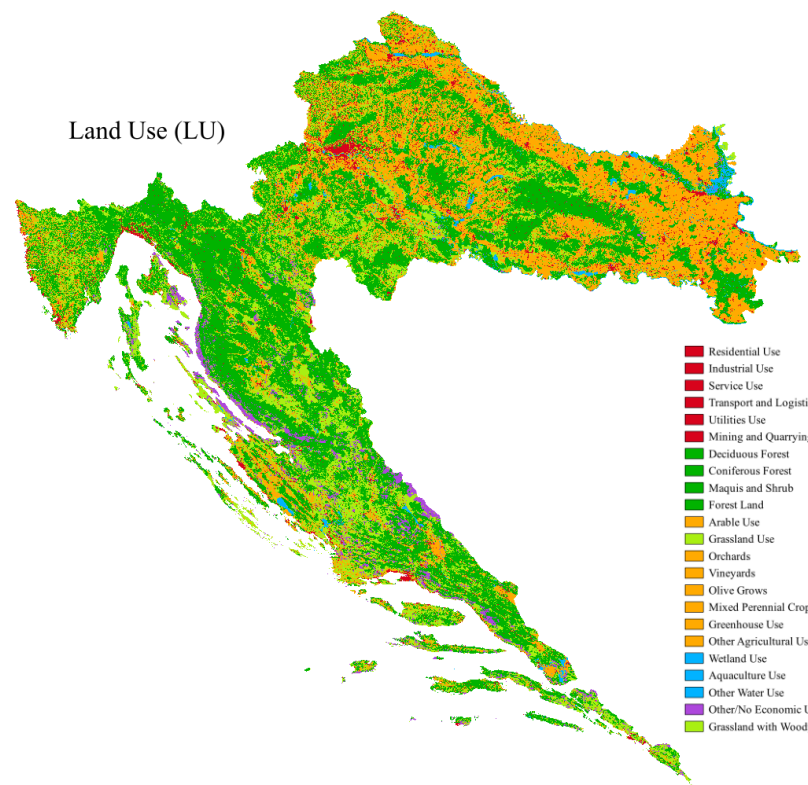
FOND ZA ZAŠTITU OKOLIŠA I  
ENERGETSKU UČINKOVITOST





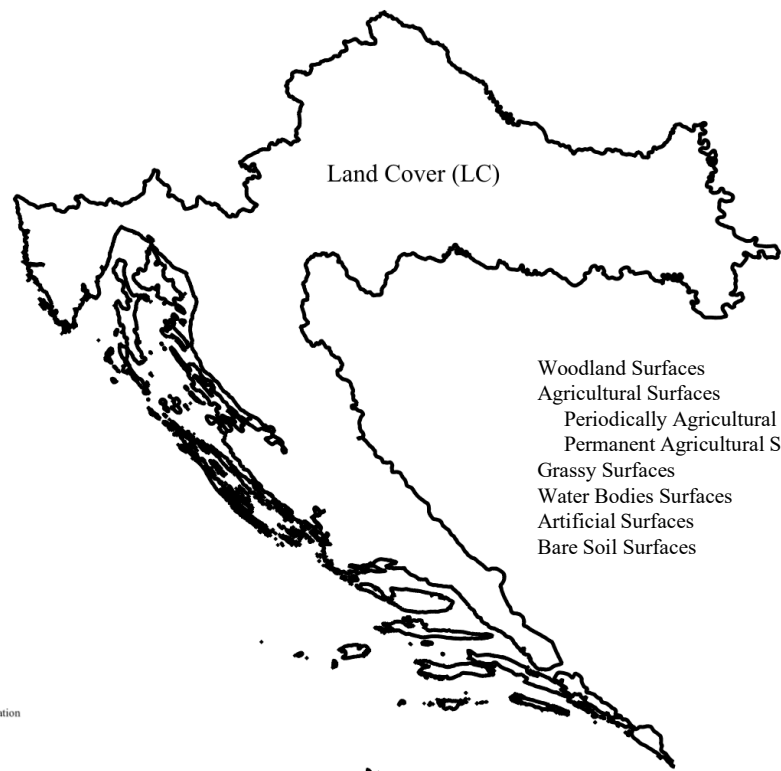
# CROLIS - LULUCF

Land Use (LU)



- Residential Use
- Industrial Use
- Service Use
- Transport and Logistics Use
- Utilities Use
- Mining and Quarrying Use
- Deciduous Forest
- Coniferous Forest
- Maquis and Shrub
- Forest Land
- Arable Use
- Grassland Use
- Orchards
- Vineyards
- Olive Groves
- Mixed Perennial Crops
- Greenhouse Use
- Other Agricultural Use
- Wetland Use
- Aquaculture Use
- Other Water Use
- Other/No Economic Use
- Grassland with Woody Vegetation

Land Cover (LC)



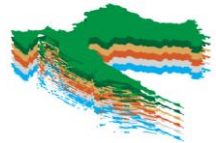
- Woodland Surfaces
- Agricultural Surfaces
- Periodically Agricultural Surfaces
- Permanent Agricultural Surfaces
- Grassy Surfaces
- Water Bodies Surfaces
- Artificial Surfaces
- Bare Soil Surfaces

LULUCF Instance

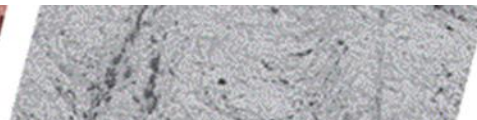
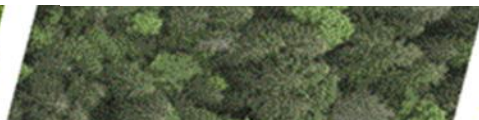
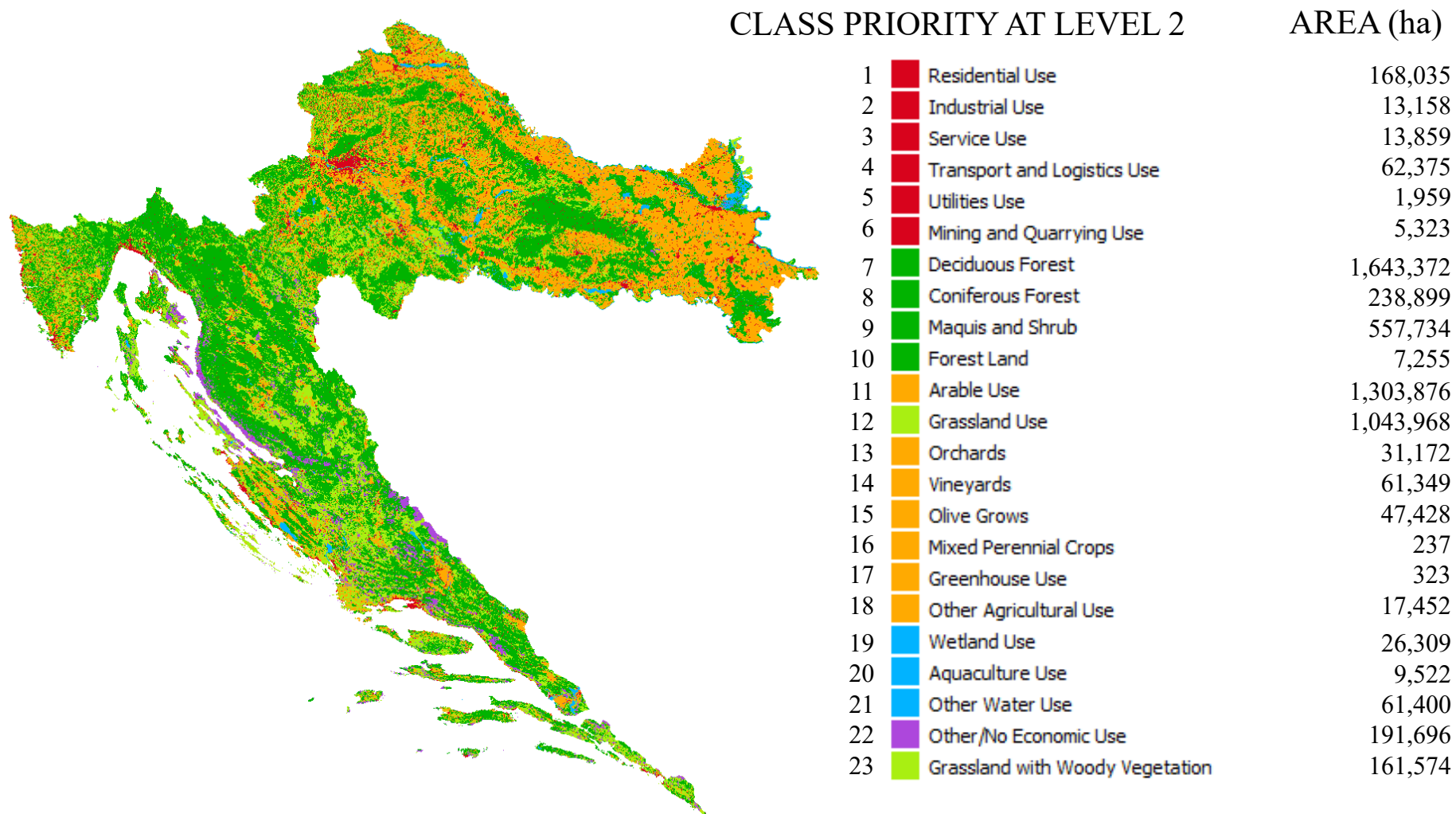


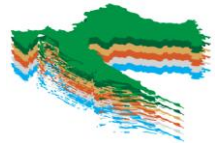
- Forest Land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other Land





# CROLIS – LAND USE





# LAND USE - METHODOLOGY

1. Collection of **national LU data** from authorized institutions by classes

■ DGU - Temeljna topografska baza  
 Prostorni podaci grada Zagreba  
 Hrvatske ceste  
 Hrvatske autoceste  
 Hrvatske željeznice  
 Hrvatske šume

2. **Rasterization** of vector data (vector → raster)

■ Hrvatske šume

■ APPRRR – ARKOD  
 Ministarstvo poljoprivrede  
 DGU - Temeljna topografska baza  
 MZOZT - Karta staništa RH

3. Merging individual rasters into **one raster for the whole of Croatia**

▸ by class priorities, 22 LU layers

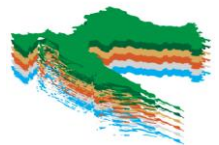
■ APPRRR – ARKOD  
 Ministarstvo poljoprivrede  
 MZOZT - Karta staništa RH

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 DGU - Temeljna topografska baza  
 Hrvatske šume

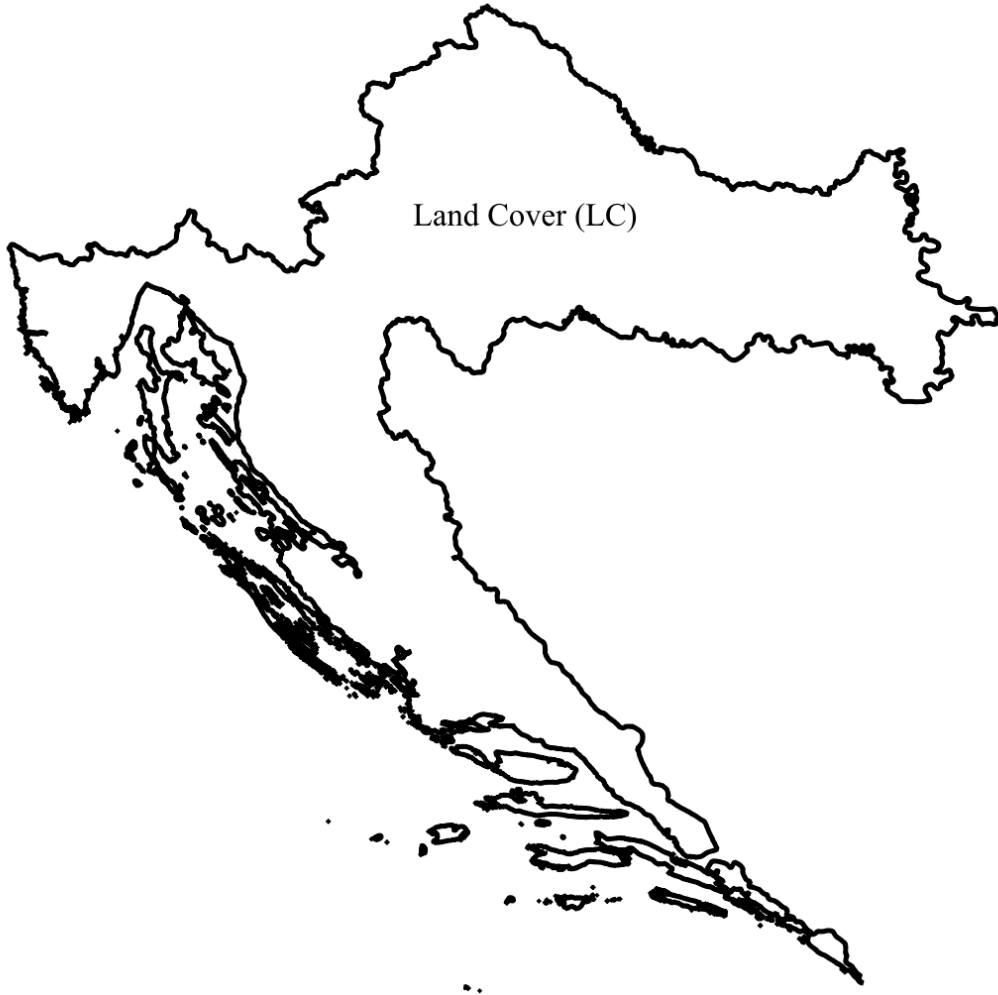
4. **Filling gaps** – class 23 (Grassland with Woody features)









■ MZOZT - Karta staništa RH  
 Hrvatske šume

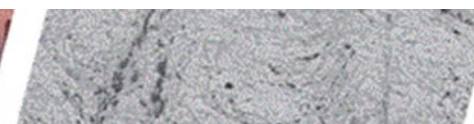
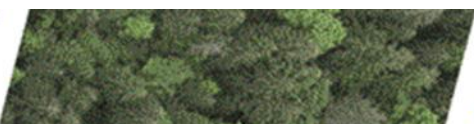


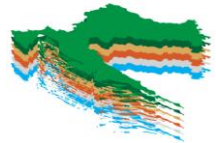


# CROLIS – LAND COVER



-  WOODLAND SURFACES
-  AGRICULTURAL SURFACES
  -  PERIODICALLY AGRICULTURAL SURFACES
  -  PERMANENT AGRICULTURAL SURFACES
-  GRASSY SURFACES
-  WATER BODIES SURFACES
-  ARTIFICIAL SURFACES
-  BARE SOIL SURFACES

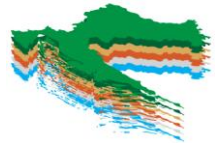




# LAND COVER - METHODOLOGY

- Faculty of Geodesy, University of Zagreb
- Object-Based Image Analysis
- radiometric indices: NDVI, SAVI, EVI, NDSI, NDWI, NDBI ...
- 1. segmentation on two levels
- 2. machine learning – based classification
- 3. classification accuracy assessment
- 4. post-processing





# LAND COVER - METHODOLOGY

- software: eCognition Developer 10.3

- Input data:

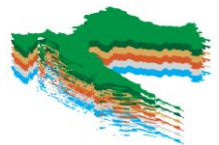
## *Raster:*

- LiDAR
- nDSM
- Digital Orthophoto Map - CIR and RGB 2019/2020
- Sentinel-2

## *Vector:*

- input data for LU layer
- data from Hrvatske šume, ARKOD, Temeljna topografska baza, Hrvatske ceste, Hrvatske autoceste, Hrvatske željeznice, Hrvatske vode, Digitalni katastarski plan
- Open Street Map, CLC+

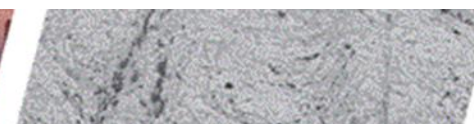
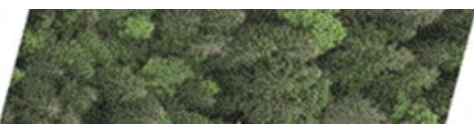


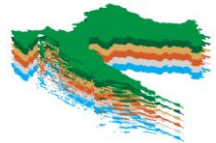


# LULUCF INSTANCES



- FOREST LAND
- CROPLAND
- GRASSLAND
- WETLANDS
- SETTLEMENTS
- OTHER LAND

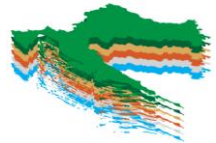




# HISTORIC PERIOD

- for reporting purposes in the Land Use, Land Use Change and Forestry (LULUCF) sector
- historical land cover change data
- historical imagery: digital orthophoto maps 1968, 2000, 2010 and 2020, and SPOT image 1990
- manual visual interpretation
- prerequisite for land matrix





# LAND MATRIX - LULUCF

		1990-2000						
klasa	1	21	22	3	31	4	5	6
1	0.00	0.00	0.00	0.00	0.00	0.00	489.43	0.00
21	0.00	0.00	4,219.12	23,482.45	10,961.90	285.53	3,643.23	387.43
22	0.00	509.20	0.00	145.49	439.49	0.00	0.00	0.00
3	824.92	3,889.54	1,684.96	0.00	46,905.82	783.84	5,179.02	1,016.81
31	1,237.38	72.74	0.00	3,011.54	0.00	391.92	875.95	944.07
4	0.00	0.00	0.00	971.26	145.49	0.00	0.00	157.34
5	412.46	0.00	0.00	218.23	290.97	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	72.74	0.00	0.00	0.00

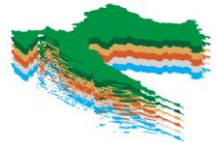
		2000-2010						
klasa	1	21	22	3	31	4	5	6
1	0.00	2,422.34	0.00	0.00	0.00	0.00	589.14	0.00
21	985.05	0.00	13,833.72	31,317.64	15,295.98	179.14	5,043.26	617.52
22	303.09	800.18	0.00	1,206.80	2,618.77	0.00	145.49	0.00
3	3,258.24	9,959.50	4,146.38	0.00	124,333.84	1,080.26	8,300.59	2,857.52
31	20,155.62	803.26	581.95	5,519.26	0.00	72.74	2,330.82	2,009.91
4	75.77	0.00	0.00	2,255.05	654.69	0.00	0.00	251.88
5	303.09	0.00	0.00	290.97	872.92	0.00	0.00	157.34
6	75.77	0.00	157.34	302.83	72.74	0.00	0.00	0.00

		2010-2020						
klasa	1	21	22	3	31	4	5	6
1	0.00	487.78	0.00	0.00	0.00	0.00	379.83	1.71
21	758.27	0.00	4,242.84	19,741.79	3,307.11	0.00	2,109.56	0.00
22	0.00	1,527.61	0.00	2,649.81	1,673.10	0.00	145.49	0.00
3	3,336.39	6,421.82	2,255.05	0.00	83,909.09	1,813.14	4,563.58	751.15
31	24,492.17	945.67	145.49	11,756.94	0.00	145.49	1,203.59	778.87
4	0.00	0.00	0.00	1,555.82	290.97	0.00	0.00	800.18
5	151.65	218.23	72.74	363.72	521.06	0.00	0.00	0.00
6	303.31	0.00	0.00	654.69	476.04	72.74	314.69	0.00



area in kha	1990	2000	2010	2020	2021	2022	2023	2024
<b>5A Forest Land - Total</b>	<b>2,362</b>	<b>2,364</b>	<b>2,363</b>	<b>2,423</b>	<b>2,424</b>	<b>2,424</b>	<b>2,424</b>	<b>2,424</b>
5A1 Forest land remaining forest land	2,358.51	2,360	2,359	2,359.77	2,359.95	2,360.05	2,360.26	2,360.88
5A1 Forest land remaining forest land - coniferous	220	222	222	224.23	224.42	224.52	224.73	224.84
5A1 Forest land remaining forest land - deciduous	1,624	1,624	1,623	1,623.61	1,623.62	1,623.63	1,623.63	1,624.14
5A1 Forest land remaining forest land - not in yield	514.541	514.468	512.402	511.926	511.904	511.904	511.902	511.894
5A2 LUC in forest land	4	4	25	63.3723	63.5806	63.5811	64.3940	64.7918
5A2.1.a Annual Cropland in forest land	0	0	1	2	2	2	2	2
5A2.1.b Perennial Cropland in forest land	0	0	0	0	0	0	0	0
5A2.2 Grassland in forest land	4	4	24	61	61	61	62	62
5A2.3 Wetland in forest land	0	0	0	0	0	0	0	0
5A2.4 Settlement in forest land	0	0	0	0	0	0	0	0
5A2.5 Other land in forest land	0	0	0	0	0	0	0	0
<b>5B Cropland - Total</b>	<b>1,625.38</b>	<b>1,621.80</b>	<b>1,567.10</b>	<b>1,524.320</b>	<b>1,522.938</b>	<b>1,521.837</b>	<b>1,519.821</b>	<b>1,517.805</b>
Cropland annual - Total	1,481	1,499	1,435	1,403	1,401	1,400	1,399	1,397
Cropland perennial - Total	145	123	132	122	122	121	121	121
<b>5B1 Cropland remaining cropland - total</b>	<b>1,618</b>	<b>1,606</b>	<b>1,525</b>	<b>1,482</b>	<b>1,482</b>	<b>1,482</b>	<b>1,481</b>	<b>1,480</b>
5B1a annual cropland remaining annual cropland	1,474	1,485	1,344	1,346	1,346	1,346	1,345	1,344
5B1b perennial cropland remaining perennial cropland	143	117	115	104	104	104	105	105
5B1c LUC annual cropland in annual cropland	0.43	1.76	18.28	24.73	24.59	24.45	24.31	24.16
5B1d LUC annual cropland in perennial cropland	0.89	2.69	7.26	7.45	7.30	7.15	7.00	6.85
5B2 LUC in cropland	7	16	42	42	41	40	39	38
5B2.1a Forest land in annual cropland	0	0	0	0	0	0	0	0
5B2.1b Forest land in perennial cropland	0	0	1.04	1.59	1.59	1.59	1.59	1.55
5B2.2a Grassland in annual cropland	6.5	12.6	32.3	32.0	31.1	30.3	29.4	28.5
5B2.2b Grassland in perennial cropland	0.4	3.2	8.7	8.6	8.4	8.2	8.0	7.8
5B2.3a Wetlands in annual cropland	0	0	0	0	0	0	0	0
5B2.3b Wetlands in perennial cropland	0	0	0	0	0	0	0	0
5B2.4a Settlements in annual cropland	0	0	0	0	0	0	0	0
5B2.4b Settlements in perennial cropland	0	0	0	0	0	0	0	0
5B2.5a Other land in annual cropland	0	0	0	0	0	0	0	0
5B2.5b Other land in perennial cropland	0	0	0	0	0	0	0	0
<b>5C Grassland - Total</b>	<b>1,201</b>	<b>1,197</b>	<b>1,171</b>	<b>1,153.222</b>	<b>1,153.222</b>	<b>1,153.222</b>	<b>1,153.222</b>	<b>1,153.222</b>
5C1 Grassland remaining grassland	1,199	1,184	1,113	1,068	1,070	1,073	1,074	1,076
5C2 LUC in grassland	2	14	57	85	83	80	79	77
5C2.1 Forest land in grassland	0	0	0	0	0	0	0	0
5C2.2.a Annual cropland in grassland	2.3	11.4	49.6	75.5	73.6	71.4	70.0	68.3
5C2.2.b Perennial cropland in grassland	0.1	2.2	7.8	9.7	9.4	9.0	8.8	8.5
5C2.3 Wetlands in grassland	0	0	0	0	0	0	0	0
5C2.4 Settlements in grassland	0	0	0	0	0	0	0	0
5C2.5 Other land in grassland	0	0	0	0	0	0	0	0
<b>5D Wetlands - Total</b>	<b>74</b>	<b>74</b>	<b>75</b>	<b>75</b>	<b>75</b>	<b>75</b>	<b>76</b>	<b>76</b>
5D1 Wetlands remaining wetlands	67	70	74	74	74	74	74	74
water bodies								
peatlands, bogs								
5D2 LUC in wetlands	7	4	1	1	1	1	1	1
5D2.1 Forest land in wetlands	0	0	0	0	0	0	0	0
5D2.2.a Annual Cropland in wetlands	6	4	1	1	1	1	1	1
5D2.2.b Perennial Cropland in wetlands	0.629	0	0	0	0	0	0	0
5D2.3 Grassland in wetlands	0.0000	0	0	0	0	0	0	0
5D2.4 Settlement in wetlands	0	0	0	0	0	0	0	0
5D2.5 Other land in wetlands	0	0	0	0	0	0	0	0
<b>5E Settlements - Total</b>	<b>201</b>	<b>206</b>	<b>267</b>	<b>287</b>	<b>288</b>	<b>289</b>	<b>290</b>	<b>291</b>
5E1 Settlements remaining settlements	174	187	201	206	212	218	224	230
5E2 LUC in settlements	26	18	67	81	76	71	66	60
5E2.1 Forest land in settlements	0	1	3	3	2	2	2	2
5E2.2.a Annual Cropland in settlements	15	10	38	47	44	40	37	34
5E2.2.b Perennial Cropland in settlements	2	1	4	5	4	4	4	3
5E2.3 Grassland in settlements	9	6	22	28	26	24	22	20
5E2.4 Wetlands in settlements	0	0	0	0	0	0	0	0
5E2.5 Other land in settlements	0	0	0	0	0	0	0	0
<b>5F Other land - Total (as to be reported)</b>	<b>196</b>	<b>196</b>	<b>196</b>	<b>196</b>	<b>196</b>	<b>196</b>	<b>196</b>	<b>196</b>
5F1 Other land remaining other land	71	76	58	76	78	80	82	84
5F2 LUC in other land	196	196	196	196	196	196	196	196
5F2.1 Forest land in other land	0	0	0	0	0	0	0	0
5F2.2.a Annual Cropland in other land	0	0	0	0	0	0	0	0
5F2.2.b Perennial Cropland in other land	0	0	0	0	0	0	0	0
5F2.3 Grassland in other land	0	0	0	0	0	0	0	0
5F2.4 Wetlands in other land	0	0	0	0	0	0	0	0
5F2.5 Settlements in other land	0	0	0	0	0	0	0	0
<b>Total area Croatia</b>	<b>5,659.40</b>	<b>5,659</b>	<b>5,659</b>	<b>5,659.40</b>	<b>5,659.40</b>	<b>5,659.40</b>	<b>5,659.40</b>	<b>5,659.40</b>

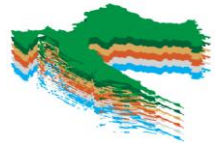




# LAND MATRIX - LULUCF

- closure of the land matrix
- the importance of surfaces for the calculation of emissions/removal
- the importance of information on uncertainty in spatial data





# THANK YOU!

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i zelene tranzicije



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REPUBLIKA HRVATSKA  
Državna geodetska uprava



FOND ZA ZAŠTITU OKOLIŠA I  
ENERGETSKU UČINKOVITOST

