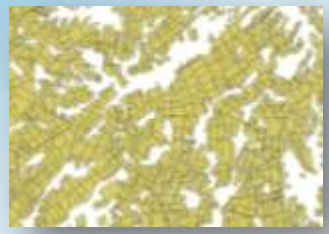

VALIDATION OF LAND COVER MAPS USING IN-SITU DATA AND PHOTOINTERPRETATION

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Joint Experiment of Crop Assessment and Monitoring

JECAM GOALS

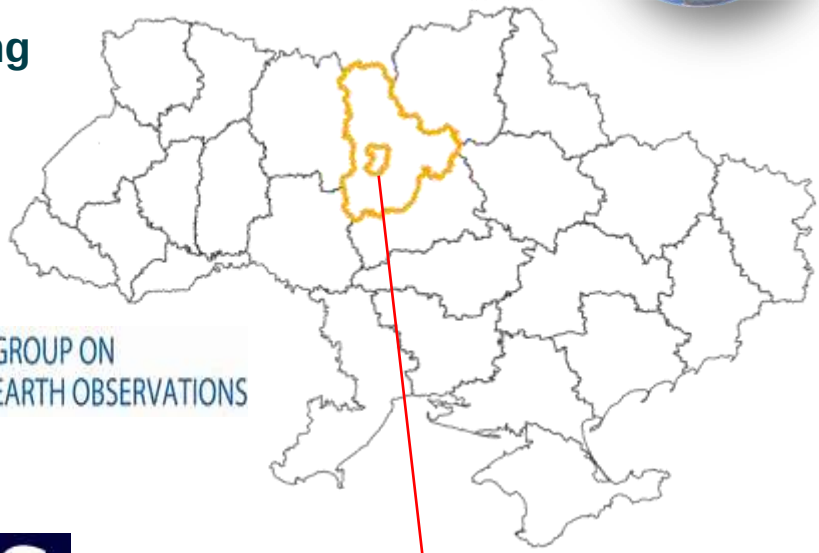
The overarching goal of JECAM is to reach a convergence of approaches, develop monitoring and reporting protocols and best practices for a variety of global agricultural systems.

Ukraine JECAM site

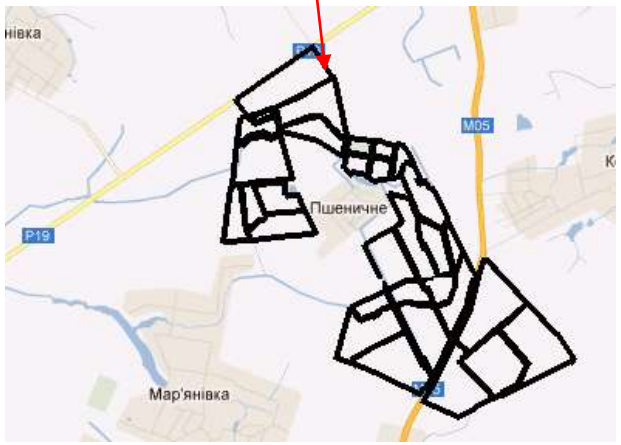
Joint Experiment of Crop Assessment and Monitoring

Site description

- **Location**: Ukraine (Kyiv oblast with area 28,000 km^2; intensive observation sub-site of 25x15 km^2). Centroid: lat: 50.35˚ N, long: 30.71˚ E
- Intensive agriculture area. Main crop types: **winter wheat**, **winter rapeseed**, **spring barley**, **maize**, **soybeans**, **sunflower**, **sugar beet**, and **vegetables**
- Field size: **from 30 to 250 ha**
- Crop calendar: **Winter: September – July**; **Summer: April – October**
- Cloud coverage can be very frequent during the growing season
- Topography: mostly flat, slope: 0% to 2%
- Soils: different kinds of **chernozems**
- Soil drainage is ranging from poor to well-drained. Irrigation infrastructure is limited
- Climate and weather: **humid continental**



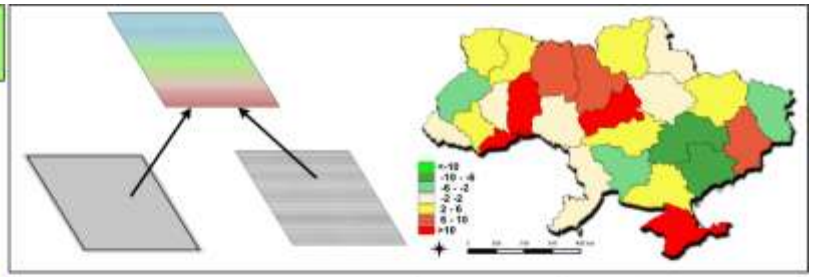
Kyiv oblast & Vasylkiv district



Map of intensive observation sub-site

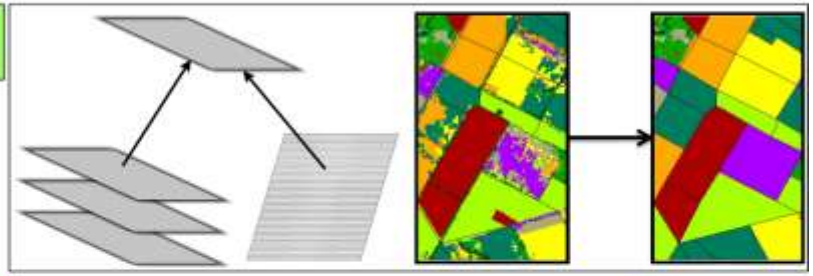
Core expertise: Deep Learning

IV



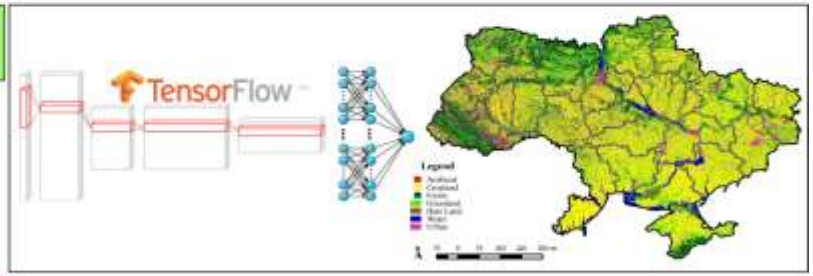
4. Data Fusion and geospatial intelligence, geospatial socio-economic analysis

III



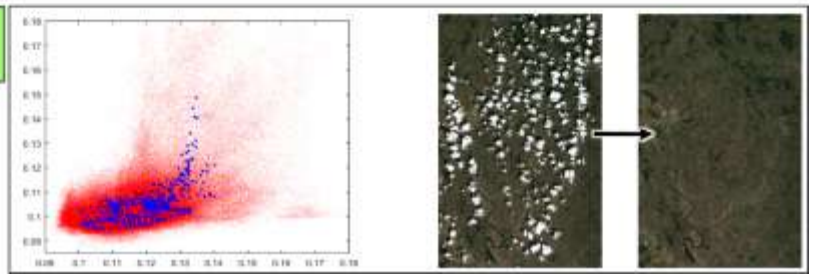
3. Map filtering (weighted voting approaches with division parcels into the fields)

II



2. Universal deep learning approach for time series classification at regional level

I



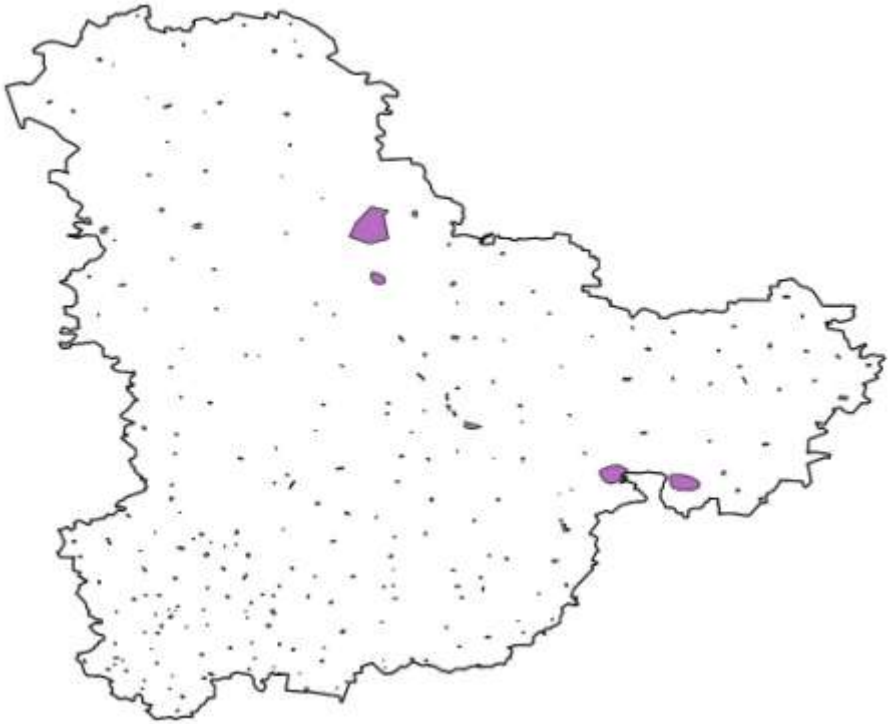
1. Clustering and no-data pixels restoration (clouds and shadows) using self-organized Kohonen maps

Land covers to validate

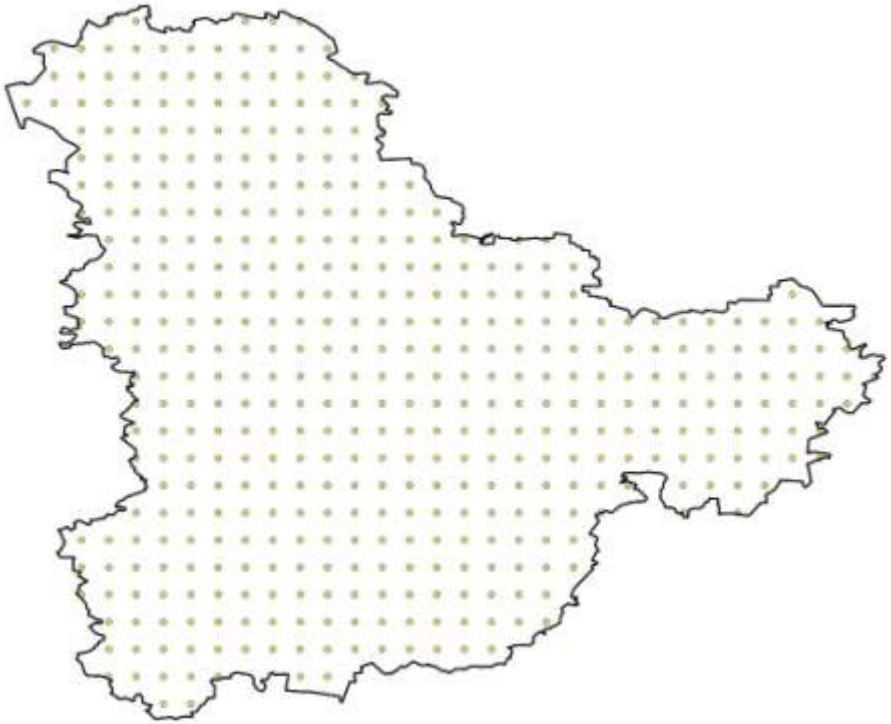
Map	Year	Resolution	Coverage
GLCNMO v2 2008	2008	500, 500	Global
GlobCorine 2009 - unspecified source	2009	300, 300	Global
GlobCover 2009	2009	300, 300	Global
GlobalLand30	2010	30, 30	Global
UALandCover30-2010	2010	30, 30	Regional (Ukraine)
UALandCover30-2000	2000	30, 30	Regional (Ukraine)
UALandCover30-1990	1990	30, 30	Regional (Ukraine)

Photointerpretation sampling schemes

Pseudo-random sampling scheme



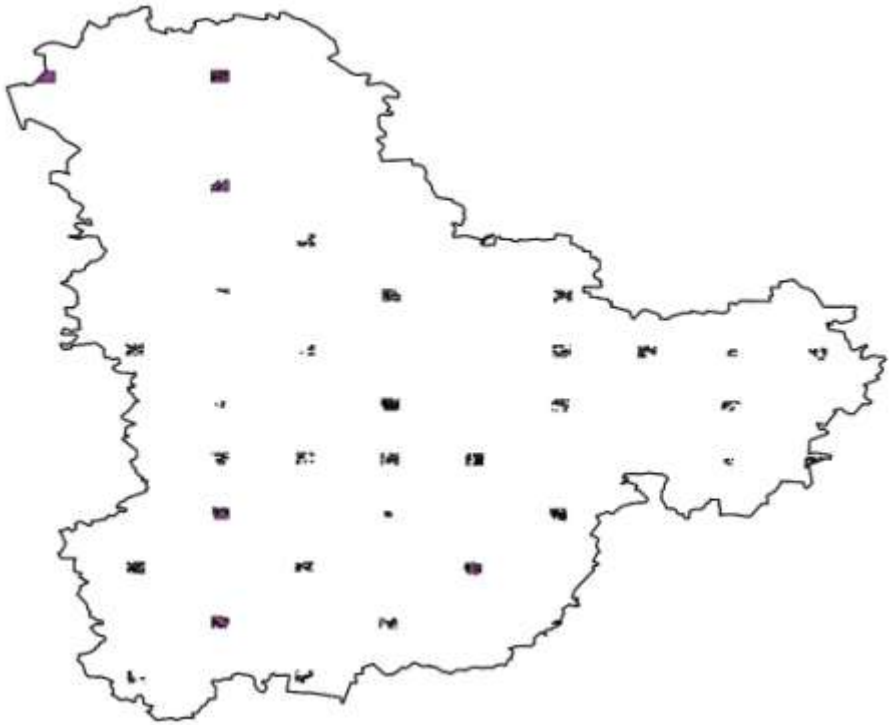
Systematic sampling on the regular grid



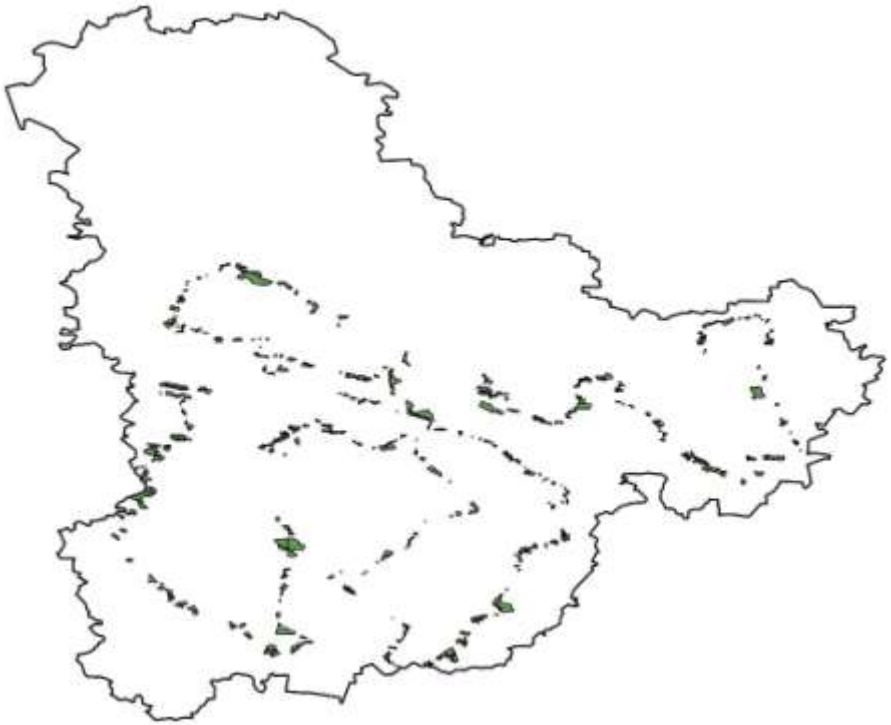
Kyiv region
(area 28,131 km^2)

In-situ data sampling schemes

Segment based stratified approach



In-situ sampling scheme along the roads



Kyiv region
(area 28,131 km^2)

Validation data statistics

		Points 2010		Points 1990		Points 2000		Along roads 2010			
		Polygons		Polygons		Polygons		Polygons		Area	
№	Class	No.	%	No.	%	No.	%	No.	%	10^3 ha	%
1	Artificial	37	8.26	36	8.04	35	7.81	-	-	-	-
2	Cropland	160	35.71	173	38.62	165	36.83	347	59.62	42.566	56.58
3	Forest	101	22.54	100	22.32	99	22.10	69	11.86	19.280	25.63
4	Grassland	129	28.79	114	25.45	128	28.57	131	22.51	10.525	13.99
5	Bare land	-	-	-	-	-	-	-	-	-	-
6	Water	21	4.69	25	5.58	21	4.69	35	6.01	2.864	3.81
	Total	**448**		**448**		**448**		**582**		**75.236**	

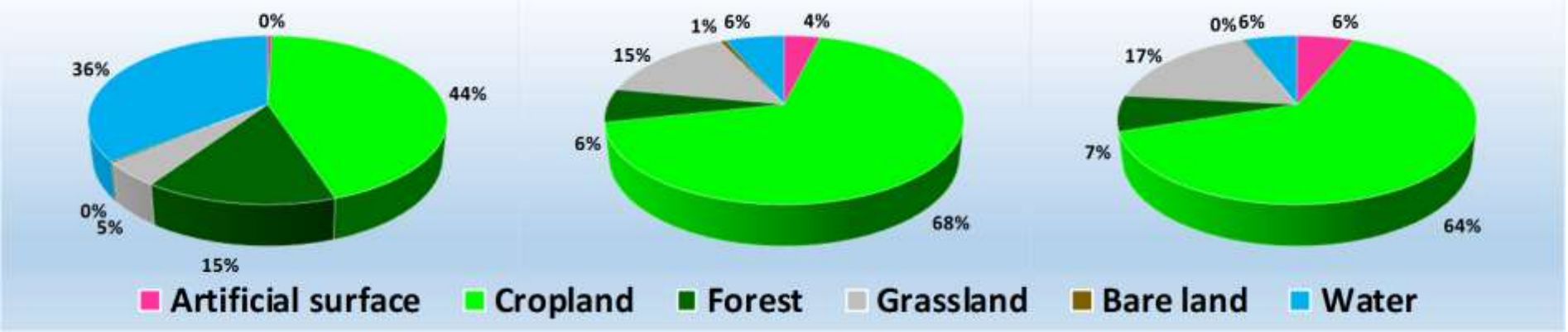
		Segments 2010				Photo interpretation 2010			
		Polygons		Area		Polygons		Area	
№	Class	No.	%	10^3 ha	%	No.	%	10^3 ha	%
1	Artificial	-	-	-	-	-	-	-	-
2	Cropland	259	67.45	16.194	48.57	141	55.51	9.680	23.98
3	Forest	31	8.07	8.204	24.61	43	16.93	1.831	4.54
4	Grassland	78	20.31	7.319	21.95	36	14.17	2.704	6.70
5	Bare land	-	-	-	-	2	0.79	0.018	0.05
6	Water	16	4.17	1.625	4.87	32	12.60	26.133	64.74
	Total	**384**		**33.344**		**254**		**40.368**	

The samples area proportion

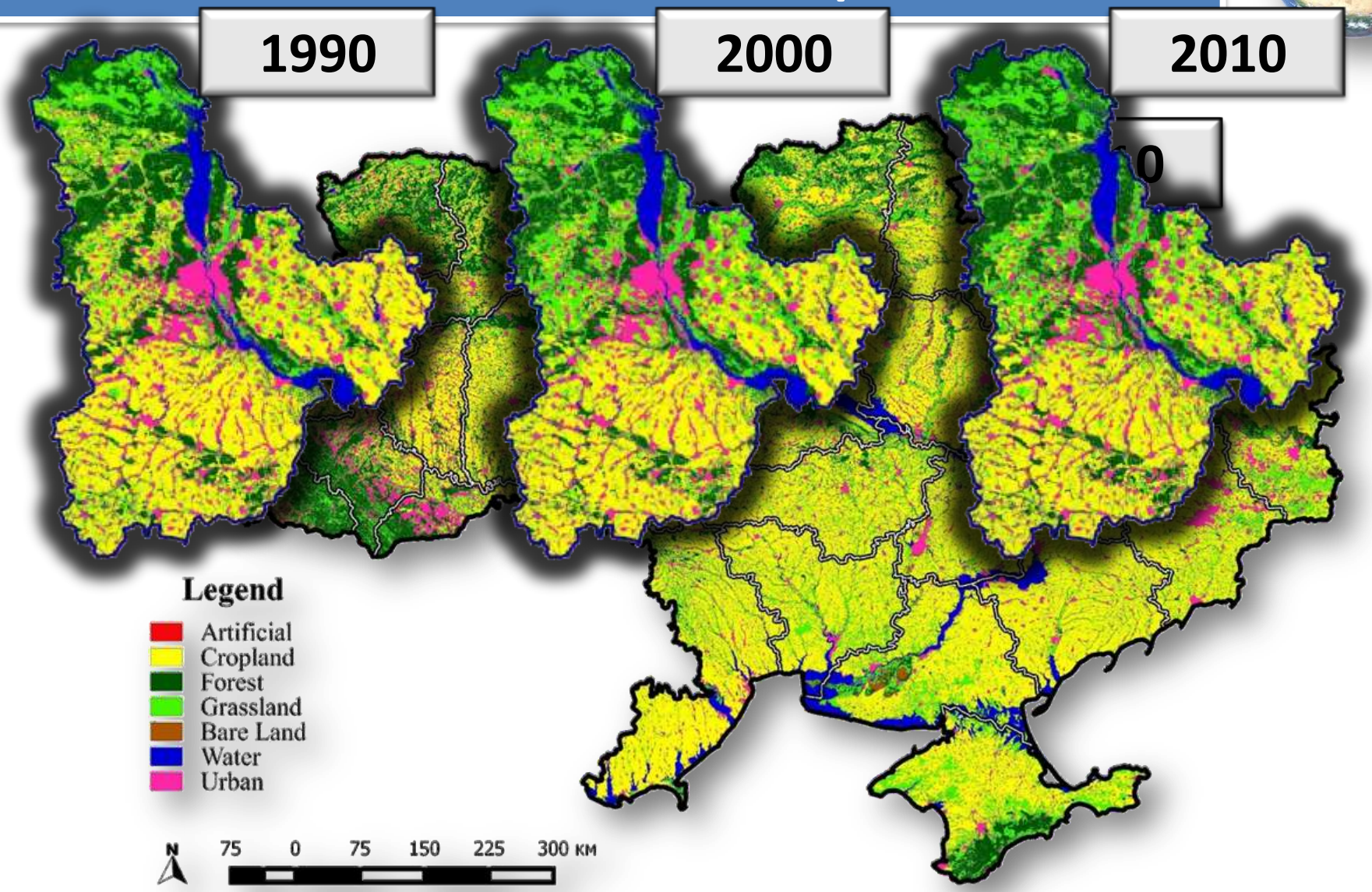
Pseudo-random sampling scheme

Statistics

Systematic sampling on the regular grid



Land cover maps

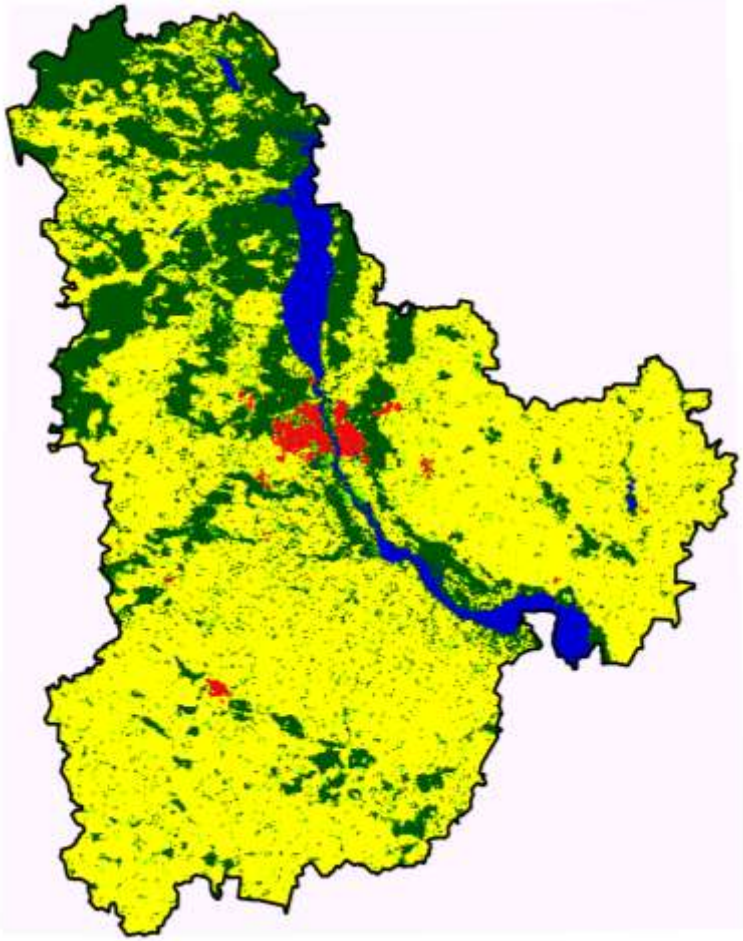


UALandCover30-2010, 2000, 1900

Class number	Product	UALandCover30-2010								UALandCover30-2000		UALandCover30-1990	
		I		II		III		IV		I		I	
	Class	UA	PA	UA	PA	UA	PA	UA	PA	UA	PA	UA	PA
1	Artificial	-	-	-	-	-	-	-	-	-	-	-	-
2	Cropland	91.3	76.3	99.8	95	99	93.5	99.9	86.3	94,3	74,4	87	86,5
3	Forest	83.2	90.3	97.7	95.5	93.7	94.9	71.5	99.9	91,2	90,2	89,2	88,3
4	Grassland	67.4	77.4	75.6	96.5	79.3	91.5	60.6	74.9	64,8	83,9	67,7	68,4
5	Bare land	-	-	-	-	-	-	-	-	-	-	-	-
6	Water	90.9	100	97.7	87.4	95	79.2	99.9	100	79,2	95	78,6	91,7
	OA, %	**80.9**		**95.1**		**92.8**		**95.1**		**81,5**		**81,9**	

I - points	II - along roads	III - segments 4x4 km	IV - photo interpretation

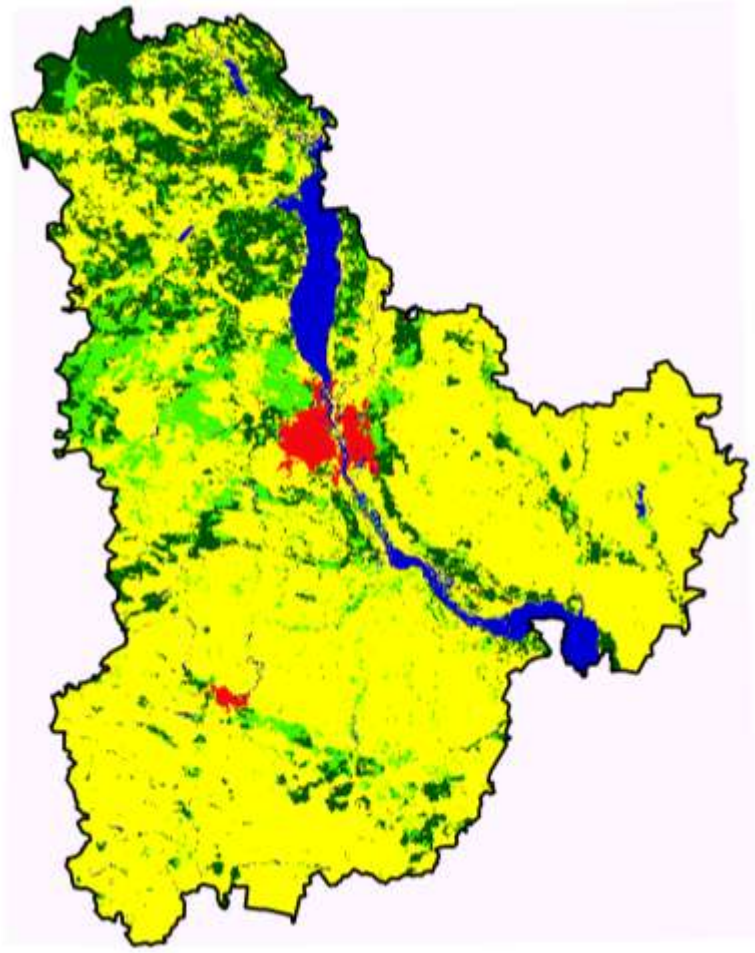
GLCNMO-2008 map



Class number	Product	GLCNMO_2008							
		I		II		III		IV	
	Class	UA	PA	UA	PA	UA	PA	UA	PA
1	Artificial	66.7	10.8	-	-	-	-	-	-
2	Cropland	51	96.3	74.3	93.1	64.8	95.7	81	92.5
3	Forest	70.1	81.2	80	78.1	77.3	76.9	52.7	92.8
4	Grassland	75	2.3	9.2	1.6	27.6	2.4	7.7	1.7
5	Bare land	-	-	-	-	-	-	-	-
6	Water	94.7	85.7	100	51.6	100	30.7	100	97.3
	OA, %	**58.3**		**74.6**		**67.8**		**89.7**	

I - points	II - along roads	III - segments 4x4 km	IV - photo interpretation

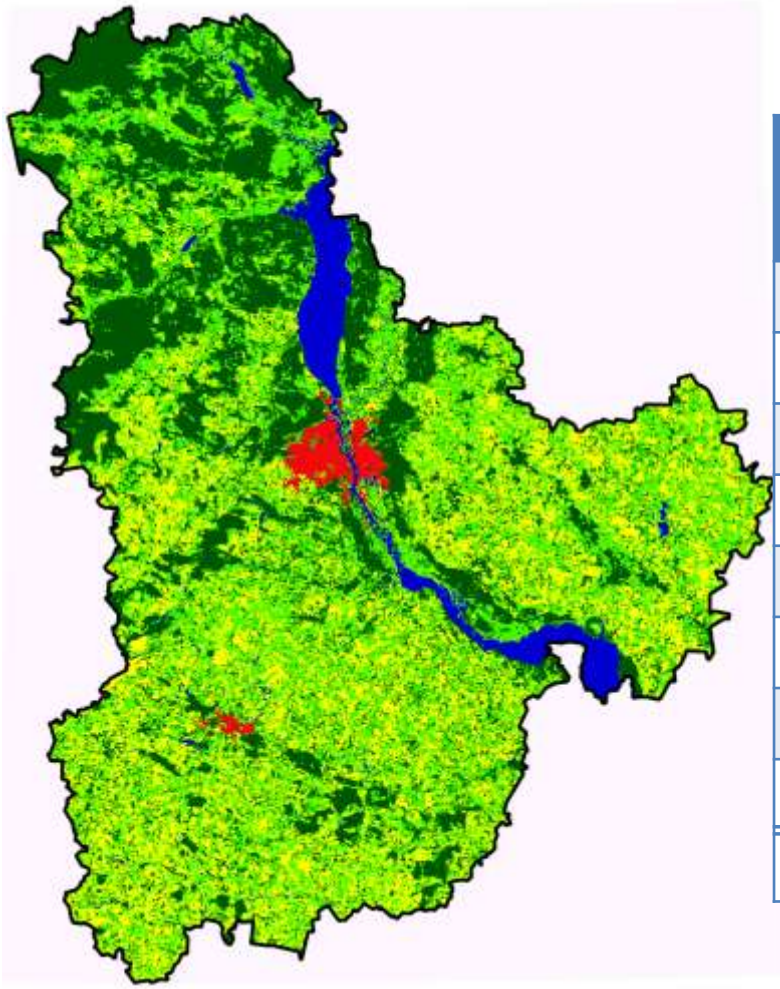
GLOBCORINE-2009 map



Class number	Product	GLOBCORINE_2009							
		I		II		III		IV	
	Class	UA	PA	UA	PA	UA	PA	UA	PA
1	Artificial	57.1	10.8	-	-	-	-	-	-
2	Cropland	50.2	97.5	76.9	98.7	65.7	99.4	83.5	97.7
3	Forest	80.8	58.4	96.4	44.7	88.7	58.5	60.2	69.4
4	Grassland	28.2	8.5	11.9	10.7	27.4	8.3	38.6	13.4
5	Bare land	-	-	-	-	-	-	-	-
6	Water	100	85.7	99.5	75.8	99	64.2	100	99.8
	OA, %	**55.4**		**71.8**		**67.9**		**92**	

I - points	II - along roads	III - segments 4x4 km	IV - photo interpretation

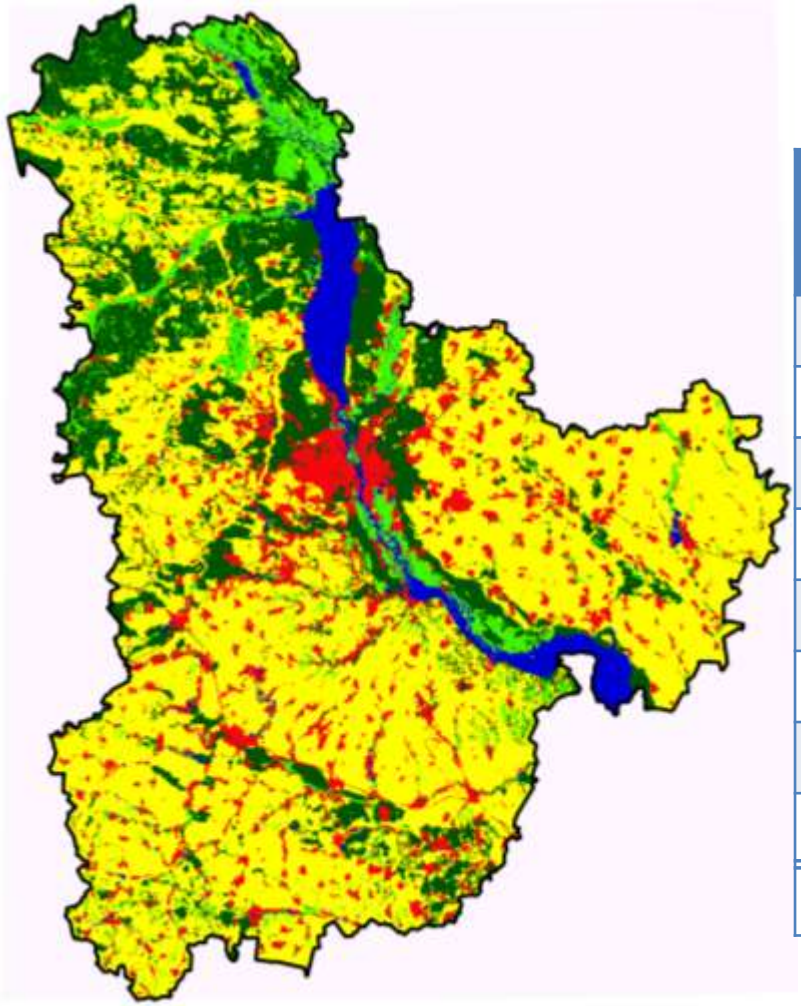
GlobCover-2009 map



Class number	Product	GlobCover_2009							
		I		II		III		IV	
	Class	UA	PA	UA	PA	UA	PA	UA	PA
1	Artificial	80	10.8	-	-	-	-	-	-
2	Cropland	66.4	45.6	79.8	45.6	77.5	48.8	89.5	43.7
3	Forest	59.3	82.2	65	78.7	61.3	83	37.9	96.7
4	Grassland	43.6	58.6	18.8	46.1	32.4	49.1	23.5	43.5
5	Bare land	-	-	-	-	-	-	-	-
6	Water	100	95.2	96.4	65.3	97.8	58.1	99.9	99.5
	OA, %	**57**		**54.9**		**57.7**		**82.3**	

I - points	II - along roads	III - segments 4x4 km	IV - photo interpretation

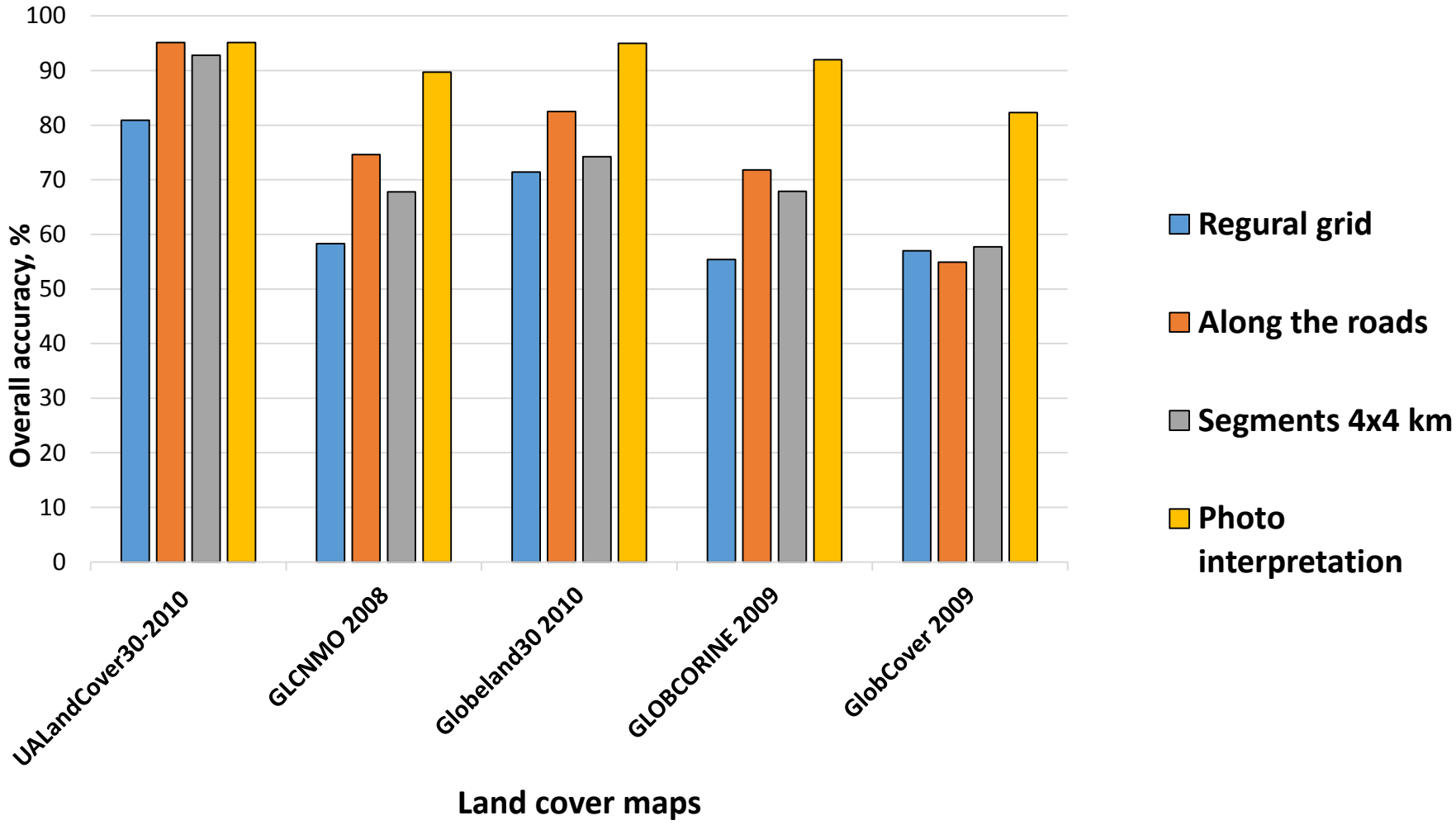
Globeland30-2010 map



Class number	Product	Globeland30_2010							
		I		II		III		IV	
	Class	UA	PA	UA	PA	UA	PA	UA	PA
1	Artificial	68.9	83.8	-	-	-	-	-	-
2	Cropland	62.7	97.5	79.6	98.9	70	98.9	88.1	98.6
3	Forest	87.4	82.2	94.7	87	94.3	81.4	71.8	96.4
4	Grassland	76.3	22.5	29.2	5	39.5	10.9	98.3	30
5	Bare land	-	-	-	-	-	-	-	-
6	Water	100	100	98	81.2	94.4	66.8	100	100
	OA, %	**71.4**		**82.5**		**74.2**		**95**	

I - points	II - along roads	III - segments 4x4 km	IV - photo interpretation

Histogram of accuracy for different sampling schemes



Summary

- Pseudo-random interpretation validation overestimates the accuracy due to significant human impact to the samples selection;
- Along the road sampling scheme has approximately the same result as a segment based stratified approach;
- The most precise approach (with the lowest accuracy) obtained using regular grid scheme, but it is the most independent and optimal approach for land cover maps validation. It perfectly fits to the statistics.

References

1. N. Kussul, G. Lemoine, F. J. Gallego, S. V. Skakun, M. Lavreniuk and A. Y. Shelestov (2016) “Parcel-Based Crop Classification in Ukraine Using Landsat-8 Data and Sentinel-1A Data”, **IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing**, vol. 9, no. 6, pp. 2500-2508, June 2016. doi: 10.1109/JSTARS.2016.2560141.

2. Kussul, N., Skakun, S., Shelestov, A., Lavreniuk, M., Yailymov, B., Kussul, O. (2015) “Regional Scale Crop Mapping Using Multi-Temporal Satellite Imagery”, **International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences**, DOI: 10.5194/isprsarchives-XL-7-W3-45-2015.

3. M. Lavreniuk, N. Kussul, S. Skakun, A. Shelestov, and B. Yailymov, “Regional retrospective high resolution land cover for Ukraine: methodology and results,” **in: IGARSS 2015**, pp. 3965–3968, 2015. DOI: 10.1109/IGARSS.2015.7326693.

Thank you!