LAND COVER CHANGE DETECTION IN TIMIS COUNTY BASED ON CORINE LAND COVER DABASES FROM 1990 - 2018

C. SVESTAC[1], M. V. HERBEI[2], F. SALA[3,*]
Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Timisoara, 300645, Romania
[1]Land Measurements and Cadaster, [2]Remote Sensing and GIS, [3]Soil Science and Plant Nutrition
[*]Corresponding author: florin_sala@usab-tm.ro

Abstract. *The purpose of this paper was to perform an analysis in order to detect the change in land cover in Timis County. Timis is the largest county in Romania in terms of land area, occupying 8.696,7 km^2, respectively 3.65% of the country's surface. It is intersected by the parallel of 46 Lat. N, by the meridian of 21 Long. E and 22 Long. E. For this to be done, the existing database at European level was used, following IMAGE and CORINE Land Cover (CLC) 2000 project managed jointly by the European Environment Agency in Ispra, Italy and downloaded from the portal www.landcopernicus.eu. The database Corine Land Cover includes 29 countries from Europe, covering an area of approximately 4.5 km^2, at a scale of 1:100.000. This research wants to analyse based on Geomatic Technologies, the land cover change detection in Timis County, based on the open-source data CLC. For analysis, four groups were taken from the data set, Artificial Surface (AS), Agricultural Areas (AA), Forest and Seminatural Areas (FSA) and Wetlands and Water Bodies (WWB), whose evolution was analysed during the period 1990 to 2018. Data manipulation and processing were performed with specialized programs, such as: ArcGIS v. 10.3, Microsoft Excel and Past. In this study was used GIS data: raster and vector, Vector Data sets CLC 2990 – 2018, Limits of administrative units, countries, territorial administrative units, localities – in vector format, Statistical data in database format, Base maps in raster format and a SRTM model – raster format. Timis county, according to Land cover, it is a county that has mainly agricultural lands in its component. It shows that most of the land in Timis county (51.4% and 32.9%) has an elevation between 0-100m, respectively 100-200, and most of the land covers characteristic of this range, is specfic up of Agricultural areas 46.1%, respectively 32.9%. In the year 2018, the percentage of the agricultural area in Timis County was 78.17%, which represented 45557.69 ha.*

Keywords: *land cover, monitoring, Timis County, GIS*

INTRODUCTION

The purpose of this research is to analyse based on Geomatic Technologies, the land cover change detection in Timis County (POPESCU et al., 2020), based on the open-source data that were downloaded from the next link (www.landcopernicus.eu).

The assessment of change regarding the use of land (ALAM et al., 2019) in time is a relevant problem on the recent list of development and concerns in the international context, which has been included in the recent funding programs within the 2020 Agenda for the next coming years.

The development planning (BEGOV et al., 2016) of a region cannot be achieved without analyzing the changes that could appear and the use of land (FONJI and TAFF, 2014; LAMBIN, 1997; HERBEI and SALA, 2014) in the context of a healthy urban development (LIPING et al., 2018; POPESCU et al., 2020; DRAGOMIR and HERBEI, 2012).

In view of urban development, modern methods of approach (GOVEDARICA et al., 2015; HERBEI et al., 2016), simulation and monitoring of the land surface and construction, should be used.

Remote sensing and the disciplines in the field of geomatics (CALINA et al., 2018; CALINA et al., 2020) helps with the decision-making process regarding land planning and land development, with concrete applications in these fields, but also in related fields, such as

agriculture (SALA et al., 2020; HERBEI et al., 2015a,b), environment, hydrography, (BĂDĂLUȚĂ-MINDA et al., 2011; CREȚU and BĂDĂLUȚĂ-MINDA, 2007), forestry, land valuation (TARAU et al., 2013) etc.

MATERIAL AND METHOD

Timis is a county of western Romania, in the centre of the historical region Banat, with the county seat at Timisoara. Geographically, it is the westernmost county in Romania. It borders the counties Arad, Caras – Severin and Hunedoara, also with the districts South Banat, Central Banat and North Banat from Serbia, and the county Csongrad from Ungaria with which it forms state borders, figure 1.

Figure 1. Location of the Study Area

Timis is the largest county in Romania in terms of land area, occupying 8.696,7 km^2, respectively 3.65% of the country's surface. It is intersected by the parallel of 46 Lat. N, by the meridian of 21 Long. E and 22 Long. E.

Most of the county is occupied by zonal soils namely, leached and meadow chernozems appear in the northwest, then in the hilly area different types of wild soils follow one another from west to east, among which the brown ones predominate. Dark brown soils, gray and reddish-brown soils occupy surfaces in the western half. The podzolic wild soils are arranged in the form of an almost continuous strip in the south-eastern corner of the county.

Mountain soils (wild-brown, yellow-brown podzolic, and acid-brown), developed under forests and secondary meadows, they appear on a mountainous surface, in the eastern part of the county.

The soil of Timis county offers favorable conditions for the cultivation of agricultural plants, especially for the cultivation of cereals, but also of technical and fodder plants, fruit trees and vines (BERTICI et al., 2012; DUNCA and BADALUTA – MINDA, 2018).

The climate is a temperate continental one, with Mediterranean and oceanic influences, due to the fact that Banat is sheltered by the Carpathian chain, which stops the cold air masses from the North and Northeast and allows the penetration of maritime ones from the Southwest and West. The average annual air temperature exceeds 11 °Celsius in the plains, and 10 °Celsius in the region of the Lipova's hills (BARBU, 2013).

The purpose of this paper was to perform an analysis in order to detect the change in land cover in Timis County. For this to be done, the existing database at European level was used, following IMAGE and CORINE Land Cover 2000 project managed jointly by the European Environment Agency in Ispra, Italy (www.landcopernicus.eu). The database Corine Land Cover includes 29 countries from Europe, covering an area of approximately 4.5 km^2, at a

scale of 1:100.000.

CLC 1990 - 2018 data's, were obtained based on remote sensing images from the systems Landsat 5 MSS/TM (1990), Landsat 7 ETM (2000), SPOT 4/5 and IRS P6 LISS III (2006), IRS P6 LISS III and RapidEye (2012), and Sentinel 2 and Landsat 8 (2018).

Data presented in table 1 were used within the study.

Table 1

Format and type of GIS data used

GIS DATA	TYPR
Data sets Corine Land Cover 1990 – 2018 https://land.copernicus.eu/pan-european/corine-land-cover	Vector si raster
Limit of administrative units, counties, territorial administrative units, localities	Vector
Statistical data	Vector
Base Maps	Raster
Shuttle Radar Topography Mission (SRTM) 30m resolution (http://earthexplorer.usgs.gov)	Raster

Data manipulation and processing were performed with specialized programs, such as: ArcGIS v. 10.3, Microsoft Excel and Past (HAMMER et al., 2001).

RESULTS AND DISCUSSIONS

From the database at European level were extracted the information from the level at Timis County, information presented in figure 2.

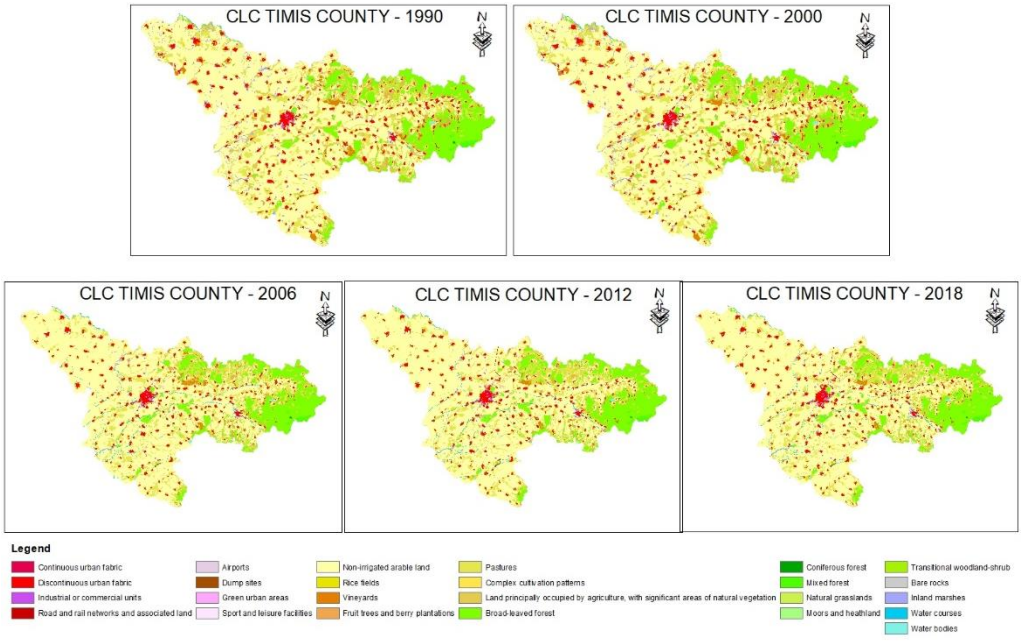

Figure 2. Graphical representation of information Corine Land Cover, Timis County, Romania

Raster data CLC (SAAH et al., 2019) were reclassified according to the existing code in the database, and then all existing polygons were converted into vector data (SAAH et al., 2019). The Corine Land Cover data legend contains both the code for each land class and the RGB values to standardize this data throughout the European Union. This legend is presented in table

2.

Table 2

Legend of Corine Land Cover

LEVEL 1	LEVEL 2	LEVEL 3	GRID_CODE	RGB
1. ARTIFICIAL SURFACES	1.1 Urban fabric	1.1.1 Continuous urban fabric	1	230-000-077
		1.1.2 Discontinuous urban fabric	2	255-000-000
	1.2 Industrial, commercial and transport units	1.2.1 Industrial or commercial units	3	204-077-242
		1.2.2 Road and rail networks and associated land	4	204-000-000
		1.2.3 Port areas	5	230-204-204
		1.2.4 Airports	6	230-204-230
	1.3 Mine, dump and construction sites	1.3.1 Mineral extraction sites	7	166-000-204
		1.3.2 Dump sites	8	166-077-000
		1.3.3 Construction sites	9	255-077-255
	1.4 Artificial, non-agricultural vegetated areas	1.4.1 Green urban areas	10	255-166-255
		1.4.2 Sport and leisure facilities	11	255-230-255
2. AGRICULTURAL AREAS	2.1 Arable land	2.1.1 Non-irrigated arable	12	255-255-168
		2.1.2 Permanently irrigated land	13	255-255-000
		2.1.2 Rice fields	14	230-230-000
	2.2 Permanent crops	2.2.1 Vineyards	15	230-128-000
		2.2.2 Fruit trees and berry plantations	16	242-166-077
		2.2.3 Olive groves	17	230-166-000
	2.3 Pastures	2.3.1 Pastures	18	230-230-166
	2.4 Heterogeneous agricultural areas	2.4.1 Annual crops associated with permanent crops	19	255-230-166
		2.4.2 Complex cultivation patterns	20	255-230-077
		2.4.3 Land principally occupied by agriculture , with significant areas of natural vegetation	21	230-204-077
		2.4.4 Agro-forestry areas	22	242-204-166
3. FOREST AND SEMI NATURAL AREAS	3.1 Forest	3.1.1 Broad-leaved forest	23	128-255-000
		3.1.2 Coniferous forest	24	000-166-000
		3.1.3 Mixed forest	25	077-255-000
	3.2 Scrub and/or herbaceous vegetation associations	3.2.1 Natural grasslands	26	204-242-077
		3.2.2 Moors and heathland	27	166-255-128
		3.2.3 Sclerophyllous vegetation	28	166-255-128
		3.2.4 Transitional woodland-shrub	29	166-242-000
	3.3 Open Spaces with little or no vegetation	3.3.1 Beaches, dunes, sands	30	230-230-230
		3.3.2 Bare rocks	31	204-204-204
		3.3.3 Sparsely vegetated areas	32	204-255-204
		3.3.4 Burnt areas	33	000-000-000
		3.3.5 Glaciers and perpetual snow	34	166-230-204
4. WETLANDS	4.1 INLAND WETLANDS	4.1.1 Inland marshes	35	166-166-255
		4.1.2 Peat bogs	36	077-077-255
	4.2 MARITIME WETLANDS	4.2.1 Salt marshes	37	204-204-255
		4.2.2 Salinas	38	204-204-255
		4.2.3 Intertidal flats	39	166-166-230
5. WATER BODIES	5.1 Inland waters	5.1.1 Water courses	40	000-204-242
		5.1.2 Water bodies	41	128-242-230
	5.2 Marine waters	5.2.1 Coastal lagoons	42	000-255-166
		5.2.2 Estuaries	43	166-255-230
		5.2.3 Sea and ocean	44	230-242-255

Reclassification tools reclassify or change cell values to alternative values using a variety of methods. All reclassification methods are applied to each cell in an area. That means, when an alternative value is applied to an existing value, all reclassification methods apply the alternative value to each cell in the initial area.

For analysis, four groups were taken from the data set, Artificial Surface (AS), Agricultural Areas (AA), Forest and Seminatural Areas (FSA), and Wetlands and Water Bodies (WWB), whose evolution was analysed during the period 1990 to 2018, table 3 and table 4, with graphical representation in the figures 3 – 6.

Table 3

The evolution of the surfaces on the categories that were used in the study, from 1990 to 2018

Categories	Period				
	1990	2000	2006	2012	2018
	(ha)				
Artificial Surfaces	50119.63	50291.03	42787.07	44113.84	45557.69
Agricultural Areas	674581	674320.8	684637.2	681976.5	680437.1
Forest and Seminatural Areas	131616.3	131605.9	129961.5	131976.6	131978
Wetlands and Water Bodies	12089.45	12182.39	11015.09	10341.21	10437.09
Total	870396.3	870400.1	870406.8	870420.1	870427.9

Table 4

The evolution of the surfaces on the categories that were used in the study, from 1990 to 2018

Categories	Period				
	1990	2000	2006	2012	2018
	(%)				
Artificial Surfaces	5.76	5.78	4.92	5.07	5.23
Agricultural Areas	77.50	77.47	78.66	78.35	78.17
Forest and Seminatural Areas	15.12	15.12	14.93	15.16	15.16
Wetlands and Water Bodies	1.39	1.40	1.27	1.19	1.20
Total	100	100	100	100	100

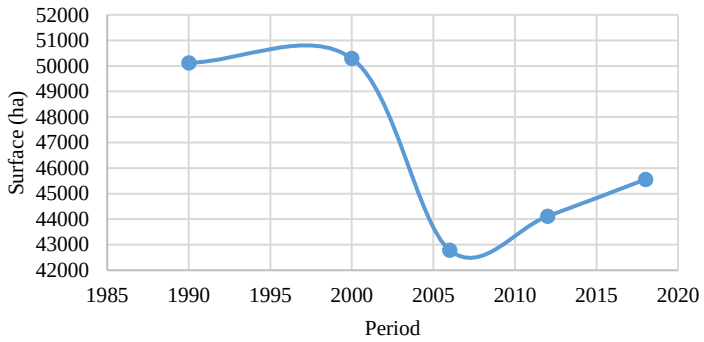

Figure 3. Graphical representation of Artificial Surfaces, from 1990 to 2018

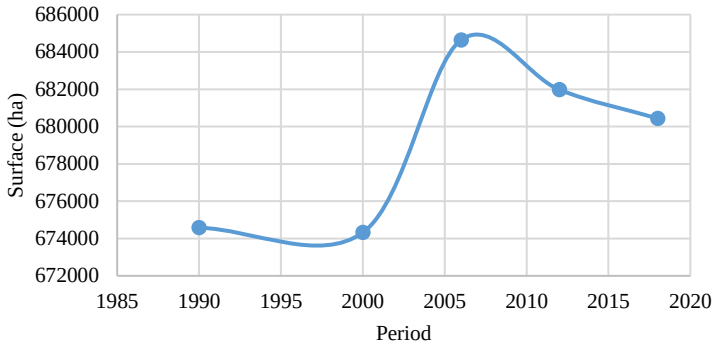

Figure 4. Graphical representation of Agricultural Areas, from 1990 to 2018

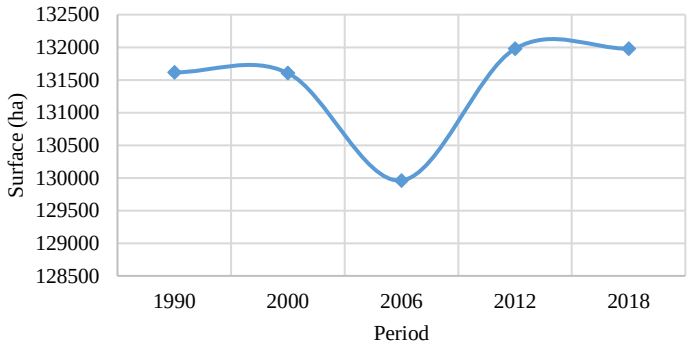

Figure 5. Graphical representation a Forest and Seminatural Areas from 1990 to 2018

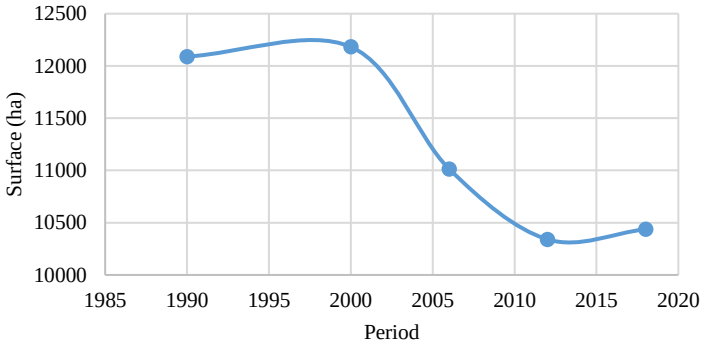

Figure 6. Graphical representation of Wetlands and Water Bodies from 1990 to 2018

Morphological parameters of the Timis county area have the spatial representation presented in figure 7, and representation of Land Cover 2018, depending on the land share in

Timis County, it is presented in table 5.

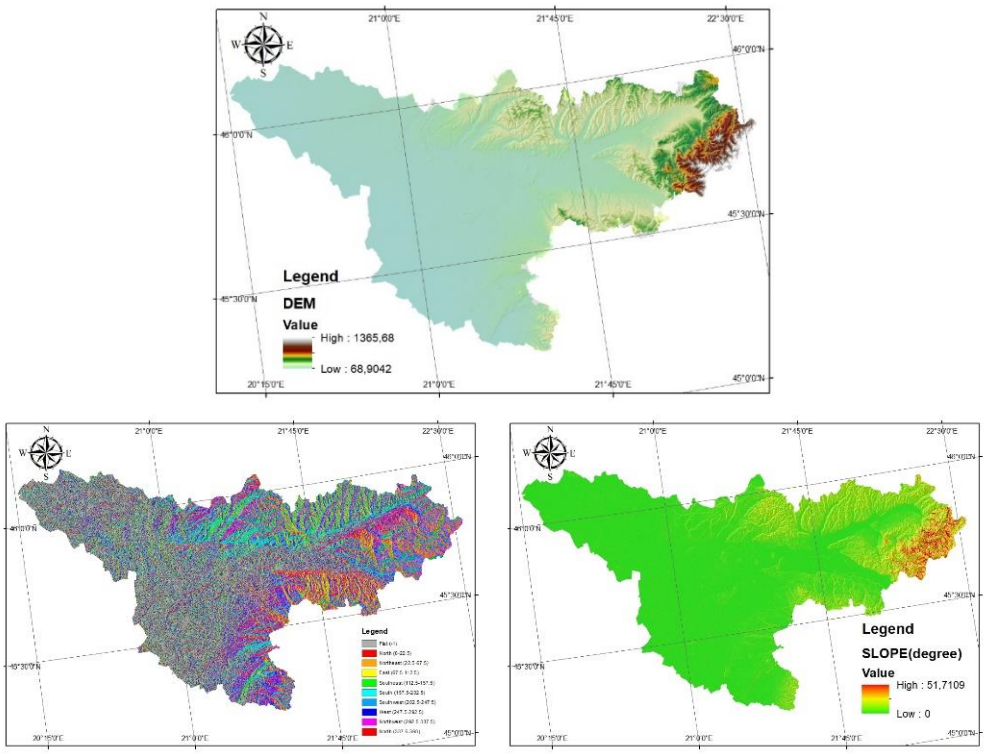

Figure 7. DEM, Slope and Aspect maps for Timis County

Table 5

Land Cover 2018, depending on the share of land in Timis County

Land Cover and Height Classes	Area (ha)	Percent
0-100m	447242.10	51.434
Agricultural areas (AA)	400928.41	46.107
Artificial surfaces (AS)	29558.24	3.399
Forest and semi natural areas (F)	6226.96	0.716
Water bodies (WB)	1052.01	0.121
Wetlands (W)	9476.48	1.090
100-200m	286223.71	32.916
Agricultural areas (AA)	232758.99	26.768
Artificial surfaces (AS)	18277.20	2.102
Forest and semi natural areas (F)	33112.87	3.808
Water bodies (WB)	785.25	0.090
Wetlands (W)	1289.39	0.148
200-300m	73921.29	8.501
Agricultural areas (AA)	31123.69	3.579

Artificial surfaces (AS)	2358.15	0.271
Forest and semi natural areas (F)	40438.68	4.651
Water bodies (WB)	0.78	0.000
300-400m	14700.37	1.691
Agricultural areas (AA)	2826.58	0.325
Artificial surfaces (AS)	262.64	0.030
Forest and semi natural areas (F)	11611.15	1.335
400-600m	16371.37	1.883
Agricultural areas (AA)	1351.68	0.155
Artificial surfaces (AS)	49.25	0.006
Forest and semi natural areas (F)	14970.44	1.722
600-700m	6533.12	0.751
Agricultural areas (AA)	349.95	0.040
Forest and semi natural areas (F)	6183.17	0.711
700-700m	5605.89	0.645
Agricultural areas (AA)	249.50	0.029
Forest and semi natural areas (F)	5356.39	0.616
800-1000m	6822.56	0.785
Agricultural areas (AA)	2.16	0.000
Forest and semi natural areas (F)	6820.40	0.784
1000-1200m	2436.46	0.280
Agricultural areas (AA)	11.54	0.001
Forest and semi natural areas (F)	2424.92	0.279
1200-1400m	423.37	0.049
Forest and semi natural areas (F)	423.37	0.049

CONCLUSIONS

Timis County, according to Land Cover, it is a county that has mainly agricultural lands in its component. It shows that most of the land in Timis County (51.4% and 32.9%) has an elevation between 0-100m, respectively 100-200, and most of the land cover characteristic of this range is made up of Agricultural areas 46.1%, respectively 32.9%. In the year 2018, the percentage of the agricultural area in Timis County is 78.17%, which represents 45557.69 ha.

ACKNOWLEDGEMENT

The authors thanks to the Geomatics Research Laboratory and to the GIS Scientific and Remote Sensing Student Circle from BUASMV "King Michael I of Romania" Timisoara, for the facility this research.

BIBLIOGRAPHY

ALAM, A., BHAT, M.S., MAHEEN, M., 2019 - Using Landsat satellite data for assessing the land use and land cover change in Kashmir valley. GeoJournal, 87(3): 1529-1543.

BADALUTA MINDA, C., CRETU, G., ALEXOAIE, L., 2011 - Flood risk assessment for three river defense works: dikes, dams and riparian wetlands. 11th International Multidisciplinary Scientific GeoConference SGEM, 2011: 1314-2704.

BEGOV UNGUR, A., SĂLĂGEAN, T., FERENCZ, Z., 2016 - Example of a GIS Application afferent to the introduction of real estate cadastre in Cluj Napoca city using AutoCAD Map 3D. 16-th International Multidisciplinarry Scientific Geoconference SGEM 2016. Conference Proceedings. Volume III. Book 2. Informatics. Geoinformatics and Remote Sensing, 207-214.

BERTICI, R., GROZAV, A., ROGOBETE, GH., ȚĂRĂU, D., 2012 - Experimental research of vertic phenomena during of 45th years in Cheglevici – Romania. Analele Universitatii din Craiova. Edit. Universitară.

CĂLINA, J., CĂLINA, A., BĂDESCU, G., VANGU, G.M., IONICĂ, C.E., 2018 - Research on the use of aerial scanning for completing a GIS database. AgroLife Scientific Journal, 7(1): 25-32.

CĂLINA, J., CĂLINA, A., MILUȚ, M., CROITORU, A., STAN, I., BUZATU, C., 2020 - Use of drones in cadastral works and precision works in silviculture and agriculture. Romanian Agricultural Research, 37: 273-284.

CREȚU, G., BĂDĂLUȚĂ-MINDA, C., 2007 - Model for floods simulation and floods occurred due to the breaching of the longitudinal defense hydro technical works. International Conference Disaster and pollution monitoring, Iași, Romania, 47-54.

BARBU, D. 2013 – Mic atlas al Județului Timiș (caleidoscop) (pdf). Artpress (ed. a V-a, revăzută și adăugită). Consiliul Județean Timiș, ISBN 978-973-108-553-1.

DRAGOMIR, L.O., HERBEI, M.V., 2012 - Monitoring the subsidence phenomenon in Petrosani city using modern methods and technologies. Environmental Engineering and Management Journal, 11(7): 1349-1354.

DUNCA, A.M., BĂDĂLUȚĂ-MINDA, C., 2018 - The determination of the maximum runoff in the representative and experimental hydrographical basin of Sebes River (Banat, Romania). Rocznik Ochrona Środowiska, 20(1): 54-72.

FONJI, S.F., TAFF, G.N., 2014 - Using satellite data to monitor land-use land-cover change in North-eastern Latvia. SpringerPlus, 3: 61.

GOVEDARICA, M., RISTIC, A., HERBEI, M.V., SALA, F., 2015 - Object oriented image analysis in remote sensing of forest and vineyard areas. BulletinUASVM Horticulture, 72(2): 362-370.

HAMMER, Ø., HARPER, D.A.T., RYAN, P.D., 2001 - PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica, 4(1): 1-9.

HERBEI, M.V., SALA, F., 2014 - Using GIS technology in processing and analyzing satellite images - case study Cheile Nerei Beusnița National Park, Romania. Journal of Horticulture, Forestry and Biotechnology, 18(4): 113-119.

HERBEI, M.V., SALA, F., 2020 - Evaluation of urban areas by remote sensing methods in relation to climatic conditions: Case study City of Timisoara. Carpathian Journal of Earth and Environmental Sciences, 15(2): 327-337.

HERBEI, M.V., POPESCU, C.A., BERTICI, R., SMULEAC, A., POPESCU, G., 2016 - Processing and use of satellite images in order to extract useful information in precision agriculture. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Agriculture, 73(2): 238-246.

HERBEI, M., SALA, F., BOLDEA, M., 2015a - Relation of Normalized Difference Vegetation Index with some spectral bands of satellite images. AIP Conference Proceedings, 1648:670003-1 – 670003-4.

HERBEI, M., SALA, F, BOLDEA, M., 2015b - Using mathematical algorithms for classification of Landsat 8 satellite images. AIP Conference Proceedings, 1648:670004-1 – 670004-4.

LAMBIN, E.F., 1997 - Modelling and monitoring land-cover change processes in tropical regions'. Progress in Physical Geography: Earth and Environment, 21(3): 375-393.

LIPING, C., YUJUN, S., SAEED, S., 2018 - Monitoring and predicting land use and land cover changes using remote sensing and GIS techniques-A case study of a hilly area, Jiangle, China. PLoS ONE, 13(7): e0200493.

POPESCU, C.A., HERBEI, M.V., SALA, F., 2020 - Remote sensing in the analysis and characterization of spatial variability of the territory. A study case in Timis County, Romania. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 20(1): 505-514.

SALA, F., POPESCU, C.A., HERBEI, M., 2020 - Fractal analysis in estimating the fragmentation degree of agricultural lands. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 20(3): 517-524.

SAAH, D., JOHNSON, G., ASHMALL, B., TONDAPU, G., TENNESON, K., PATTERSON, M., POORTINGA, A., MARKERT, K., QUYEN, N.H., AUNG, K.S., SCHLICHTING, L., MARTIN, M., UDDIN, K., ARUAL, R.R., DILGER, J., ELLENBURG, W.L., FLORES-ANDERSON, A.I., WIELL, D., LINDQUIST, E., GOLDSTEIN, J., CLINTON, N., CHISHTIE, F., 2019 - Collect Earth: An online tool for systematic reference data collection in land cover and use applications. Environmental Modelling & Software, 118: 166-171.

SAAH, D., TENNESON, K., MATIN, M., UDDIN, K., CUTTER, P., POORTINGA, A., NGYUEN, Q.H., Patterson, M., Johnson, G., Markert, K., Flores, A., 2019 - Land cover mapping in data scarce environments: challenges and opportunities. Frontiers in Environmental Science, 7: 150.

ŢĂRĂU, D., ROGOBETE, G., DICU, D., BERTICI, R., 2013 - Using pedological information to define land productivity and environmental protection in mountain and pre-mountain area of Timis County. Research Journal of Agricultural Science, 45(2): 303-308.

http://earthexplorer.usgs.gov

https://land.copernicus.eu/pan-european/corine-land-cover