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THE USE OF CORINE LAND COVER 2012 AND URBAN ATLAS 2012 DATABASES IN AGRICULTURAL SPATIAL ANALYSIS. CASE STUDY: CLUJ COUNTY, ROMANIA

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Abstract: *The goal of this paper is to apply agricultural spatial analysis to freely available high accuracy land cover databases in Cluj County, Romania. The CLC 2012 and Urban Atlas 2012 databases are downloadable from the Copernicus Land Monitoring Services website. Using the ESRI ArcGIS software, a series of spatial analysis tools were used to evaluate the agricultural land use in Cluj County. The results consist in spatial distribution maps and graphs for land use, Manning's n coefficient and cover management factor (C factor). Although the geodatabases are suitable for small-scale spatial distribution maps, their accuracy (100m cell size) makes them inappropriate for large-scale analysis. The results can be used by all GIS specialists in agriculture and similar fields for fast and efficient means to evaluate the land use in large areas.*

Key-words: *CLC 2012, Urban Atlas 2012, land-use, land-cover, GIS, agriculture, Cluj*

INTRODUCTION

The goal of this paper is to apply agricultural spatial analysis to freely available high accuracy land cover databases in Cluj County, Romania.

In 1985, European Union initiated the CORINE Land Cover (CLC) programme, a prototype project focusing on different environmental issues, such as an inventory of land cover in 44 classes presented as a cartographic product, at a scale of 1:100000 (MOSIADYS & PERAKIS, 2014). The European Environment Agency (EEA) has contracted the CORINE databases and several of its programmes. The main characteristics of CORINE include the use of the MSS sensor of the Landsat satellites mission, a working scale of 1:10000 and a photo interpretation of false colour composites of satellite imagery. CORINE Land Cover 2012 (CLC2012) is the fourth European Land Cover inventory (1990, 2000, 2006 and 2012). The number of participating countries is in-creasing, at present being 39 with a total of mapped area of 5.8 million km^2 (STOIMENOV *et.al.* 2014).

The data is organized in both vector and/or raster layers, and is downloadable from the Copernicus Land Monitoring Services website (http://land.copernicus.eu). The Copernicus programme comprises satellite-borne earth observation and in-situ data, and a services component that combines these in order to provide information essential for monitoring the terrestrial environment. The Copernicus land monitoring service provides geographical information on land cover/land use and on variables related to vegetation state and the water cycle. It supports applications in a variety of domains, such as spatial planning, forest management, water management and agriculture.

The European Urban Atlas is part of the local component of the GMES/Copernicus land monitoring services. It provides reliable, inter-comparable, high-resolution land use maps for 695 Functional Urban Area (FUA) and their surroundings (more than 50,000 inhabitants) for the reference year 2012. The GIS data can be downloaded together with a map for each urban area covered and a report with the metadata from the Copernicus Land Monitoring Services website. The 50m resolution is higher than the CLC geodatabase (100m).

MATERIAL AND METHODS

The raster layer is freely available in both 100m and 250m resolution while the vector layer is organized on three levels (table 1) corresponding to the CLC nomenclature (http://ec.europa.eu/agriculture/publi/landscape/index.htm).

Table 1.

CORINE land cover nomenclature*

Level 1	Level 2	Level 3
1. Artificial surfaces	1.1. Urban fabric	1.1.1. Continuous urban fabric
		1.1.2. Discontinuous urban fabric
	1.2. Industrial, commercial and transport units	1.2.1. Industrial or commercial units
		1.2.2. Road and rail networks and associated land
		1.2.3. Port areas
		1.2.4. Airports
	1.3. Mine, dump and construction sites	1.3.1. Mineral extraction sites
		1.3.2. Dump sites
		1.3.3. Construction sites
	1.4. Artificial non-agricultural vegetated areas	1.4.1. Green urban areas
		1.4.2. Sport and leisure facilities
2. Agricultural areas	2.1.Arable land	2.1.1. Non-irrigated arable land
		2.1.2. Permanently irrigated land
		2.1.3. Rice fields
	2.2. Permanent crops	2.2.1. Vineyards
		2.2.2. Fruit trees and berry plantations
		2.2.3. Olive groves
	2.3. Pastures	2.3.1. Pastures
	2.4. Heterogeneous agricultural areas	2.4.1. Annual crops associated with permanent crops
		2.4.2. Complex cultivation
		2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation
		2.4.4. Agro-forestry areas
3. Forests and semi-natural areas	3.1. Forests	3.1.1. Broad-leaved forest
		3.1.2. Coniferous forest
		3.1.3. Mixed forest
	3.2. Shrub and/or herbaceous vegetation association	3.2.1. Natural grassland
		3.2.2. Moors and heathland
		3.2.3. Sclerophyllous vegetation
		3.2.4. Transitional woodland shrub
	3.3. Open spaces with little or no vegetation	3.3.1. Beaches, dunes, and sand plains
		3.3.2. Bare rock
		3.3.3. Sparsely vegetated areas
		3.3.4. Burnt areas
		3.3.5. Glaciers and perpetual snow
4. Wetlands	4.1. inland wetlands	4.1.1. Inland marshes
		4.1.2.Peatbogs
	4.2. Coastal wetlands	4.2.1. Salt marshes
		4.2.2. Salines
		4.2.3. Intertidal flats

**retrieved from http://ec.europa.eu/agriculture/publi/landscape/index.htm*

The vector layer consists of a single shapefile (in contrast to the multiple seamless shapefiles in CLC 2006) which is very useful when extracting all the data for a specific area.

All data was processed in ArcGIS 10 software, but it can easily be used with open GIS software such as QGIS or GRASS GIS. The Cluj County and Cluj Municipality borders shapefiles (accessible from the www.geo-spatial.org and www.data.gov websites) were used to clip the databases to this paper's spatial analysis extent. The background hill shading was obtained from the Shuttle Radar Topography Mission (SRTM) 30m resolution files (http://earthexplorer.usgs.gov).

ArcGIS 10's spatial analyst toolbox was used for various analysis, such as conversion, extraction, hill shading or reclassification.

RESULTS AND DISCUSSION

The main use of the database is in land evaluation purposes especially at regional or county levels. The 1st level units of the CLC nomenclature is shown in Fig. 1.

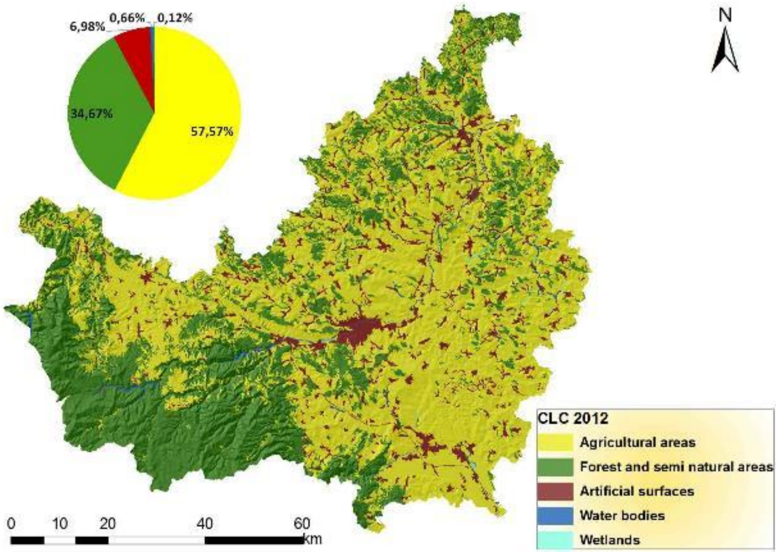

Fig. 1 – The CLC 2012 1st level distribution in Cluj County

The agricultural area cover more than 57% of the county's area. In the 2nd level, the agricultural areas are divided into arable land, permanent crops, pastures and heterogeneous agricultural areas (fig. 2).

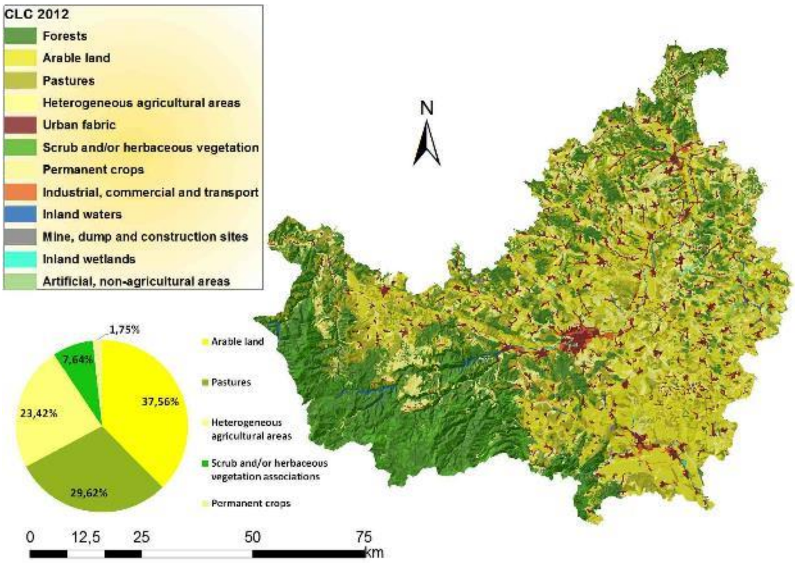

Fig. 2 – The CLC 2012 2nd level distribution in Cluj County

The arable land predominates in the eastern hilly areas of the county, while pastures cover the mountainous areas in the west along with the forest cover.

In the 3rd level of classification each subclass is divided into culture types making it easy to calculate statistical values such as the percentage or proportion of cultures in a given area. The current way of use of an agricultural land can be correlated with land evaluation analysis (ZISU, 2016) to estimate whether the land is used to its maximum productive efficiency.

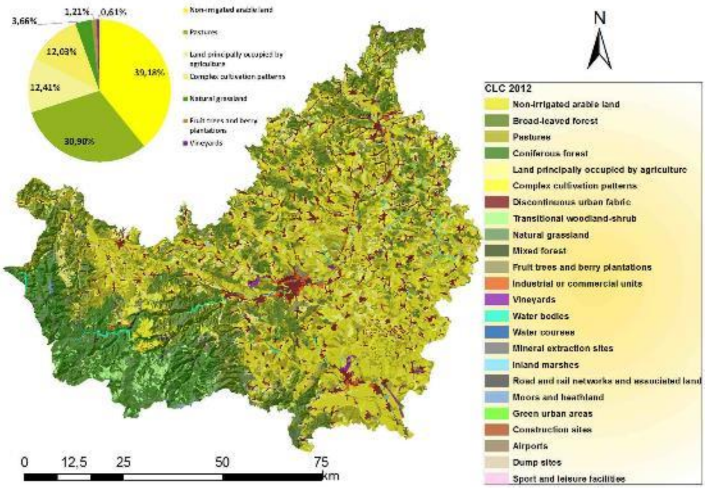

Fig. 3 – The CLC 2012 3rd level distribution map in Cluj County

The Land Cover Change (LCC) 2006-2012 geodatabase (also downloadable from http://land.copernicus.eu) can be used to identify changes in the spatial structure of a landscape. While it is possible to perform a direct comparison between the two raster layers

(CORPADE, *et.al*, 2016), the LCC provides accurate results that can be used to identify spatial trends in land use distribution (fig. 4).

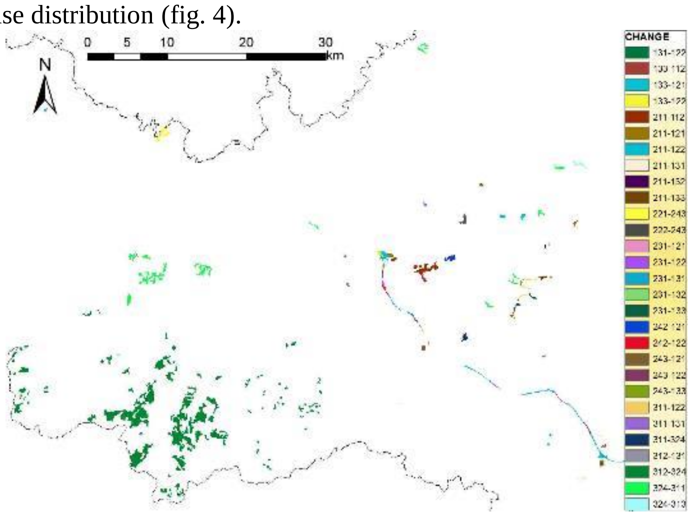

Fig. 4 – The LCC 2012-2016 distribution map in the eastern part of Cluj County

The map shows large areas of land cover changes in the mountainous part of the county where more than four thousand hectares of coniferous forest were replaced by shrubs, or more than one thousand hectares of arable land was replaced by roads, constructions and commercial units (fig. 5).

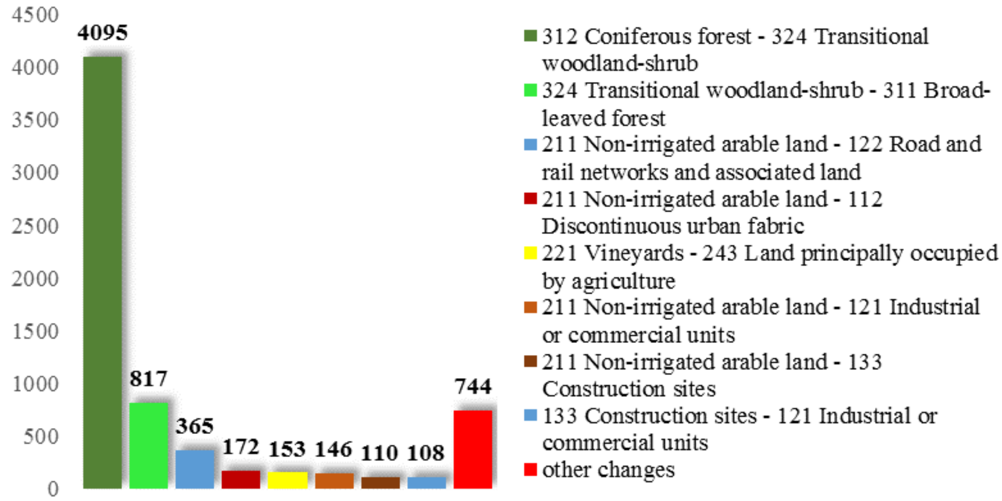

Fig. 5 – The LCC 2012-2016 distribution map in the eastern part of Cluj County

The CLC database values can be converted to Manning’s n coefficient values for use in flood simulation scenarios such as Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) software. For agricultural analysis the values in table 2 were used (PHILLIPS, 2007). The distribution map is shown in figure 6.

Table 2.

CLC 2012 – Level 2 classification	Manning's "n" value
Pastures	30
Arable land/Heterogeneous agricultural areas	35
Permanent crops/Inland waters	40
Scrub and/or herbaceous vegetation associations/Artificial, non-agricultural vegetated areas	50
Inland wetlands	70
Forests	120
Urban fabric/Industrial, commercial and transport units/Mine, dump and construction sites	150

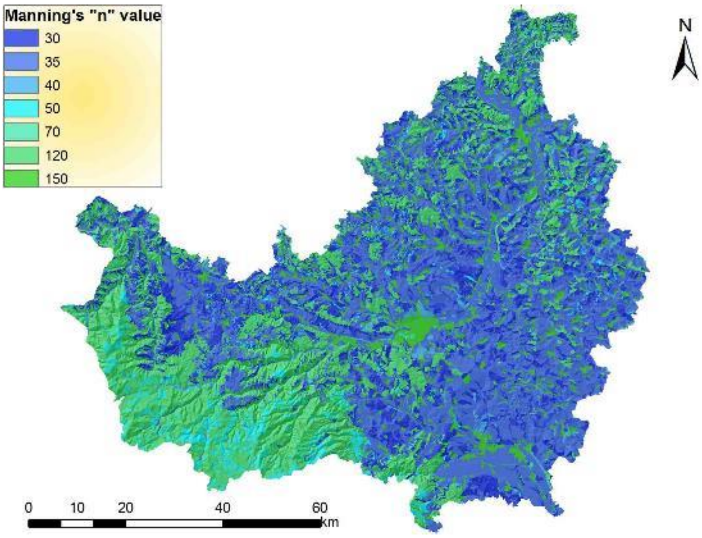

Fig. 6 – Manning's n coefficient distribution map in Cluj County

The CLC 2012 geodatabase can be used in soil erosion estimations, for calculating the cover-management factor (C factor) in Universal Soil Loss Equation. The C factor is probably the most important USLE factor because it represents the easiest modifiable condition for reducing erosion (RENARD *et. al*, 1997). Factors that influences the soil use values are given by the degree of soil surface covered with vegetation, canopy trees, and the height of which the rain drops are falling, root extension and the previous soil usage. The mean C-factor values per land-cover type at the European scale (PANAGOS *ET. AL*, 2015), were used for the reclassification of the CLC file in Cluj County (table 3).

Table 3.

Group	CLC class	Description	C-factor values
Artificial surfaces	141	Green urban areas	0,040
Arable land	211	Non-irrigated arable land	0,300
Permanent crops	221	Vineyards	0,353
	222	Fruit trees & berry plantations	0,219
Pastures	231	Pastures	0,090
Heterogeneous agricultural areas	242	Complex cultivation patterns	0,138
	243	Land principally used for agriculture, with significant areas of natural vegetation	0,123
Forests	311	Broad-leaved forest	0,001
	312	Coniferous forest	0,001
	313	Mixed forest	0,001
Scrub and/or herbaceous vegetation associations	321	Natural grasslands	0,044
	322	Moors and heathland	0,042
	324	Transitional woodland-shrub	0,022

The C factor distribution map (fig. 7) shows high values in the hilly agricultural areas, whereas the mountainous parts (covered mostly with forests) presents the lowest values.

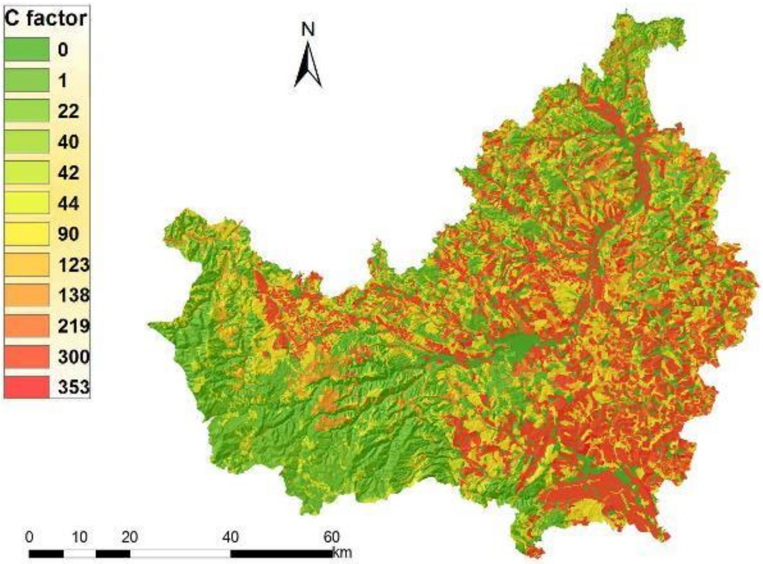

Fig. 7 – The C factor distribution map in Cluj County

The Urban Atlas geodatabase will contain the land cover maps for all the European Cities with a population larger than fifty thousand inhabitants. For now, in Cluj County, only the Cluj-Napoca Municipality is included (fig. 8).

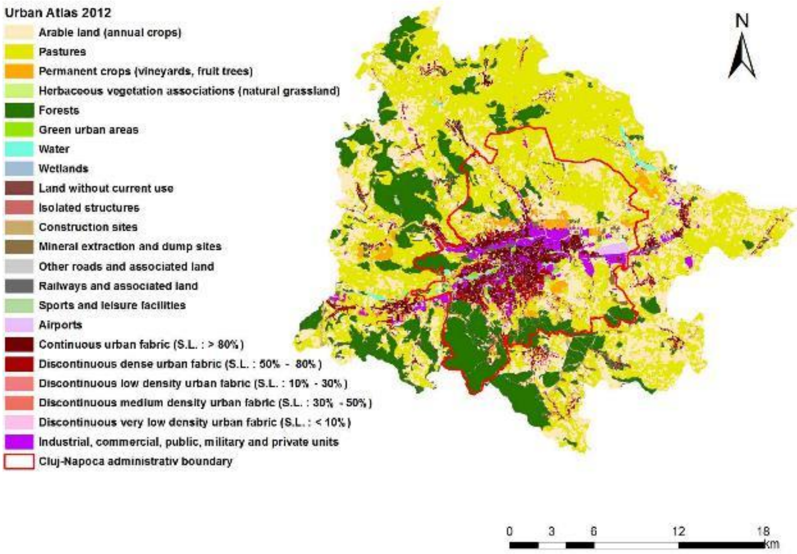

Fig. 8 – The Urban Atlas land cover distribution map in and around Cluj-Napoca

For most of the cities, the maps include the peripheral area around the administrative boundaries, which can prove very useful in agricultural analysis. The land cover distribution and weighted graphs are shown in figure 9.

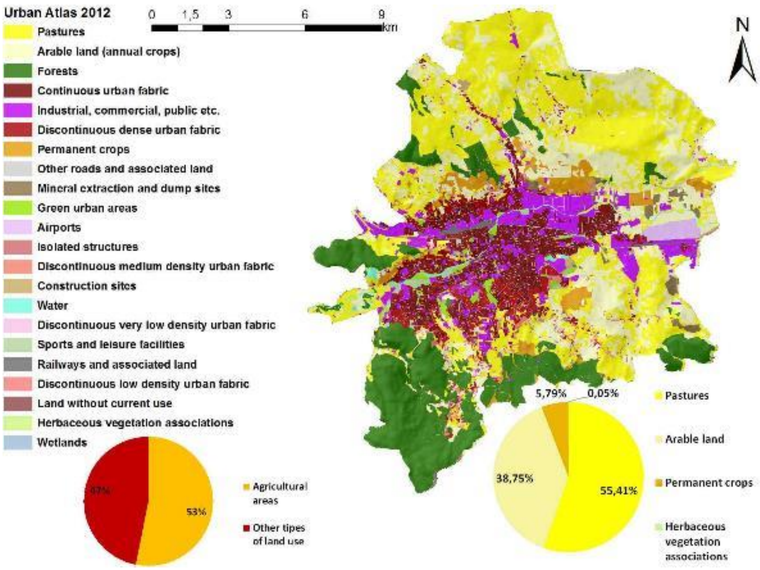

Fig. 9 – The Urban Atlas land cover distribution map in the Cluj-Napoca Municipality

The agricultural area cover more than a half of the city's surface, of which 55 percent is represented by pastures, followed by arable land (38%). As expected, permanent crops covers around 5 percent of the agricultural areas.

CONCLUSIONS

The results can be used by all GIS specialists in agriculture and similar fields for fast and efficient means to evaluate the land use in large areas. The database values can be converted to Manning's n coefficient values for use in flood simulation scenarios (e.g. HEC-RAS) or soil erosion estimations (e.g. C factor in Universal Soil Loss Equation). Although the geodatabases are suitable for small-scale spatial distribution maps, their accuracy (100m cell size for CLC 2012 and 50m cell size for Urban Atlas 2012) makes them inappropriate for large-scale analysis.

BIBLIOGRAPHY

CORPADE, C., NICOLIN, ALMA LIOARA, CORPADE, ANA-MARIA, ARSENE, G.-G., 2016, Changes in the spatial structure of landscape within the site of community interest ROSCI0233 Someșul Rece, Research Journal of Agricultural Science, 48 (2), p. 21-28.

MOYSIADIS, ATHANASIOS and PERAKIS, KONSTANTINOS, 2014, European land cover mapping systems for the natural and urban environment, Fresenius Environmental Bulletin, vol. 23, no. 11a, p. 2814-2818.

PANAGOS, P., BORRELLI, P., MEUSBURGER, K., ALEWELL, C., LUGATO, E., MONTANARELLA, L., 2015, Estimating the soil erosion cover-management factor at the European scale, Land Use Policy, Volume 48, Pages 38–50.

PHILLIPS, J.V. and TADAYON, S., 2007, Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance

Plan Guidelines for Vegetated Channels in Central Arizona, U.S. Geological Survey, Reston, Virginia, p. 12-13.

RENARD, K.G., FOSTER, G.R., WEESIES G.A., MC COOL D.K., YODER D.C., 1997, Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Soil Loss Equation (RUSLE). U.S. Dept. of Agriculture, Agricultural Handbook No. 703.

STOIMENOV, A., KOLEVA, R., DIMITROV, V., TEPELIEV, Y., LUBENOV, T., AND KROUMOVA, J., 2014, Sattelite mapping of Bulgarian land cover – CORINE 2012 Project, Forestry Ideas, vol. 20, No 2 (48): 189–196.

ZISU, IONUȚ, 2016, Correlations between the quality of the agricultural land from Lugoj Hills and its current way of use, Carpathian Journal of Earth and Environmental Sciences, Vol. 11, No. 1, p. 167 – 179.

http://land.copernicus.eu
http://ec.europa.eu/agriculture/publi/landscape/index.htm
http://www.geo-spatial.org
http://www.data.gov
http://earthexplorer.usgs.gov
http://www.hec.usace.army.mil/software/hec-ras/