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QUANTIFICATION OF *C FACTOR* FROM *USLE* MODEL USING CERTAIN SETS OF CLASSICAL AND SATELITE DATA IN NW ROMANIA

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Abstract: C Factor is alongside the topographic factor, one of the most influential factors in estimating soil losses by means of the USLE model. Starting from this reality, we have used three methodologies in this study in order to obtain a cover-management factor in a 291 km^2 territory located in North-West of Romania. The main objective of this comparative analysis is to highlight the best suited workflow for the medium-sized areas under the medium and high usage of data sets. The results were partly corroborated with data obtained from ESDAC which resulted from the application of the so-called LANDUM model. The best results have been obtained by using the *Linear Spectral Unmixing* technique on Landsat 8 OLI/TIRS to derive the vegetation and bare soil at the pixel level, and two more variants of built-up areas, namely one for the water, followed by the algorithm of the first four components and the evaluation of the C Factor (C_{LSU}).

Key words: C-factor - cover management factor, Linear Spectral Unmixing - LSU, Abundances, Endmembers, Normalized Difference Vegetation Index - NDVI

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INTRODUCTION

Soil losses caused by the sheet and rill erosion due to water under conditions of antropic intervention represents one of the most important of today's world issues with multiple economic and environmental implications (Vrieling, 2006), since the decreasing of agricultural lands fertility, increase of the suspended solid flow at the rivers and changes in the global circuit of CO_2 (Wang et al., 2010). According to Oldeman et al. (1990), the fields on which soil decaying inducted by the sheet and rill erosion takes place (considering the two process categories) are summing up globally 920,3 mil ha. In Europe alone, this type of erosion affects 104,6 mil ha, that is 16% of the continent's area, except for the European side of Russia (Gobin et al., 2002; Jones et al., 2012).

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Utterly natural, due to numerous social demands, the issue raised a particular interest from geoscientists, many methods of erosion and/or deposition assessment and prediction have been developed over time, applicable on the parcel, slope, basin level (local level), regional or global (Kirkby and Cox, 1995): empirical methods, among which it is remarked USLE (Wischmeier and Smith, 1965, 1978) and its derivative variants (MUSLE, Williams, 1975; RUSLE, Renard et al., 1994, 1997); process-based models – physically based methods, which are based on minimum energy dissipation rate theory (Yang, 1971, 1976, 1996), also known as the unit stream power theory, adapted for inter-rill and rill flow (Moore and Burch, 1986).

Many of them underwent translations and adaptations in electronic format, thus becoming empirical, physical or mixed computerized models of simulation / estimation of erosion and / or sedimentation processes: RUSLE 1, RUSLE 2, [1] USPED (Mitasova et al., 1996, Mitas and Mitasova, 1998), USLE 2D (Desmet and Govers, 1996), Watem/Sedem (Van Oost et al., 2000; Van Rompaey et al., 2001, Verstraeten et al., 2002;), WEPP (Nearing et al., 1989), ANSWEARS (Beasley et al., 1980), AGNPS (Young et al., 1989), CREAMS (Knisel, 1980; Foster et al., 1980), KINEROS (Woolhiser et al., 1990), EUROSEM (Morgan et al., 1998), LISEM (De Roo et al., 1996, Jetten et al., 2003), PESERA (Kirkby et al., 2004), EROSION 3D (Schmidt et al., 1999).

Synthesis studies about the weight and utilization of these methods at European level are revealing the fact that USLE (Universal Soil and Loss Equation), in its various adapted variants, represents the most used evaluation/prediction model of soil erosion on a long term. For instance, Van Camp et al. (2004) performs an inventory of the estimation methods of erosion exercised by water on the E.U. countries, and the presented result can be summarized as follows: in 16 out of the 36 studied countries there could be identified the used patterns, and 12 out of those 16 countries are using USLE. Van Beek, and Tóth (2012), in a synthesis for RAMS (Risk Assessment Methodologies) about erosion, carried out on the basis of thematic questionnaires within the EU RAMSOIL project in which 17 countries were involved, mentions that 7 out of the 11 RAMS for soil erosion inventories are using USLE (or some of the modified versions of it):

$A = R \times K \times L \times S \times C \times P$ (Wischmeier and Smith, 1978), where:

A - the medium rate of erosion (t $ha^{-1}yr^{-1}$)

R - the rainfall and runoff factor, plus a factor for runoff from snowmelt, where it is significant (MJ mm ha^{-1} $h^{-1}yr^{-1}$);

K - the soil erodibility factor, understood as an intrinsic measure of soil susceptibility to erosion (t ha h MJ^{-1} ha^{-1} mm^{-1});

L - the slope-length factor (dimensionless);

S - the slope-steepness factor (dimensionless);

C - the cover and management factor (dimensionless);

P - the support practice factor/ influence factor of anti-erosion works (dimensionless).

The Wischmeier and Smith equation was tested and adapted (calibrated) in Romania as well for several decades on standard leakage plots in experimental stations (Perieni - Vaslui County, Bilceşti - Argeş County, Câmpia Turzii - Cluj County, Valea Călugărească - Prahova County, Aldeni - Buzău County), under the aegis of ICPA (Research Institute for Pedology and Agrochemistry, at present INDCPAPM – National Research and Development Institute for Pedology, Agrochemistry and Environmental Protection), so that today the Romanian derived model of USLE has the widest spatial-temporal applicability spread at national level:

$E = K \times L^n \times I^n \times S \times C \times C_S$ (Moţoc et al., 1975, 1979, 2002), where:

E - the average annual rate of the effective erosion (t $ha^{-1}yr^{-1}$);

K - the correction coefficient for pluvial aggressiveness;

[1] *www.ars.usda.gov*

L - the length in meters of the slope;
I - the slope (%);
m and n - coefficients; m = 0.3; $I^n = 1,36 + 0,97\ i + 0,381\ i^2; i$ – mean slope
S - the indicator of soil erodibility;
C - the indicator of the protection offered by crops;
Cs - the indicator for the effect of the erosion control measurements.

Of all the factors taken into account in these equations, the cover-management factor (C factor) is considered to be among the top two as the level of importance for the risk of rill and inter-rill erosion (Renard et al., 2011) is concerned, as at the micro and mesoscalar level, alongside the topographic factor (LS factor), it induces greater variability in terms of input data and as it can act on it in a real way, by management measures, to reduce erosion processes.

The main objectives of this material are:

- to perform a comparative analysis of the C-factor (cover-management factor) estimation methods applied to a selected territory;
- to highlight and interpret the value differences from the results obtained;
- to validate a method that is suitable for the NW of Romania, by reference to the results obtained on European scale (Panagos et al., 2015).

STUDY AREA

The territory to which this study applies belongs to the territorial administrative units of Oradea, Biharia, Paleu and Cetariu, which are integrated from the territorial and economic management point of view to Oradea Metropolitan Area in Bihor County, located in the north-west of Romania (figure 1).

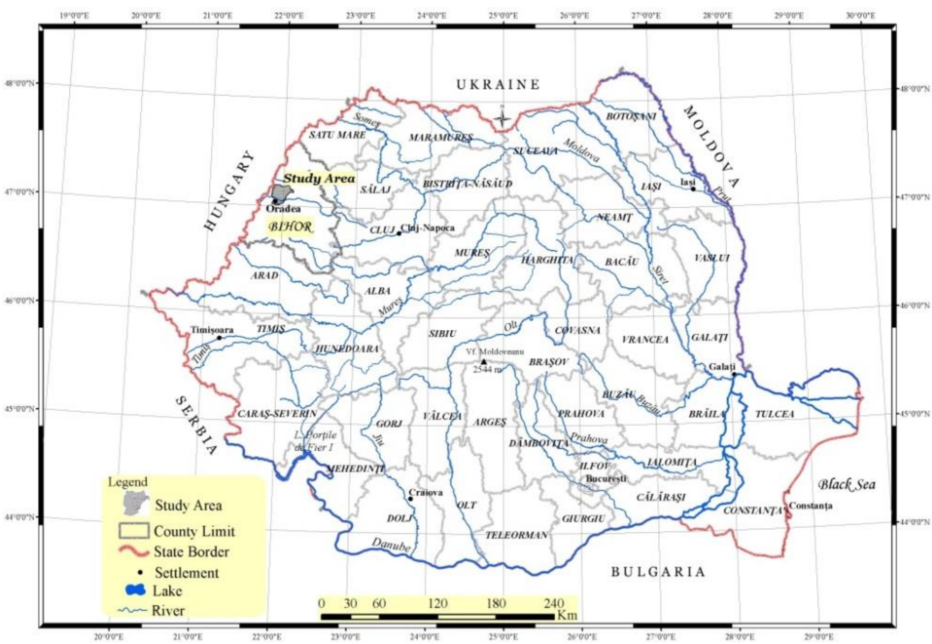

Figure 1. Location of the Study Area

The motivation for choosing this workspace resides in the accentuated dynamics of functional and especially residential areas, which have gradually expanded into fragile geomorphosystems in terms of stability.

On a macro-morphological scale, the four administrative units are developing on relief units belonging to the Hills and the West Plain: Oradei Hills (Crişene Hills Subunit), Crișurilor Low Plain, Miersigului Plain, and Bihariei Plain (figure 2). From a genetic point of view, we are in the situation of a fluvial morphology, imposed mainly by Crişul Repede, which interacts with the hillslope geomorphostructures conditioned by the torrential, gully and gravitational processes, their functional and geomorphic interconnection being ensured by glacises.

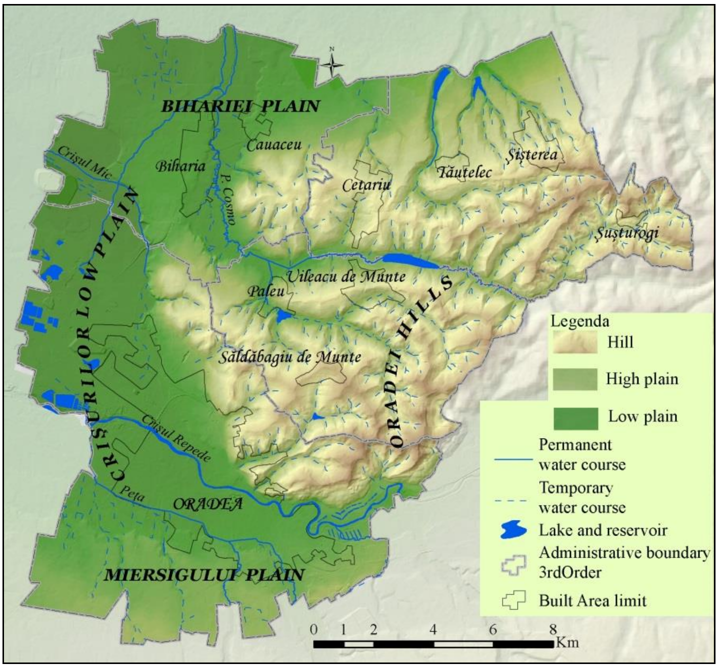

Figure 2. Relief Units Map
(Background data source: EU-DEM v1.1)

MATERIALS AND METHODS

Starting from the stated objectives, some clarifications have to be made regarding the cover-management factor connotation. From a quantitative point of view, in USLE, it expresses the ratio of long time soil loss in a field with a particular type of agricultural crop and the soil losses that took place in the uncultivated standard Unit Plot (22.1 m long, 9% slope), over the same time period (Kinnel, 2010), and is quantified dimensionless. Conceptually, it expresses the combined effect of all the interrelated cover and management variables (Wischmeier and Smith. 1978).

Initially, both USLE and the variant adapted for Romania were designed to predict soil erosion on agricultural land, respectively for arable land with reduced territorial extension. During over 50 years this equation has been used, in the context of the diversification of the techniques for processing and extraction of the coefficients taken into account, the work areas have become increasingly varied from geomorphological and bio-pedogeographical point of view, but also more extended, from the hydrographic basins (Van Rompaey et al., 2005) to continental territories (Van der Knijff et al., 2000; Panagos et al., 2014).

Therefore, cover-management factor underwent a series of modifications, in the sense that it needed to be adapted to the lands which are not arable and which have another type of land cover as well.

If we were to summarize its estimation methods, irrespective if it is about USLE or RUSLE, with their different variants, there could be outlined three main group of methods:

- the standard methodology, which we shall call the classical methodology;
- methods based on the processing of multispectral satellite images;
- mixed methods.

Classical methodology requires the use of correction coefficients established according to the USLE Standard Technique as set out above, i.e., on the basis of the reporting of soil losses in parcels of different agricultural uses or natural vegetation coverings, to soil losses in homogeneous parcels without vegetation or with poor vegetation, obtained by measurements made in the experimental research stations. In Romania, the values of these correction indices can be found in tables or cartographic format in a series of specialized materials (Moţoc et al., 1975; Moţoc and Sevastel, 2002; Moțoc et al., 2010).

This is the technique used in most studies published since 2000s in Romania, which aimed at the multiannual estimation of soil losses in different areas of the national territory (Anghel and Todică, 2008; Anghel and Bilașco, 2008; Bilașco et al., 2009; Arghiuş and Arghiuş, 2011; Ștefănescu et al., 2011; Alexandru et al., 2012; Zisu and Năsui, 2015), and with respect to the data sources, CORINE Land Cover is the dominant one for the identification of the land use types, which means a resolution of 100 m, and in a relatively small proportion, orthophotos, with a resolution appropriate to this type of research (0.5 m).

We used orthophotos with a 0.5 m resolution from 2012 for parcel vectoring corrected on Pleiades 1A high resolution multispectral images (1.6 m for multispectral and 0.4 m for panchromatic) of June 2014 (figure 3), as 2014 is the reference year for all data categories used in the study. The latter were reprojected in Stereo 70 from GCS_WGS_1984 (Geographic WGS84) and subjected to a geometric correction process (warp from GCPs, with 32 ground control points).

Figure 3. Detail from ortophoto 2012 (ANCPI) and Pleiades 2014, panchromatic (Source: ANCPI) [2]

The result of this processing consists of a set of vector data, with alphanumeric data where can be found the types of land cover and the values of the C factor, according to Moţoc et al. (2010), with small changes that we will specify when referring to the results obtained. For viewing, they have been transformed into a map showing the heterogeneity and mosaic of the analyzed territory in terms of land use patterns (figure 4).

[2] *https://spacedata.copernicus.eu*

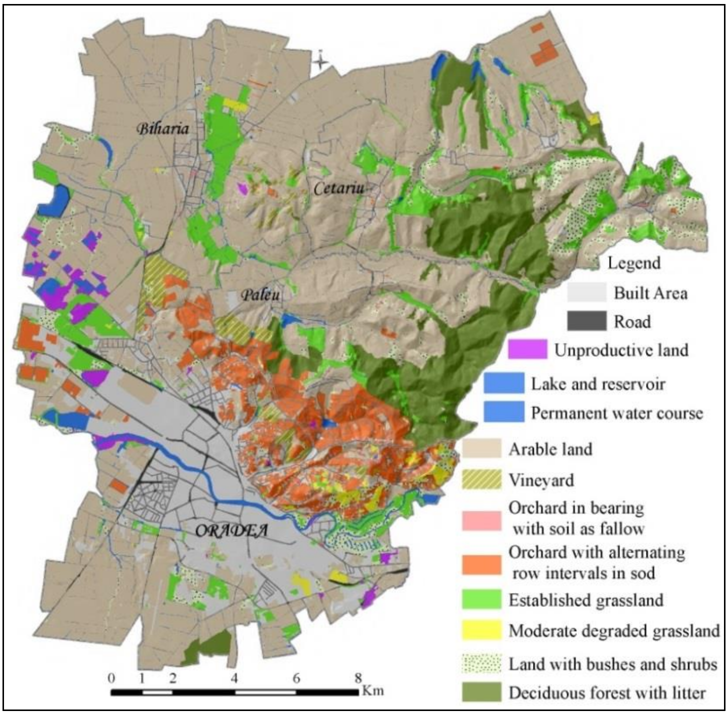

Figure 4. Land Cover Map
(Source: Ortophoto and Pleiades 1A)

Methods based on the processing of multispectral satellite images

Generally, starting from specialized works dealing with this issue, there can be identified two main working directions which use satellite data to extract the C factor: the first one is based on finding certain correlations, by means of regression equations, between itself and the slope-based vegetation indices, the best known and used being *Normalized Difference Vegetation Index – NDVI* (Rouse et al., 1973), and the second one uses processing techniques from *Spectral Mixture Analysis* group.

The extraction of factor C by *rescaling NDVI* is probably the most used, but also the most criticized way of working in this direction due to the speed and ease of obtaining the normalized index of vegetation differentiation on the one hand and due to the poor correlation that can appear between it and the cover-management factor, under certain environmental conditions, which are related to the particularities of climate, soil and vegetative vitality in the work area, on the other hand. Thus, it is well known that the value of this index is strongly influenced by the presence of dark soils and atmospheric pollution (Jiang and Huete, 2010), and its nonlinear or linear relationship with fractional vegetation cover, and implicitly with C factor, is still discussed in the specialty literature with pros and cons (Jiang et al., 2006; Ding et al., 2016).

Essentially, the most used procedure starting from this spectral index (De Jong, 1994; Van der Knijff et al., 2000; Lin et al. 2002; Durigon et al., 2014) involves obtaining it using NIR and RED spectral bands: $(NIR - RED)/(NIR + RED)$, as green vegetation absorbs radiation from red domain and reflects radiation from infrared domain, then the values obtained are related to vegetation coverage in the field, resulting an empirical expression that may be linear or exponential, but which does not have physical basis anyway. The validity of these regression equations is strictly related to the study territory, and the application of such regression models from one region to another can generate great confusion in the results. They were mostly critically analyzed by those who promoted them.

With all the criticisms we have known, we have selected a model of this kind that we will apply in the field, which should have been adapted by the authors (Van der Knijff et al., 2000) to the European continent or at least of the European Union:

$$C = e^{\left(-\alpha * \frac{NDVI}{\beta - NDVI}\right)}, \text{ unde } \alpha = 2;\ \beta = 1$$

It is worth mentioning that at the level of the Romanian territory, except for the material mentioned above, which is anyway on a European scale, there are some attempts to estimate the C factor on the NDVI, which use different regression equations, such as those of De Jong (Patriche et al., 2006), Van der Knijff et al. (Roşca et al., 2012) or Karaburun (Copăcean and Oncia, 2015), the former being derived for a Mediterranean territory in southern France, and the latter for an area in Turkey, west of Istanbul.

Linear Spectral Unmixing (LSU) is a standard technique for processing multispectral and hyperspectral satellite scenes developed by Adams et al. (1986), by means of which the fractions and the percentage weights, referred to as abundances, can be obtained at the pixel level, of the material components considered, called endmembers, based on their spectral responses.

The model assumes that the spectral signatures at each pixel level can be expressed as a linear combination of so-called endemembers, weighted by their abundance (Iordache and Dias, 2012):

$$y_i = \sum_{j=1}^{q} m_{ij}\ \alpha_j + n_i$$

where y_i is the measured value of reflectance at the spectral band i, m_{ij} is the reflectance of the *j*th endmember at spectral band *i*, α_j is the fractional abundance of the *j*th endmember, and n_i represents the error term for the band *i*.

The LSU has been applied with good results in a series of studies that aimed at the effective obtaining of factor C in USLE (Meursberger et al., 2010a) or assessing soil losses through the USLE / RUSLE model (Lu et al., 2004; Alejandro and Omasa, 2007; Meursberger et al., 2010b).

The essential aspects in this procedural approach are the selection of those endmember value elements so as to best cover the component pixel structure of the used satellite scenes as well as the quality of the spectral signatures of these components that can be extracted directly from multispectral data, field data, or online databases.

The number of selected components, that will eventually identify with those land cover categories that we consider to be the main in work area should not exceed the number of spectral bands in the used satellite images (ENVI EX User`s Guide; Bangira et al., 2017), and from our point of view it is advisable to be even smaller.

In this regard, we used a Landsat 8 OLI / TIRS satellite scene acquired in June 2014 with 30 m resolution (15m for panchromatic), from https: //glovis.usgs. Before the actual processing in the LSU operational stream of ENVI 5.3, the data stored in the Multispectra (Level 1 Product) were converted from the DN (digital number) format into radiation values (a process called Radiometric Calibration), after which into reflectance values (ToA - Top of Atmosphere Reflectance) through the Dark Subtraction method.

Five categories of endmember-value components were selected for this study: vegetation, bare soil, water, and two variants for the built-up surfaces due to their chromatic heterogeneity. For each of them, the spectral signature was extracted directly from the pure pixel of the satellite image (figure 5). They were identified by the Pixel Purity Index (PPI) application from ENVI.

Based on these spectral responses the relative abundance at the pixel level of the components (figure 6) was obtained, which is actually identified with their percentage per pixel. The values are between the 0 to 1 scale (by LSU constraint mode), i.e. 0 is translated to the absence of the component in question, and the value 1 represents the 100% weight of the component in the elementary unit of work.

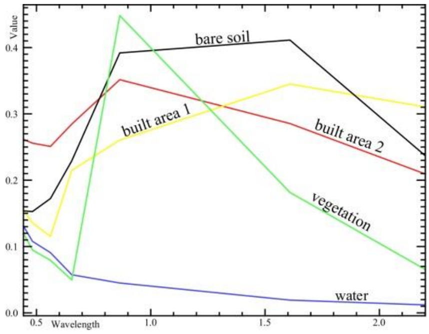

Figure 5. Spectra for endmembers

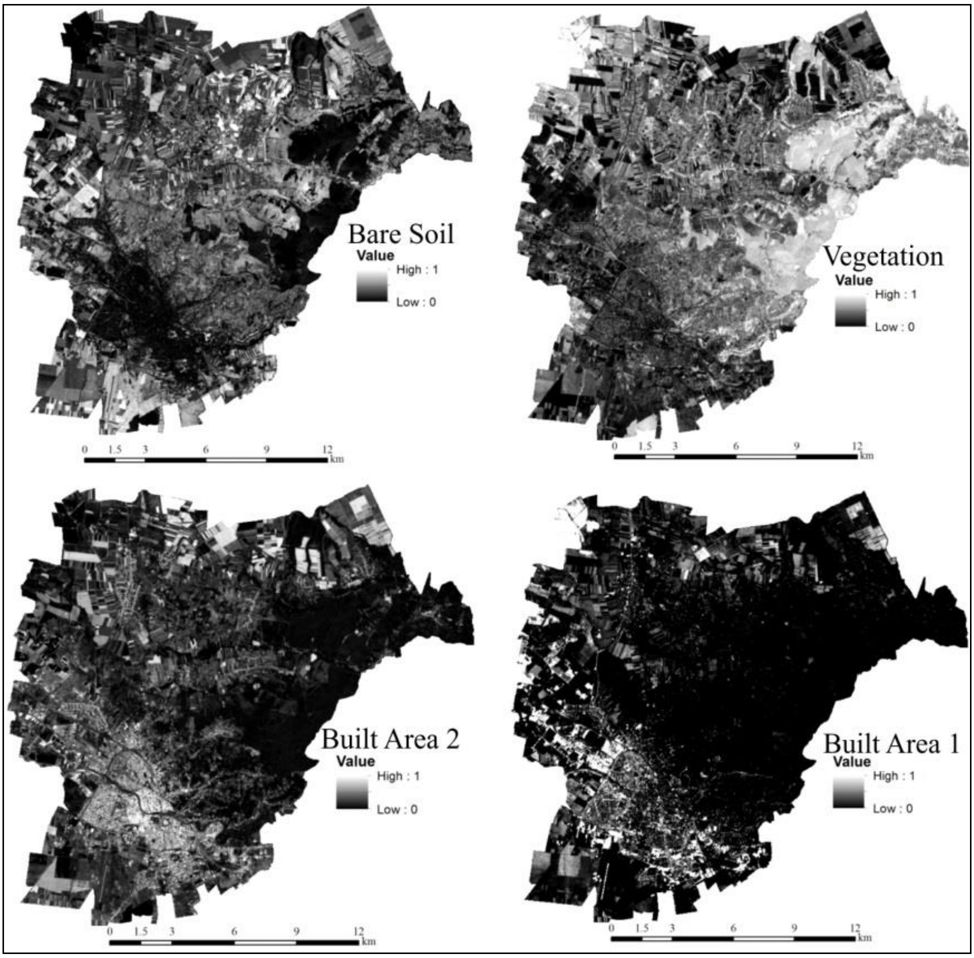

Figure 6. Abundances for endmembers

The water component, which is identified with shadow, had to be considered for the Linear Spectral Unmixing process, since it is part of the core component of the study area, but the factor C algorithm is insignificant, which is why we did not consider it necessary to illustrate it in figure 6.

Further, obtaining the values for the C factor was made by adapting the Alejandro and Omasa equation (2007) to the territorial reality of our work area:

$$C = \frac{F_{bs}}{1 + F_v + F_{ba1+}F_{ba2}}$$

were, F_{bs}, F_v, F_{ba1} and F_{ba2} are the fractions of bare soil, vegetation and built areas.

For *mixed / hybrid methods*, they involve a combination of standard data and remote sensing data. In this category we can frame the work of Panagos et al. (2015), where one type of data is used for factor C at the arable land level, while for other land, satellite data is used (see the so-called LANDUM model).

RESULTS AND DISCUSSIONS

Three sets of data stored in the rasters for *cover-management factor* of were obtained for the area, following the methodological approaches presented, plus a fourth, obtained from ESDAC (European Soil Data Center), developed by Panagos et al. (2015).

As we have pointed out, in order to obtain the C factor through the standard methodology, based on C_{LC} - C land cover, we have used the correction indexes reviewed by Moţoc et al. in 2010. The small changes we took the liberty of making, are related to the need of introducing a new class, in this case land with bushes and shrubs, and a bar field limitation to 1 (not 1.6). More than half of the surface of the 4 territorial administrative units (50.56%), the factor C is 0.8 (figure 7) due to the extension of the arable land, the structure of which dominates maize in monoculture. In contrast to the homogeneity of parcels of C factor obtained traditionally, we notice the heterogeneity of the spatial distribution of C derived values by LSU (figure 8) where we notice a higher weight of the class 0.04 - 0.25, which is 151.6 km^2 (table 1) and 52.012%, respectively.

In other words, from a quantitative – numerical point of view, in a comparative analysis between C_{LC} and C_{LSU}, there is clearly a change of place in the dominance between classes 0.7 - 0.8 (in fact 0.8) and 0.04 - 0.25.

Table 1. Surface distribution of value classes for C factor

Serial No.	Class values	C_{LC} (km^2)	C_{LSU} (km^2)	C_{NDVI} (km^2)	C_{LANDUM} (km^2)
1.	1 - 1.47	0	0	1.4	0
2.	0.8 - 1	3.09	0.95	4.56	0
3.	0.7 - 0.8	*147.391*	1.3	12.38	0
4.	0.6 - 0.7	3.93	3.45	18.2	0
5.	0.4 - 0.6	0.37	25.71	54.7	1.22
6.	0.25 - 0.4	2.13	51.5	*63.39*	*132.22*
7.	0.04 - 0.25	19.68	*151.616*	*99.05*	68.16
8.	0.01 - 0.04	13.48	28.27	33.85	4.49
9.	0.001 - 0.01	19.88	6.58	3.88	25.52
10.	0.0001 - 0.001	26.63	0.59	0	0.009968
11.	0 - 0.0001	54.87	21.5	0	0

For the NDVI factor C, there can be noticed approximately the same spatial heterogeneity in the distribution of the values (figure 9), and from the quantitative point of view the classes 0.04 - 0.25 and 0.25 - 0.4 hold 55.72% of the total area. Data from ESDAC (European Soil Data Center) indicates a predominance of classes 0.25 - 0.4 (45%) and 0.04 - 0.25 (23.38%) with a spatial continuity in the distribution of C_{LC} - like values (figure 10).

The differences in territorial extension for class 0.8-1 are related to the interpretation of the land categories included here, meaning that in C_{LC} we considered non-productive land with correction index 1, equivalent to bare soil / fallow land, but in this category fall in particular as land types: those without vegetation, land on the banks of rivers and lakes occupied by hydrophilic vegetation, swamps, salty soils, landfills, dumps, areas occupied by torrents and ravines, while for

C_{LANDUM}, the authors considered, according to Eurostat, that the fallow land category is: bare land bearing no crops at all, land with spontaneous natural growth which may be used as feed or ploughed in, and land sown exclusively for the production of green manure (this is also the explanation for using a correction coefficient of only 0.5 for this type of lands). In addition, for C_{LSU}, we considered bare land to be the only non-vegetation areas that really occupy relatively small areas in continuous form, but the soil bar fractions identified in agricultural crops or in forestry at the pixel level, are very important in the correct estimation of factor C.

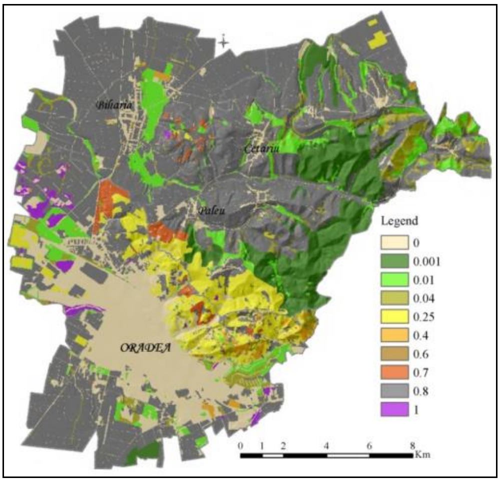

Figure 7. C_{LC} Map

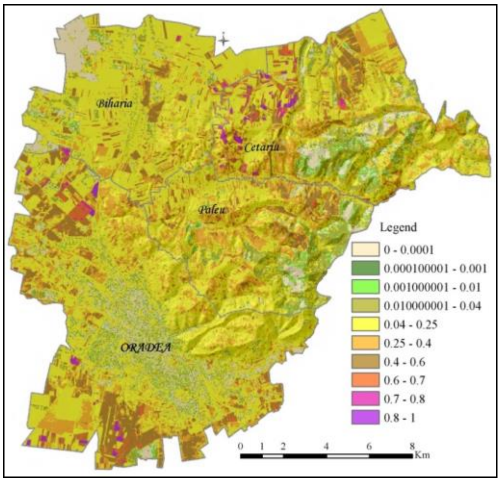

Figure 8. C_{LSU} Map

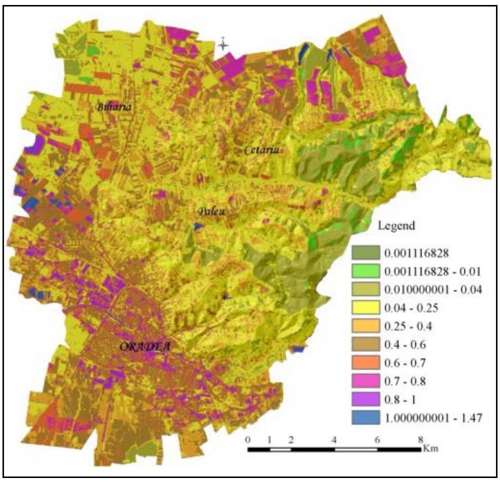

Figure 9. C_{NDVI} Map

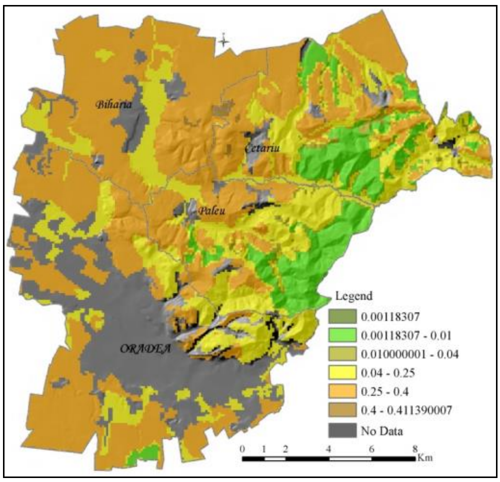

Figure 9. C_{LANDUM} Map
(Source: European Soil Data Center)

As for the areas occupied by the forest, equivalent to the classical methodology with the value of 0.001, it is observed that C_{LC}, C_{LANDUM} and C_{NDVI} appear as compact areas, classified in classes 0.0001 - 0.001, 0.001 - 0.01 and 0.01 - 0.04, respectively while at C_{LSU} there is a redistribution of values on three classes, which leads to a spatial mosaic in their distribution.

In order to obtain a complete image of spatial relationships between C_{LCU} and C_{LSU} value classes, which we consider to be most relevant in this study, we performed a Tabulated Area process between the two datasets, where the areas are defined by classes derived from land cover (table 2).

Table 2. Tabulate Area between C factor from classical method (C_{LC}) and C factor from LSU (C_{LSU})

C_{LC} Classes	C_{LSU} Classes (km^2)									
	0 - 0.0001	**0.0001 - 0.001**	**0.001 - 0.01**	**0.01 - 0.04**	**0.04 - 0.25**	**0.25 - 0.4**	**0.4 - 0.6**	**0.6 - 0.7**	**0.7 - 0.8**	**0.8 - 1**
0	8.12	0.21	2.27	8.64	30.51	3.99	1.01	0.069	0.02	0.004
0.001	5.36	0.21	2.61	11.41	6.85	0.15	0.02	0	0	0
0.01	0.44	0.01	0.14	0.71	8.32	5.82	4.19	0.16	0.035	0.0009
0.04	2.03	0.058	0.53	2.01	6.95	1.26	0.59	0.018	0.004	0
0.25	0.16	0.0081	0.079	0.54	14.39	4.22	0.30	0.003	0	0
0.4	0.03	0.0027	0.01	0.05	1.28	0.54	0.21	0	0	0
0.6	0.0018	0.0000	0.002	0.01	0.31	0.036	0.0009	0	0	0
0.7	0.0189	0.0009	0.008	0.03	2.41	1.4	0.054	0	0	0
0.8	5.19	0.083	0.886	4.76	*78.90*	*33.24*	*18.92*	3.18	1.24	0.95
1	0.128	0.0018	0.018	0.08	1.65	0.81	0.37	0.018	0	0

From the analysis of the results it is clear that almost 79 km^2 in the class 0.04 - 0.25, 33 km^2 in the class 0.25 - 0.4 and approx. 19 km^2 in the class 0.4 - 0.6 overlapped over class 0.8 from C_{LC}.

The 30 km^2 of class 0.04 - 0.25, which overlap with the C_{LC}-rated class 0, are perfectly justifiable (as well as the entire distribution of this value class), as not even Oradea city we cannot talk about an urban continuum, that is, everywhere, but especially at the outskirts, the built surfaces alternate with the green spaces, the agricultural cultivated parcels and even small forest areas. The 5 km^2 of class 0 - 0.0001 (C_{LSU}), appearing in C_{LC} class 0.8 space, which seem at first sight in total contradiction with the conceptual logic of C factor, actually come to complete a reality so far by numbers and percentages: by its conception the C_{LSU} also expresses the phenological reality in the field, meaning that the vegetative stages of the different cultures or the phenophases from the natural vegetation greatly influence the value of C, through the density of the strains, the size of the foil covering or the height of the canopy (more details from this point of view can be found in the handbooks and other works cited so far). In other words, on the same cultivated surface or land with natural vegetation, the value of factor C varies over a year, a fact known and illustrated in literature, even from the studies of Wischmeier and Smith, only that those methodologies are applicable at the microscale level.

CONCLUSIONS

Starting from the stated objectives and the results materialized in spatial distributions or the value strings of the factor studied, we can make some statements supported by the presented data.

When working on areas with medium expansion (our work area was 291 km^2), where it is physically impossible to apply the classical methodology due to the high consumption of time and the high material costs, regardless of the USLE or RUSLE models, obtaining the C factor with LSU is the method that has results closer to the requirements of the model considered (USLE), because even if soil losses are considered as multiannual average estimates, the values of the factors taken into account are punctual, adapted to the reality of the land or the work plot. It should not be forgotten that, at the plot, factor C of this model takes into account the type of crop rotation (crop rotation), the type of agricultural works, the residual elements of the plant crops, and the stages of development of plants as well. We have used the classical methodology in the sense it is used in most studies in Romania or elsewhere, but the values of those indices have been calibrated for morpho-erosion conditions that are not present in western Romania and there are no experimental data for this region either. On the other hand, we must point out that given the absolutely conventional management practices, here we refer to tillage practices (not to be confused with support practices), they can be considered as 1, so anyway they would not affect the results in the classic workmanship.

It is obvious that C_{LSU} does not directly store all the C factor subcategories taken into account at parcel level, but among all the methods we have applied, the one that provides good quality results in average resolution data of the insertion data is *LSU* based.

As expected, the use of NDVI in the manner presented above overestimates the values of C factor, as noted by other researchers mentioned throughout the paper. Moreover, by rescaling, aquatic surfaces usually fall into the class with the highest values. This would not be the major impediment (pixels containing lakes or other hydrological entities may be masked), but overestimation at the level of value classes, which can be reflected in the final estimates derived from the equation. It is, however, a quick method, and correspondence between values and land use patterns can be established.

The C_{LANDUM}, derived from ESDAC data, can be used for partial verification of other data sets of the same profile, but in no case for validation, as we thought in the pre-stage of detail analyzes. The reasons are multiple, but all of us note the resolution of the input data which, in our opinion, is insufficient to provide adequate content to the final result (CORINE Land Cover and MERIS data with 100 m and 300 m resolution respectively). A question mark is also related to the harmonization of sets of hierarchical data in different value scales that have been incorporated into the same factor. Even if we believe that such analyzes should be limited to narrower territories, so that the results do not become too general, it is to be appreciated the considerable effort made by the authors to get an EU-wide C-factor as a starting point in the local scale analyzes.

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