Quantitative analysis of Soil loss in the Plateau administrative territorial units of Suceava county

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ABSTRACT: Beginning with the statement that the economic activities of the main sector occupy a majority share in Suceava Plateau, this study aims to highlight the negative impact that the use of the land has on soil. The determination of soil loss from the said area will be accomplished through a GIS analysis using the USLE model (Universal Soil Loss Equation), where, in addition to the land utilization will be taken into consideration a number of other factors regarding the climatic, soil and topographic particularities. The result of this type of modeling permits an inventory of the soil loss values and the identification of areas where the admitted quality of soil loss is exceeded, therefore, being lost the main nutrient elements of the soil, decreasing fertility. The utility of the USLE model application is found in determining the crops alternation structures or in determining the soil protection measures. Moreover USLE model is an effective tool in defining a territory's dysfunctions connected to the soil's degradation, screening an eloquent image of the existing situation regarding the environmental quality in developing the land setup plans.

KEY WORDS: Land use managemnet, USLE model, soil erosion, administrative territorial units

1. Introduction

There is no doubt that the highlighting of the anthropization process represents a threatening element over the environment's quality protection. The soil, regarded as an environment agent, it is subject to a long degradation process, the main cause being the erosion. The land use management is one of the main reasons that contributes in a negative manner over the soil's degradation. Beside the land's exploitation, the climatic conditions, the landscape features, same as the pedological cover's peculiarities contribute to trigger the erosion process. Farming in accordance to the environment protection, requires the identification and quantification of all the elements that impede the achievement of sustainable development. The objective of this study is to determine the medium erosion value of the soil, more precisely to estimate the soil loss in the plateau area of Suceava County. The soil loss inventory, on each administrative territorial unit in

the county's plateau region, will reflect an eloquent image of the soil degradation problem, achieving a review of the settlement in which is necessary implementing erosion control measures.

1.1. Study area

The plateau region of Suceava belongs to the North-West subunit of the Moldavian Plateau, Suceava Plateau occupies on the county's territory an area of 2.840 km², approximately 33% from the entire area of the mentioned territorial entity.

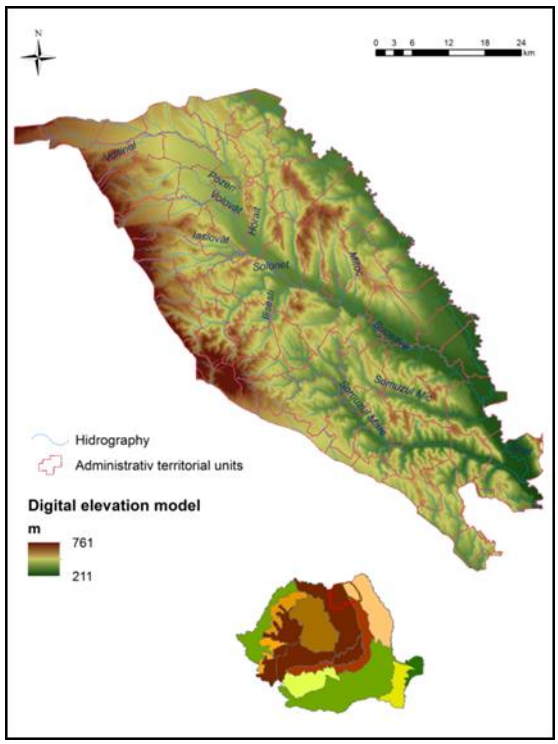

Figure 1 Geographical position of study area.

From the morphostructural point of view the county's plateau unit is characterized by a monoclinal landscape, where the storied slopes are overweight remarked. (Băcăuanu, quoted by Irimuș, 2003)

From the administrative point of view, the county's plateau region sums a number of 87 administrative territorial units. (Figure 1)

2. Methods

In order to estimate the soil loss rate values (t/ha/y), a first step was the preparing and the proccesing the initial databases which was included in the Universal Soil Loss Equation. The data source is formed by vector type elements, as line, polygon and dot shape (the limit, the hydrographic network, the localities network, the soils, the use of land) and by raster type elements (the digital elevation model, the erosion coefficient established on terms of pluvial aggression, the correction coefficient of the erosion control measures, the correction coefficient for soil's erosion, the correction coefficient for crops' effects, the correction coefficient for the erosion control measures effects, the cliffs' length (m) and the land's slope (%). (Tabel 1)

The primary data source is extracted from Romania's topographical maps of (1:25.000), geo-referenced in the projection system Stereo 70. Based on this was digitized the level curves through which the digital elevation model was accomplished (DEM), the hydrographic network and the localities. The soil types were digitized from Romania's soils map (1:200.000) and were corrected according to the SRTR 2003 Nomenclature. The use of lands from the studied area concurs to the Corine Land Cover 2000 data source.

The soil loss determination in Suceava's Plateau region will be accomplished by utilizing the Esri ArcGis 10.1 program, initiated by Wishmwier and Smith (1997). In Romania the one who adopted

the USLE model was Moțoc et. al. (1973, 1979, 2002),according to the climatic conditions of our country. (ROMSEM)..

The universal erosion equation formula of the soils is represented as:

$$E = K \cdot S \cdot C \cdot Cs \cdot Ls$$

Table 1 Database structure.

Cartographic sources	Extracted data	Data source type
Topographic map of Romania (1:25.000)	Contour	vector
	Hidrography	vector
	Administrative territorial units	vector
	Digital elevation model	raster
	Slope	raster
	Slope length	raster
Romanian soils map (1:200.000)	Soil	vector
	Correction coefficent for soil erosion	raster
Corine Land Cover 2000	Land use management	vector
	Correction coefficient for the effect of erosion control measurements	raster

E - The annual average erosion rate (t/ha/y)

K – The correction coefficient for the climatic aggressivity (pluvial)

S – The correction coefficient for the soil's erosion

C – The correction coefficient for to the land use

Cs – The correction coefficient for the erosion control measures

Ls – The topographic factor, represented by the slope length coefficient (m) and the land's slope (%).

Table 2 The estimative value of the correction coefficient for crops effects.

The use of land classification	C (acc to Dârja)
Coniferous forests	0,001
Broadleaf Forests	0,001
Mixed forests	0,001
Secondary pastures	0,6
Transitional woodland - shrub	0,003
Heterogeneous areas	0,8
Non-irrigated arable lands	1
Complexe crops zones	0,9
Orchards	0,5

1. The climatic aggressivity coefficient (K) represents the erosion index created by rains (Figure 2). This coefficient was established after the studies realized by Stănescu et al (1969), being the result of the rainfall amount and the torrential nucleus intensity with duration of 15 minutes, respectively the water's concentration time inside the draining lots to create ditches. For the plateau region on which is done this study, the proper value is 0.1.

2. The correction coefficient for the soil's erosion (S) represents the topsoil resistance to the action of raindrops and the micro-tides generated by the storm water runoff (Figure 3). The erosion coefficient estimation method was based on the 186 indicator in "The methodology of the pedological studies elaboration", expanded by ICPA Bucharest in 1987. The 186 indicator establishes the erosion classification according to the genetic type of soil, the erosion degree and the soil's texture. Thereby, each type of soil corresponds to a value, the resistance ability of the soil being proportionally to the given value (Table 2).

Table 3 The estimative value of the correction coefficient for the soil erosion.

Soil types (according to SRTS 2003)	S - (acc to Moțoc et al)	Soil types (according to SRTS 2003)	S - (acc to Moțoc et al)
Chernozem	0,85	Alluvial soils	1,1
Argillic chernozem	0,8	Brown acid soils	0,8
Cambic chernozem	0,8	Eu-mesobasic brown soils	0,9
Erodisoil	1,1	Brown luvic-soils (podzolic)	0,9
Marsh soil	1,1	Grey soils	0,75
Albic luvisol (podzolic argillic)	0,8	Cernoziomoid soils	0.8
Sands	1,1	Gleysoil	1,1
Alluvial protosols	1,1	Pseudogleic soils	1,1
Pseudorenzin	0,9		

3. The correction coefficient for the land use (C) represents the protection capacity of the green layer (Figure 4). For the Suceava Plateau the values are between 0.001 and 1 (according to Dârja, 2000, p. 69), the minimum value matching with the areas in which the green layer protects the soil, (e.g. the forest) and the maximum value corresponding to the areas in which the use of land offers a minimum protection for the soil (Table 3)

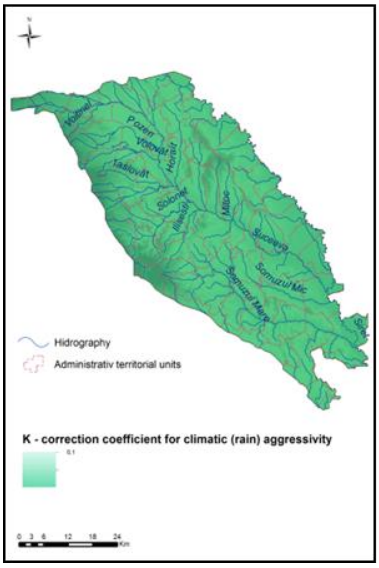

Figure 2 The correction coefficient for climatic (rain).

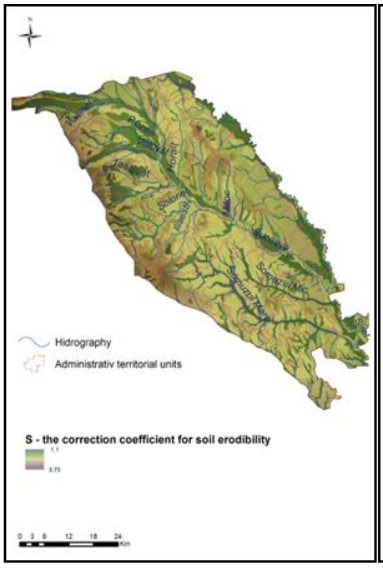

Figure 3 The correction coefficent for soil erosion.

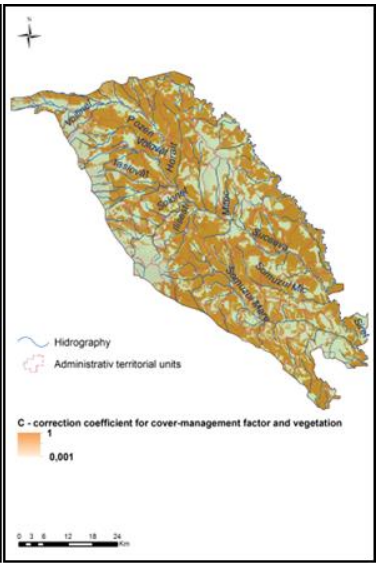

Figure 4 The correction coefficient for cover-management factor and vegetation.

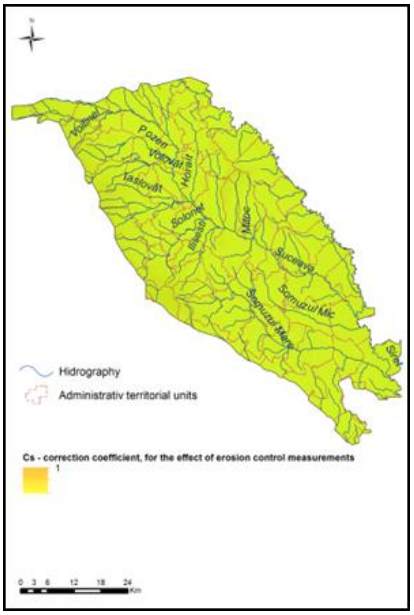

Figure 5 The correction coefficient, for the effect of erosion control measures.

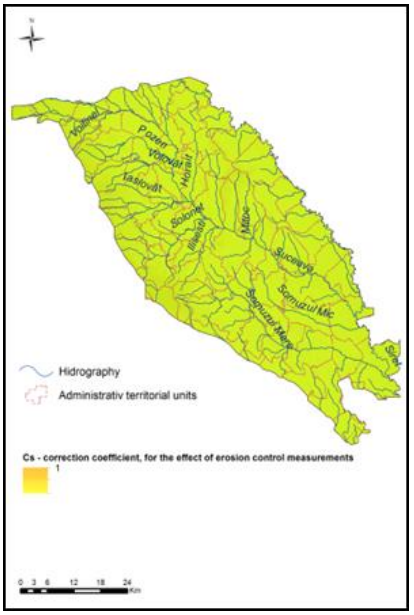

Figure 6 Slope lenght.

4. The correction coefficient for the erosion control measures (Cs) for Suceava's plateau region is 1, because of the decreased extension in the field of the soil protection works (Figure 5).

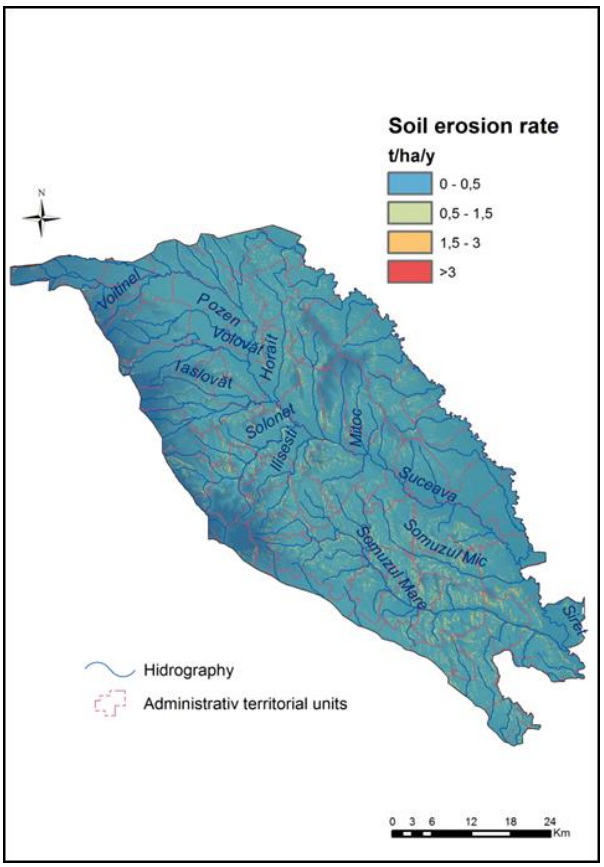

Figure 7 Soil erosion rate.

5. The topographic factor (Ls) is represented by the slope length, respectively by the land declivity. This coefficient is obtained with Lm function, using the ArcGis program, based on the Digital Elevation Model (Figure 6)

As result of using the Raster Calculator model from the Spatial Analyst module was obtained at a pixel level (20x20) the soil's erosion potential value. The estimative value of the soil loss from Suceava's plateau region is between 0 and 42.3 t/ha/y (Figure 7).

3.Results

The final map that we have obtained, which represents the spatial extension for the soil erosion rate from the Suceava plateau region was classified by using the Reclassify function, with the Natural Breaks method from the Spatial Analyst module. For the studied region, were established four erosion rates classes, with values between 0-0.5 t/ha/y (rate 1), 0.5-1.5 t/ha/y (rate2), 1.5-3 t/ha/y (rate 3) and higher values than 3 t/ha/y (rate 4).

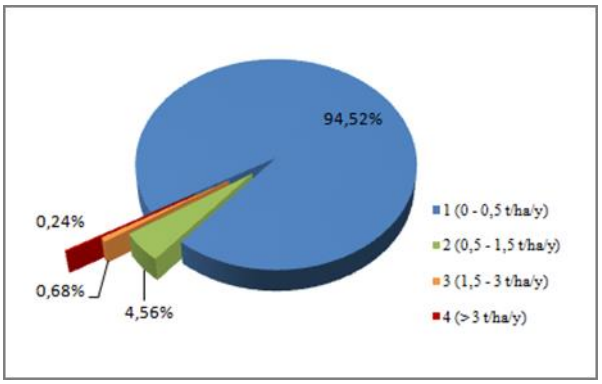

Figure 8 The percentage representation of each erosion rate

After the GIS modeling was demonstrated the fact that the plateau region of Suceava is situated in a ratio of about 95% in the 1st erosion class, the soil loss having a maximum value of 0.5 t/ha/y. It is due to the landscape reduced slope, to the extended housing areas, as well as the coniferous, broadleaf and mixed forest existed in the Eastern side of the plateau and broadleaf forest in the Western side of the plateau. The 2nd erosion rate is represented by a ratio of about 5% (128km²) being afferent to the areas in which the slop is overcoming 5%, the land having agricultural role (arable land mixed with natural vegetation, pastures). The third, as well as

the fourth erosion rate develop on a small area around 0.68 % (19.3km²) respectively 0.24 % (6.7km²) from the total of the analyzed region, being representative for the areas in which the arable lands have a large development.

Tabel 4 The inventory of soil loss on the territorial administrative units from Suceava's Plateau region.

U.A.T.	Erosion classes							
	0 - 0,5 t/ha/year		0,5 - 1,5 t/ha/year		1,5 – 3 t/ha/year		>3t/ha/year	
	Km²	%	Km²	%	Km²	%	Km²	%
Adâncata	34,6	96,2	1,08	3,01	0,21	0,57	0,08	0,22
Arbore	65,2	95,9	2,23	3,28	0,40	0,59	0,13	0,18
Balaceana	25,1	94,5	1,24	4,65	0,19	0,70	0,03	0,11
Balca	24,1	99,2	0,17	0,69	0,02	0,09	0,00	0,01
Bălcăuți	37,3	99,5	0,00	0,01	0,16	0,41	0,03	0,07
Berchișeti	11,9	98,9	0,04	0,37	0,06	0,50	0,03	0,23
Bosanci	44,7	89,5	4,59	9,18	0,53	1,05	0,12	0,24
Botoșana	16,1	91,4	1,33	7,54	0,15	0,85	0,03	0,18
Bunești	24,9	87,4	3,12	10,93	0,40	1,40	0,09	0,32
Burla	17,6	93,5	1,02	5,43	0,17	0,91	0,03	0,19
Cajvana	22,9	91,3	1,81	7,22	0,30	1,18	0,07	0,28
Calafindești	24,3	93,3	1,47	5,65	0,22	0,84	0,07	0,26
Ciprian Porumbescu	28,1	94,4	1,40	4,72	0,18	0,61	0,09	0,31
Comănești	18,1	91,0	1,53	7,68	0,20	0,99	0,07	0,36
Dărmănești	45,9	93,6	2,52	5,14	0,50	1,02	0,13	0,26
Dolhasca	93,1	94,7	3,88	3,95	0,94	0,96	0,36	0,36
Dolhești	38,1	89,7	3,31	7,78	0,72	1,70	0,37	0,86
Dornești	28,2	96,6	0,85	2,90	0,13	0,45	0,03	0,10
Drăgoiești	31,4	92,8	2,06	6,08	0,27	0,78	0,11	0,32
Drăgușeni	23,1	93,3	1,46	5,90	0,17	0,68	0,04	0,15
Dumbrăveni	40,1	98,1	0,65	1,58	0,08	0,20	0,04	0,09
Fălticeni	26,3	91,5	2,09	7,27	0,26	0,91	0,08	0,28
Fântânele	39,9	99,3	0,23	0,57	0,04	0,09	0,01	0,02
Forăști	52,9	91,1	4,33	7,46	0,61	1,05	0,22	0,37
Frătăuții Noi	52,9	97,7	1,03	1,91	0,16	0,29	0,03	0,06
Frătăuții Vechi	36,3	99,7	0,11	0,31	0,01	0,03	0,00	0,00
Gălănești	20,0	98,5	0,28	1,36	0,02	0,12	0,00	0,01
Grămești	31,6	95,5	1,28	3,86	0,19	0,58	0,03	0,08
Grănicești	47,9	94,0	2,57	5,03	0,42	0,82	0,10	0,20
Hântești	35,5	94,8	1,61	4,30	0,25	0,66	0,08	0,21
Hârtop	15,4	83,6	2,59	14,06	0,30	1,62	0,13	0,69
Horodnic	77,4	98,2	1,20	1,53	0,18	0,23	0,05	0,06

Horodniceni	52,5	92,0	3,94	6,90	0,49	0,85	0,12	0,22
Iaslovăț	17,3	95,5	0,68	3,76	0,10	0,53	0,03	0,17
Ilișești	31,4	92,9	1,98	5,85	0,30	0,88	0,12	0,34
Ipotești	21,7	92,6	1,09	4,65	0,16	0,69	0,47	2,01
Liteni	68,4	95,1	2,62	3,65	0,58	0,81	0,29	0,40
Milișăuți	33,3	96,9	0,90	2,62	0,14	0,41	0,02	0,06
Mitocu Dragomirnei	51,0	96,1	1,69	3,19	0,29	0,55	0,09	0,18
Moara	39,3	92,6	2,68	6,32	0,35	0,83	0,12	0,28
Mușenița	37,2	96,8	1,03	2,69	0,19	0,50	0,02	0,06
Păltinoasa	290,0	99,7	0,66	0,23	0,08	0,03	0,05	0,02
Pârteștii de Jos	41,2	95,1	1,81	4,18	0,24	0,55	0,08	0,19
Pătrăuți	36,4	96,1	1,17	3,09	0,19	0,49	0,11	0,29
Preuțești	57,5	85,6	8,26	12,31	0,98	1,46	0,42	0,63
Rădășeni	38,2	93,7	2,26	5,53	0,25	0,61	0,08	0,21
Rădăuți	32,3	99,4	0,17	0,52	0,02	0,07	0,00	0,00
Salcea	53,3	96,8	1,26	2,29	0,32	0,57	0,16	0,29
Satu Mare	24,4	96,6	0,76	3,02	0,07	0,28	0,03	0,11
Siminicea	31,0	97,1	0,72	2,26	0,16	0,50	0,05	0,16
Siret	41,1	95,8	1,49	3,48	0,23	0,53	0,07	0,16
Stroiești	34,2	92,7	2,21	5,98	0,33	0,90	0,15	0,40
Suceava	49,7	96,3	1,58	3,07	0,25	0,48	0,07	0,13
Șcheia	53,0	91,6	4,06	7,02	0,60	1,04	0,20	0,35
Șerbăuți	29,3	95,2	1,24	4,04	0,18	0,59	0,07	0,22
Todirești	56,7	92,0	4,23	6,87	0,54	0,87	0,13	0,21
Udești	71,1	93,0	4,38	5,73	0,69	0,90	0,32	0,41
Verești	37,5	99,2	0,27	0,72	0,03	0,08	0,00	0,01
Vicovu de Sus	38,0	98,6	0,47	1,23	0,05	0,13	0,01	0,04
Volovăț	21,8	97,7	0,40	1,79	0,10	0,45	0,01	0,04
Vulturești	44,6	96,1	0,56	1,20	0,84	1,80	0,43	0,92
Zamostea	49,2	97,7	0,95	1,89	0,16	0,32	0,06	0,13
Zvoriștea	63,9	96,2	2,13	3,20	0,34	0,51	0,07	0,11

Although the medium rate of erosion situated between 0-0.5 t/ha/y occupies 97% of the entire territory, from the environment quality point of view, the focus is on the towns in which the medium soil erosion with more than 3 t/ha/y value has the higher percentages (figure 9). Thereby, the GIS modeling has shown the fact that the most affected territorial entities regarding the soil loss, with high values, are the towns situated in the Southern half of the region, respectively Ipotești, Vulturești, Dolhești, Hârtop, Preuțești și Udești. The landscape conditions (the slope), the predominant land farming as well as the insufficiency of the erosion control management are, therefore, the main factors that lead to the soils degradation.

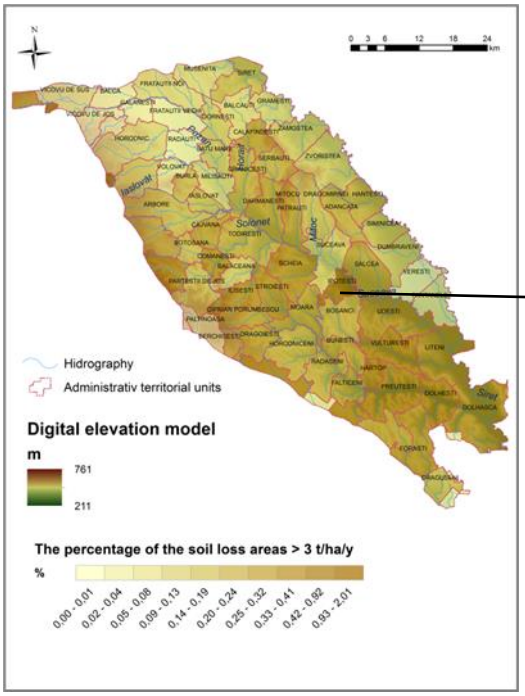

Figure 9 The percentage of the soil loss areas > 3 t/ha/an.

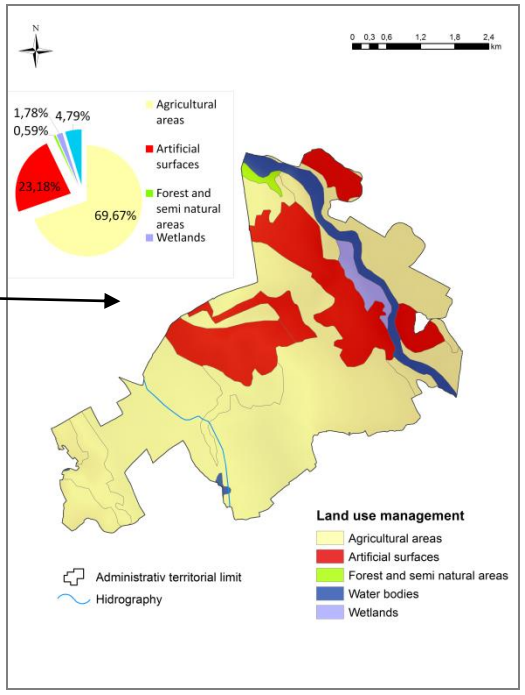

Figure 10 Land use management in Ipotești.

The territorial administrative units where the loss percentage, higher than 3 t/ha/y, is reduced, are situated in the northern side of the region. The representative units for this situation are Rădăuți, Gălănești, Frătăuții Vechi, Balca, Voitinel.

In Ipotesti, the soil loss share with values over 3 t/ha/y is 2.01%, which represents approximately 0.5km^2. Unlike the other towns, in Ipotesti the agricultural land is about 70% (Figure 10).

5. Conclusion

Even though they are of a great importance, the soil losses in Suceava's plateau regions do not pass the admitted limit of erosion, only in small areas, therefore the surfaces share with high degree of erosion is reduced (0.24 t/ha/y).

The quantitative analysis for the level of the entire area, as well as for the level of each territorial administrative unit, with the help of the universal equation factors of the soil loss determination, brought up the fact that the main cause of the soil erosion is the lands use management, specially their agricultural use.

The way of determining the soil loss has its utility in founding problems related to the environment's quality. The inventory of the eroded surfaces finds itself in the approach succeeded by the implementation of the erosion control measure.

Likewise using the USLE model serves to identify the existing characteristics of a territory regarding the anvironement factors, whose results can be recorded and regulated by the local improvement plans.

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