STUDIES REGARDING SPECIFIC MEASURES FOR SOIL REHABILITATION FROM RAZVAD DAMBOVITA AREA, IN THE CONTEXT OF SUSTAINABLE RURAL DEVELOPMENT

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Abstract
Soil is under increasing pressure due to inappropriate agricultural and forestry practices, industrial development and urban tourism. These activities cause disruption of the normal functioning of the soil biota in various natural or artificial ecosystems, affecting fertility and bio capacity, both quantitatively and qualitatively. Because it is a limited resource and non-renewable, soil degradation has an impact on other areas of interest, such as water, health, climate change, nature protection, survival of ecosystems, food security.

Excessive land degradation through erosion of downhill areas in the last 20 years is due to lack of funds necessary to complete the work already started and for its maintenance. One example is Razvad, Dâmboviţa County, which benefited from the design of a complex arrangement works of slopes since 1987, works that were completed in a very small procent and they were also damaged mainly due to lack of maintenance.

Soils in the administrative territory Razvad underwent profound influences owing to unreasonable intervention of man. Thus, by changing the use of technology and tillage, the intensity of the accumulation process decreased, reducing the amount of humus and nutrients, degrading the soil structure and therefore settlement phenomena often appear. During the ecological reconstruction of soils affected by different processes, general measures and specific measures of agricultural soils should be considered.

Keywords: soil, errosion, texture, slope, hydrographic basin

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1. INTRODUCTION

In hilly inhabited areas, increasingly large areas of forest disappear due to the fact that wood is being used either as a building material or for home heating. Irrational exploitation of wood in the study area leads to sharp degradation of the environment, favoring the appearance of deep erosion and landslides. Deforestation negatively influences the microclimate of the area. Also, in some areas, grazing has led to irrational upper horizon soil settlement, developing forms of microrelief like cattle paths.

Consequently in this activity, forms of erosion in depth have occurred on the slopes and are constantly evolving, represented by trickles, channel cutting and landslides that circuit out significant areas of land.

2. MATERIAL AND METHOD

A series of data have constituted the base of this study, provided by the Dâmboviţa County Soil and Agrochemistry, that performed work of mapping land on 2737 ha belonging to Razvad administrative territory, at a profile density of a 1:5000 scale, using 1:10000 land records plans provided by OJCPI Dâmboviţa. The informative resources used were the following: “Romanian System of Soil Taxonomy”, Bucharest 2003; "Soil Survey Elaboration Methodology", I.C.P.A Bucharest 1987. There were 47 profiles opened on the field, from where samples and 222 surveys were collected. From the main profiles, 235 soil samples have been gathered. The samples were dried and conditioned in Dâmboviţa County Office of Soil Education and Agrochemistry Laboratory. The following analisys have been made: soil reaction -

potentiometric method in aqueous solution; the $CaCO_3$ content - gas volumetric method (Scheibler); the content of changeable aluminium – Sokolov method; humus content – Titrimetric dosage (Walkley-Black method modified by Gogoasa); the mobile phosphorus content – the Egner Riehm Domingo method; the mobile potasium content – Egner Riehm Domingo method; the azoth content (nitrogen index - NI) – calculus; changing capacity for H (S.H) - percolation extraction to exhaustion with potassium acetate pH 8.3; sum of exchangeable bases (S.B) – extraction with HCl 0,05n; granulometric analysis – Kacinski.

In order to estimate the amount of soil lost by erosion, the indirect method based on Wischmeier model was used - adapted to the conditions of our country by Prof. M. Moțoc in 1970. Coefficients of the model change their value according to the proposed rehabilitation method, which is why estimate calculation is done based on the model, before and after fitting.

The model adapted by Prof. M. Motoc to the conditions of our country, is presented as such:

$E = K_a\ S\ C\ C_s\ L^m\ i^n$ (t/ha/year), where:

K - coefficient of rainfall aggression;
S – soil erosion factor;
C - correction factor for the influence of culture (vegetation);
C_s - correction factor for the influence of anti-erosion measures;
L^m - length correction of the line steepest slope surface computing;
i^n - slope correction calculation area (%)

On the surfaces that are proposed for terracing works to establish orchards there are used sizing mathematical relationships.

On the terraces with horizontal platform and slope of land, the following equations are used for sizing:

$$L = (n-1)d + x + y \quad [m]$$

$$h = \frac{LxI_t}{i - mI_t} \quad [m]$$

$$Lt = L + mh \quad [m]$$

$$Vt = \frac{Lp * h}{8} \bullet (1 - mIp) \quad [m^3]$$

In case of technological paths, embankment volume shall be determined as follows:

$$Vt = \frac{Lp * h}{8} \quad [m^3]$$

Meaning of the terms:
d-distance between rows
x-distance from the cut slope to first row
y-distance from the last row to the embankment slope
L = Lp - platform of the terrace or cultivated height of the terrace (m);
hd - cut slope height (m);
mhd - projection cut slope (m);
1/mr- embankment (m);
1/md-slope excavation of the terrace (m);
hr - embankment slope height (m);
MHR - projection of embankment slope (m);
Lt - total width of the terrace (m);
n - number of lines on the platform;
h - the total height of the slope (m);
I - slope before terracing, (%)
Ip - terrace platform slope (%)
V - unit volume of earthworks (m3).

Number of terraces was calculated using the formula: *No.of terraces = Lp/Lt where*:
Lp – lenght of the lot or field (m);
Lt- Total width of the terrace.

The total area of platforms of the terraces planted with fruit trees was calculated using the formula:

$$Sp = \frac{L * l * No.of.terraces}{10^4}(ha)$$

where: Sp – the surface occupied by platforms or planted with fruit trees(ha);
L- Width of the terrace platform (m);
L- Width of the lot or lenght of the field (m);
No. of terraces – number of terraces.

Technical efficiency of the proposed works is determined by recalculating the amount of soil erosion washed after fitting, and in case of terraces the coefficient is taken into account:

$$Cu = \frac{Sp}{St} * 100$$

where: Cu- utilization coefficient of the surface by terracing;
Sp - surface of platforms (ha)
St – surface of the lot before terracing (ha).

Figure 1 Degraded field from Razvad area

3. RESULTS

In hill areas parental materials on whereon soils were formed are diversified, specific soil of this area is regosolul with eutric and limestone subtypes. Here are slope deposits with different textures (from clayey-sandy to clayey), discontinuous or with carbonates. However, the parental materials mentioned, the most restrictive in the "T.A. Razvad" area are carbonate clays giving an alkaline reaction to the soils, but favors the emergence and evolution of sliding phenomena and the banks collapsing.

(T.A.=administrative territory)

Table 1. Clases and types of soil from the Răzvad area

Clasa de soluri	Tipul de sol	Suprafața (ha)
Protisoluri (2564,10 ha)	Regosol	977,10
	Aluviosol	1587,00
Cambisoluri	Eutricambisol	102,40
Luvisoluri (70,50 ha)	Preluvosolul	32,70
	Luvosolul	37,80
Total agricultural area		**2737**

Groundwater level lowers in the hilly area, generally over 10 m, but there are areas where groundwater is between 5-10m depth. Also, there are areas where I met very dangerous coastal streams because it fosters the development of landslides, especially as the soil texture is medium-fine or fine.

By linking the 19 indicators of evaluation, it resulted the classification of the 2737ha area generally studied in 2nd, 3rd and 4th category of quality. At an administrative territory level, It obtained an average 63 grade of evaluation for the use of arable land, corresponding to 2nd category quality. For the use of grazing at a territory level resulted an average 38 grade of evaluation, which is the fourth category of quality. For the use of grassland it resulted an average 29 grade of evaluation, which is 4th category quality. Case Study on land surface erosion was performed on an area falling in TEO 9, 10 and 19 by U.S. 7 and 14.

(TEO =ecologically homogeneous territory)

Foto 1 Gullies formed in deforested areas

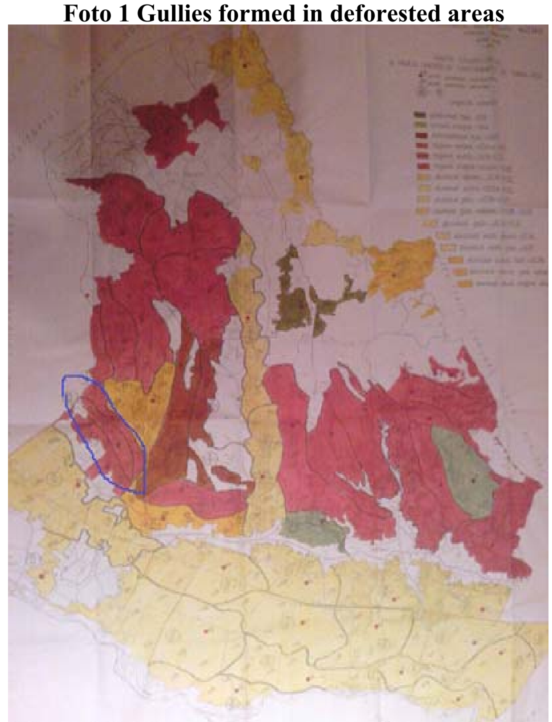

Figure 2 Cartogram of soils from administrative territory (TA) Răzvad

Preventive measures aimed at, first, installing forest vegetation on land with agricultural use in micro-zones with high potential for erosion (streams, slopes with gradients greater than 30%, shallow soils, skeletal, etc..), on the cadastral network etc. Also falling into the category of preventive measures is the phase performed as "relocation of agricultural uses."

This step led to changes in the value of the use of pastures and meadows area of 32.85 ha of degraded pastures and hayfields to heavily degraded to 4.81 ha pastures and meadows in very good maintenance. This considerable decrease was chosen for the establishment of a terraced orchards on an area of 25.46 ha. Surfaces exhibiting higher slope of 30-35% have been proposed for afforestation.

After completing the steps necessary to estimate soil erosion using the indirect method (using universal formula for calculating the erosion adapted to the conditions of our country by Professor M.Moțoc) resulted in a weighted average erosion value throughout the analyzed area of 6.43 t / ha and year, therefore a value close to acceptable limits (6 t / ha and year). Major problems raises the amount of soil washed by erosion from homogeneous surfaces of relief 6, 8 and 22, where intense erosion processes are produced that exceeds of two, even three times the values accepted as being normal. (Table 2) Given the need for intervention on analyzed perimeter and also area tradition for horticulture and livestock, they proceeded to relocate uses of pasture and meadow in an area of only 4.51 ha. Land area of the watershed was proposed for afforestation. An area of 25.46 ha has been proposed to establish terracing orchards. To achieve this goal we have designed the terraces on horizontal platforms type A or B (with one or two rows of trees on the platform) for categories of land with an inclination of 15-21%, and technological paths for lands with slopes between 22-24%.

Technical efficiency advantaged the technological paths due to the high degree of land use, thereby achieving optimum density orchards. Following the antierosion establishment of analyzed perimeter it was achieved a reduction in the average amount of washing soil by erosion of about 50%.

Overall, the entire administrative territory Razvad is also proposing a number of measures both preventive and curative, such as cultivation of plants according to the level of protection they offer, avoiding stubble-turning works of vulnerable soils, improving pasture quality , banning deforestation or acidic soil improvement works; Technical efficiency of improvement project resulted from estimating the amount of soil washed by erosion after fitting. Estimate calculation was performed also by using the formula developed and published by Prof. M. Moțoc in 1970.

Thus, analyzing the new uses being proposed for establishment, but also those being maintained by intervening with erosion works in both cases there is a decrease erosion from critical values recorded on homogeneous surface relief 14, ie 65.48 t / ha and year-before planning, to 3.36 t / ha and year - average surface on the entire studied surface after fitting.

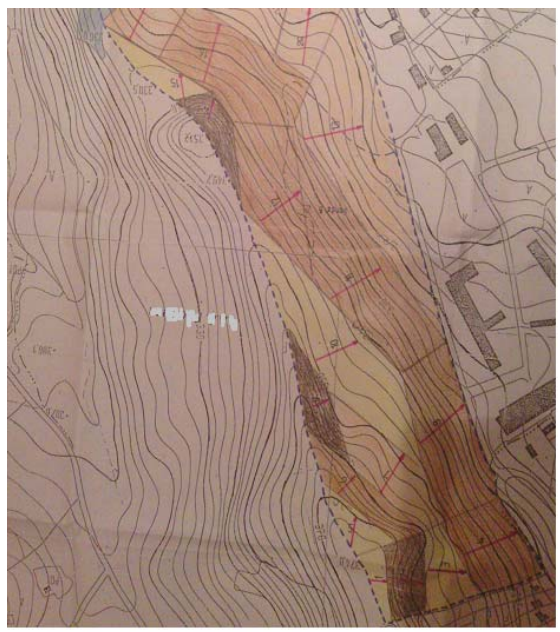

Figure 3 The surface proposed for establishment

Agricultural area is reduced due to the 30.27 ha afforestation work, thereby eliminating agricultural areas with very steep slopes and thus diminishes the land showing types of erosion depth. To establish the technical efficiency of terracing it was calculated the use coefficient from understanding terrace surfaces.

Tabel nr.2 ESTIMAREA EROZIUNII SOLULUI INAINTE DE AMENAJARE

Nr. crt.	Sup (ha)	Folosința	Ka	L(m)	L^m	I (%)	I^n	S	C	Cs	Es (t/ha*an)	Et (t/an)
1	0,24	fâneață	0,14	32,80	2,74	7,81	17,95	0,8	0,06	1	0,33	0,079
2	0,67	pășune	0,14	44,80	3,02	27,90	136,71	0,9	0,80	1	41,61	27,870
3	0,63	fâneață	0,14	74,00	3,56	10,13	24,86	0,8	0,06	1	0,59	0,370
4	1,05	pășune	0,14	82,00	3,71	21,34	82,59	0,8	0,30	1	10,29	10,80
5	0,44	fâneață	0,14	48,00	3,21	10,41	24,86	0,8	0,06	1	0,53	0,230
6	0,69	pășune	0,14	32,80	2,74	22,86	96,67	0,8	0,30	1	8,89	6,130
7	1,17	fâneață	0,14	60,80	3,41	12,33	32,87	0,8	0,06	1	0,75	0,870
8	1,84	pășune	0,14	100,00	3,98	20,00	75,96	0,8	0,30	1	10,15	18,670
9	0,63	pășune	0,14	30,90	2,74	32,36	173,71	0,9	0,80	1	47,97	30,220
10	3,00	fâneață	0,14	74,80	3,56	10,02	24,86	0,8	0,06	1	0,59	1,770
11	3,12	fâneață	0,14	92,80	3,84	18,85	69,61	0,8	0,06	1	1,79	5,580
12	1,67	fâneață	0,14	64,00	3,41	19,53	75,96	0,8	0,06	1	1,74	2,900
13	3,56	fâneață	0,14	104,00	3,98	14,42	41,99	0,8	0,06	1	1,12	3,980
14	0,56	pășune	0,14	35,20	3,02	35,51	215,13	0,9	0,80	1	65,48	36,660
15	0,56	fâneață	0,14	22,40	2,46	11,16	28,73	0,8	0,06	1	0,47	0,260
16	2,53	fâneață	0,14	84,40	3,71	17,68	63,53	0,8	0,06	1	1,58	3,990
17	1,05	fâneață	0,14	109,20	3,98	13,73	41,99	0,8	0,06	1	1,12	1,170
18	1,20	fâneață	0,14	144,00	4,40	12,15	32,87	0,8	0,06	1	0,97	1,160
19	3,87	fâneață	0,14	143,20	4,40	12,22	32,87	0,8	0,06	1	0,97	3,750
20	0,83	fâneață	0,14	69,20	3,56	7,22	17,91	0,8	0,06	1	0,35	0,290
21	1,45	fâneață	0,14	60,40	3,41	12,41	32,87	0,8	0,06	1	0,75	1,080
22	0,92	pășune	0,14	47,60	3,21	21,00	82,59	0,8	0,30	1	8,90	8,180
23	1,17	pășune	0,14	84,40	3,71	23,69	104,13	0,9	0,80	1	38,94	45,550
Total	32,85											211,550

Eroziunea medie = 6,43 t/ha*an

Tabel nr.3 Estimarea eroziunii solului înainte de amenajare

Nr. crt.	Supr. (ha)	Folosința	Ka	L(m)	L^m	I (%)	I^n	S	C	Cs	Es (t/ha*an)	Et (t/an)
1	5,39	Livada (alei tehnologice)	0,14	154	4,49	22,86	96,67	0,8	0,70	0,15	5,10	27,51
2	9,93	Livada (terase)	0,14	217	5,04	17,28	57,73	0,8	0,70	0,15	3,42	33,96
3	10,14	Livada (terase)	0,14	246	5,18	15,24	46,96	0,8	0,70	0,15	2,86	29,00
Total plantatie pomicolă = 25,46 ha												
T1	1,37	pășune	0,14	190	4,82	18,42	66,57	0,9	0,01	0,8	0,32	0,43
T2	1,31	fâneață	0,14	91	3,84	13,73	41,99	0,9	0,01	0,7	0,14	0,18
T3	1,33	fâneață	0,14	66	3,41	7,57	19,61	0,8	0,01	0,6	0,44	0,58
T4	0,80	fâneață	0,14	29	2,74	8,62	19,91	0,8	0,01	0,6	0,03	0,02
											Eroziune totală	101,77
TOTAL SUPRAFAȚA AMENAJATA = 30,27												

Eroziunea medie = 3,36 t/ha*an

- Technical efficiency of technological paths

S *lane* = 7,8*350*19 = 5,187 ha

St= 0,5*350*19 = 0,33ha

$$Cu = \frac{5.187}{5.39} * 100 = \mathbf{96,23\%}$$

- Tehnical efficiency of terraces

Sp P2 = 10*400*19 = 7,6ha

St = 1,68*400*19 =1,27ha

$$Cu = \frac{7.6}{9.93} * 100 = \mathbf{76,53\%}$$

Sp P3 = 10*400*21 = 8,4ha

St = 1,5*400*21 = 1,26ha

$$Cu = \frac{8.4}{10.14} * 100 = \mathbf{82,84\%}$$

For areas proposed for afforestation are recommended antiforest forest shelterbelts that have sloping land along the contour and are designed to transform the surface drainage in underground leaking, which is why they are also called absorbing curtains. Forest curtains are cultures in strips resulting from partial afforestation. The bands consist of at least three rows of trees or trees and shrubs, resulting in a minimum width of five metres (three meters between selvage rows plus two meters from edge). These works are performed on eroded slopes and around water reservoirs for anti-erosion purposes. The distance between these curtains is determined in relation to critical distance erosion and ranges typically between 50 and 100 m and their width, b - In meters, is calculated by the formula:

$$b=\frac{d \cdot k \cdot i}{y-i} \text{ [m]}; \quad \textit{where:}$$

-d is the distance between the curtains, in m; -k- calculation rain leakage factor; - I-rain intensity calculation in mm / min; -y-intensity of water absorption by the soil in mm / min. If the calculation results in an unacceptably high width, then it is taken equal to 20 m and between rows of seedlings are executed grooves or waves of water retention

4. CONCLUSIONS

The comparison results have a technical efficiency in the use of technological paths to classical terraces, the latter having a coefficient of land use lower by 12-20%.

From an economic perspective, improving the land by executing technological paths, requires a much smaller amount of embankment, and a significantly lower labor consumption, especially in finishing the work, compared with traditional terraces. Moreover, finishing of classical terraces requires extra operations for leveling the platforms and correcting the slopes, operation performed with earthmoving machines.

In conclusion, the arrangement works presented in this paper recommends through the advantages exhibited and their overall efficiency, moving to the next phase to persuade key actors of the local administration to take steps in order to access RDP funds that can extend the current state of project to technical execution project - which will require a number of technical details.

5. REFERENCES

[1] Canarache A., Soil physics, Creses Publishig House, 1974
[2] Ene Al., Radu Alexandra, Ştirbu Clara, Muşat M., Land improvements, soil erosion and irrigation, Printech Publishing House, Bucharest, 2007
[3] John Boardman,Soil Erosion in Europe, Ed. Jean Poesen, 2006
[4] *** Methodology of pedologic studies elaboration – I.C.P.A. Bucharest, 1987.
[5] Motoc M. şi colab. (1975) Soil erosion and methods of combat. Ceres Publishing House, Bucharest.
[6] Florea N, I.Munteanu, (2003) - “Romanian System of Soil Taxonom”y. Estfalia Publishing House, Bucharest;
[7] Ştirbu C.C. (2003) Stadiul actual al pajiştilor degradate de eroziune din nord-vestul zonei colinare a județului Dâmbovița – Sesiunea internațională de comunicări științifice „Resursele de mediu şi protecția lor pentru o dezvoltare durabilă – Oradea”
[8] Mihalache Mircea, Ilie Leonard (2009), Bonitarea terenurilor agricole, Editura Dominor, Bucureşti
[9] Mihalache Mircea, Ilie Leonard (2011), Bonitarea terenurilor agricole-Lucrari practice, AMC -USAMV Bucureşti
[10] Mircea Sevastel (2011) – Impactul ravenării asupra mediului în B.H. Slănic/Buzău, Editura BREN, Bucureşti