LAND DEGRADATION AND SOIL CONSERVATION WITHIN THE PERESHIVUL MIC CATCHMENT – TUTOVA ROLLING HILLS

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Abstract

Spindle–shape like in form the Pereschivul Mic catchment is located in the Tutova Rolling Hills, Southern Moldavian Plateau, and covers 8,031 ha where 17.35 % is under forest. The native vegetative cover was dramatically changed over the last two centuries in the favor of the agricultural land, mainly cropland. The improper human activity such as the up and down hill farming and inadequate road network resulted in a significant development of soil erosion, gullying and sedimentation.

By means of the aerial photos, delivered in 2005 in the scale 1:5000, a number of 305 gullies (24 valley-bottom gullies and 281 valley-side gullies) have been inventoried. By comparing the present state of 8 valley-bottom gullies with the previous one, derived from topographical maps at similar scale it was possible to estimate gullying indicators, such as gully-head advance and areal gully growth. The most significant development has occurred in the Hreasca gully where the mean gully-head advance was 45.3 m yr^{-1} over the period 1961-1984. The value of gully erosion rate was estimated at 9.8 t $ha^{-1}yr^{-1}$ that represents almost 56 % of the total erosion within the Pereschiv basin.

The high rate of soil and gully erosion triggered a significant sedimentation rate along floodplains. The use of ^{137}Cs technique in the areas of deposition illustrates that since 1986 the mean rate of aggradation was 6.1 cm yr^{-1} within the lower catchment of Pereschivul Mic.

The major effect of the Land Reform Act no. 18/1991 is the revival of the old traditional agricultural system, the up-and-down hill farming. In order to deal with an optimum land use significant changes of the land use and implementing conservation practices are required. The case study associated with an area of 1,087 ha within Bartalus area in the Upper Pereschiv catchment is showing that the local combination between strip-cropping and a network of wind-breaks would represent the most efficient practices in cropland.

Key words: soil erosion, gullying, sedimentation, conservation practices

The Moldavian Plateau, located in Eastern Romania and extending about 27,000 square kilometers, is one of the most severely eroded agricultural areas in the country. Spindle–shape like in form the Pereschivul Mic catchment is located in the Tutova Rolling Hills, Southern Moldavian Plateau, and covers 8,031 ha where 17.35 % is under forest. Sandy-clayey Upper Miocene layers with a gentle gradient of 7-8 m km^{-1} NNW-SSW have outcropped from sedimentary substratum (Jeanrenaud, 1971). The climate is temperate continental with a mean annual temperature 9.1 ^0C and average annual precipitation of about 510 mm. Chernisoils and luvisoils (forest soils) are among the most common soils and have been used for crop production. The native vegetative cover was dramatically changed over the last two centuries in the favor of the agricultural land, mainly cropland. The improper human activity such as the up and down hill farming and inadequate road network resulted in a significant development of the land degradation.

Under these circumstances, at present soil erosion, gullying and sedimentation have been recognized as major environmental threats in the Pereschiv basin. The total erosion is averaging 20 t ha^{-1} yr^{-1}. By 1960, the traditional agricultural system on slopes consisted of up-and-down hill farming. Most of the land was excessively split into small plots, each under one hectare in size. Since 1960, awareness of soil erosion and the adoption of conservation practices have increased over entire Moldavian Plateau and the cropland within the Pereschiv catchment was adequately protected under different conservation practices. Implementing the provisions of new Land Reform Act No. 18/1991 has resulted in the revival of the old traditional up-and-down hill farming.

MATERIAL AND METHOD

Catchment mapping including both the geomorphologic and soil surveys was of particular interest. The use of the TNT mips Program has resulted in obtaining the Digital Elevation Model and the associated thematic maps, such as hypsometric map, map of slopes and orientation of slopes.

In order to evaluate the severity of land degradation there was a need to get reliable information. Current methods of erosion and deposition assessment may be divided into three approaches, namely long-term monitoring of experimental runoff plots, repeated field survey of gully erosion features, and field measurements to identify spatial patterns of sedimentation. The effect of soil cover on runoff and soil losses was determined using research plots over the period 1970-1999 at the Central Research Station for Soil Erosion Control Perieni-Barlad. Two main areas of monitoring gullies were explored, namely: aerial photographs from flights of the 1960s, 1970s and 2005s, and classical topographic levelling. The Caesium-137 technique was used to get information on dating specific levels of sediments and documenting erosion and sedimentation rates along the Pereschivul Mic floodplain. After manual sampling of the sediments, the Gamma spectrometry was used to get the Caesium-137 depth profile and to assess sedimentation rates.

RESULTS AND DISCUSSIONS

a)Land degradation

The Perieni runoff plots were set up on the left valley-side of Tarina catchment with 12% slope and slightly eroded cambic chernozem. Generally, data collected here over a 30-year period on soil and water losses indicate the following (Ionita, I., 2000a, Ionita et al., 2006):

- Mean annual precipitation is 504.3 mm, and precipitation which caused runoff and erosion falls as rain during the crop-growing months of May through October;
- About 26 percent (133.5 millimeter) of the annual precipitation induced runoff and or erosion for continuous fallow and 18.5 percent (93.5 millimeter) for maize;
- Runoff ranges from 36.5 mm under continuous fallow with the peak of 12.0 mm during July and 17.7 mm under maize with the peak of 6.5 mm during June;
- Soil loss is averaging 33.1 t $ha^{-1}yr^{-1}$ for continuous fallow with the peak of 12.8 t ha^{-1} during July and 7.7 t $ha^{-1}yr^{-1}$ for maize with the peak of 3.7 t ha^{-1} during June.

One mention must be made, namely that on severe eroded wooden soils, the value of the soil loss is doubling. According to Motoc, M. et al. (1998) and Ionita, I.(2000a) data collected under continuous fallow plot and processed by using a 3-year moving average revealed that over the period 1970-1999 there were three soil erosion peaks, namely in 1975, 1988 and 1999.

Another major and typical degradation process is associated with gully erosion. By means of the aerial photos, delivered in 2005 in the scale 1:5000, a number of 305 gullies, divided in 24 valley-bottom gullies and 281 valley-side gullies, have been inventoried (Niacsu, L., 2009). By comparing the present state of 8 valley-bottom gullies with the previous one, derived from topographical maps at similar scale it was possible to estimate gullying indicators, such as gully-head advance and areal gully growth. In regards to continuous valley-bottom gullies, the most significant development has occurred in the Hreasca gully where the mean gully-head advance was 45.3 m yr^{-1} over the period 1961-1984 (Ionita, I., 2000b). As for discontinuous gullies, usually located on valley-sides the mean gully-head advance was 1.0 m yr^{-1}. Another main finding of the stationary gully monitoring was that 57 % of the total gullying occurred during the cold season, especially in March due to the influence of the freeze-thaw cycles (Ionita, I., 2000b). Generally, the value of gully erosion rate was estimated at 9.8 t $ha^{-1}yr^{-1}$ that represents almost 56 % of the total erosion within the Pereschiv basin (Niacsu, L., 2009).

The high rate of soil and gully erosion triggered a significant sedimentation rate along floodplains. The use of ^{137}Caesium technique in the areas of deposition illustrates that since Cernobyl nuclear accident of 1986 the mean rate of aggradation was 6.1 cm yr^{-1} within the lower catchment of Pereschivul Mic (*fig. 1*).

Landslides are typical for most of the Moldavian Plateau but they have a local occurrence in the Pereschiv catchment due to prevailing sandy layers.

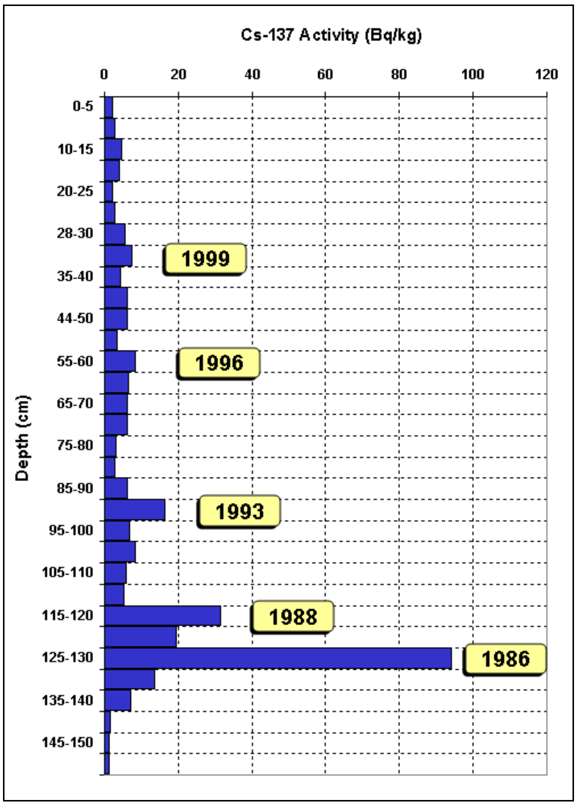

Figure 1 **Depth profile of ^{137}Cs in the floodplain of Pereschivul Mic (August 28, 2006)**

b) Soil conservation

By 1960 most of the land was excessively split into small plots, each under one hectare in size. Since 1960, awareness of soil erosion and the adoption of conservation practices have increased over entire Moldavian Plateau and the cropland within the Pereschiv catchment was adequately protected under different conservation practices. A new Land Reform Act No. 18 was promulgated in 1991 and that includes two provisions which are not of a nature to create conditions for the extension of conservation measures. One of these stipulates that the land reallotment has to be usually done on the old sites. This means in most cases that the plots will be up-and-down the hill led out. The second refers to the successors' right up to the fourth degree! That enables an increasing rate of land splitting which is higher than that before the Second World War. Meanwhile, another Act, Number 1/2000, was promulgated and having in view forestland splitting on a large area. The major effect of the above-mentioned laws is revival of the old traditional agricultural system, the up-and-down hill farming consisting in small and narrow private plots, and the rate of erosion and sedimentation doubled.

Therefore, to improve the quality of the local environment design and implementation of the conservation practices on slopes are necessary. A first step to fulfill this goal refers to designing the best management practices with main focus on the soil and water conservation. A case study was undertaken in Dumbrava Valley and it is associated to an area of 1,087 ha around Bartalus Village within the Upper Pereschiv catchment. The local topography under agricultural land is gentle-moderate with an average slope of 14% but the previous luvisoils are severe subjected to erosion. *Figure 2* is showing that the strip-cropping system is an appropriate one to be implemented at local scale. The strip width ranging from 56 to 92m is practicable and the spacing was computed using the formulas that were established by Stănescu P. in 1973:

- log. L = 2,22 – 0,03 i (for resisting soils to erosion);
- log. L = 2,15 – 0,03 i (for middle resisting soils to erosion);
- log. L = 2,05 – 0,03 i (for slightly resisting soils to erosion).

where:

L = the width of the strip (m);

i = the value of slope (%).

However, the best recommendation would be the combination between the strip-cropping system and a network of wind-breaks, each of them 12m in width.

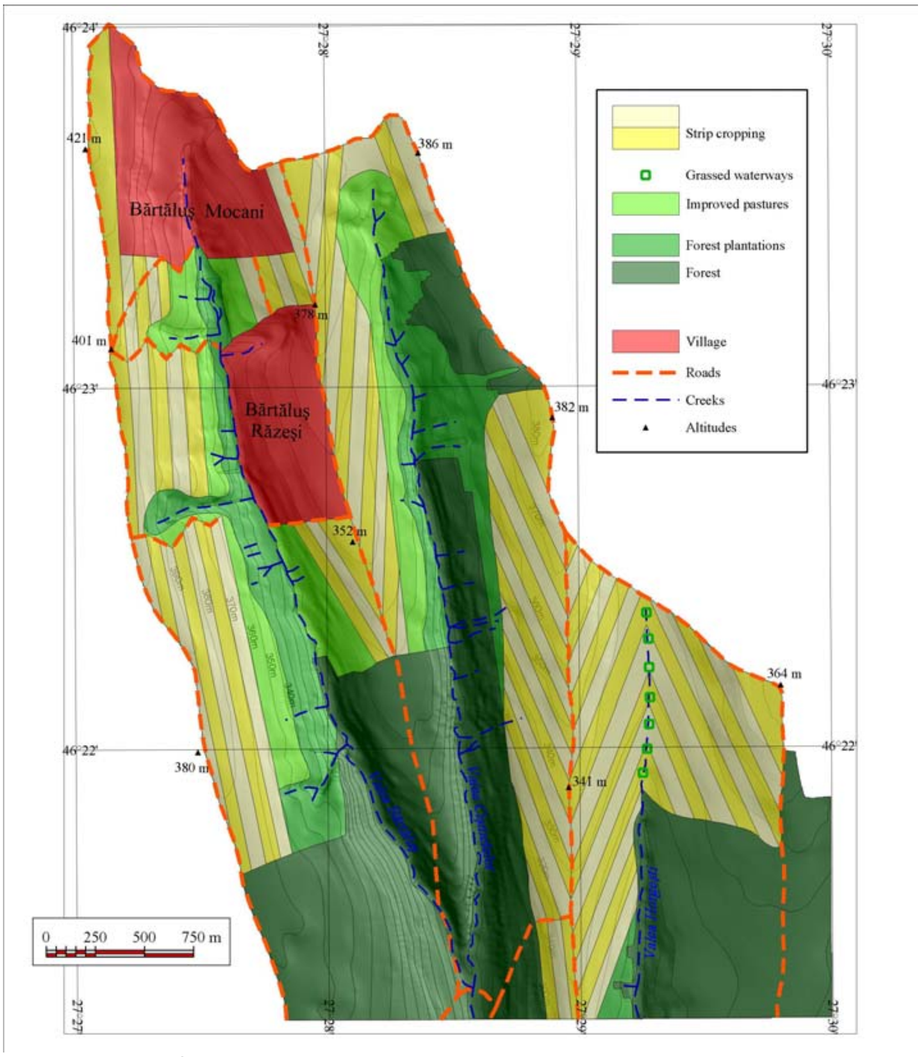

Figure 2 **Map of the conservation practices within the Upper Dumbrava basin**

The main data of the proposed project are also summarized in the table no.1. The major changes in the land use stratification are as follows:

- Setting the entire arable land under strip-cropping system;
- Improving the quality of the pasture;
- Extending the area under forest;
- Disappearance of the unproductive land;
- Reduction of the road area.

Table 1

Summary of the designing conservation practice on slopes in the Upper Dumbrava basin

Land use	Before implementing conservation practices		After implementing conservation practices	
	ha	%	ha	%
Arable	416.88	38.35	-	-
Arable as strip-cropping	-	-	433.92	39.92
Pasture	181.33	16.68	-	-
Improved pasture	-	-	85.33	7.85
Forest	305.74	28.13	305.74	28.13
Forest plantations	-	-	155.37	14.29
Vineyards	7.53	0.69	-	-
Roads	18.85	1.73	9.46	0.87
Unproductive	43.55	4.01	-	-
Villages	113.12	10.41	113.12	10.41

CONCLUSIONS

On slightly eroded cambic chernozem soil losses averaged 33.1 t $ha^{-1}yr^{-1}$ for continuous fallow and 7.7 t $ha^{-1}yr^{-1}$ for maize over 1970-1999 while on severe eroded forest soils these values are double.

A number of 305 gullies, divided in 24 valley-bottom gullies and 281 valley-side gullies, have been inventoried. The value of gully erosion rate was estimated at 9.8 t $ha^{-1}yr^{-1}$ that represents almost 56 % of the total erosion within the Pereschiv catchment.

Since Cernobyl nuclear accident of 1986, the mean rate of aggradation along the floodplain was 6.1 cm yr^{-1} in the lower Pereschivul Mic basin.

By 1960, the traditional agricultural system on slopes consisted of up-and-down hill farming. The awareness of conservation practices increased significantly over 1961-1990. By implementing the provisions of the Land Reform Act Number 18/1991 the old traditional up-and-down hill farming is “on the screen” again, recreating the frame to favour the high rates of land degradation.

The design of conservation practices in an area of 1,087ha within Upper Dumbrava basin is suggesting that the best management practice on cropland is consisting in the combination between the strip-cropping system and a network of wind-breaks.

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