RAPID MAPPING OF THE VEGETATION AND EROSION ON A GRASSLAND

MARIAN Mădălina, NEBLEA Monica, HERA Oana, GIOSANU Daniela

Abstract. The present paper is a study of vegetation and soil erosion on a grassland which is a private property in the village of Sătic, Aninoasa locality, Argeș county. The area of the grassland was 18.18 hectares, being classified as a locality in the hydrographic basin of the Bratia River, tributary of the Argeş River. The purpose of the study was to find a simple, cost-free, viable method to provide landowners with an idea of the erosion potential of the land and an analysis of the vegetal layer, taking into account the partial impossibility of periodic grazing on different land plots. In order to achieve the objectives, the cartography method was chosen, using different tools. For cadastral technical determinations, cheaper tools with a precision to fit within the tolerance of the measurements from agriculture were used. For vegetation mapping, the geobotanic method was used. The researches carried out have made it possible to determine the estimation of soil loss on a grassland, indicating the erosion degree with regard to potential erosion. The start of erosion was due to natural and social economic factors. The hydrographic basin of the Bratia River is known for the intensity of erosion phenomena. Simple remedies were indicated in terms of floral composition. The mapping responded to the two problems of the original purpose of the paper. Solutions have been offered both to reduce soil erosion and to modify the floral composition of degraded habitats.

Keywords: grassland, cormophyte, soil, impact, erosion.

Rezumat. Cartarea rapidă a vegetației și eroziunii pe o pășune. Lucrarea de față constituie un studiu asupra eroziunii solului și asupra vegetației, având ca locație de desfășurare o pășune proprietate privată din satul Sătic, localitatea Aninoasa, județul Argeș. Suprafața pășunii a fost de 18,18 hectare, încadrându-se ca localizare în bazinul hidrografic al râului Bratia, afluent al râului Argeș. Scopul studiului a fost acela de a găsi o metodă simplă, fără costuri mari, viabilă, care să aducă proprietarilor de terenuri pășunabile o imagine asupra potențialului erozional al terenului și o analiză a covorului vegetal, ținând cont de imposibilitatea parțială a pășunatului periodic pe tarlale diferite. În atingerea obiectivelor, metoda a fost cea a cartării, folosind instrumente diferite. Pentru determinările tehnice cadastrale s-au folosit instrumente mai ieftine și cu o precizie care să se încadreze într-o toleranță a măsurătorilor folosite în agricultură. Pentru cartarea vegetației, s-a folosit metoda geobotanică de cercetare în itinerar a fitocenozelor. Cercetările efectuate au permis estimarea pierderilor de sol pe o pășune cu precizarea gradului de eroziune cu privire la eroziunea potențială. Declanșarea eroziunii s-a datorat factorilor naturali și celor social economici. Bazinul hidrografic al râului Bratia este cunoscut prin intensitatea fenomenelor erozionale. Din punct de vedere al compoziției floristice, au fost indicate măsuri simple de remediere. Cartarea a răspuns la cele două probleme din scopul inițial al lucrării. Au fost oferite soluții atât în ceea ce privește reducerea eroziunii solului, cât și a modificării compoziției floristice a habitatelor degradate.

Cuvinte cheie: pășune, cormofite, sol, impact, eroziune.

INTRODUCTION

Soil erosion is manifested on all uses, in different phases, being considered a national, continuous and universal phenomenon that has contributed and contributes to the shaping of the earth's crust. Soil erosion generally has certain characteristics in the process of agricultural development, with impact from the use of land by modifying soil properties (OUYANG et al., 2018).

The proposed method is that of cartography, considered as a method for outlining both the intensity and forms of erosion, as well as other factors that intervene in the erosion process. The method allowed the fitting of the surface in the erosion class, the study of the natural and anthropogenic factors, the causes and consequences of soil erosion. The vegetal layer analysis plays an important role in knowing and explaining the changes that occur in the structure of vegetation under the influence of natural factors, of the works that improve the quality of habitats and the way of their use.

DÎRJA (2000) mentions the content in assimilable nutrients in the sense that they decrease in relation to the degree of erosion. For a grassland, very good ecological quality is given by rich and well-drained soil.

Soil is a renewable factor. Used rationally, it is not exhausted and does not degrade. If it is properly supported, fertility is maintained. It is known that keeping the quality of vegetal layer on a grassland for two or three years has a positive effect on soil erosion (ZHANG et al., 2003). Let us not forget another aspect, namely that the measures and works for prevention and erosion control prevent the pollution of the soil and water courses, improve the conditions of the environment, contribute to the enrichment of the environment, to improve the health of the population from area, creating premises for the development of agritourism in general.

MATERIALS AND METHODS

Research area. The studied area is located on the administrative territory of the Aninoasa commune (Argeş County) in the hydrographic basin of the Bratia River. It is a private property, used for grazing purposes (Fig. 1). The sheep grazed in the year 2018 until June 4, and the grass mowing was done once in August.

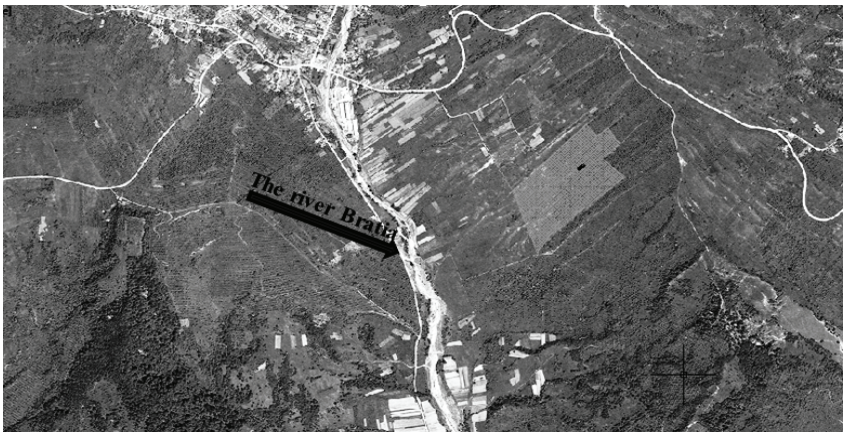

Figure 1. Land location in the Basin of the Bratia River (original).

Coordinates were collected with the TRIMBLE Juno SB handheld GPS. The recorded coordinates were geographic ones (latitude, longitude, elevation). Each record has been converted to Stereo '70 coordinates with TransDatRO program version 4.04. All the points have been reported on the location plan with AutoCAD program. The plane coordinates on the outline of the land were generated on the orthophotoplan: area of 181836.70 m^2, perimeter of 2009.91 m. Four zones were established. For each of these zones, a reference point with GPS was determined, around which, on a radius that oscillated around 200 m^2, the habitat is located.

Coordinates on the outline for the entire area were: Point 1 (X=492546.6279, Y=413527.0285), Point 2 (X=492633.6500, Y=413609.4827), Point 3 (X=492687.6995, Y=413661.7270), Point 4 (X=492722.5699, Y=413694.2348), Point 5 (X=492765.5770, Y=413736.6108), Point 6 (X=492834.7458, Y=413805.8631), Point 7 (X=492880.6910, Y=413848.2687), Point 8 (X=492915.3716, Y=413885.0728), Point 9 (X=492966.5689, Y=413817.1174), Point 10 (X=493023.3502, Y=413864.1786), Point 11 (X=493064.4037, Y=413798.0119), Point 12 (X=493064.4037, Y=413798.0119), Point 13 (X=493082.4642, Y=413781.7201), Point 14 (X=493082.4642, Y=413781.7201), Point 15 (X=493082.4642, Y=413781.7201), Point 16 (X=493067.368, Y=413764.9851), Point 17 (X=493045.1560, Y=413734.3591), Point 18 (X=492988.9934, Y=413701.3610), Point 19 (X=493106.1098, Y=413595.8959), Point 20 (X=492893.8348, Y=413423.4483), Point 21 (X=492736.7851, Y=413288.6170), Point 22 (X=492671.0124, Y=413193.7247), Point 23 (X=492546.6279, Y=413527.0285).

Vegetation mapping. To observe how anthropozoogenic activity influences the structure and functionality of natural habitats, the geobotanic research method was used. Species of cormophytes were determined both in the field and in the laboratory, based on literature: Flora R.P.R. - R.S.R. (1952-1976), Vascular Plants in Romania (SÂRBU et al., 2013).Grassland vegetation was characterized by the following aspects: the use (pasture in our case), the stage of fallow (very strong, strong, weak) and the floristic composition.

Erosion mapping. Research on soil conditions was correlated with the study of other natural factors. The soil is brownish (yellowish) podzolic and pseudogleization is one of its negative characteristics.

The calculation of the potential erosion on the studied pasture was done using: the equation adapted for pedoclimatic conditions in our country; the universal equation of soil loss revised by MOŢOC (1973, 1975, 1979), MOŢOC & SEVASTEL (2002), according to U.S.L.E. -WISCHMEIER & SMITH (1958), respectively R.U.S.L.E. - EVANS &LOCH (1996).

$$E = K_a \cdot S \cdot C \cdot C_S \cdot L^m \cdot i^n \ (t/ha/year)$$

E - average annual soil loss (t/ha/year)

K_a - the pluvial aggressivity coefficient. The value of this coefficient is 0.14 for the studied area and it appears in the map of zoning of the climatic (pluvial) aggressiveness on the territory of Romania.

S - erodibility factor depending on soil resistance to erosion. Its value is 0.9 for the brown podzolic soil in the studied area under moderate erosion conditions and medium-clayey texture.

C - factor representing the vegetation influence. This factor was considered to be 0.3 for a moderately degraded pasture.

C_S - factor representing the influence of measures to control soil erosion. This factor has a value of 1 for the absence of any land improvement work on the survey area.

L – slope length was measured with the ruler on the map in level curves, in cm, then converted to the scale plan at a reduced distance to the horizon, corresponding to the field value.

i - the slope of the area was calculated as the average slope by reading the curve elevations within the studied unit boundary.

$i^n = 1{,}36 + 0{,}97i + 0{,}138i^2$, m and n = parameters, m = 0,4 at a slope length of more than 100 meters for "L^m i^n".

RESULTS AND DISCUSSIONS

Vegetal layer analysis

Zone 1

Stereo '70 coordinates: N - 413608,63; E - 492919,50 (Fig. 2); Altitude: 590 m

The area is degraded (Fig. 3) and grass is over 70 cm tall. The grassy species with the highest frequency are: *Plantago lanceolata* L., *Cichorium intybus* L., *Capsella bursa-pastoris* (L.) Medik., *Xanthium strumarium* L., *Chenopodium album* L., *Lactuca serriola* L., *Torilis arvensis* (Huds.) Link, *Sonchus arvensis* L., *Amaranthus retroflexus* L., *Bidens tripartitus* L., *Bromus sterilis* L.. There are areas covered with *Phragmites australis* (Cav.) Trin. ex Steud. as invasive species, which has expanded from nanodepressions with excess of humidity.

Due to the anthropozoogenic activities in this perimeter, areas with weeds were formed, like: *Xanthium strumarium* L., *Bromus sterilis* L., *Capsella bursa-pastoris* (L.) Medik., *Erigeron canadensis* L.. Besides these, specimens of *Ambrosia artemisiifolia* L. have been observed, which is sporadic and its ability to spread is limited because it is mown before flowering and fructification.

Figure 2. Reporting point 1 on orthophotomap- winter stable (original).

Figure 3. Pasture habitat invaded by *Xanthium strumarium* L. – zone 1 near winter stable (original).

Zone 2

Stereo '70 coordinates: N - 413723,74; E - 492940,19 (Fig. 4); Altitude: 588 m

The animals stay throughout the day from spring until June. However, the edifying species for the habitat of the hay (*Festuca rubra* L., *Agrostis capillaris* L.) have a low coverage. The average height of the species is 20-30 cm (Fig. 5).

The floral composition is made up of typical species for mountain meadows but with a reduced size due to grazing. These include *Holcus lanatus* L., *Agrostis capillaris* L., *Cruciata glabra* (L.) Ehrend., *Dorycnium pentaphyllum* Scop., *Ononis arvensis* L., *Agrimonia eupatoria* L., *Leucanthemum vulgare* (Vaill.) Lam., *Stachys officinalis* (L.) Trevis., *Filipendula vulgaris* Moench, *Trifolium pratense* L., *Briza media* L., *Lotus corniculatus* L., *Ranunculus sardous* Crantz, *Pimpinella saxifraga* L., *Linum catharticum* L., *Centaurea phrygia* L. ssp. *pseudophrygia* (C. A. Mey.) Gugler, *Medicago lupulina* L., *Veronica arvensis* L., *V. chamaedrys* L., *Achillea millefolium* L., *Elymus repens* (L.) Gould., *Echium vulgare* L., *Stellaria graminea* L., *Thymus pulegioides* L., *Symphytum officinale* L., *Convolvulus arvensis* L., *Poa annua* L., *Plantago media* L., *P. lanceolata* L., *Rhinanthus minor* L., *Knautia arvensis* (L.) Coult., *Cirsium canum* (L.) All.. Sporadically small specimens of *Phragmites australis* (Cav.) Trin., *Ambrosia artemisiifolia* L., *Xanthium strumarium* L. appear. Also, in the perimeter of this area, shrubs of *Rosa canina* L. and *Crataegus monogyna* Jacq. grow.

Figure 4. Orthophotomap with the addition of point 2 (original).

Figure 5. Grassland habitat – zone 2 (original).

Zone 3

Stereo '70 coordinates: N - 413834,87; E - 492926,80 (Fig. 6); Altitude: 601 m

In this area (Fig. 7), the animals are staying at night. The habitat is completely degraded due to organic load, large areas are lacking of vegetation. In some areas, as a result of soil pH modification, due to the activity of the animals, species such as *Chenopodium album* L.*, Cichorium intybus* L.*, Amaranthus retroflexus* L.*, Plantago lanceolata* L.*, Potentilla reptans* L.*, Elymus repens* (L.) Gould.*, Lotus corniculatus* L.*, Convolvulus arvensis* L. are abundant.

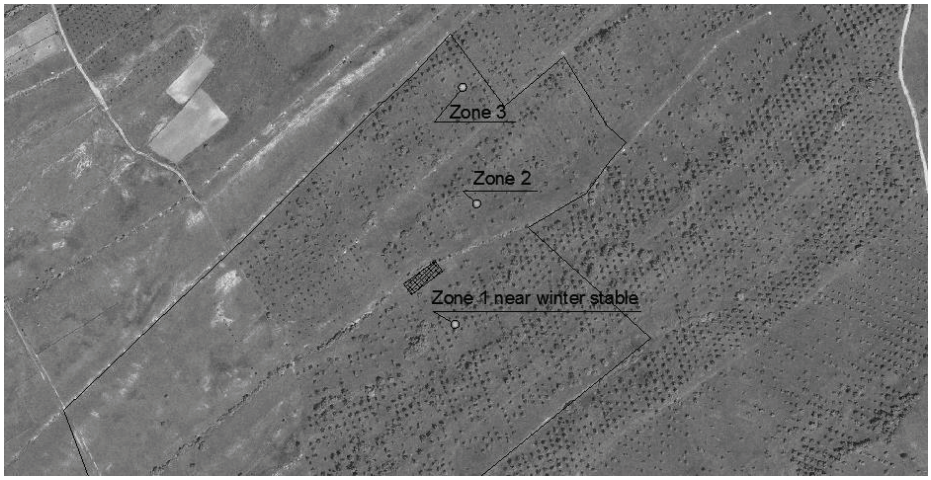

Figure 6. Orthophotomap with the addition of point 3 (original).

Figure 7. Surfaces without vegetation – zone 3 (original).

Zone 4

Stereo '70 coordinates: N - 413328,66; E - 492663,05 (Fig. 8); Altitude: 555 m

In this area, animals are staying from March to June. In the floristic composition, typical species appear for grassland, but with low coverage (Fig. 9) such as: *Filipendula vulgaris* Moench, *Holcus lanatus* L., *Briza media* L., *Galium mollugo* L., *Leucanthemum vulgare* (Vaill.) Lam., *Trifolium repens* L., *T. montanum* L., *Thymus pulegioides* L., *Agrostis capillaris* L., *Medicago lupulina* L., *Prunella vulgaris* L., *Cirsium canum* (L.) All., *Stachys officinalis* (L.) Trevis., *Achillea millefolium* L., *Ranunculus sardous* Crantz, *Polygala vulgaris* L., *P. major* Jacq., *Onobrychis viciifolia* Scop., *Asperula cynanchica* L., *Rhinanthus minor* L..

Dorycnium pentaphyllum Scop. has a large coverage (more than 50%). It is known as an indicator of grassland habitats with low ecological quality (http://www.rndr.ro/documente/brosuri/brosuri-pajisti-cu-valoare-naturala-ridicata.pdf).

Besides this, *Lotus corniculatus* L., *Bromus sterilis* L., *Equisetum telmateia* Ehrh. are also mentioned. Sporadically, specimens of *Phragmites australis* (Cav.) Trin. ex Steud. have been reported to penetrate from microdepressions with excess of moisture. There are some shrubs such as *Rosa canina* L., *Crataegus monogyna* Jacq. and juveniles of *Populus alba* L..

Figure 8. Orthophotomap with the addition of point 4 (original).

Figure 9. Grassland habitat with *Dorycnium pentaphyllum* Scop. – zone 4 (original).

The nitrophilous species (*Chenopodium album* L., *Elymus repens* (L.) Gould., *Amaranthus retroflexus* L.) and *Phragmites australis* (Cav.) Trin. ex Steud. must be removed from the grasslands. According to MARUȘCA et al. (2014) is not recommended to fertilize the oversheep-folding grasslands (zone 3 in our study) until the excess of nitrogen and potassium is exhausted.

Phragmites australis (Cav.) Trin. ex Steud. has no forage value (KOVÁCS, 1979) and it is a very competitive invasive species that uses resources and shades other species due to its height (JUTILA, 2001).

A special attention should be paid to other invasive species like *Ambrosia artemisiifolia* L. and *Erigeron canadensis* L., that must be monitorized year after year to prevent their expansion. Since these species have small populations in the studied area, measures like pulling up and mowing individuals before seed maturation are needed for their control (WITTENBERG Eds., 2005; https://plants.usda.gov/plantguide/pdf/pg_coca5.pdf).

Wooden vegetation (juveniles of *Populus alba* L., *Crataegus monogyna* Jacq., *Rosa canina* L.) that can invade the grasslands must be removed until afforestation.

Erosion study

In the equation of potential erosion of this pasture with an area of 181836,70 m^2(18,18 ha), the average slope value of 17% and an average slope length of 468,9 m were added.

$E=K_g \cdot S \cdot C \cdot C_S \cdot L^m \cdot i^n \ (t/ha/year)$ = 0,14 x 0,9 x 0,3 x 11,71 x 57,73 = 25,55 t/ha/year

L^m = 11,71

i^n = 1,36 + 16,49 + 39,882 = 57,73

The value of 25.55 t/ha/year indicates a high erosion, ranging from 17-30 t/ha/year.

The potential erosion value increases with the slope, slope length and soil type (the soil with a stronger erosion), the slope of the land being decisive.

The increase the length of the slopes does not influence the accumulation of water in the soil too much, it leads to the increase of the water layer height in the downstream area and implicitly of the erosion force. In this case, the increase of the leakage length created an accumulation of water in the soil, an increase in the velocity and potential energy, implicitly an increase of the erosion capacity. Excessive eroded surfaces were not encountered.

The resulting value shows a degraded pasture and its invasion with shrubs on some portions. Also, there is a period of excess humidity. The stagnation of precipitation water should be avoided. Ground water is at deep depths, but often hanging groundwaters, which are insignificant in terms of flow, may still favour sliding processes.

The climate regime is moderately temperate continental with severe winters but without blizzards and not very warm summers, hilly relief acting as an obstacle to air masses. The cold air of the Iezer-Păpuşa massif goes down the valley of Bratia, causing the late spring frosts. A re-seed is required to improve the flora composition of the pasture. Measures to combat soil erosion must primarily be directed to excess water, leakage should be directed to reduce or even eliminate the causes of possible landslides.

CONCLUSIONS

The researches carried out have made it possible to determine the erosion on pasture, indicating the degree of erosion with regard to potential erosion. Regarding potential erosion, the resulting value is quite high, with a value of 25.55 t/ha/year. The start of erosion was due to both natural and social economic factors.

A decisive role was played by torrential rainfalls that fell in the hydrographic basin, precipitations characterized by high intensity, the torrential nucleus at mid and late rains, the period during which it is recorded (May-June), elements favouring erosion. There is an excess of moisture in the studied area. Priority will be given to removing excess of moisture (levelling, modelling, drainage).

Grazing used in an irrational way will lead to quick degradation of the land. The slope of the studied land is not very high (18%), but a large animal load, with early spring grazing on the soft ground and before the grass grows, leads to soil degradation.

In the studied pasture, we mention habitat degradation with the alteration of the floristic composition, and on certain surfaces (zone 1 near winter stable) we report the existence of large areas with weeds. Practically, maintenance work is required to remedy the degradations that occur in the process.

A forest plantation is indicated on this surface. Forestry species on pasture would have an anti-erosion belt that could improve microclimate conditions. These forest belts should be placed as far as possible on the level curve.

In the future, continuous monitoring of erosion is necessary, taking into account the history of this hydrographic basin (Bratia), which includes the studied area. It is known that in this hydrographic basin works were executed mainly on ravines, works that have fulfilled their role of stopping the development of torrential formations but, as well as the whole hydrographic basin at the Argeş river, works were performed for depth erosion to the detriment of the works that combat and prevent surface erosion (less expensive).

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Marian Mădălina, NebleaMonica, HeraOana, Giosanu Daniela
University of Pitești, Târgu din Vale Street, no. 1, Pitești, Argeș County, Romania.
E-mails: madalina.marian@yahoo.com; monica_neb@yahoo.com; oana.hera@yahoo.com; giosanu@yahoo.com

Received: March 29, 2019
Accepted: May 12, 2019