Ecopedological Research for Ecological Rehabilitation of Degraded Lands from Eastern Romania

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Abstract: The assessment study of the global ecological impact tries to highlight the main factors and negative ecological determinants, due to a lack or excess, and it also focuses on highlighting the main negative ecological effects with the aim to rehabilitate and restore the ecological balance within degraded ecosystems. The methodology used in the assessment process was based on graphs, tables in the shape of Leopold matrix, considerably improved by authors. In order to assess qualitatively the negative ecological effects, a reliability scale with 3 indicators and 3 graduations was used, designed to underline the importance of the impact (minor, medium, and major), the quality of the impact (neutral, negative, and positive) and the certainty of the appearance of a negative impact (improbable, probable, and certain). Our research was accomplished in the pasture ecosystem degraded by pluvial erosion from the Tutova Hills, located in the Eastern part of Romania. This ecosystem is characterized through active geo-morphological processes in the depth and on the surface and it drew attention to the presence of 8 negative ecological factors grouped in 3 main categories: geo-climatic, pedological, and anthropogenic. 8 main negative effects were identified and quantified by means of 3 qualitative indicators with 3 graduation scales. The analysis of the current state of the effects of the complex ecological impact upon the degraded ecosystem ask for a series of urgent measures elaborated by scientists, researchers, and representatives of the local administration system. The aim of these measures is to improve the ecological balance and to eliminate the negative anthropogenic impact that augments and aggravates the action of the negative geo-climatic and pedological factors, in of with the protection of soil quality.

Keywords: assessment of ecological impact; degraded soils; Eastern Romania; ecological remediation; impact matrix

The soil, in its quantitative and qualitative state, represents an essential component of the terrestrial ecosystems and a fundamental component for their proper function. It is a complex environment that allows for divers physical, chemical and biological processes (Bridges & Van Barren 1997; Cârstea 2001).

The quality of the soil reflects its own features along with the characteristics and the processes determine the cationic capacity to change and auto-regulation in the context of the relation with the environment (Lal 1994; Bireescu *et al.* 2005; Teodorescu-Soare *et al.* 2006). Soil erosion has become one of the major problems the mankind has to face nowadays, mainly due to its negative effects upon both the environment and food safety. Thus, recent assessments show that almost 40% of the agricultural land are degraded, a fact that

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accounts for low yield values that go far below the soil potential. (Szabolcs & Varallyay 1978; Bălteanu & Şerban 2005; Varallyay 1989, 2006).

The assessment of the ecological impact focuses on highlighting the main factors and negative ecological determinants and main negative ecological effects with a view to rehabilitating and restoring the ecological balance of degraded ecosystems (Bireescu *et al.* 1996, 1999; Teodorescu-Soare 1998; Teodorescu-Soare *et al.* 2006).

The impact matrix analyses the quality of the factors with negative impacts and negative ecological effects based upon 3 qualitative indicators – reliability scale with a view to establishing the strategies of protection, preservation and ecologic rehabilitation.

The main objectives of this research were:

(1) Complex inter-disciplinary ecological study on the present state of the soil resources and the vegetal resources in view of the protection of the soil quality and sustainable use of the natural resources.

(2) Factor indication and ecological determinants which in a regional or local ecological context can stress, attenuate, or limit the rational use of the natural vegetal resources and of the soil.

(3) The monitoring of the resource quality in view of protecting or ameliorate it.

(4) The strategies for protection, amelioration and ecological remedy of the degraded lands.

MATERIAL AND METHODS

The quality of the soil must be tested and verified for any key that might indicate deterioration caused by the man or nature, for the protection or amelioration of the entire soil in view of a durable use, maintaining diverse bio-systems and the ecological equilibrium. The study of the soil features (Stagnic Luvisol – Luvosol, after Florea *et al.* 1987, Luvisols, after WRB 2006) was performed on the field and in the laboratory through specific usual methods elaborated by Pedology and Agrochemistry Research Institute from Bucharest, Romania (1987).

The evaluation of the primary zonal and local ecological factors and determinants was done from the quantitative point of view through the ecological size classes, and from the qualitative point of view through the ecological favourability classes. The 20 main important eco-pedological factors and determinants were studied: N_t – total nitrogen content; P_2O_5 – obile phosphorus content; K_2O – exchangeable potassium; Alc-Ac – alkality-acidity; Con – soil consistency; Tx – soil texture; PA – porosity aeration; pH – soil reaction; BS – base saturation; SOM – soil organic matter content; Uer – summer relative humidity; Pe – summer precipitations; W – winds; Pmm – annual average precipitations; T (°C) – annual average temperature, DA – dehydrogenase activity; Ve – edaphic vo-lume; BLP –bioactive length period, Pt – potential trophicity; ET – effective trophicity.

From the factors that have been mentioned stand out thouse that assure the qualitative base of the soil and also the factors that through their lack or excess determine a negative ecological impact (the Chiriță method (1974), improved by Bireescu *et al.* 1996). The main negative ecological impact factors along with their negative effects were interpreted through the graphic matrix (method of Leopold, improved by Bireescu *et al.* 1996; 1999).

RESULTS AND DISCUSSION

The ecological research has been carried out within a larger framework provided by the study of the interrelations between biotope-biocenosis with a view to assessing the possibilities of restoring the ecological balance of the ecosystems located on degraded lands. The restoration time of a degraded ecosystem depends on how seriously and how much it has been disturbed (Zhao *et al.* 2005; Dobson *et al.* 1997). The research programme focused on the Tutova Hills area of the Moldavian Plateau (Eastern part of Romania), one of the most active areas in Romania in terms of geomorphologic processes. The main geomorphologic process is represented by active processes of the slope fluvial-torrential nature. The temperate climate with torrential rainfalls alongside the negative anthropogenic impact amplifies and aggravates the degradation processes and phenomena.

On the basis of a qualitative bonification scale with 3 indicators and 3 graduations, we appreciated the effects of the degradation processes in view of adopting the strategies and measures for the protection of the natural vegetal resources and soils and for the ecological remedy of the degraded fields. The erosion potential of the Tutova Hills is one of the most aggressive in the country. The main geomorphologic process is represented by fluvial-torrential processes alongside the slope erosion processes. Pluvial erosion is influenced and favoured by the temperate climate with torrential rainfalls and by the anthropogenic impact, due mainly to an aggressive and intensive grazing. The ecologic study pointed out the main local ecologic factors and determinants of the negative impact, as well as the main negative ecologic effects and results.

Ecological specificity file

The main 20 factors and local ecologic determinants have been analysed from a quantitative and qualitative perspective, using the ecological specificity file (Figures 1 and 2). Thus, we observed that the main factors and ecologic determinants are enclosed into medium size classes of medium levels of the vegetation conditions. The main factors and negative edapho-climatic ecological determinants are: hard summer consistency of dry soil, low summer rainfalls, low soil aeration, fine texture at Bt horizon.

Local and global matrix of ecological impact

The fundamental ecosystem processes are influenced by the changes in the agricultural practices and soil resources management, affecting ecosystem functions (Koulouri & Giourga 2007). The analysis of the edapho-climatic ecologic specificity matrix highlights the existence of some factors and ecological determinants of the negative impact, mainly due to their absence or excess.

In order to evaluate the global ecologic impact, we have used the method of graphic-table analysis, namely the Leopold matrix cross referencing (1971) improved by Bireescu *et al.* (1996, 1999). The matrix comprises on its left-hand side the main factors of the negative ecologic impact, and on its right-hand side the main negative ecologic effects (Figure 3).

The main 8 negative ecologic factors are: geoclimatic factors (steep slopes, narrow valleys, low seasonal rainfalls, temperate climate with torrential rains); eco-pedologic factors (hard summer consistency and low soil aeration); anthropogenic factors with negative impact (irrational, intensive and aggressive grazing, irrational chemical fertilisation, and the lack of maintenance works, improvement, and entrepreneurial investments). We can also talk about a relatively large number of negative ecologic effects: surface or in depth erosion processes, regression of biodiversity, vegetation overgrown with weeds, decreasing the percentage of valuable fodder plants, decreasing soil biological activity, destroying soil structure. Consequently, the vegetation regression is associated with deterioration of the biological health of the soil, with diminished organic matter and nitrogen contents (Rodríguez Rodríguez *et al.* 2005). In other studies of degraded areas, showing a low resilience against human transformation that causes a significant impact (Arbelo *et al.* 2002; Rodríguez Rodríguez *et al.* 2002a,

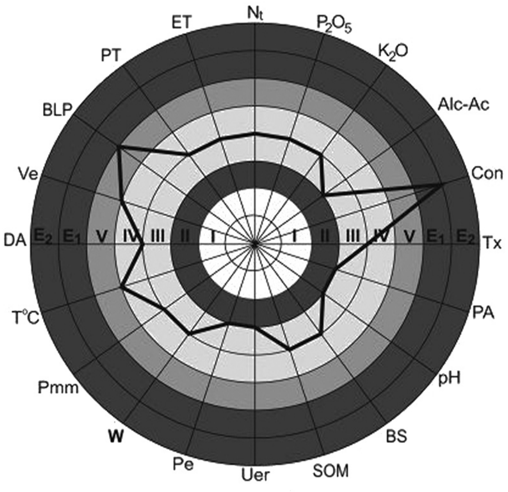

Figure 1. Size classes of eco-pedological factors and determinants

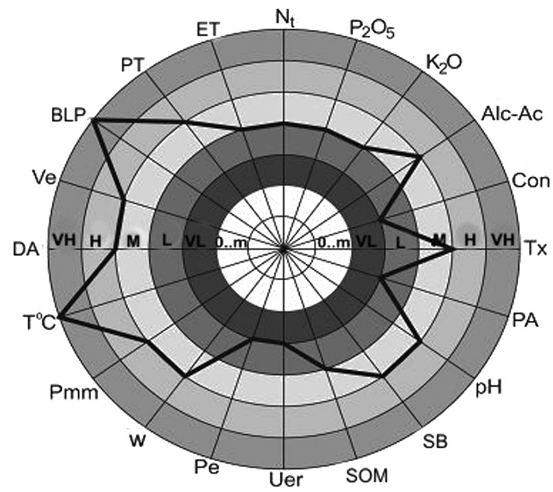

Figure 2. Favourability classes of eco-pedological factors and determinants

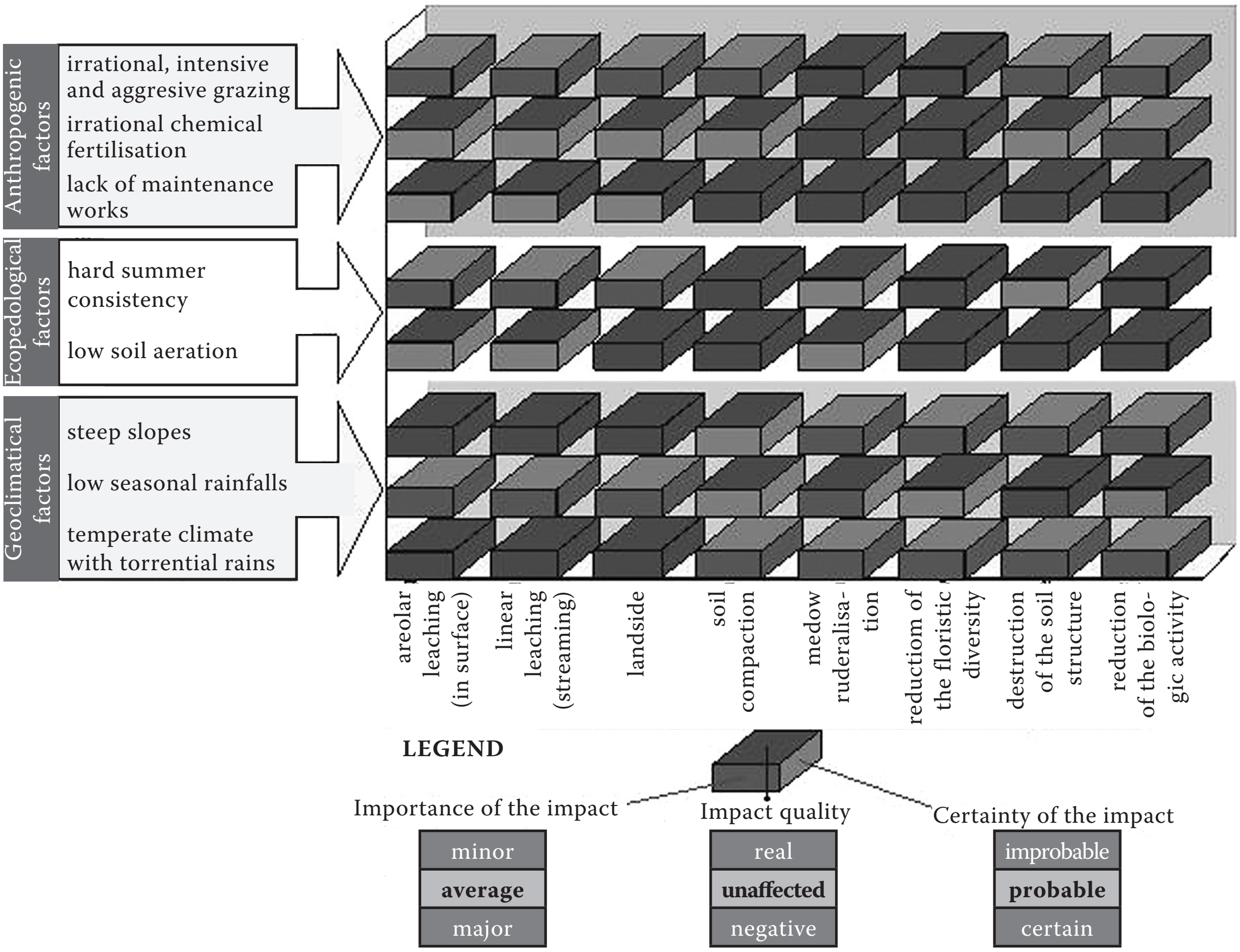

Figure 3. Global, zonal, and local matrix of ecological impact

2002b), it has been established that the degradation of the ecosystem always implies a regression of the ecological succession accompanied by the processes of soil degradation that cause a decrease in soil quality.

In order to qualitatively appreciate the negative ecologic effects, we have proposed and used a reliability scale with three qualitative indicators: the importance of impact, the quality, and the certitude of the impact. Within each qualitative indicator 3 gradual levels have been identified:

(1) the importance of the impact: minor, average, and major;

(2) the quality of the impact: real, unaffected, and negative;

(3) the certitude of the impact: improbable, probable, and certain. Combining the 3 qualitative indicators with their corresponding graduations leads towards a series of important conclusions regarding the priorities and their order within a managerial strategy of rehabilitation and ecologic protection alongside with:

– Reducing and eliminating the negative anthropogenic impact caused by aggressive grazing as some urgent measure of low investment value.
– Performing the regular and necessary works of maintenance and exploitation of natural resources of soil and vegetation.Vegetation cover has long been recognised as a key factor in the runoff production and protection against erosion, as the vegetation increases infiltration and surface roughness and reduces the kinetic impact of raindrops (Morgan 1995). The plant cover is the most important vegetation parameter for splash and inter-rill erosion, whereas for rill and ephemeral gully erosion plant roots are at least as important as the vegetation cover (Gyssels *et al.* 2005; Gimeno-García *et*

al. 2007). Where the vegetation recovery is slow, and the erosion processes may be active, the soil restoration may be a very slow or irreversible process (Zhao *et al.* 2005).

– Setting up some average and major investment works destined to entrepreneurial protection and for scientific and rational exploitation of the natural resources.

CONCLUSIONS

– The analysed pasture ecosystem Plopana-Bacau is situated on degraded lands from the Tutova Hills – Moldavian Plateau in the Eastern Romania. In this ecosystem, great and intense morpho-dynamic processes occure, ones of the most intense in Romania. The main geomorphological processes are pluvial erosions made by rainfalls and active versant processes.
– The global, zonal, and local ecological impact study shows the principal 8 factors and the negative ecological impact determinants caused by their lack or excess which determine the degradation processes: geo-climatic factors (abrupt slope and tight valley, low level of summer precipitations, and temperate climate with heavy rains-Tma 98°C, Pma 450–600 mm), pedological factors (hard summer consistency of the soil and reduced soil aeration), and anthropogenic factors (overgrazing, irrational chemical fertilisation and the lack of maintenance tillage- amelioration and anti-erosion investments).
– The main negative ecological effects are: the soil compaction, the surface pluvial erosion, the deep pluvial erosion, landslides, the reduction of the biodiversity, ruderalisation, the diminution of the soil biological activity, the destruction of soil structure.
– Measures and strategies for the protection of the natural vegetal and soil resources and the ecological remedy:
  (1) the reduction and elimination of the negative anthropogenic impact obtained by an irrational overpopulation of animals;
  (2) the maintenance tillage for an optimal and scientific exploitation;
  (3) specific investment tillage, anti-erosion tillage;
  (4) liming (calcium) amendment;
  (5) scientific organic-mineral fertilisation.
– Eecological rehabilitation of this ecosystem with advanced pluvial erosion which belongs to agricultural landed properties can be put into effect in the most efficient way, through afforestation, supported by supplementary measures of consolidation. In fact, it is necessary a close and permanent co-operation between forest sector, agricultural sector and local administration. On the other hand, it is necessary to improve the pasture steadiness through sowings and oversowings associated with fertilisation and addition of fertilisers.

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