# LAND EVALUATION FOR GRASSLAND USE FROM AMPOI BASIN UNDER NATURAL AND HEAVY METAL POLLUTION CONDITIONS

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**Abstract**

In Zlatna area, because of Ampellum S.A activity, large quantities of heavy metal and oxides sulfates that caused the soil and plants contamination were issued. Due to heavy metal pollution, the soils productivity has a decrease. Soil quality assessment was done using land evaluation system both under natural and heavy metal pollution conditions for grasslands. Land evaluation, in natural conditions, was based on indicators of ecological characterization of soil – land territorial associations (TEO) provided by the methodology for studied soils, (ICPA, 1987 – Volume II ), while for the pollution with heavy metals condition, the methodology proposed by Dumitru et al. (1994; 2008) was used. As a result, the average land evaluation marks and the areas for each class of land evaluation were established on grasslands, under natural conditions and corrected then according to pollution. In natural conditions, the quality classes of the grasslands varies between Ist and Vth classes. The largest areas belong to IInd (32.210 ha), followed by Ist (10.470 ha), IIIrd (4.650 ha), Vth (920 ha) and IVth quality classes (70 ha). On the whole area, the average evaluation mark is 70, belonging to the IInd quality class. Land evaluation marks of grasslands, in pollution condition, ranged from 6 to 81 points and on the whole area, the average mark was 48 points, belonging to the third quality class. Compared with natural conditions, the average evaluation mark obtained under pollution conditions decreased with 22 points, leading to a decrease with one quality class.

**Key words**: soil, land evaluation, Zlatna area, heavy metals pollution

Soil quality is a holistic picture of soil in the landscape and the way that the ecosystem works (Larsen and Pierce, quoted by Cârstea, 2001).

Also, soil quality reflects its own attributes: structure, porosity and the pore size distribution, effective rooting depth of plants, retention of water, reaction, organic matter content, and soil nutrient reserves available to plant (Doran et al., 1994; Lal, 1993; Larson and Pierce, 1994; Nrc, 1993; Parr et al., 1992, quoted by Cârstea, 2001).

Teaci (1980) proposed to assess the quality of agricultural land using land evaluation method. Land evaluation is a complex operation for basic knowledge of growth and fruit-bearing of plants and to determine the degree of favourability of these conditions for each land use and crop, through a system of technical indices and land evaluation marks (Teaci et al., 1985).

Since the capacity of land is affected, in addition to natural and anthropogenic factors, land conditional evaluation should reflect this. In the first case, it is conditional evaluation for natural conditions (Predel, 1987).

Because of heavy metals pollution from the former S.C. Ampellum Zlatna S.A plant, the land production capacities of Zlatna area have been affected. To assess the impact of heavy metal pollution on the yields, the land evaluation was made both under natural conditions, and in pollution conditions, for one of the prevailing agricultural land uses in this area: grasslands.

## MATERIAL AND METHOD

Soil surveys were conducted during the field investigation phase on an area of 48320 ha. The assignment of work itineraries was made according to ICPA Methodology (vol. I) (1). Soils samples were collected on genetic horizons; the soil profile was characterized by soil texture and basic chemical properties ($pH_{H2O}$, cationic exchange capacity, organic carbon, nitrogen, available phosphorus and potassium contents, base saturation percentage).

Land evaluation, in natural conditions, was based on indicators of ecological characterization of soil – land territorial associations (TEO) provided by the methodology for soil studies, (ICPA, 1987 – Volume II (MESP), while for the pollution with heavy metals condition, the methodology proposed by Dumitru et al. (1994; 2008) was used.

## RESULTS AND DISCUTIONS

### Natural condition

The study area comprises the Mureş Mountain, Zlatna-Meteş depression, and Ampoi

valley. In the study area, six soil classes and 22 soil associations were delineated (Manea et al., 2009).

The main soil classes in the study area are as follows: Protisols, Cernisols, Cambisols, Luvisols, Hidrisols and Anthrisols. Most of the soils belong to Dystric Cambisols (29.5%) and Eutric Cambisols (47.3%).

***Land evaluation marks for grassland in natural conditions***

Land evaluations marks in Zlatna area were calculated for natural conditions in the aim to determine the quality classes for the grasslands.

In soils from Zlatna area (Basin Ampoiului: Spring Ampoiului sector – Zlatna – Sard – Ighiu – Alba Iulia), 13 of the 17 indicators proposed for land evaluation under natural conditions were met.

Ecopedological indicators involved in determining of the evaluation mark for grassland are as follows: mean annual temperature (corrected values according to land slope and aspect), average annual rainfall (corrected values according to slope and soil permeability), soil texture in the Ap horizon or in the toplayer, slope, landslides, ground water depth, total soil porosity, restrictive horizon, total $CaCO_3$ content in the first 0-50 cm, soil reaction in the toplayer, the degree of base saturation in the toplayer; useful edaphic volume, humus reserve on the 0-50 cm depth). That contributed to the conditional evaluation of land and related codes for these indicators, as MASP, Volume II (1987), for grassland, which are most representative in the territory.

The calculation of these ecopedological indicators was carried out by territorial units of soil-land (UT). On the whole area, 47 UT were determined.

For grasslands, evaluation marks vary from 13 points to 90 points (fig. 1). The highest evaluation marks belongs to TEOs 4, 16, and 18, corresponding to soil association consisting of Fluvisols and Eutric Cambisols (TEO 4), Luvisols (TEOs 16 and 18).

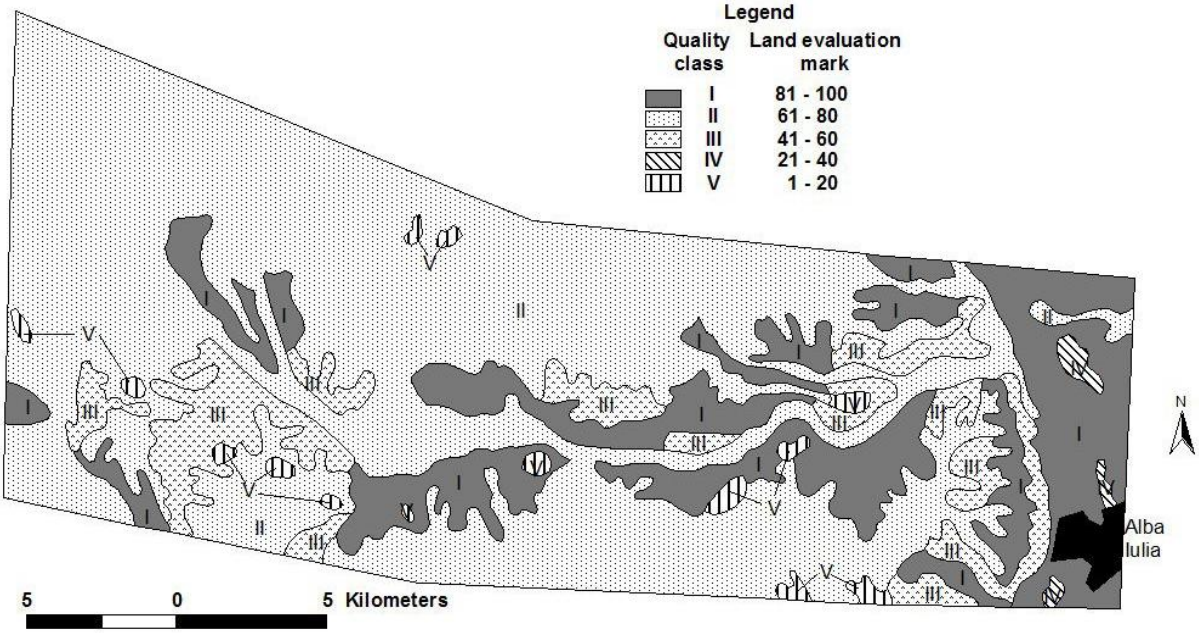


Figure 1. Map of grasslands quality classes according to land evaluation marks in natural conditions from Ampoi Basin (Izvorul Ampoiului-Zlatna-Meteș-Alba Iulia Sector)

Also, TEOs 5, 6, 15 are in quality class I, with over 81 points. The soils correspond to Phaeozems (TEO 5), and soil association consisting of Eutric Cambisols, Luvisols (TEO 6).

About 10470 ha belong to quality class I, the average mark being 85 points.

The most part of the study area (67% of the study area, i.e. 32210 ha) belong to quality class II and the evaluation marks range from 65 to 75 points (average evaluation mark = 69 points) (table 1).

Table 1

**Distibution of grasslands quality classes in natural conditions**

| Quality class | Area | |
|---|---|---|
| | ha | % |
| I | 10470 | 21.7 |
| II | 32210 | 66.6 |
| III | 4650 | 9.6 |
| IV | 70 | 0.2 |
| V | 920 | 1.9 |
| | 48320 | 100.0 |

Only 9,6% of study area belong to quality class III with evaluation marks between 43 and 60 points. These are specific to Eutric Cambisols associated with Lepti-eutric Cambisols and Eutric

Leptosols (TEO 7), Dystric Cambisols associated with Lepti-dystric Cambisols (TEO 14), Calcaro-rhodic Erodosols and Calcaro-rhodic Regosols (TEO 22).

The quality class IV characterizes Gleysols (TEO 20) with 38 points.

The lowest evaluation marks of 13 and, respectively, 19 points, are in TEO 1 and 2, corresponding to Leptosols and Rendzic Leptosols from this area and belonging to the quality class V.

The quality classes of grassland from Zlatna area range from I to V. The largest areas belong to quality classes II (32.210 ha), followed by I (10.70 ha), III (4.650 ha), V (920 ha) and IV (70 ha). On the whole area, the average evaluation mark is 70 points, belonging to the quality class II.

***Land evaluation marks for grasslands in pollution conditions***

In order to assess the effect of heavy metal pollution on soil production from Zlatna area, the land evaluation methodology proposed by Dumitru et al. (1994, 2008), specific to the land loading with heavy metals, was applied.

In the study area, TEOs were divided according to the degree of pollution. In some cases (TEOs 3 and 6), these were divided into 6 subunits, while other were divided only in 2 or 3 divisions.

For grasslands in pollution conditions, evaluation marks range from 6 points to 81 points (fig. 2). In all the studied TEO decreases of evaluation marks were recorded, that, generally, changes the quality classes. In the most part of the studied TEOs, quality classes decreased with one class.

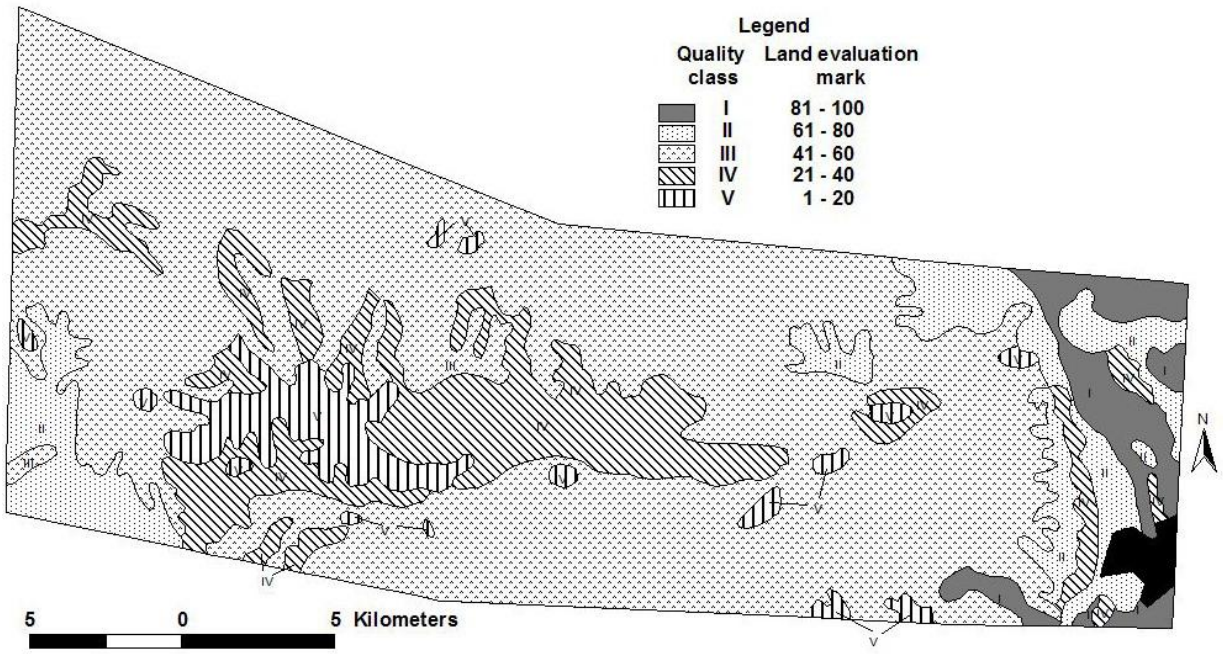


Figure 2. Map of grasslands quality classes according to land evaluation marks – pollution conditions – from Ampoi Basin (Izvorul Ampoiului-Zlatna-Meteș-Alba Iulia Sector)

Generally, the shift was from the quality class II to III, even with 31 points, as TEOs 10 or 27, or with 25 points as for TEOs 3, 15 and 19. In TEOs 6, 17, 18, and 21, as a result of pollution, there was a decrease with 2 quality classes, and in TEO 18 with 3 quality classes, loosing over 50 points, the situation the most serious being for the TEOs 6, 17, 18 and 21 located in the most heavily polluted area.

In the TEOs 3, 10, 21, as a result of pollution, a decrease of soil quality with two classes was found, while in the TEOs 17 and 18, the decrease was with three quality classes, losing between 28 and 46 evaluation points. The worst situation was recorded in sites 6, 17, 18 and 21 located in the heavily polluted area.

Decreases of evaluation marks without changing soil quality classes were recorded in TEOs 1, 2, 4, 9, 16 and 20. Within the same quality class, evaluation points were reduced up to 13 points.

After correction of evaluation marks according to heavy metals soil pollution, evaluation marks range from 6 to 81 points, with significant changes of lands in ceea ce priveste clasa de calitate (Fig. 2).

Because of pollution, about 63% of land are in the quality class III (table 2), followed by those from the quality classes IV (17,2%), II (11,8%), V (5,8%) and I (2,5%).

The area in the first quality class decreased from 10470 ha to 1220 ha, while those from the

quality class II decreased from 32210 ha to 5680 ha (over 80%). The area with lands from the quality class III increased with 25,635 ha, from the class IV with 8255 ha and from class V with 1890 ha.

Table 2

**Distibution of grasslands quality classes in pollution conditions**

| Quality class | Area | |
|---|---|---|
| | ha | % |
| I | 1220 | 2.5 |
| II | 5680 | 11.8 |
| III | 30285 | 62.7 |
| IV | 8325 | 17.2 |
| V | 2810 | 5.8 |
| | 48320 | 100.0 |

On the whole area, in terms of pollution, evaluation mark was 48 points, belonging to the quality class III.

Compared with the evaluation mark obtained under natural conditions, the decline was 22 points and was accompanied by changes of quality class.

## CONCLUSIONS

For grasslands, evaluation marks range from 13 points to 90 points. The land quality of grasslands from Zlatna area range from the quality classes I to V. The largest areas belong to quality classes II (66,6 %), followed by class I (21,7%), class III (9,6%) and class V (2%).

For the whole area, the grasslands have average land evaluation marks of 70 points, belonging to quality class II.

In pollution condition, land evaluation marks of graslands ranged from 6 to 81 points.

Due to pollution, about 62.7% of land belongs to quality class III, followed by the class IV (17,2%), class II (11,8%), class V (5,8%) and class I (2,5%).

On the whole area, in pollution condition, the average evaluation marks belong to IIIrd class with 48 points.

Compared with land evaluation marks obtained under natural conditions, the decline was 22 points, accompanied by changes of quality class.

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