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AGRICULTURAL LAND EVALUATION CONSIDERING THE CZECH LESS FAVOURED AREAS DELINEATION

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Abstract

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This paper analyses the impact of the common European criteria on the Less Favoured Areas (LFA) delineation in the Czech Republic (CR) and compares it with currently used point evaluation system. Further, it compares the advantages and disadvantages of both delineation systems from various points of view and concerning the needs of common agricultural policies.
In the Czech Republic, a system of point evaluation of the agricultural land productivity based on the Evaluated soil-ecological units (ESEU) is used for delineation of the other than mountain LFA since 2001. Within the programme period 2014–2020, the European Commission proposes to delineate the other than mountain LFA using a single set of criteria, common for all the member states. Some criteria of the natural handicap proposed by the European Commission (EC) can be derived directly from the ESEU five-cipher code and from the soil maps. The comparison clearly shows that the current Czech system of point evaluation of the productivity of agricultural land can express better the influence of worse soil and climatic conditions on the limitations of the agricultural use of the land than the system proposed by the EC.
Additionally, the ESEU point evaluation can express also the effect of simultaneous influence of more factors, which may thus increase or decrease the final ESEU point values. Conversely, it is necessary to remark that the land quality evaluation based on ESEU is rather complicated and not easily understandable for the wide public. Also, it cannot be applied in all the EU countries.

Keywords: EC criteria, ESEU, delineation, differentiation, LFA, land evaluation

INTRODUCTION

The need of maintaining the agricultural production in the areas with unfavourable natural conditions arose already during the period of dawn of the Common agricultural policy (CAP). Based mainly on the experience of France and Great Britain, measures aiming at the areas with unfavourable conditions were prepared. The result of this process was the accepting of the Council Directive 75/268 on mountain and hill farming and farming in certain less favoured areas, the goal of which was the support of the agricultural production in the areas with structural and permanent natural disadvantages in order to ensure certain minimal level of population and landscape maintenance. The Council Directive 75/268 defined three basic types of the unfavourable areas: i) mountain areas, ii) other LFA and iii) areas with specific disadvantages.

In 2003, the European Court of Auditors (ECA, 2003) published a report, which pointed out numerous problems in the LFA delineation, particularly for the "other" LFA category. The report questioned the LFA classification criteria, for example, that the criterion of share of farmers on the economically active population was not on changed throughout the years, in contrast with the changing structure of the population economic activity. The European Court of Auditors also

criticized the wide range of the criteria used for the delineation of the "other" LFA, which may be the cause of disparity among the subsidies beneficiaries. The EU Commission ordered a detailed study of the LFA measures in EU member countries (Cooper, *et al.*, 2006). It was found out that the in the EU member countries, about 100 different criteria are used for delineation of the low-quality agricultural land, with various threshold values (e.g. crop yields, share of grassland, share of arable land, cattle density, etc.). The LFA payment system (including delineation) was also criticized by Shucksmiths, Thomson and Roberts (2005), who assessed regional impact of CAP and the devoted also to LFA. Their results supported the ECA report; they found out tendency of higher payments in the member states in North of EU in comparison with the southern. Also Dax (2005), assessing 2nd Pillar of CAP and land use, found out large differences among member states in case of 2nd Pillar financial allocation.

Expert group of the Joint Research Centre (JRC) has in March 2007 prepared a technical report (Eliason, Terres, Bamps, 2007), including a set of bio-physical criteria, which should be further used to delineate the areas with limitations of agricultural production in Europe due to less-favourable soil, relief and climatic conditions. Based on following discussions with the member countries, this set of criteria was specified: short vegetative period, thermal stress, wetlands, unsuitable soil texture (grain size), rocky soil (stoniness), soil depth, soil moisture balance, steep slope and chemical properties of the soil. It support also other authors, such us (Doran, 1994; Karlen, 1997; Purdon, 2003) define soil utilization and its quality as the ability to function within an ecosystem. It is possible to accept a very simple definition by Pierce and Larson (1993), stating that soil quality represents its "suitability for general use". Despite arguments of experts on soil, due the various approaches of soil evaluation in European countries refused the Commission the complex criteria, expressing the soil fertility. Finally in 2009 instructions of EC criteria application were prepared by Bőttcher, *et al.* (2009), including the threshold values, and presented to the member countries. Also, the Commission relinquished the centrally ordered so called "fine-tuning". In the process of fine-tuning, the areas where the farmers manage to overcome the handicaps using technical measures or production structure changes (cf. irrigated land in dry areas, vineyards on the rocky soils, etc.), should be removed from the LFA zones.

The aim of this paper is to compare the common bio-physical criteria, as defined by the Commission with the purpose of delineation of the naturally handicapped areas, with the possibilities of the complex point evaluation of the agricultural land, currently in use in the Czech Republic. Authors also aimed to assess the advantages and disadvantages if the two systems, with the aim to propose a complex system for evaluation of the agricultural land for application of the common agricultural policy in the CR.

MATERIALS AND METHODS

The input data included proposed common European criteria for the delineation of the "other" LFA and projection of their impact on the area of the CR. Second input represented the Evaluated soil-ecological units used in the CR. The code of ESEU was studied regarding the soil and climate characteristics that it expresses. A concord with the criteria proposed by the Commission was assessed, as well as point value of those ESEU that express certain common European criterion.

Then, the average, maximum and minimum of the ESEU point values expressing given criterion was calculated. The average point values for each cadastre (both inside and outside other LFA according to common European criteria) were compared with average point value of all agricultural land in the CR (42.3 points) and with average point value of all agricultural land outside mountain areas (46.3 points).

Proposed common European criteria for delineation of the "other" LFA (Bőttcher, *et al.*, 2009; EC, 2011a; EC, 2011b, Eliasson *et al.*, 2010).

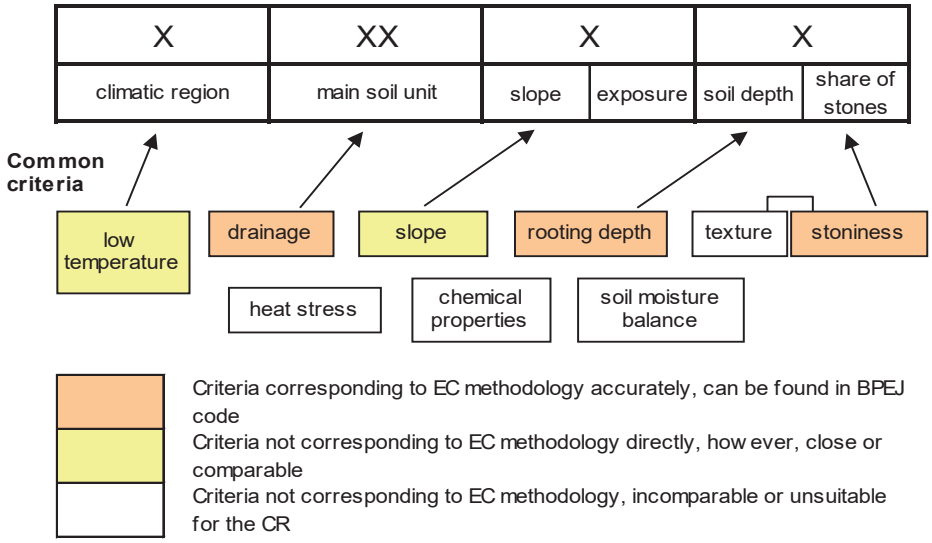
- Low temperature
- Heat stress
- Drainage
- Texture and Stoniness
- Rooting depth
- Chemical properties
- Soil moisture balance
- Slope

Fig. 1 illustrates the composition of the ESEU coding and the limiting criteria that can be assessed from the code.

Methodics for the evaluation of the soil productivity point used in the Czech Republic

For assessment of the possibility to use the system of evaluation of the agricultural land for the LFA proposals, we have used the data on the point productivity values for each ESEU, same data that were used for the LFA delineation in the previous programme period (Government of the Czech Republic, 2004).

System ESEU was developed as a part of the evaluation information system based on the pedological mapping performed since 1960ies. As indicators of the soil production capacity were chosen the crop yields of the most important crops cultivated in the CR (cereals, maize, sugar beet, potatoes, rape, and fodder crops) including the grasslands. Further, so called "type structures" of these crops were defined for those ESEUs suitable for their production. These were based on the results of long-term observations of the influence of the soil and climatic conditions on the crops' yields.



1: *ESEU mapping as a data source for the common European criteria*
Source: Němec (2001), Eliasson, *et. al.* (2007), own elaboration

At the same time were defined and used coefficients for decreasing of these "basic" yields for the soils with high large particles content, for slopes and their orientation towards south in warm and dry regions and towards north in cold and wet regions. The share of the particular crops in the "type structure" in each group of the ESEUs corresponded to the optimal agro-ecological principles.

Based on the share of particular ESEUs on the agricultural land of evaluated area (municipality or cadastre area) and on the yield point value of these ESEUs was calculated the average value of the productivity of the agricultural land of given area. Into "other" LFA and areas with specific handicaps were sorted areas with average productivity value below 34 points, i.e. below 80% of the CR average. In these LFA types is currently situated 1,503,000 hectares of the agricultural land of the CR, i.e. 35.5% (Government of the Czech Republic, 2010).

Based on the Common European criteria (natural handicap on more than 66% of the municipality area), it would be possible to sort into the "other" LFA category 1,792,000 ha of the agricultural land of the CR, i.e. 42.3% (Štolbová *et al.*, 2010).

RESULTS AND DISCUSSION

Analysis of the climatic criterion "low temperature"

System of the quality-evaluated soil-ecological units contains in the first cipher of the code evaluation of the so called "climatic region". The Climatic Regions (CR) includes areas with approximately corresponding climatic conditions for the growth and development of the agricultural crops.

Primary criterion for classification into climatic regions was the sum of average daily temperature equal to or higher than 10°C. Other criteria were average annual air temperature, average annual precipitation, droughts in vegetation period expectancy and average moisture certainty (Klečka, 1979).

The European Commission proposed to evaluate the climatic conditions based only on the thermal characteristics (sum of temperatures above 5°C) for expressing the short vegetative period. The spatial distribution of the ESEUs for each climatic region was compared with the distribution of areas considered as handicapped with the low temperatures according to the EC methodology (Fig. 2).

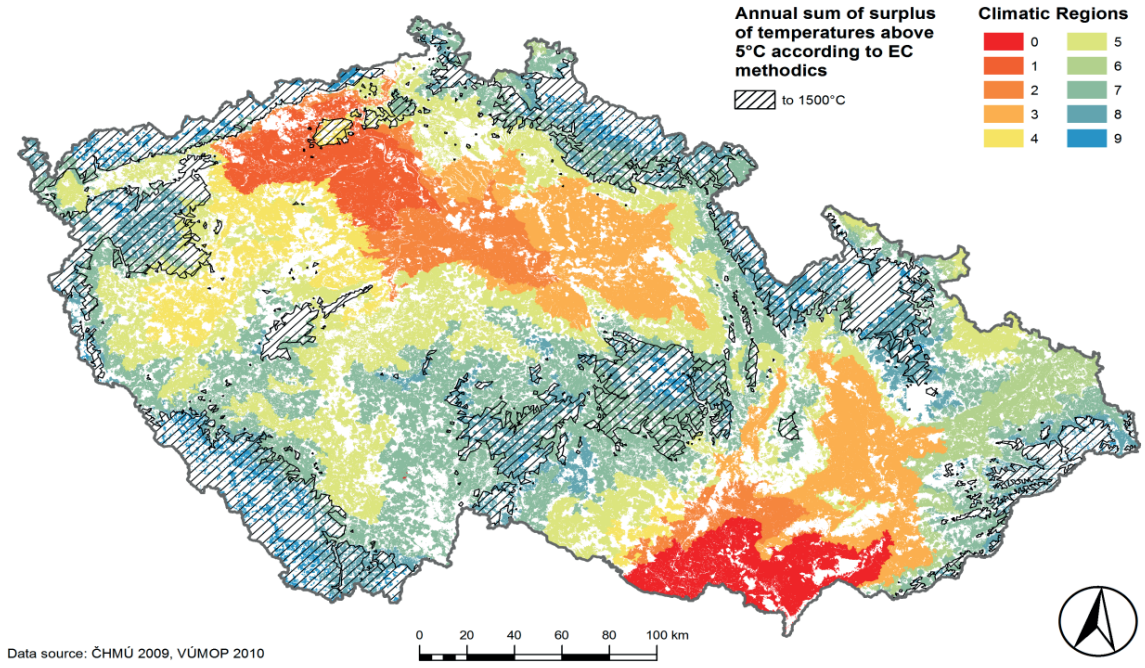
Areas delineated according to the EC criterion are situated practically only in the v 7th, 8th a 9th climatic regions. The European criterion also covers part of the ESEUs of warmer regions, particularly situated at the borders with the colder regions. The overlap with the areas handicapped according to the EC methodology is caused by the technical reasons – the data measured at the meteorological stations were interpolated.

Amount of the overlap between the areas according to the EC methodology criterion with the ESEU climatic regions was calculated (Tab. I).

Aside from the temperature characteristics, includes ESEU classification in comparison with EC definition also moisture parameters, which also influence the crop yields of given region. The EC criterion is in this case much simpler; however, the ESEU climatic regions characterize the climatic conditions more accurately.

Analysis of the "Poor Drainage" criterion

Each main soil unit (MSU) has in its description, among other, characteristics of the moisture conditions (Klečka *et al.*, 1979). Simple overview is given in the Tab. II. The soils permanently and



2: *Comparison of the criterion "Low temperature" and Climatic regions*

periodically water-logged, which in the conditions of the CR correspond to the demands of the EC, were defined by Research institute of based on the experience of its experts. These include ESEUs with following codes of the MSU: 43, 44, 46–54, 58, 62–76.

The production point value of the soils with unfavourable water regime is not, however, dependent on this one characteristic. It can be influenced by other ESEU parameters. The Fig. 3 shows the range of the point values for all the ESEUs, falling inside the EC criterion range. The average point value of these ESEUs is 29.3 point, minimum 9.9 points and maximum 72.1 points.

It would be possible to express similar characteristics for the ESEUs grouped according to the MSU codes. The Fig. 4 shows average point values for selected MSUs weighted by the area of the ESEUs. The values range from 12.2 to 54.4 points. It is clear that some ESEUs fulfilling the EC criterion may reach above average point value. It is possible, that in some cases the input data, used for the calculation of these ESEU point values, may have been influenced by the melioration of these areas. For the areas delineated as "other" LFA based only on the criterion of water-logging. It will be necessary to consider fine-tuning by excluding areas with functional melioration drainage. Also, it

I: *Comparison of the areas delineated using the "low temperature" criterion with the climatic regions according to ESEU*

Climatic region	Area of agricultural land ESEU in climatic regions	of this area, handicapped by the "low temperature" criterion		Average ESEU point value in the climatic region*
	thousand ha	thousand ha	%	points
0	229.7	0.0	0.0	64.26
1	243.9	1.7	0.7	54.97
2	306.9	0.1	0.0	60.89
3	683.2	0.0	0.0	71.48
4	269.6	7.9	2.9	39.99
5	1,031.6	23.0	2.2	41.86
6	201.6	0.0	0.0	42.58
7	**1,278.3**	**201.2**	**15.7**	**29.16**
8	**574.9**	**377.1**	**65.6**	**19.70**
9	**159.1**	**154.9**	**97.4**	**17.82**

Source: data by VÚMOP, data by ČHMÚ, own calculations
* Average point value weighted by the area of given ESEU

II: *Characteristics of the main soil units according to moisture conditions*

Characteristics of the water regime	Main soil unit
Extremely dry	21
Very dry	04
Moderately dry	05, 22, 38
Dry	17, 37, 39, 55
Depending on the precipitation	13, 31, 32, 40, 41
With low retaining capability	18, 27
With generally favourable water regime	01, 28, 29, 30, 56
With favourable water regime	02, 03, 09, 10, 12, 14, 15, 16, 24, 25, 33, 34
Favourable to wetter water regime	11
Temporarily too wet	06, 26, 35, 36, 57, 60, 61
Shortly too wet	19
Periodically too wet	07
With tendency to temporary water-logging	42, 43, 44, 45, 46, 47, 48, 49, 51, 52
Temporarily water-logged	50, 53, 54, 62
Water-logged – after melioration suitable as meadow	65, 67, 68, 69, 70, 71, 73, 75, 76
Water-logged – difficult for melioration, suitable only as meadow	66
With high level of the ground water	63, 72
Water-logged with occurrence of slope springs – only for meadows	74
Unfavourable moisture conditions (better only grasslands), after melioration suitable as arable land	58, 59, 64
Alternate water regime	23

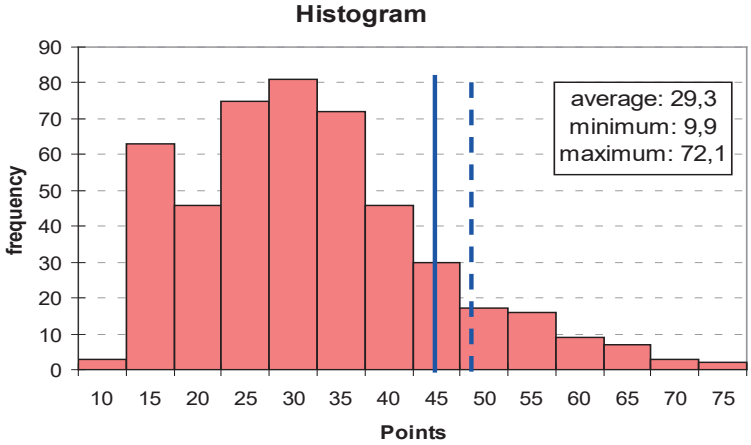
Source: Klečka, M. *et al.* 1979

is possible to account for the share of the arable land on the agricultural land, which may also indicate overcoming of the handicap using suitable soil melioration.

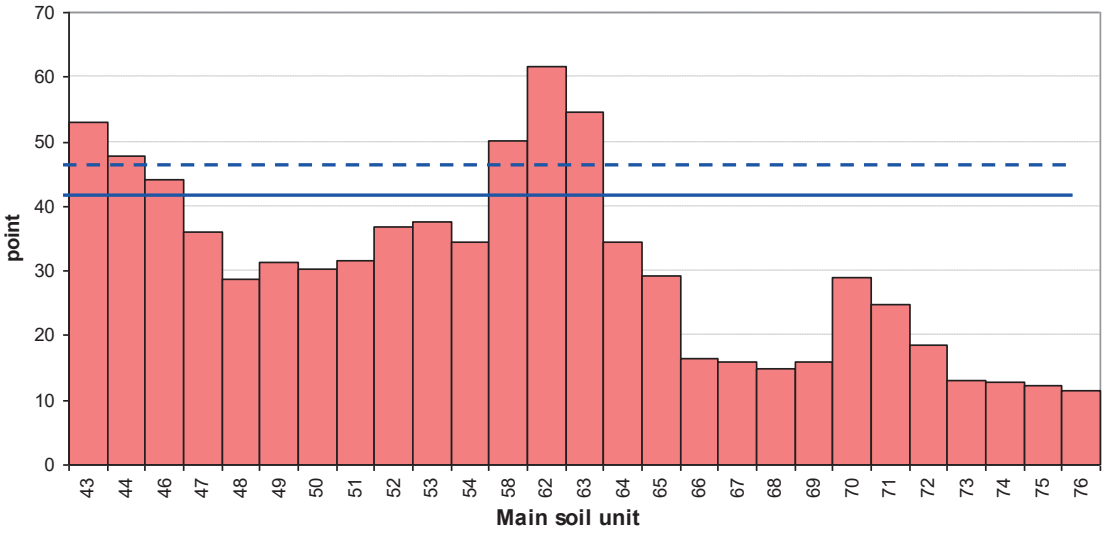
Analysis of the criterion "rooting depth"

The EC criterion "rooting depth" for handicap caused by inadequate depth of the soil (less than 30 cm) can be derived directly from the code of the ESEU. It is described, together with stoniness, by the 5th cipher of the code. Productivity point value of the ESEUs with shallow soil is influenced also by other parameters of their code; generally it is, however, well below the national average of the soil production values.

Compared with the average point values, expressing some of the other common European criteria (drainage, slope, and stoniness), shallow soils reach in average much lower point value (14.3 points). This means that in the conditions of the CR the shallow soil represents much more serious handicap than other criteria (water-



3: *Histogram of the ESEU point value with the characteristics of permanently and periodically water-logged soil*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR ——
average point value after removing the mountain LFA - - - -



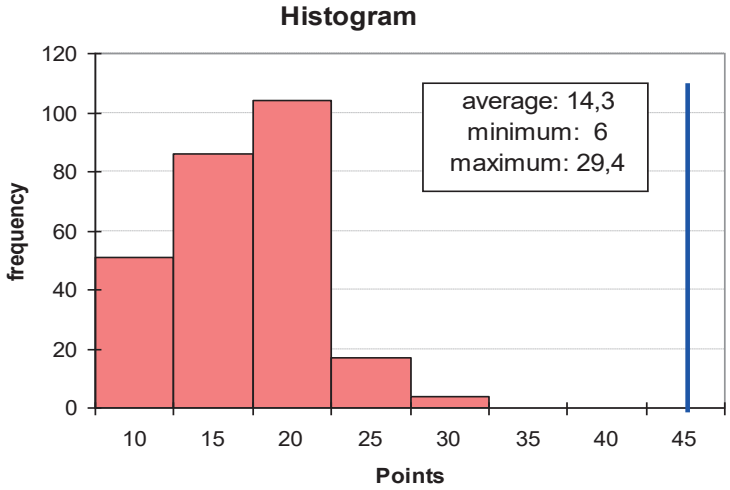
4: *Productivity point value of the ESEUs according to MSUs permanently and periodically water-logged areas*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR ——
average point value after removing the mountain LFA - - - -

logging averages 29.3 points, stoniness 22.2 points). Indexing system can in this case express the seriousness of the handicap better than the EC criterion. The system, proposed by the Commission, is based only on the share of the criterion-affected area on the municipality agricultural land, not on the seriousness of the handicap.

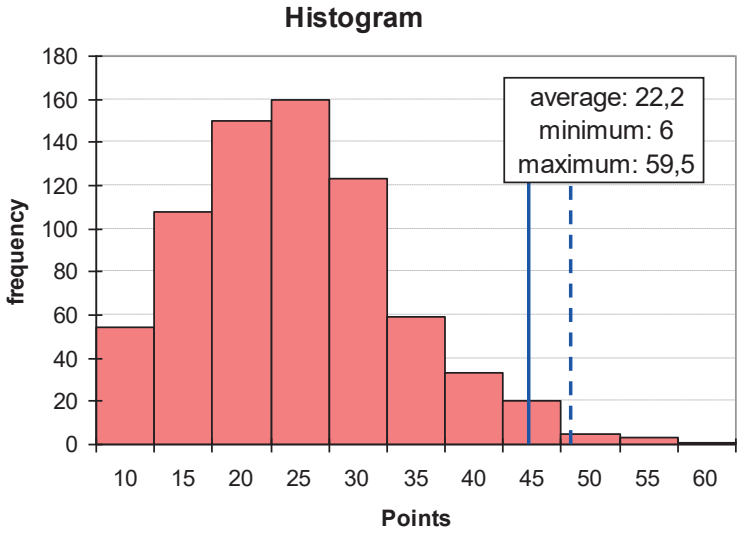
Analysis of the "Stoniness" criterion

ESEU classification differentiates the soil without stones (up to 10%), slightly stony (10-25%), medium stony (25-50%) a very stony (above 50% of the soil volume). For the purposes of the expressing the stoniness for delineation of the LFA according to EC methodics were used maps of medium stony and very stony ESEUs.

The point system of soil evaluation for ESEU can express wider range of handicap as it splits the EC category into two finer ones and can identify even more serious handicap for soils with stoniness above 50%. Therefore, the ESEUs in the highest stoniness category have very low point averages. The ESEUs with stoniness above 25% have average value of 22.2 points, well below national average of 42.3 points. Very few ESEUs in this stoniness category have above average point value. The total point value is in these cases influenced by extraordinarily favourable other soil-climatic conditions in these ESEUs. This shows that the ESEU system classification is of highly-sophisticated, complex nature, while at the same time it even in the case of



5: *Histogram of the point values of ESEUs with the soil depth below 30 cm.*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR ——



6: *Histogram of the point values of ESEUs with stoniness above 25 %.*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR ——
average point value after removing the mountain LFA - - - -

stoniness criterion the point system expresses better the amount of natural handicap.

The texture criterion cannot be derived directly from the ESEU code in the form required in the methodics of the JRC. The texture characteristics are included in the MSU and are considered in the calculations of the point values of the ESEUs.

Analysis of "slope"

In the ESEU code, the slope measured in degrees is represented by fourth cipher. The ESEU slope scale has threshold values, none of which corresponds to the 15% slope, demanded by the EC methodics. The slope characteristics used in the ESEU definition, their categories in degrees and corresponding categories in % are shown in Tab. III. The 15% slope corresponds to 8.5°, which value falls into ESEU class 7–12 degrees. For the analysis, areas with the slope above 7° were used, which corresponds to 12.3 %. Aside from slope inclination, the ESEU system allows for the evaluation of exposition of the slopes and its consequences for the crops' yields.

Following histogram (Fig. 7) shows the ESEU point values for the areas approximately fulfilling the European criterion for slope. In average, their ESEU value reaches 24.1 points. As the EC criterion is slightly stricter, this includes some ESEUs that do not fulfil it. This can be seen from the rather high maximum point productivity values in the analyzed dataset. Most of the areas with steep slopes, however, have the point values well below the average of the CR.

Here, we can again illustrate a disadvantage of the EC criterion – it considers all these steep slope areas as equally handicapped. On the contrary, the ESEU system allows even to express the effect of the steep slopes on the production value of the areas – it decreases the average productivity value by 6 points.

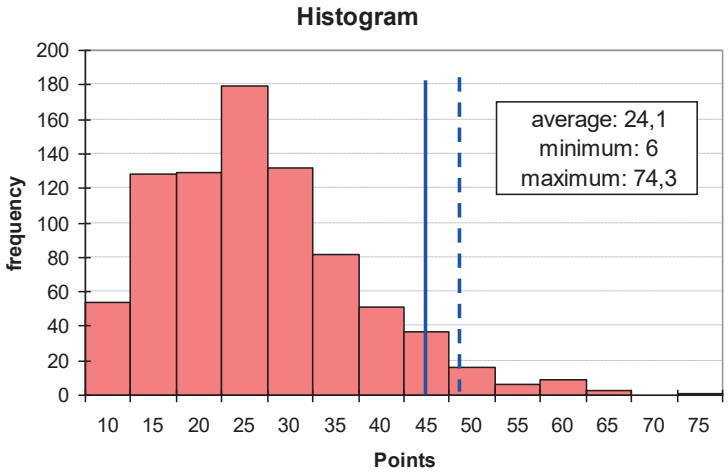
General differences between analysed systems

As was already mentioned above, the EC considers a municipality area unit as handicapped by unfavourable soil-climatic conditions if the handicapped area exceeds 66% of the agricultural land of the given unit. This system considers neither different severity of given criterion (for example the slope) nor whether the area is handicapped by one handicap criterion or by more

III: *Characteristics of the slope in the ESEU code*

Category characteristics	Degrees	Converted to % slope
Completely flat	0–1	0–1.7
Flat	1–3	1.7–5.2
Mild slope	3–7	5.2–12.3
Mediocre slope	7–12	12.3–21.3
Significant slope	12–17	21.3–30.6
Steep slope	17–25	30.6–46.6
Precipice	>25	>46.6

Source: Directive No. 546/2002Coll, and own calculations



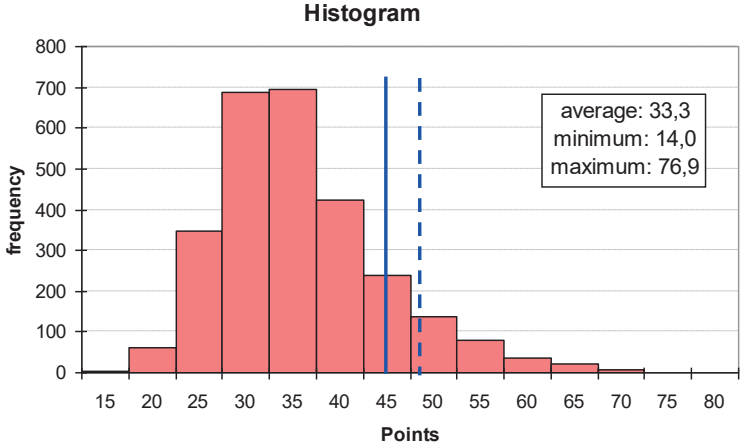
7: *Histogram of ESEU point values for areas with slope above 7°*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR
average point value after removing the mountain LFA

(for example, shallow soil on steep slope in an area with short vegetative period).

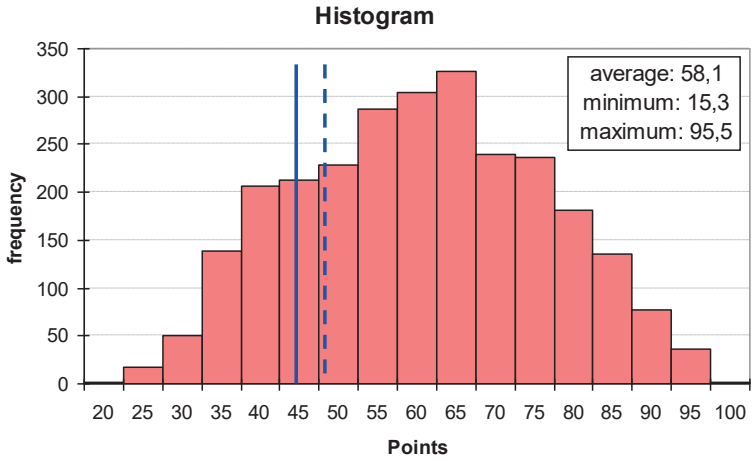
The current Czech system of delineating the LFA according to the average point value of all ESEUs on the given municipality unit includes not only the handicaps and their severity, but the average is also influenced for example by occurrence of very fertile soils with high point value on a part of the evaluated area. This fertile land can also influence the eligibility of the municipality unit for the LFA. The Fig. 8 shows the distribution of the average production point values of the agricultural land for the municipalities, which fulfil the common European criteria. The extent of the handicap according to the EC criteria exceeds 66% of the agricultural land of the municipalities. Municipalities in the mountain areas are excluded.

As can be seen from the Fig. 9, the average point value for the agricultural land in these municipalities spans over a rather wide range. This means that it will not be possible to set only one or two payment tariff, but it will be appropriate to differentiate the tariffs. Figure 9 shows the same values for the municipalities which do not fulfil the common European criteria.

On the Fig. 9 we can observe that in some municipalities, where the handicap was limited to less than 66% of their area, the point values of the agricultural land is far below the average of the CR, even though they did not fulfil the conditions of the EC for eligibility as a LFA. This can be attributed to the presence of ESEUs where are several handicaps at the same time and thus these soils having a very low productivity point values. The support of these areas should be also established so that these lands will not abandon in future.



8: *Histogram of ESEU point values for municipalities which fulfil the EC criteria*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR
average point value after removing the mountain LFA



9: *Histogram of ESEU point values for municipalities which do not fulfil the EC criteria*
Source: Research Institute of Melioration and Soil Protection (data), own elaboration
Note: average point value of agricultural land in CR ——
average point value after removing the mountain LFA – – – –

CONCLUSION

Some criteria of the natural handicap proposed by the EC can be derived directly from the ESEU five-cipher code and from the soil maps. For these criteria, we have calculated the ranges of their ESEU point values. The comparison clearly shows that the current Czech system of point evaluation of the productivity of agricultural land can express better the influence of worse soil and climatic conditions on the limitations of the agricultural use of the land than the system proposed by the EC. The Czech system can not only express the existence of the limiting factor, but also the severity of such handicap. For example, unfavourable stoniness is in the ESEU code differentiated into two levels of severity – large particle content above 25% and above 50%. Slope is expressed on a scale from a totally flat land to steep slopes above 25°. The land evaluation in the ESEU system can even express the fact that some limiting criteria may represent more severe handicap than other. In the conditions of the CR, it can be, for example, a shallow soil. The average ESEU point value in the areas with shallow soils is lower than in the case of ESEUs handicapped by other limitations according to common European criteria. Additionally, the ESEU point evaluation can express also the effect of simultaneous influence of more factors, which may thus increase or decrease the final ESEU point values. Conversely, it is necessary to remark that the land quality evaluation based on ESEU is rather complicated and not easily understandable for the wide public. Also, it cannot be applied in all the EU countries.

The system of European criteria evaluates only the extent of given criterion above a threshold value on given area unit. Thus, an area unit in this evaluation system either is, or is not eligible for the LFA support. However, the EC system is also much less complicated and therefore easier to apply in all the EU countries. Based on the results is recommended to implement ESEU within the first step of delineation for at least two criteria: rooting depth and stoniness. There can be considered more detailed and more specific information about the soil quality in the CR. The authors also propose to complement the less complicated LFA delineation using the common European criteria with a "fine-tuning" (second step of delineation) and defining of subcategories within the "other" LFA when introducing it in the CR.

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