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Analysis of criteria for delimiting less favoured mountain areas (LFA)

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Abstract

The objective of this work was to analyse and establish the criteria for the course of the elevation boundaries applied in delimiting of less favoured areas (LFA) under mountain and foothill conditions. This aim was achieved by verifying of the structural data on land use in relation to an altitude a.s.l. Based on the information collected on the areas in the particular land categories, and in order to assess land use, a database was created for 99 mountain communes (NUTS-5). The regulation by the Minister of Agriculture and Rural Development (2009) distinguishes the areas of less favourable farming (LFA, mountain), where over 50% of the agricultural land (AL) is located above an altitude of 500 m a.s.l. Previous studies have shown that the adopted limit of the average elevation for mountain LFA is too restrictive for the Polish conditions and needs correction. This is particularly clear in the case of agricultural land elevated above sea level. Support for rural development is necessary because the economic importance of agriculture in the Polish mountain and foothill regions is decreasing, and these areas are characterized by a considerably limited land use, under conditions of higher production costs. This is to do with terrain elevation a.s.l. and with the presence of large areas of significant land slopes, making it too to use normal equipment.

Key words: *delimiting, land use, LFA, mountain areas*

INTRODUCTION

Since 1975, the countries of the European Union have profited from compensation payments, and the idea of supporting farmers from less favoured areas (LFA) originates from England (1946), where the farmers who bred sheep and cattle in the foothill areas were supported [CZAPIEWSKI, NIEWĘGŁOWSKA 2006]. The present conception of less favoured areas was based on Regulation no. 1257/1999 of the Council of the European Union, the Regulation no. 4445/2002 of the European Commission concerning rural development support by the European Agricultural Guidance and Guarantee Fund (EAGGF), which is a fund within the overall European Union budget for the financing

of the Common Agricultural Policy (CAP) [EC 2005; 2009].

The most suitable criteria for distinguishing mountain areas tend to be institutionalized criteria for the implementation of the Common Agricultural policy set out in Council Regulation no. 1257/1999. These are associated with conditions that affect agricultural activity (climate, altitude, etc.). According to article 18 of that regulation, mountains are defined as areas characterized by significant limitations of land use and a considerable increase in labour costs in connection with: a) the existence of an elevated terrain, and harsh climatic conditions, which results in shortening of the growing season; b) at lower altitudes, the presence of a large area of slope too steep to

be able to use ordinary machinery or requiring the use of very expensive special equipment, or c) a combination of the above two factors. Each of these factors on their own is less acute, but the existence of both at the same time increases the difficulties. Each member country refers to these European criteria to determine the boundary of their own mountain LFA.

The share of the altitude zones in the total area of the Polish Carpathians is given in Table 1.

Table 1. The share of the altitude zones in the total area of the Polish Carpathians (%)

Altitude zones m a.s.l.	Foothills	Mountains	Total
200–300	36.9	0.4	16.3
300–400	51.6	6.9	26.4
400–500	10.3	18.7	15.0
500–600	1.0	25.4	14.8
600–800	0.2	32.2	18.2
800–1000	–	12.1	6.8
>1000	–	4.4	2.5
Total area	100	100	100

Source: GUZIK [1995], modified.

The areas north of the 62nd parallel (Arctic areas of Finland and Sweden and certain adjacent areas) are treated in the same way as mountain areas [DAX 2009; 2002]. The Polish legislation was adopted regarding which municipalities are eligible to be less favoured mountain areas whereby more than 50% of agricultural land is located above an altitude of 500 m a.s.l.

The aim of the LFA activities is to ensure the continuity of agricultural land use and thereby to maintain the vitality of the rural areas, preserve the landscapes and maintain sustainable farming, taking into consideration the environmental aspects.

Overall it is an instrument of financial support for farms in areas where agricultural production is hampered by unfavourable natural conditions. Compensatory payments (320 PLN per ha) for farms located in mountainous areas and in other less favoured areas compensate for the existing difficulties, which are not experienced by holdings situated outside the LFA.

Within the framework of the delimitation of less favoured mountain areas (LFA) the following criteria were established [EC 2009]:

- mountain areas, where agricultural production is hampered by unfavourable climatic conditions and terrain; these mountain areas include the communes/municipalities and cadastral precincts in which more than half of the agricultural land is situated at an altitude of 500 m a.s.l.;
- foothills (piedmonts) with specific handicaps, where more than 50% of agricultural land is situated at an altitude of over 350 m a.s.l.

Despite the small share of agricultural land, farming in the mountain areas plays an important role in preserving the environmental and cultural values of these regions, which represent 5–8% of the total area of the country. The purpose of the LFA payments is to

compensate for the difficult conditions for agricultural production and maintaining output in the marginal areas in terms of demographic and production potential, resulting from the inherent limitations of the habitat.

In Poland, the implementation of the regulations relating to the LFA is covered by the provisions of paragraph 29, points 1 and 2 and points 1a, 2 and 3, of the Law of 7 March, 2007 on support for rural development (Journal of Laws no. 64, item 427, as amended), together with the Regulation of the Minister of Agriculture and Rural Development dated 11 March, 2009, “Support for farming in the mountain areas and in other less favoured areas (LFA)” under the Rural Development Programme for 2007–2013 (Journal of Laws no. 40, item 329, as amended) [Ordinance, 2009]. As part of the activity included in the second pillar of the Common Agricultural Policy, implemented under the Rural Development Programme, the beneficiary of the LFA can be a grower who farms with at least a total of one hectare of the agricultural plot qualified as LFA [The Rural Development Programme for 2007–2013]. The economic importance of agriculture in the Polish mountain and foothill regions is decreasing, because these areas are characterized by considerably limited land use and higher labour costs [KOSTUCH, TWARDY 2004; KUREK *et al.* 1978].

The elevation of the land above sea level is important for agriculture, even for mountain forestry, because it largely determines the climatic conditions of the area. As the terrain rises above sea level, the air temperature lowers, the length of the growing season shortens, the time of the snow cover extends and the amount of precipitation increases as well as the severity of the winds, making it difficult for vegetation plants, thereby eliminating growth of a number of cereals.

HESS *et al.* [1977] designated in the Polish Carpathians six vertical climatic zones (from 230 to 2665 m a.s.l.), which coincide roughly with the zones of vegetation. Under the conditions of the Carpathians, each 100 m a.s.l. of terrain elevation lowers the air temperature by an average of 0.55°C. At the same time and elevation the annual amount of precipitation increases on average by 30 mm and the growing season shortens by eight days [GÓRECKI 1993; HESS 1977].

The mountain areas in Poland constitute only about 2.9% of the total area of the country and cover about 25,400 km², of which the Carpathian mountains account for around 19,500 km², i.e. 76.8% of the total area of the Polish mountains [TWARDY 1993]. More than half of the Carpathian area is used as agricultural land, and two-thirds of farmland lies in the lowest zone, up to 400 m a.s.l. In the Polish Carpathian mountains, about 50% of the total area of agricultural land is occupied by the four main cereals (wheat, rye, barley, oats) and potatoes. The yields of cereals (according to data from the Małopolska and Podkarpackie regions) reach 2.55 t·ha⁻¹ and potatoes 150 dt·ha⁻¹ [MRiRW 2007].

In the Polish Carpathians, fallow and barren lands have become a problem, and the largest area was in the Podkarpackie region (30.7% of AL). In this region, at an altitude of 500–600 m a.s.l., the share of fallow land was up to 40–60 %. In the altitude zone of 350–400 m a.s.l., the share of fallow land was also high at 25–27.6 % (Tab. 2). In the Carpathian part of the Małopolska region, the area of fallow farmlands is much smaller, and its contribution varies from 8.3% in the altitude zone of 400–450 m a.s.l. to 14.9% in the zone of 350–400 m a.s.l. This phenomenon may become of interest in the management of land in the coming years, because previously used instruments for supporting farms have proven to have little effect in the management of abandoned land.

The share of fallow farmland (% AL) by regions in the altitude zones of the Polish Carpathians is shown in Table 2 [MUSIAŁ 2008].

The situation has not been improved by the existing delimitation of the LFA at an altitude of 500 m a.s.l., which meant that more than 50% of all areas of the Carpathians were excluded from the possibility of qualifying for the mountain LFA [TWARDY 2006; 2008]. Consequently the objective of this was to establish the course criteria for an altitude boundary used in the designation of less favoured areas (LFA) under mountain and foothill conditions. This was done by verifying the structural data on land use in relation to altitude.

Table 2. The share of fallow and barren lands (in % AL) in the Polish Carpathians, altitude zones by regions

Altitude zone m a.s.l.	Regions				
	Małopolskie	Podkarpackie	Śląskie	total	
350–450	a	23.2	52.6	43.3	37.3
	b	3.1	11.5	5.7	6.8
450–550	a	26.9	61.3	56.7	34.1
	b	3.8	11.1	4.0	5.3
>600	a	23.4	70.0	46.6	39.0
	b	2.1	6.1	6.3	2.9
Total	a	12.3	30.7	24.4	18.4
	b	1.5	4.8	2.7	2.5

Explanations: a – fallow land, b – barren land.
Source: own elaboration based on MUSIAŁ [2008].

MATERIAL AND METHODS

For the analysis of the Polish Carpathians, the Nomenclature of Territorial Units for Statistics (NUTS) was applied, which at present is in force in the European Union. NUTS was introduced in Poland by the regulation of the Council of Ministers dated 13.07.2000 [Rozporządzenie... 2000]. Based on information collected on various categories of land use [GUS 2006], a database for the assessment of elevation compared to land use in 99 municipalities was created (Fig. 1). This enabled verification of the structural and land use data.

The elevation above sea level is the most important parameter in assessing the mountain LFA. For

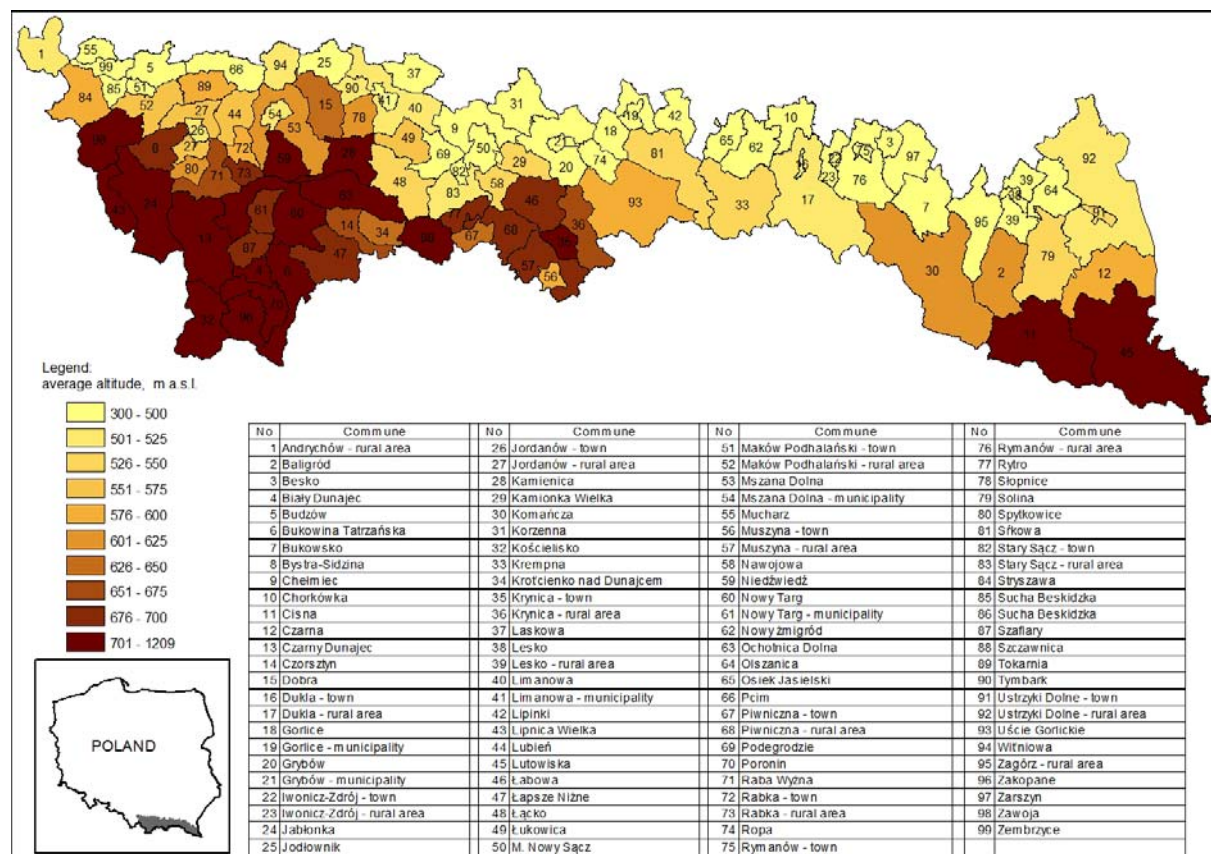


Fig. 1. Location of the mountains and the foothill communities in the Polish Carpathians; source: own study

this purpose, a DTM (Digital Terrain Model) or DEM (Digital Elevation Model) was applied, which allows the altitude of any point on the basis of the coordinate plane to be determined. The model is a numerical representation of the topographic elevation of the land surface with the interpolation algorithm, which allows for reconstruction of its shape in a specific area (Fig. 1). Such a defined model contains information about the topological relations connecting various points in the area. Defining topology occurs as a result of interpolation algorithms that reproduce a modelled surface configuration with respect to any of the analysed characteristics of the environment.

The Carpathian area was analysed with regard to administrative units: municipalities NUTS 5 → region NUTS 2 in force in EU countries, the classification – Nomenclature of Territorial Units for Statistics.

The agri-environmental indicators derived from our own research [KUŹNIAR *et al.* 2007], and the guidelines of the EEA (the European Environment Agency in 2002, Eurostat 2001) have been applied. The agri-environmental indicators (AR/A), (GR/AL) and (AR/AL) are the parameters defining the relationships between environmental factors and the widely understood agricultural activities at the commune level (NUTS 5) where: AR – arable land, A – the total area of the municipality, GR – grassland area, and AL – agricultural land.

These indicators provide information on the status of the rural environment and the ongoing trends over time:

- they may facilitate the decision-makers in understanding the impact of agricultural policies on the environment;
- they may objectify the accuracy of economic decisions in the field of sustainable development (e.g. the Common Agricultural Policy).

In this way, the information on the interaction between agriculture and environment was synthesized. With the help of the terrain model (DTM), the relationship between elevation above sea level (m a.s.l.) and land use indicators in the various municipalities was determined.

In Poland, the less favoured areas (LFA) occupy a total of 9,048,4000 ha of agricultural land (more than 50% of AL), of which 2.12% are classified as mountain areas. However, these mountain areas play an increasingly important role in protecting the natural environment and landscape and preserve the social structure of the village [FATYGA 2009; FATYGA, GÓRECKI 2001].

RESULTS

The land use pattern in the Polish Carpathians is shown in Table 3 and the structure of the agricultural land in the different altitude zones is shown in Table 4. The data indicate that in the lowest zone, up to 350 m a.s.l., arable land constitutes 70%. In the zone of 700–800 m a.s.l. its share is kept within about 26%

and above 800 m a.s.l. it occupies about 15% of agricultural land. In the lowest altitude zone, meadows and pastures occupy about 28%. Above 600 m a.s.l., their contribution increases to about 62–74%. The data presented in Tables 3 and 4 indicate an excessive proportion of arable land in relation to grassland (in the range of 300 to 350 m altitude the grassland share is only 27.6%).

Table 3. Land use pattern in the Polish Carpathians (for the selected 99 communes – NUTS-5)

Item	Area	
	hectares	per cent
Total area	999,853	100.0
Agricultural land	385,106	38.5
Arable land	170,093	17.0
Orchards	5,639	0.6
Meadows	148,233	14.8
Pastures	61,141	6.1
Forests	508,606	50.9
Others	106,141	10.6

Source: own studies based on GUS data [2006].

Table 4. Share (%) of the altitude zones in the agricultural land of the Polish Carpathians (for the selected 99 communes – NUTS-5)

Altitude zones m a.s.l.	Share in % of agricultural land		
	arable land	grasslands	others inc. orchards
300–350	71.0	27.6	1.4
350–400	59.2	38.5	2.3
400–450	61.3	32.7	6.0
450–500	57.1	41.9	1.0
500–550	45.0	53.1	1.9
550–600	47.0	51.2	1.8
600–700	37.8	61.7	0.5
700–800	25.5	74.2	0.3
>800	15.4	84.5	0.1

Source: own study.

The relationship between the agri-environmental indicators and altitude above sea level (m) was determined by linear regression analysis based on the value of the coefficient of determination R^2 (Figs. 2, 3). It was found that: the AR/P indicator (arable land to the area of municipalities) was negatively correlated with the elevation above sea level, with the coefficient of determination $R^2 = 0.54$; the GR/AL indicator (grassland to agricultural land) was positively correlated with the elevation above sea level, with $R^2 = 0.598$; and the AR/AL indicator (arable land to agricultural land) was negatively correlated with the elevation above sea level, with $R^2 = 0.5845$.

The above indicators confirm the decrease in arable land as altitude increases and a corresponding increase in grassland area. Table 5 shows the current (500 m a.s.l.) and further proposed (350 m a.s.l.) criteria for the mountain LFA. The amendments concern the 21 municipalities.

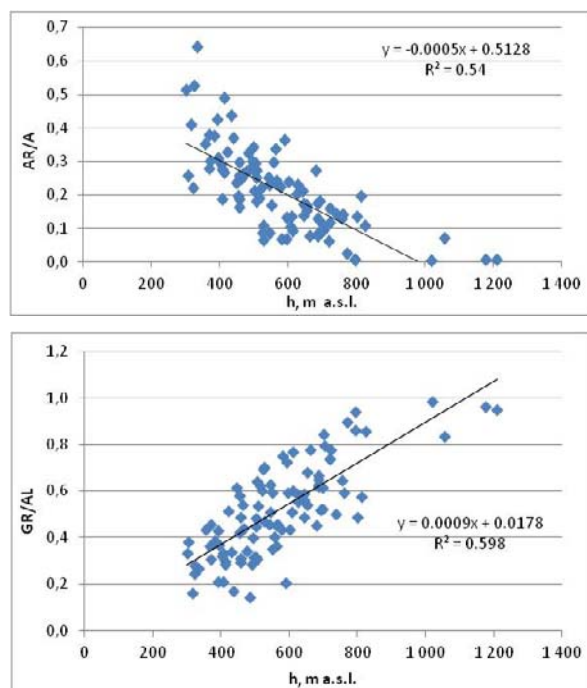


Fig. 2. The relationship between land use indices (AR/A) and (GR/AL) and altitude a.s.l.; AR – arable lands, A – total area of the commune, GR – grasslands, AL – agricultural lands; source: own study

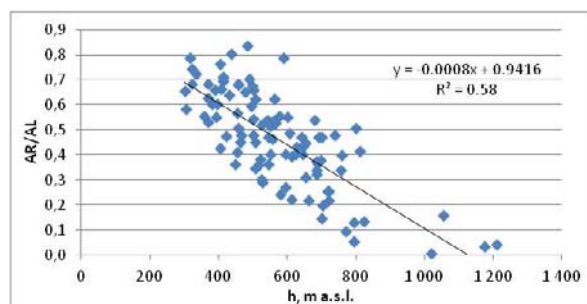


Fig. 3. The relationship between the land use indicator AR/AL and altitude a.s.l.; areas in communes: AR, AL – as in Fig. 2; source: own study

Table 5. Delimiting criteria for less favoured mountain areas (LFA)

Elevation criteria of LFA – location of AL	The numbers of communes with LFA in voivodeships		
	Śląskie	Małopolska	Podkarpackie
More than 500 m a.s.l. acc. to the Minister’s regulation [Rozporządzenie 2009]	12	46	13
More than 350 m a.s.l. acc. to the proposed amendment	0	15	6
Total	12	61	19

Source: own study.

DISCUSSION

The data collected include municipalities (communes) with a large spatial and altitude diversity and the increase in elevation causes a decrease in yield,

and at the same time an increase in the cost of cultivation and consequently higher production costs. Crop yields decrease with increasing altitude, especially in the case of cereals and potatoes [JAGŁA *et al.* 1981; TWARDY 2009]. These dependencies are related to the diversity of the vertical climatic zones and are related reaching the upper limit of cultivation in the Carpathians, which, locally, on the ridges and slopes with southern exposure, can reach up to 750 m a.s.l., but in the valley bottoms only 450–500 m a.s.l. [KOSTUCH 1976; TWARDY 1993].

In the Sudeten mountains, it was found that the maximum yields of cereals at an elevation of 600–650 m a.s.l. were lower by about 50% than those obtained at an altitude of 300 m a.s.l. [DZIEZYC 1960]. From the statistical data for the Carpathian regions it was evident that the average yields of four cereals at an altitude of 700 m a.s.l. were over 30% lower than in the zone up to 500 m a.s.l. [JAGŁA *et al.* 1981].

Smaller decreases in yield than for the growing cereals are exhibited by grassland. Yields of hay from grasslands decreased by approximately 50% with increasing elevation (Fig. 4). Based on the results of previous studies, a decrease in the yield of grassland by 5–10% was identified for every 100 m increase in altitude above sea level. It follows that the permanent grassland, as well as some fodder plants (clover, grasses), is better adapted to the ecological conditions in the higher parts of the mountain. Therefore, grasslands should dominate in the structure of agricultural land. But their profitability is lower than for cultivated plants.

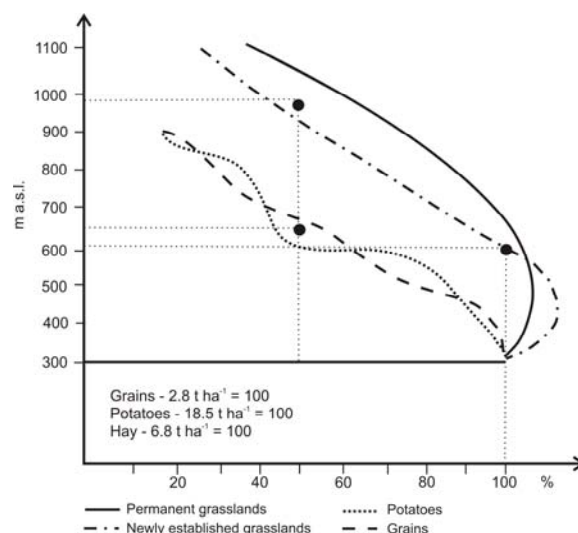


Fig. 4. The impact of altitude a.s.l. on crop production in the Polish Carpathians; source: TWARDY *et al.* [2011]

The Carpathian mountains, in terms of natural handicaps to agricultural production, are often compared with the Alps, because both of these mountain ranges are largely climatologically and biotically similar. Terrain and climate are the decisive factors in

terms of the comparability of the nature of the Carpathians and the Alps. The differences between the Carpathians and the Alps concern the boundaries of vertical climatic zones of economic importance, ranging from 200 m in the very cool upper zone to 350 m in the moderately cold zones. Similarly, the difference between the upper ceilings of the moderately warm zones in the Western Carpathians (650 m a.s.l.) and in the Eastern Alps (920 m a.s.l.) is 270 m [MRiRW 2007].

The criteria for the determination of mountain areas in EU countries for the purpose of ensuring the continuity of land use range from 400 metres a.s.l. in the Belgian Ardennes to 1200 m a.s.l. in the area of Piedmont. In most European countries the criteria for mountain areas are between 700 and 800 m a.s.l. As for the slope of the land, the delimitation criterion is a minimum of 20% [GERBAUX 2004; MARTIN, WEINGARTEN 2004; MUSIAL 2008; ŠTOLBOVÁ, MÍČOVÁ 2012].

The large diversity of the lie of the land determines the occurrence of large thermal differences in the Polish Carpathians. In the designated area the average length of the growing season ($t > 5^{\circ}\text{C}$) is 180 days, and at an elevation of 1600 m a.s.l. it is only 140 days and disappears at an altitude of about 2500 m a.s.l. The average length of the growing season for the Polish lowland is 215 days, and 250 days for lowland Europe. Comparing the length of the growing seasons in relation to the altitude a.s.l. for the conditions in Poland, France, Germany and Austria (Fig. 5), it follows that the length of the growing season in Poland is the shortest in the altitude range between 350 and 850 m a.s.l.

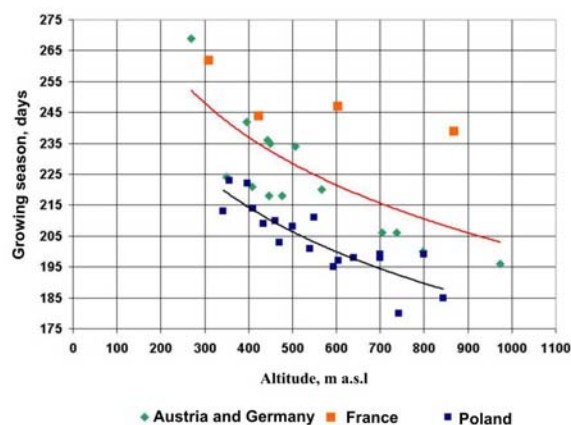


Fig. 5. The length of the growing season in relation to the elevation above sea level (m a.s.l.) in selected countries of the EU; the red line shows the relationship for France, Germany and Austria and the black line represents the same relation for the Polish conditions; source: MRiRW [2007]

This may be one of the arguments justifying the proposal for a reduction of the altitude criterion in the Polish mountains. The Ministry of Agriculture, comparing the economic delimitation of the mountain areas in EU-15 with the criteria for distinguishing

mountain areas in Poland, believes that it would take an amendment of 250 m. Therefore, the adopted limit of the average elevation for mountain LFA according to the current criteria of the Community > 600 m as (Commission 784) should be adjusted by 250 m [MRiRW 2007].

The criteria for the delimitation of the mountains in the countries newly admitted to the EU were similar to those used in the old member states; however, the limits of the required minimum altitude (m a.s.l.) were generally lower. The Czech Republic and Slovakia have adopted, as a cut-off value, respectively 700 and 600 m a.s.l. [MUSIAL 2008].

CONCLUSIONS

Research on land use in the mountain areas indicates a need to change the current structure of land management within the framework of the activities of the LFA programme. This is due to both economic and natural conditions, and smaller effects of agricultural production were found in these areas than in the areas located lower down. For the delimitation of mountain LFA, a municipality (commune) is defined as one in which more than 50% of agricultural land (AL) is located above an altitude of 500 m above sea level. In the case of the Western Carpathians, it is proposed to reduce the altitude limit of the LFA to 350 m above sea level, because studies have shown that the presently accepted limit of the average elevation for mountain LFA is too restrictive for our conditions, and excludes many municipalities with difficult conditions that require correction. This may be motivated by the fact that the vertical climate zones of the mountains and foothills of the Polish Carpathians, compared to the Alps, have shorter growing seasons due to the strong influence of the continental climate. This is also important for the economy. The Applied Terrain Model DTM enables the altitude of municipalities to be determined in m a.s.l., which is the most important parameter in assessing the mountain LFA. It also allows: structural data on land use to be obtained at the municipal level, taking into account the altitude, and verification of the boundary elevation applied in the designation of less favoured areas (LFA), in the mountain and foothill areas.

In the less favoured mountain areas (LFA) of Poland, agriculture itself has no chance of greater development, since the increase in the elevation causes plant growing to result in a decrease in crop yields, and an increase in the cost of cultivation. This is also reflected in a very high proportion of fallow and barren lands in areas of agricultural land.

Implemented activities within the framework of the mountain LFA should be treated as pro-ecological actions to maintain a permanent grassland. The objective should be to support the LFA areas, so as to maintain their vitality and natural values, and promote agriculture and rural space and a natural environmentally friendly society.

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Analiza kryteriów wydzielenia obszarów górskich o niekorzystnych warunkach gospodarowania (ONW)

STRESZCZENIE

Słowa kluczowe: *kryteria ONW, obszary górskie, użytkowanie ziemi*

Celem pracy była analiza i ustalenie kryteriów przebiegu granicy wysokości, stosowanej w wyznaczaniu obszarów o niekorzystnych warunkach gospodarowania (ONW) w warunkach górskich i podgórskich. Cel ten osiągnięto, weryfikując dane strukturalne o użytkowaniu ziemi w odniesieniu do wysokości n.p.m. Na podstawie zebranych informacji o powierzchni poszczególnych kategorii użytkowania stworzono bazę danych dla 99 gmin górskich w celu oceny użytkowania ziemi. Delimitację obszarów ONW zawiera rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z 2009 r., gdzie wyróżniono tereny o niekorzystnych warunkach gospodarowania „ONW – górskie” wraz z gminami, w których ponad 50% użytków rolnych jest zlokalizowanych powyżej wysokości 500 m n.p.m. Dotychczasowe badania wykazały, że przyjęta graniczna średnia wysokość dla „ONW – górskie” jest zbyt rygorystyczna w warunkach Polski i wymaga korekty. Wsparcie rozwoju wsi jest konieczne, ponieważ znaczenie gospodarcze rolnictwa w rejonach górskich i podgórskich maleje, tereny te charakteryzują się bowiem znacznymi ograniczeniami możliwości użytkowania ziemi i większymi kosztami produkcyjnymi. Ma to związek z wysokością n.p.m. oraz występowaniem na dużej części terenu znacznych spadków, które uniemożliwiają użytkowanie standardowych maszyn.