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SPATIAL ANALYSIS OF GAME DAMAGE IN THE SETTLEMENT OF CSERÉNFA AT THE KAPOSVÁR FORESTRY OF SEFAG

Róbert BARNA[1], Bernadett Horváthné KOVÁCS[1], Martin KIRÁLY[2], Zsófia TURNAI[1]

[1]Hungarian University of Agriculture and Life Sciences, Institute of Rural Development and Sustainable Economy, 7400 Kaposvár, Guba Sándor u. 40. Hungary
[2]University of Pécs, Faculty of Business and Economics. 7622 Pécs, Rákóczi u. 80., Hungary

ABSTRACT

Reducing game damage is the essential interest of both farmers and hunters. A former paper on statistical analysis of game damage is complemented with spatial analysis in the recent paper. Authors examined the forest cover at Kaposvár Forestry of SEFAG, and also the location, the topography, the land cover of Cserénfa, and their relationship with the location of the game damage events. The maps clearly show that in the forested, hilly Zselic landscape, the island-like agricultural areas are inherently exposed to game damage. Only 3.77% of the total area of the Kaposvár Forestry is located further than 300 m distance of the forest, in Cserénfa, this is only 1.59%. Considering the topography of Cserénfa, it was found that only 39% of the agricultural area has a slope of less than 5%. Due to the steep slopes and the exposure to game damage, an alternative form of farming is proposed.
Keywords: forest covering, edge effect, topography, Zselic, game damage reduction

INTRODUCTION

Game damage is one of the biggest problems in agriculture. The legal regulation and the level of compensation vary from country to country (*Bleier*, 2014). In Hungary, the Act on the Protection of Game, Game Management and Hunting of 1996 (Act LV of 1996) sets the rules for the prevention of and compensation for game damage.

Preventing and mitigating game damage is in the interest and responsibility of both farmers and hunting clubs. Farmers use various methods to prevent their fields from wild game damage: fencing, guarding, electric fencing, ultrasonic alarms, or game alarms. Game alarms, although expensive, provide effective protection (*Kovács et al.*, 2014). Hunters can protect against game damage by alarms, prevention hunting, or by cultivating game land.

Managing nearly 80 000 hectares of forest, SEFAG is the largest wildlife management company in County Somogy. *Király et al.* (2020) analysed game damage at Kaposvár Forestry of SEFAG. The research covered the period from 1998 to 2017. The basic data came from the data of hand-recorded game damage information, which was later recorded on a computer. The dataset was then subjected to statistical tests.

The records contain the name of the settlement affected by game damage, the species of wildlife causing the damage, the amount of compensation, and the topographical lot number as a parcel identification. Unfortunately, we had found a large number of missing data and inaccuracies in the records.

In the examined period, most of the game damage and the largest amount paid out were also connected to Cserénfa. In the period under study, the highest number of incidents of game damage occurred in Cserénfa, and the amount paid out was also the largest here in the examined period. The settlement is located in the Zselic, so it is characterized by a variety of topography. Farming can be done most effectively on flat or low-sloping areas, where the risk of erosion is low. In Cserénfa, only one fifth of the total area, approximately 1,775 hectares is under agricultural use. In the small amount of arable crop land, another disadvantageous factor is the risk of significant game damage.

As a supplement to the previous statistical analysis, we analysed game damage by using GIS methods.

LOCATION OF GAME DAMAGE

Among several other data the records contain the name of the settlement affected by game damage, the species of wildlife that caused the damage, and the amount of compensation. The area affected by the damage could be identified on the basis of the topographical lot number. Unfortunately, the lot number was missing in many cases. Furthermore, in the case of garden plots, often only 'GP' was recorded.

Several topographical lot numbers are divided into up to 20 subsections (e.g., 029/1 – 29/20), but in the protocol only the single summary number (029) is included. In the case of such fragmented areas, it is likely that game damage occurs in several parts, but it is not possible to decide which parts.

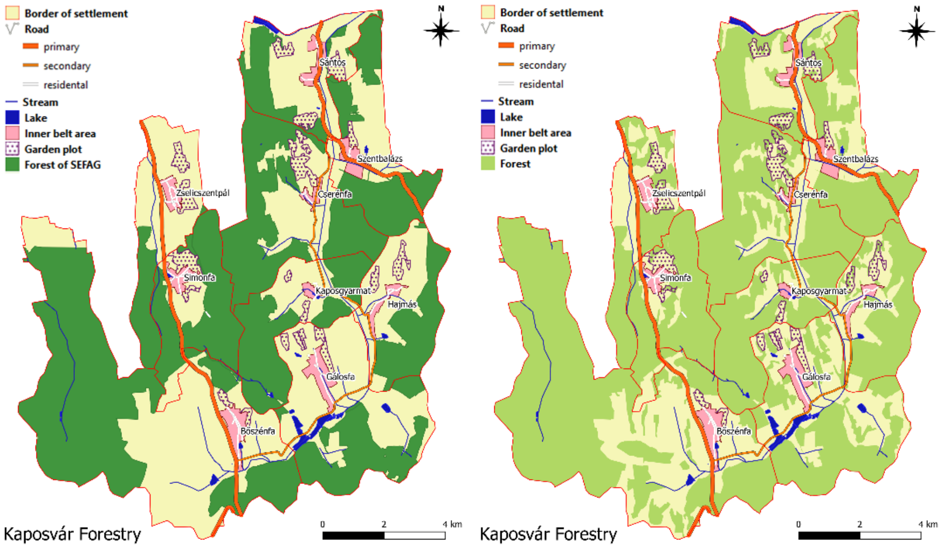
In order to solve the above mentioned problems, i.e., the missing topographical lot number in the inner belt area for the registered game damage, we took the location of the damage to be in the central part of the inner belt area, in this way, we „placed" the location of the damage into an area not affected by game damage in the middle of the garden plots. For fragmented areas, we used two methods, in one case all sub-parts were designated as damage sites, and in the other case only one. Whatever the case may be, this naturally distorted reality.

Agricultural game damage is most likely to occur in fields close to forests. *Barna et al.* (2007) say that wild animals do most of the damage within a distance of 300 metres from the forest. In addition, settlements also have the effect of attracting game damage, the number and amount of reported game damage is greater on the lots close to the inner belt areas (<300 m). Forests and settlements have an edge effect.

The research area is located in Zselic, so it is typically covered with forest. The largest forest manager is SEFAG, but there are also private forests, either individually or communally owned. SEFAG provided us with a map of the area it manages. Other forests could be identified from satellite images, but due to the size of the area, this would be a lot of work. Instead, the former FÖMI (today Lechner Knowledge

Center) prepared the improved land cover map called CLC-50 from the Corine Land Cover database created by the European Union. The forests were selected from the CLC database in the research area. *Figure 1* shows the area of the SEFAG forests in the study area and the forests on the CLC-50 map. Of course, there is a lot of overlapping between the two.

Figure 1: Forest areas of SEFAG (left) and the forest areas of CLC-50 (right)



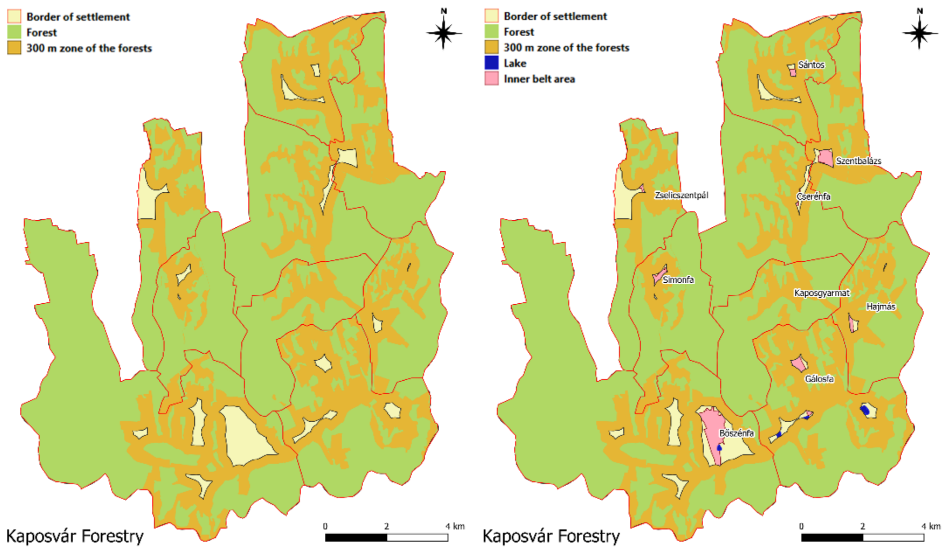
The total forest area accounts for 65% of the outer belt area of the settlements (*Table 1*). Adding the inland areas and the area of the lakes to this number, we get nearly 70% of the total area, which is covered by forest and therefore not suitable for agricultural cultivation.

Table 1: Territorial distribution of settlements

	Area (ha)	%
Total area	14749.28	100.00%
Including:		
Forest	9660.20	65.50%
Inner belt area	519.91	3.52%
Lakes	72.86	0.49%
Total:	10252.97	69.52%

Due to the edge effect, areas close to forests are the most exposed to the risk of game damage, so it is advisable to consider whether it would be worthwhile to switch to some other cultivation practice there, for example, agroforestry solutions can be recommended. *Figure 2* clearly shows that adding the 300-meter edge zones to the forest areas almost closes the open-field agricultural areas due to territorial characteristics. If we take out the inner belt areas and fishponds from the remaining parts, there is hardly any part left suitable for agriculture.

Figure 2: The 300 m zone of the forests (left) and the inner belt areas and fishponds in them (right)



Quantifying the map data from *Table 2*, it can be seen that if the 300-meter zone is added to the forest areas, only 3.77% of the total area is suitable for arable cultivation. If inner belt areas and fishponds are subtracted from this, only 2.66% remains as agricultural land. If we also take into account the edge effect of interior areas, only 1.69% of arable crop land remains, the rest is explicitly exposed to game damage.

Table 2: Territorial distribution of settlements

	Area (ha)	**Remaining area (ha)**	**%**
Total area	14749.28	-	-
Including:			
Forests	9660.20	5089.08	34.50%
300 m zone of forests	14193.20	556.08	3.77%
300 m zone of forests + Inner belt area + Lakes	14371.94	377.34	2.56%
300 m zone of forests + 300 m zone of Inner belt area + Lakes	14499.98	249.30	1.69%

In the settlements, all the points shown in the map are either topographical lot numbers, garden plots or inner belt points (*Table 3*). All missing topographical lot numbers listed as inner belt areas, but there are actually inner belt incidences, e.g., wild game animal damage on the football field as well.

Table 3: The number of places of game damage by settlements

Settlement	Topographical lot number	Inner belt area	Garden plot	Total
Bőszénfa	74	100	15	189
Cserénfa	384	65	39	488
Gálosfa	229	110	4	343
Hajmás	81	43	22	146
Kaposgyarmat	185	45	8	238
Sántos	3	6	1	10
Simonfa	23	74	89	186
Szentbalázs	143	57	6	206
Zselicszentpál	4	15	9	28
Total:	1126	515	193	1834

There were several game damage events where several smaller parts of a topographical lot number were affected, for example 029/1, 029/4 and 029/7. These parts can be “merged”, for example, instead of three small parts, the entire area marked with a single topographical lot number 029 can be considered as affected by game damage. The merge of fragmented lots would decrease the number of lots by 382.

In the centre of the areas identified from the records, the location of game damage is shown by a red dot (*Figure 3*). When evaluating the map, the distorting effects described earlier must be taken into account. The map shows the proximity of the forest and the location of the game damage events. Out of the 1,834 game damage points, 1,503 (82%) are within the 300-meter zone of the forests and only 331 points (18%) are outside of the zone. The area of the settlements is not shown in the map.

LOCATION OF CSERÉNFA

In the area of the Kaposvár Forestry, Cserénfa was the settlement most exposed to game damage. The forest map of the settlement (*Figure 4*) was provided by SEFAG. The other forests were identified in MEPAR's browser. The remaining areas are agricultural fields. In one case, according to MEPAR, the area marked with a topographical lot number contains both forest and agricultural land.

The map shows the predominance of forests in the outskirts of the settlement. Much smaller agricultural areas are wedged between forests or found next to forests, and the same can be said about garden plots. Wild game does not even have to move as much as half a kilometre between forests, it crosses an agricultural land.

Figure 3: Location of game damage events without (left) and with the edge zones of forest (right)

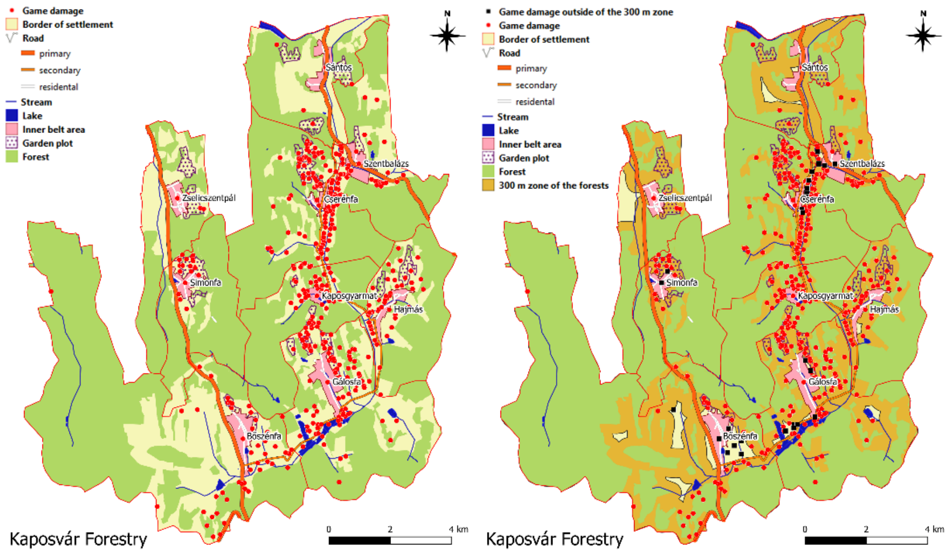
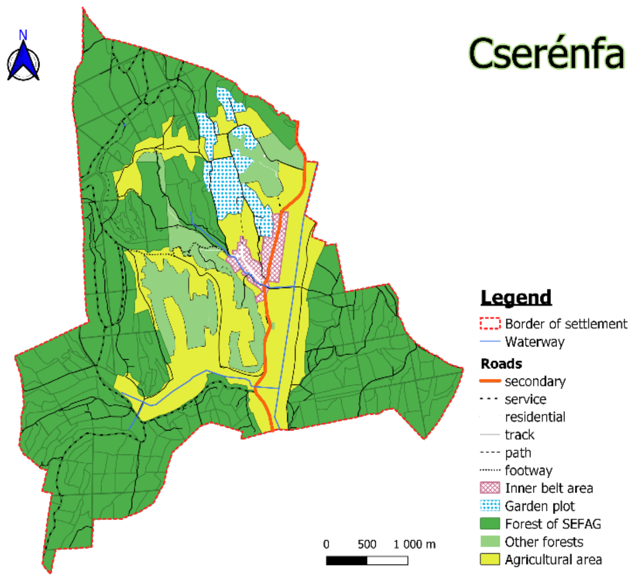


Figure 4: Settlement boundary map of Cserénfa



The forestry area of SEFAG accounts for the largest part of the settlement boundary of Cserénfa (*Table 4*), which is almost two-thirds of the total area (64%). Due to topographical conditions, agricultural areas occupy a total of 22%, according to the MEPAR browser, a large part of this is grassland.

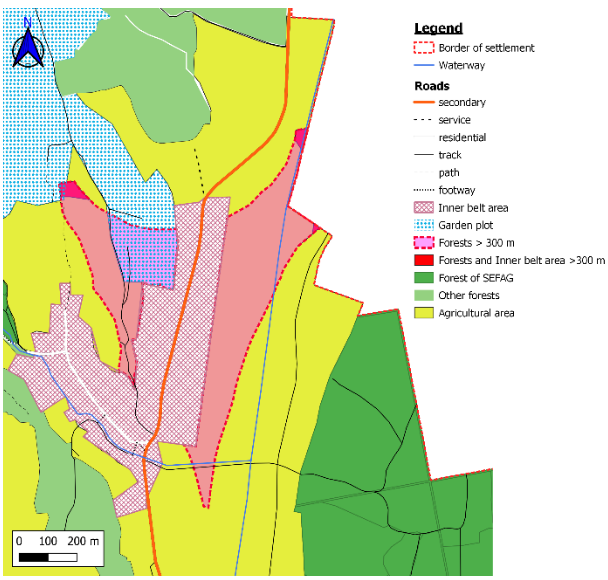
Table 4: The distribution of the different types of cultivation

Cserénfa	Area in ha	Percentage
Inner belt area	33.04	2%
Garden plot	65.41	4%
Agricultural	393.09	22%
Forest of SEFAG	1137.05	64%
Other forests	147.24	8%
Total:	1774.87	100%

RESEARCH OF THE EDGE EFFECT IN CSERÉNFA

In order to examine the edge effect of forests, we created a 300-meter zone of forest areas (SEFAG and other forests together) in QGIS, and then subtracted the entire interior area, as well as the part of garden plots and agricultural areas falling within the zone. In this way we got an area of 28.2 ha constituting agricultural fields and garden plots (*Figure 5*), which is more than 300 meters away from the forests and is therefore less exposed to wild game damage. Due to the edge effect of the settlements, we subtracted the areas that are closer than 300 meters to the inner area from the 28.2 hectares calculated above. As a result, we got an area far enough from the forest and the settlement and is consisting of two parts, totalling only 0.0846 hectares. It means that substantially there is no agricultural area in Cserénfa that is far enough from places where game damage is a threat, so the occurrence of game damage is very much likely, almost surely expected in those fields.

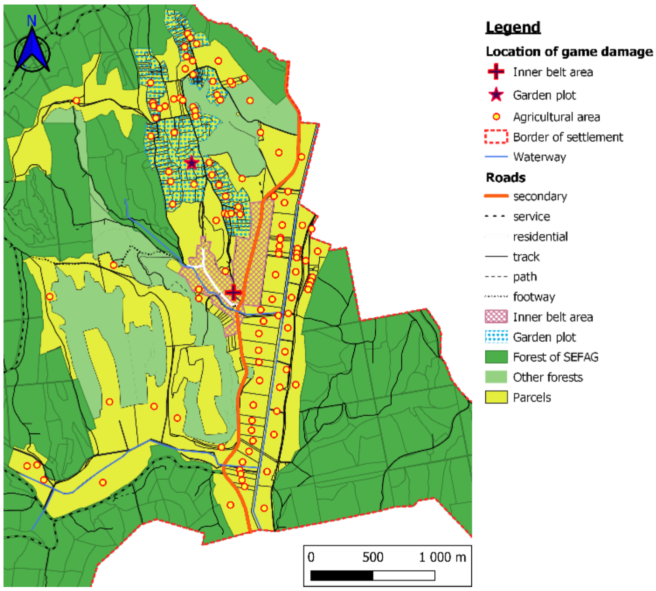
Figure 5: Areas in distance of more than 300 meters from forests and from forests and settlements



LOCATION OF GAME DAMAGE IN CSERÉNFA

The location of all game damage is shown in the map *Figure 6*. To mark the location of game damage, we used the recorded topographical lot number to identify of the parcel of the area affected by game damage. As a result of the divisions, the topographical lot number originally marked with the single number 123 was given the numbers 123/1, 123/2 and 123/3. Later new divisions or mergers further complicated the numbering. Among such areas, there are many really small parcels, which today are typically cultivated jointly, even by the same owner.

Figure 6: Location of all game damage



Unfortunately, topographical lot numbers were not always indicated and sometimes the lot number recorded was not existing in the settlement. We treated these cases as if they were in the inner belt area. Although there have been incidents of game damage both in the inner belt area and on the football field of Cserénfa.

In many cases, the damage to garden plots did not include an entry for the topographic lot number, only a text indicated that it was a garden plot or gp. abbreviation was found in the record. For the purposes of map representation, these were uniformly assigned to the centroid of the garden plot area of the settlement.

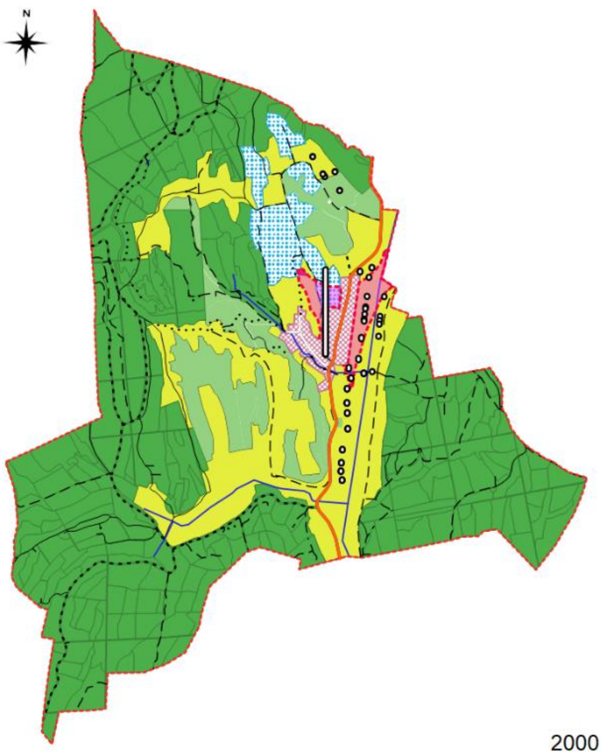
In several cases, because of extensive wild damage, several parcels were indicated in one report, while the area affected by wild damage and the amount paid were not broken down to parcels. In order to produce a map, such multiple entries had to be broken down into as many parcels as the number of parcels indicated and the amount divided between them proportionally. The fractional number of parcels was also shown separately.

Maps can also be used to illustrate the extent of wildlife damage. It is possible to map each year separately. These can then be converted into time-sharing videos to track the change in wildlife damage between years.

THE AMOUNT OF GAME DAMAGE IN EACH YEAR

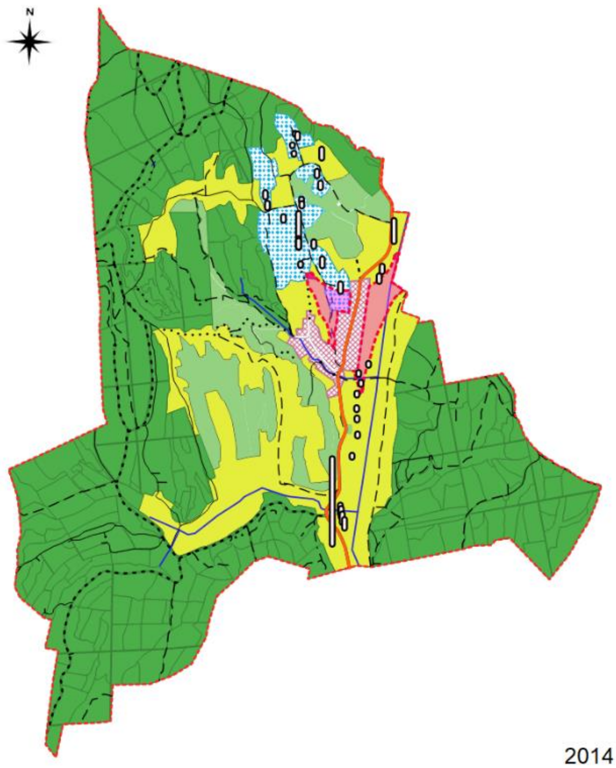
Figure 7 shows not only the location of the game damage but also the amount of game damage on the map. The location of the game damage is represented by the bottom of the rounded-end columns, and the amount of game damage is symbolized by the length of the column. It can be seen that in 2000 a large amount of damage was recorded for the inland area, but this was due to the fact that the topographical lot number was missing in many cases from the records. No wildlife damage was reported in the garden plot. The many small circles in the arable lands show that a single game damage affected several parcel numbers, but the amount of shared game damage was not large.

Figure 7: The amount and location of game damage in 2000



In 2014, however, the game damage did not „reach" the inner belt areas, but there were more of them in garden plots than in agricultural areas (*Figure 8*). The amount of game damage is also higher than in 2000, and even in one case it is exceptionally large.

Figure 8: The amount and location of game damage in 2014



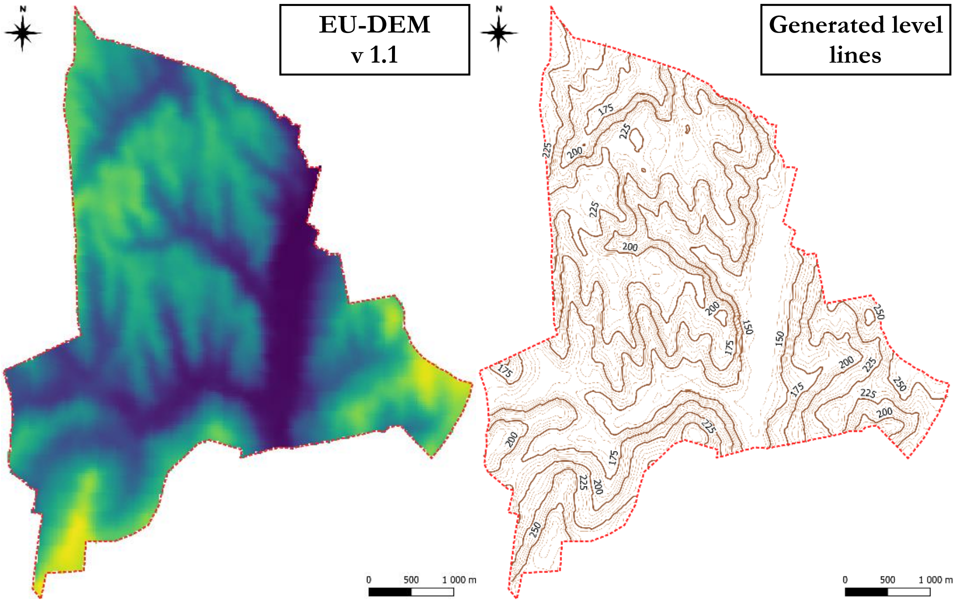
TOPOGRAPHY ANALYSIS IN CSERÉNFA

The European Union's Copernicus Programme made the EU-DEM topography model freely available. *Figure 9* shows the topography cut in the Cserénfa area and the contour line drawn from it in the QGIS program. The varied topography could be clearly seen, marked by intersections, with a large difference in level.

In order to be able to quantify the slopes, a slope map must be created (Figure 10), which shows the percentage values of the slopes. The red colour dominates, which indicates places with a slope greater than 15%. The steepest parts are located outside the agricultural area marked in blue and have forestry cultivation. The agricultural areas are in the areas with a smaller slope, but even so, the slope is greater than 15% in many places.

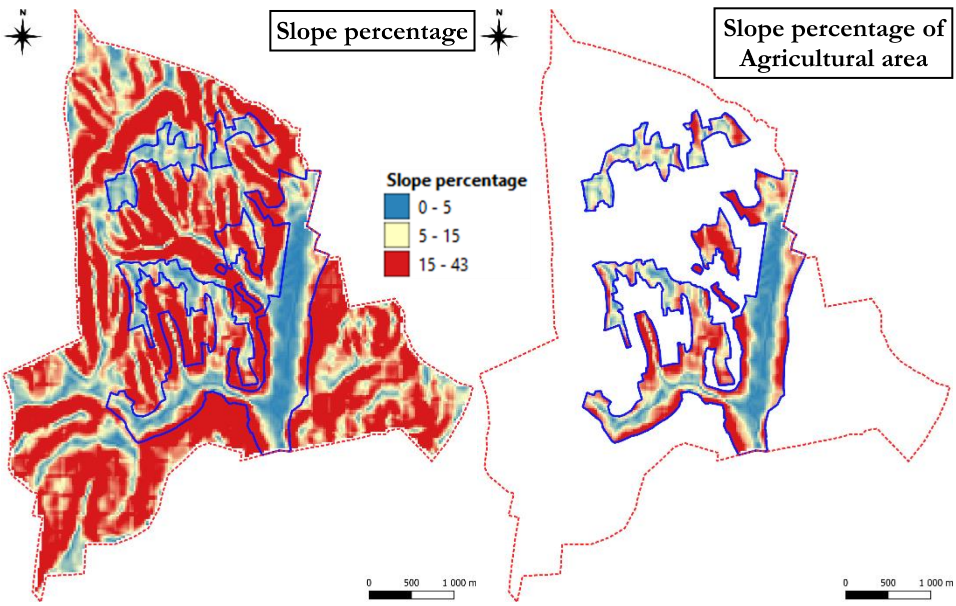
In the entire area, the number of slopes with an 5-15 % is the largest, but there are also a significant number of areas with a slope of more than 20 %, but the average is 12.5%. In agricultural areas, the slope percentages are smaller, but the average here is also 8.7%, which is quite high. In addition, there are many areas with slopes greater than 20%.

Figure 9: Topography of Cserénfa



130 m 270 m	Minimum=130.28 Maximum=267.20	Mean=189.90 StdDev=32.03

Figure 10: Slope percentage map of Cserénfa



Minimum=0.01 Maximum=50.22	Average=12.95 StdDev=7.83	Minimum=0.01 Maximum=44.70	Average=8.73 StdDev=7.61

The figure clearly illustrates the ratio of each slope percentage. For a more accurate picture, we calculated the total area of the raster regions (*Table 5*).

Table 5: Raster statistics

Scale	Total Area ha	%	Agricultural Area ha	%
Under 5%	281.81	17%	154.66	39%
Between 5% and 15%	800.26	47%	175.77	44%
Greater than 15%	619.84	36%	69.10	17%
Total:	1701.92	100%	399.53	100%

There are about 70 hectares of agricultural land with a slope of more than 15%. In these areas, it should be considered to switch from traditional agricultural cultivation to one of the agroforestry solutions, which are also less exposed to game damage.

CONCLUSION

Game damage is certain in the examined area because there are very few agricultural areas that are more than 300 meters away from the forest. The case would be even worse if the edge effect of the settlements were included.

A significant part of the agricultural land is located on steep fields where cultivation costs are much higher, and the risk of erosion is greater.

It would be advisable for farmers to consider switching to agroforestry solutions that require less machine work and are subject to less game damage.

Identifying game damage with topographical lot numbers is difficult, and data processing and representation are also complicated. Manual data recording is also an obsolete technique. It would be advisable to record the game damage records with a computer and determine the affected area with GPS measurements. As a result, the application of modern statistical, IT and geospatial solutions becomes available in data processing and display, as well.

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Corresponding author:

Róbert BARNA
Hungarian University of Agriculture and Life Sciences
Institute of Rural Development and Sustainable Economy
Department of Digitalization and Consultancy in Agriculture
Kaposvár Campus
7400 Kaposvár, Guba Sándor u. 40., Hungary
e-mail: barna.robert@uni-mate.hu