ESTIMATION OF THE GEOGRAPHIC CONCENTRATION OF A BREED KEPT IN MULTIPLE HERDS – THE RHODOPE SHORTHORN CATTLE

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Abstract

The concentration of a breed in a limited territory is one of the additional elements in estimation of the risk status. It is usually expressed as the percent of the total population located within a circle with given radius. To estimate the concentration at subpopulation level, based on generating all subsets of herds, the overall number of farms plays important role as limiting factor for the computations. This is the case of the Rhodope Shorthorn Cattle, which is present in multiple herds, but located mostly in limited number of municipalities in the Rhodope Mountains. |To evaluate if grouping of the animals by municipalities might be used to provide insight into the subpopulation concentration, four different groupings were made – by the administrative centre and by the centroid of the municipality, where the farm is located, by the closest municipality centre, and by the closest centroid. All the groupings resulted in slightly overestimated concentration, but provided a good base to identify areas with local concentration of the breed.

***Key words*:** local breeds, risk, population size

Introduction

The conservation of animal genetic resources is a complex process comprising of number of actions, from reviewing the status of each breed, determining its conservation value, choosing appropriate conservation methods, to designing a conservation programme. One important step in this chain of actions is the identification of the breeds at risk, i.e. breeds that need to be targeted by conservation programmes (FAO, 2013). This is done by estimating the potential loss of population size and genetic diversity taking also into account some other factors, which might influence the risk. One of these factors is the concentration of the population in a restricted area (Carson et al., 2009, Alderson, 2009, FAO, 2013). The potential threat of the geographic isolation is recognized in Bulgaria already in the previous century, and mentioned in the recommendations to preserve the breeds in several isolated herds (Hinkovski et al, 1984). The methodology for assessment of the risk status of the breeds in Bulgaria (Nikolov&Duchev, 2022) also accounts for the concentration of the populations and the limited number of herds. For estimation of the risks related to geographic concentration, Alderson, (2009) proposed to use the radius of the circle containing 75% of the population. In a study, part of the European Regional Focal Point (ERFP) project titled “Development of models assessing the breeds risk status by utilization of population and relevant georeferenced data”, Sturaro et al., (2013) defined 3 categories: vulnerable“ - 75% of the population within circle with 50 km radius; „endangered“ –25 km radius , and „critical“ –12.5 km radius. In Bulgaria, Duchev, (2021) did such study for four local breeds - Rhodope Shorthorn Cattle, Rhodope Tsigai sheep, Central Rhodope sheep, and Bulgarian screw-horned longhaired

goat. Duchev et al., (2022) studied the geographic distribution of the Bulgarian screw-horned longhaired goat, a small breed with geographic concentration in more than one area, on the sub-population level and presented an approach to explore also the risks associated with such concentration. This approach, based on evaluating all subsets of farms keeping more than 25 (50) % of the population in a circle with 25 (50) km radius, has its limitations. Due to the exponential increase of the number of subsets with increase in number of farms, it is applicable to breeds, kept in a limited number of farms.

The Rhodope Shorthorn Cattle (RSC) is an example of a breed distributed in large number of small farms (Duchev, 2021), which makes the calculations by farm impractical. On the other hand, the breed is present in limited number of municipalities, which provides us with option to use the above approach aggregating on municipality level. In this study, we are trying to evaluate the concentration on sub-population level on the example of RSC.

Material and methods

The data for year 2022 about the population of RSC controlled by the Association for breeding of local cattle breeds (ARMPG) was used. The data set included location of each farm (village, municipality, province), and the number of male and female animals kept there. Each farm was mapped as a point by the coordinates of the village. Then, the animals in all farms located in the Rhodope region, were grouped in four different ways:

A By the administrative centre of the municipality where the farm is located
B By the closest municipality administrative centre
C By the centroid of the municipality where the farm is located
D By the closest municipality centroid

The four sets of aggregated data were processed with the open source software QGIS 3.28 (QGIS.org, 2023) and all combinations keeping at least 25% (50%) of the population and located in circle with radius of 25 km (50 km) were analysed. For the extreme combinations, we switched back to the farm locations by village in order to evaluate the difference in the results by grouping and the results by farm.

Results and discussion

In year 2022, the population kept by the 139 farmers of ARMPG is distributed around 89 villages in 26 municipalities of 9 regions - Blagoevgrad, Veliko Tarnovo, Kardzhali, Kyustendil, Pleven, Plovdiv, Smolyan, Sofia, and Haskovo (Figure 1.).

Of these animals, 89% are kept in 83 villages in the region of Rhodope Mountains.

To get a notion about the distribution of the farms, the distances from the farms’ villages to the administrative centre of the municipality where the farm is located, to the closest municipality administrative centre, to the centroid of the municipality where the farm is located, and to the closest municipality centroid were used (Table 1.). As expected, the maximum distance was observed between a farm and the administrative centre of its municipality, namely between Lilkovo (Rodopi municipality) and Plovdiv. There are several municipalities in Bulgaria – Rodopi, Maritsa, Tundzha, where the administrative centre is located outside of the municipality. The administrative centres of Rodopi and Maritsa are located in the town of Plovdiv, belonging to the municipality of Plovdiv.

Of the four groupings, the one by the closest municipality centroid implied less movement of animals, compared to the other three groupings. The groupings by closest municipality

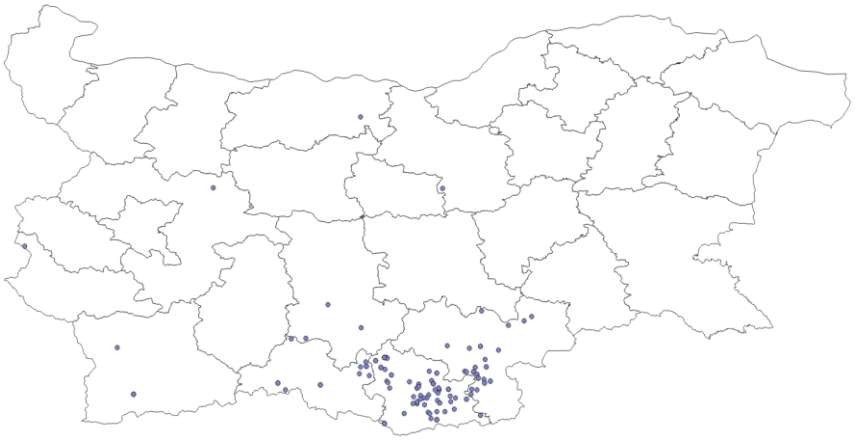

Figure 1. Distribution of the population of Rhodope Shorthorn Cattle controlled by ARMPG

Table 1. Distances to various grouping centres (km)

	Own municipality administrative centre	Closest municipality administrative centre	Own municipality centroid	Closest municipality centroid
Minimum	0	0	0.301	0.301
Maximum	29.057	21.446	20.601	16.796
Mean	10.681	9.210	8.866	8.075
Standard Deviation	6.282	4.498	4.955	3.860
Weighted mean[a]	10.061	8.504	8.516	7.945

[a]The numbers of animals in each farm were used as weights

administrative centre and by the own municipality centroid were very similar regarding the distances of moved animals.

The smallest circle radius of 0km in grouping A (Table 2.) indicates a presence of a municipality where more than 25% of total population is kept. With the exception of grouping B, all other groupings have identified the concentration of animals in the Momchilgrad municipality, where more than 27% of the total population is located in a circle with radius 10.2 km. With Grouping B, the smallest circle matched 41 farms, close to Krumovgrad and Momchilgrad, keeping 37.2% of the population in circle with 22.5 km radius.

Table 2. Maximum concentration in 25 and 50 km radius

	Grouping A	Grouping B	Grouping C	Grouping D
Smallest circle radius	0	11	0	0
Percent of the population in above circle	27.4	37.2	27.4	26.9
Maximum population concentration in 50 km	82.5%	82.6%	82.5%	83.3%
Maximum population concentration in 25 km	62.8%	61.3%	60.2%	60.6%

For the maximum concentration in circle with 25km radius, the results in all groupings involved the municipalities Kardzhali, Momchilgrad, Krumovgrad and Madzharovo. The other involved municipalities by grouping are as follows: Grouping A – Chernoochene; Grouping B – Chernoochene, Stambolovo, Dzhebel; Grouping C – Haskovo; and Grouping D – Haskovo and Stambolovo.

Looking at the farms in the four common municipalities, a cluster of 71 farms keeping 4130 animals (Figure 2.) was identified within a circle with 24.6 km radius. This result is close to the ones obtained by the four groupings.

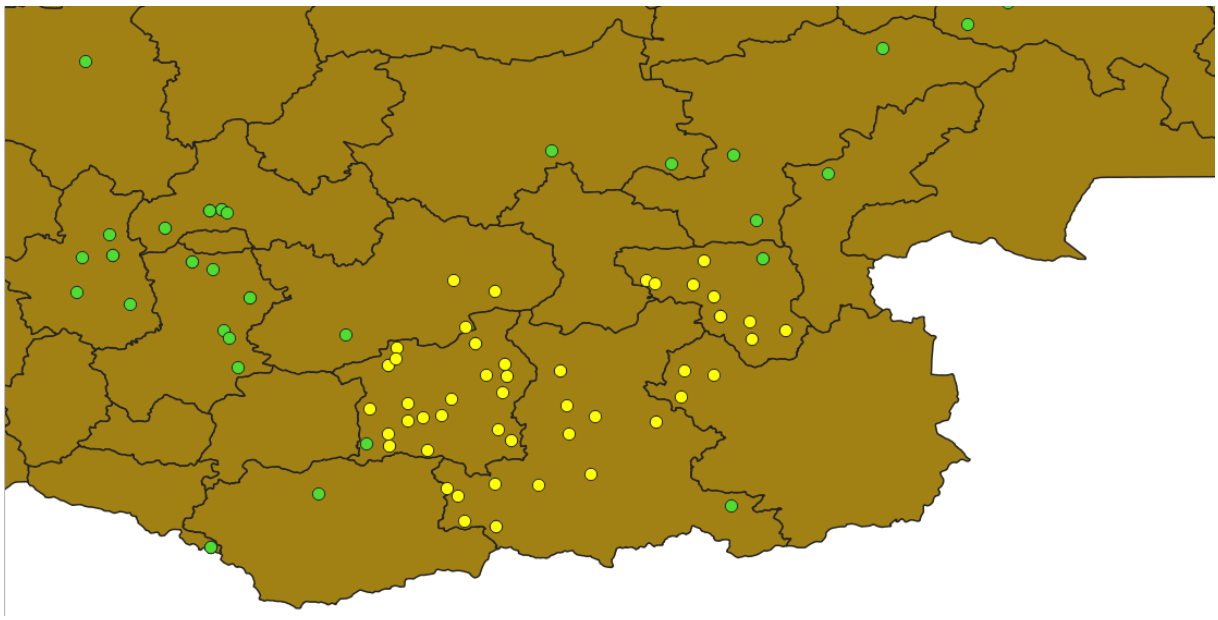

Figure 2. Combination of 71 farms keeping 57.2% of the population in a circle with 24.6 km radius

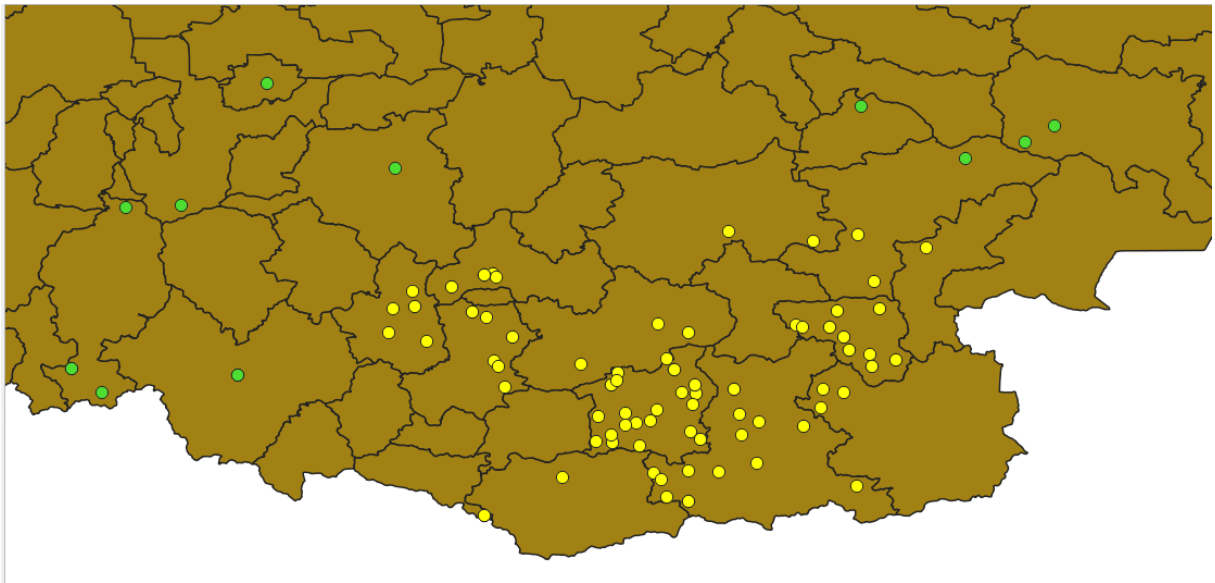

Figure 3. Combination of 115 farms keeping 81.5% of the population in a circle with 45.8 km radius

In the 50 km circle, the common municipalities were Ardino, Banite, Zlatograd, Krumovgrad, Kardzhali, Madzharovo, Momchilgrad, Harmanli and Chernoochene. Getting back to farms, a cluster of 115 farms keeping 5884 animals (Figure 3.) was identified within a circle with 45.8 km radius. This result is also close to the ones obtained by the four groupings.

Conclusions

Due to the limited size of the municipalities in Bulgaria, the groupings of the animals by municipalities led to only slightly overestimated results than the ones obtained by farms locations. Though the grouping by own municipality administrative centre is simplest, grouping by own municipality centroid should be preferred, as some municipalities have their administrative centres outside their territory.

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