MIDDLE POMERANIAN SCIENTIFIC SOCIETY OF THE ENVIRONMENT PROTECTION

Rocznik Ochrona Środowiska

Volume 21. Year 2019 ISSN 1506-218X 85-97

Evaluation of Vegetation as a Habitat Factor in Hunting Ground Based on Satellite Images

*Milutin Kovačević**, *Vladimir Marković, Igor Ponjiger, Zoran Ristić, Milosava Matejević, Rastislav Stojsavljević, Igor Stamenković*
University of Novi Sad, Serbia
**corresponding author's e-mail: milutin.kovacevic@dgt.uns.ac.rs*

1. Introduction

Habitat evaluation is one of the key elements for successful wildlife management. The quickest way for evaluation and quantification of habitats is using of remote sensing and GIS technologies. New technologies provide possibilities such as real-time and more accurate assessment of the environment, leading to a more realistic habitat evaluation (Kushwaha & Roy 2002).

Examining foreign and domestic research papers on this subject (Radeloff et al. 1999, Gerrard et al. 2001, Clevenger et al. 2002, Chan-Ryul & Woo-Shin 2003, Suchant et al. 2003, Weiers et al. 2004, Maringer & Slotta-Bachmayr 2006, Kunovac & Omanović 2012) it can be seen that GIS has become an important tool for habitat suitability assessment using various different methodologies. Certain papers cite usage advantages of NDVI to define temporal aspects of vegetation development (Pettorelli et al. 2007, Hamel et al. 2009, Jaskula et al. 2018). Previous research has shown that GIS and NDVI can be useful in all types of habitat and vast species of animals (Pettorelli et al. 2005a, Boone et al. 2006, Young et al. 2009).

According to Tomašević et al. (1997) habitat evaluation or suitability of hunting grounds represents the sum of all natural conditions as the basic factors on which the survival depends and further reproduction of the game in the hunting ground. Evaluating the habitat quality of the hunting ground is a process that provides a complex assessment of the degree of suitability of the environment conditions for the life of a particular species of game in the hunting ground, on the basis of which a possible number of game per area is determined. It is the assessment of the basic factors such as: food and water, vegetation, soil, tranquility in the hunting ground, terrain configuration and other factors that have an impact on the survival and proper growth of the game. What's more, each organism reflects also to the shape and boundaries of the habitat (Marković et al. 2014).

Habitat evaluation for hunting grounds is a complex area with special type of methodology being used in Serbia and most parts of the former Yugoslavia. Many types of research that covered this issue agree that habitat evaluation for hunting grounds is a complex indicator of vital conditions for certain species of game (Car 1961). According to Đorđevićet al. (2010) it is very important to reconcile the number of animals with the nutritional possibilities of the habitat and the condition of vegetation. This requires a realistic assessment of habitat conditions in the hunting ground, knowledge of the ecology of the game (especially when there are more species), and professional planning during hunting.Habitat evaluation is done in order to calculate the capacity of the hunting ground through the rating classes. All this indicates that habitat evaluation and determination of hunting capacity is an important and responsible job on which hunting management is based.

The habitat evaluation method using GIS represents the unification of a geographic information system and the usual habitat evaluation method used in Serbia and region. The goal of processing satellite images in GIS is to obtain the percentage representation of certain vegetation component which makes the basic habitat factor in the hunting ground. This research started with the assumption that there are ways to improve this method by applying GIS in the process of vegetation factor in the habitat evaluation process. By combination of knowledge about species biology and their habitat needs a chart was created that enables the rating of this factor.

The main hypothesis is that the method used for determining the vegetation factor within habitat evaluation is dated and doesn't provide accurate assessment of vegetation factor.No official methodology is used except descriptive explanation of suitable habitat. The scores are often transcribed and annual changes cannot be tracked so the evaluation often doesn't display realistic state. Vegetation evaluation using GIS can provide annual tracking of vegetation that can be more precise than the former method which is based on field observations. Aim of the paper is to propose a new way of determining vegetation factor using NDVI that would eventually replace existing method used as a part of habitat evaluation process.

The hunting ground "Kapetanski rit" – Kanjiža was chosen as a suitable location for this research being a sensitive area endangered by flooding (Nađ et al. 2018). This means that wildlife in the hunting ground needs to be closely monitored and all aspects and changes of habitat need to be tracked.

2. Material and methods

In the analysis of vegetation factor assessment by using GIS method, the component of vegetation as a shelter provider was emphasized. Calculation of the percentage of vegetation is done on the basis of analysis of satellite images from Copernicus Open Access Hub–SENTINEL-2, S2A_platform, 10 m resolution, for the dates 15.05.2017. and 05.01.2017. NDVI (Normalized Difference Vegetation Index) is used for these purposes. Fieldwork measurements (to determinate if vegetationtype represents appropriate hiding cover) were used as a control method (Figure 1. and Figure 2.). Twenty control points have been taken for both periods (May and Dec/Jan) for small and big game (40 points in total). On each sample plot a vegetation observation was conducted. The cover was assessed for plants 30 cm above ground for small game, and 80 cm for big game. In case of big game, accuracy was 85%. Only in 3 cases (two cases in May, and one in December/January), the vegetation was shorter than 80cm, and in 17 sample plots vegetation was higher even than 150 cm). In case of small game accuracy was 95% and only in one sample plot (December/January) vegetation was less than 30 cm high. In other 19 sample plots the vegetation was high 45 cm on average. The normalized vegetation index difference is a powerful graphical indicator that can be used to analyze images obtained by remote sensing (Pettorelli et al. 2011). For the measurement and mapping of density and dispersion of vegetation, special satellite sensors are used to obtain multilayer images that allow for various analyzes. On the basis of raw satellite data in NDVI values, it is possible to create images that give a state of the terrain according to the type of vegetation. Also a scale has been made to determine the extent to which vegetation is present in a given area (earthobservatory.nasa.gov). Values on this scale are in the range from 1.0 to -1.0 and generalized vegetation indices are presented in Table 1.

Table 1. NDVI and vegetation types; Source: (Jovanović & Milanović, 2015)

NDVI values	Vegetation indices
-0.3-0.1	water and arable land (without vegetation)
0.1-0.4	grassland, shrubs, pastures
0.4-0.85	forests, higher crops, dense vegetation

For the purpose of this paper, the share of vegetation under the NVDI index in the case of a small game is the range from 0.3 to 1.0 and from 0.4 to 1.0 for the big game (as big game don't use short vegetation for shelter) (Table 2). This range includes vegetation such as bushes, higher crop plants or forests.

According to Vospernik & Reimoser (2008), ideal habitats for roe deer (*Capreolus capreolus* L.) represent areas with smaller forests with plenty of open space. Therefore, larger forest complexes or clear fields are not what corresponds to roe deer. The ideal habitat is represented by agricultural plains with small forest areas (Jepsen et al., 2004). The European hare (*Lepus europaeus* Pall.) has adapted very well to the conditions in areas with arable land that belong to the plant index starting from 0.3. The number of brown hare populations is conditioned by the diversity of available nourishment (cereals, grass, twigs and sprouts). When habitats offer diverse nutrition throughout the year, it reflects on hare reproduction and survival, which consequently affects the population increase (Edwards et al., 2000). Therefore, the significance of vegetation for large and small game can be seen, because besides being used as a shelter it also means more available adequate food supply for game. It should be noted that, for the purpose of assessing this factor, a special table is formed, which is also valid for the large and small game on the basis of which the habitat evaluation is carried out. Collecting, presenting, analyzing and interpreting data was conducted using ArcMap 10.3.

Table 2. NDVI and game shelters

NDVI values	Shelter by species
From -1.0 to 0.3	no shelter for the game
from 0.3	shelter for brown hare
from 0.4	shelter for roe deer and wild boar

Study area is hunting ground "Kapetanski rit", which encompasses 37,691 ha and extends on the areas of arable land (80.28%), meadows and pastures (11.75%), water bodies and wetlands (3.40%) forests (2.44%), other (2.13%) and urban areas (settlements, road network) which represents non-hunting areas and cover 13.60%. The hunting ground is a located in the eastern Bačka hunting area (Vojvodina, Serbia), and it was established as a hunting ground of an open type. The hunting ground is located between the Tisa River and the E-75 highway. In the territorial aspect, the hunting ground "Kapetanski rit" belongs to the North Bačka district, it is located on the part of the territory of the Kanjiža municipality.The hunting ground is managed by the Hunting Association "Kapetanski rit" with headquarters in Kanjiža. According to the management plan, the hunting ground "Kapetanski rit" manages the following species of game: roe deer (*Capreolus capreolus* L.), wild boar (*Sus scrofa* L.) and brown hare (*Lepus europaeus* Pall). The population of roe deer on 2017 spring count was 1496 individuals, while average for 2013-2017 period was 1478 individuals.

According to the habitat suitability evaluation it was determined that habitat for roe deer encompasses 24,500 ha of suitable habitat. The density of roe deer population in this hunting ground is 6.11 individuals/100 ha.The wild boar population is smaller due to habitat conditions. Its population is 36 individuals with 40 being the 2013-2017 average. It was determined that suitable habitat for wild boar encompasses just 1500 ha of hunting ground, with density of 2.4 individuals/100 ha. Brown hare is the most numerous small game. Its population was 3540 individuals determined during the 2017 spring, and on average 5158 individuals during the 2013-2017 period. Due to smaller habitat demands it was determined that suitable habitat is 29,500 ha and the density in this hunting ground is 12 individuals/100 ha.

3. Results

On the basis of the obtained values from the table on vegetation prevalence (Table 3) maps were made showing the areas under vegetation in May 2017 and December2016/January 2017 for big and small game in the study area.

Table 3. Vegetation prevalence and rating

May	Points	Dec. – Jan.
75-100%	10	35-100%
50-75%	8	15-35%
25-50%	6	5-15%
0-25%	4	0-5%

As can be seen from the table, the ranges are given in percentages on the basis of which the number of points is assigned. In order to have a maximum 20 points the hunting ground, according to previous similar research (Andersen et al. 2004, Pettorelli et al. 2005b) this methodology suggest it is necessary to have over 75% of the vegetation in May and over 35% of the vegetation in December and January based on the results of the NVDI value in the study area. On the basis of the results obtained in GIS, the values for May and December/January are summated and the final number of points for this factor is acquired. This kind of data processing and assessment tables are used for both big and small game.

Figure 1. shows a map of vegetation prevalence for big and small game given for the month of May. It is noticeable that these maps provide a clear insight into the possible area of grouping of game during that period. These are very useful information for the management of the hunting ground because they allow the display of possible plots where a big and small game could bring up their

offspring. Often, females of both big and small game hide in the bushes and other vegetation in order to give birth. Hence, knowing this, disturbance can be minimized and thus it is possible to actively affect the population.

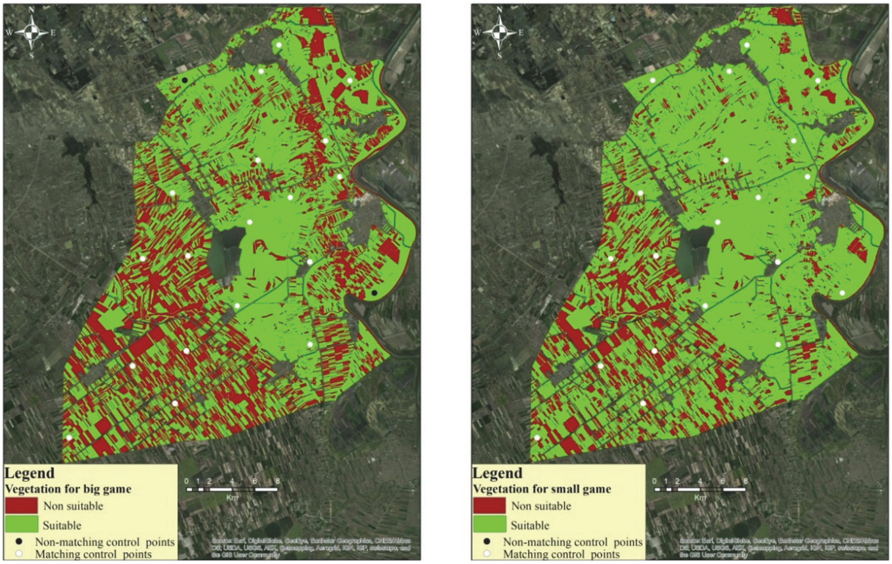

Fig. 1. Distribution of vegetation for big (left) and small (right) game in May with marked control points

Based on the calculation for big game, it was found that the suitable vegetation covers 60.2% in May, giving 8 points. Calculations for small game found that the suitable vegetation in the hunting ground covers 74.5% in May, which also gives 8 points.

Figure 2 represents a map of vegetation for big and small game for the months of December/January. It provides a clear insight into where game can be expected to stay during winter. These are extremely useful information for the management of the hunting ground, as they allow planning the dispersion of facilities during winter, that is, it points out the places where food delivery should increase in this period and the number of predators should be regulated.

As shown in Figure 2. the vegetation for big game in the hunting ground covers 6.2% in December and January, which according to the table gives this factor 6 points. For small game, vegetation covers 21.7% which gives 8 points.

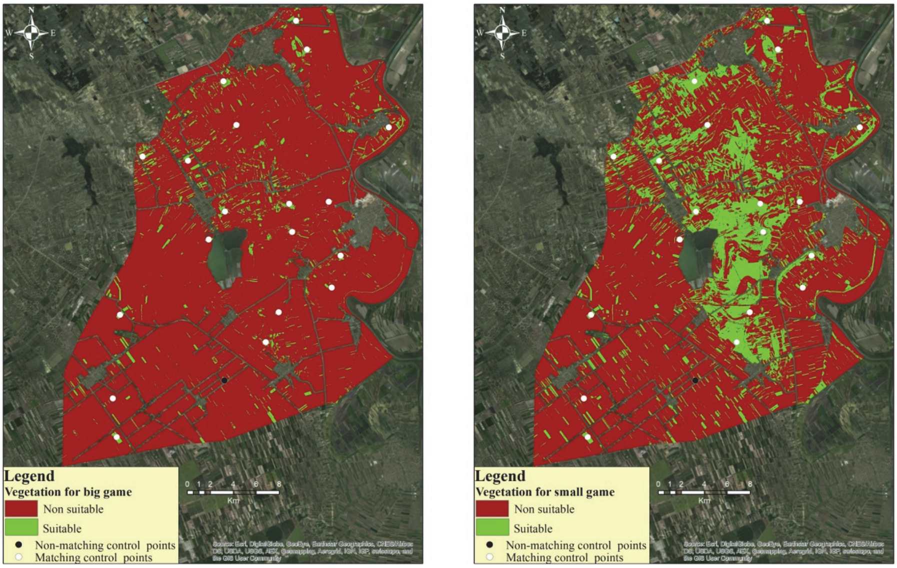

Fig. 2. Distribution of vegetation for big (left) and small (right) game in Dec/Jan with marked control points

It is known that the game is usually most commonly grouped around the forests and other areas of hunting ground with abundant vegetation during the whole year. This way, not only the management of the hunting ground can have a clearer overview of the vegetation cover, but it also helps in the planning process and analysis of the territorial distribution of the game. The overall rating of this factor on the example of the hunting ground "Kapetanski rit" Kanjiža is 14 (from max 20) points for big game, and 16 (from max 20) points for small game in this hunting ground.

According to the current game management plan, in the case of a big game, the vegetation factor was given 18 points. According to GIS methodology, the vegetation factor gets 14 points, i.e. 4 points less. This indicates to the fact that natural conditions in the hunting ground do not correspond to the subjective estimates stated in the game management plans, and that the existing vegetation is not sufficient for the proposed capacity of big game. So, it is necessary to reduce the nurtured number of roe deer from 6.11 to 5.91 individuals/100 ha or to increase the suitable vegetation area for at least 1% in May and at least 8.8% in December/January period. In the case of the small game, according to the current game management plans, this factor was given 16 points, the same is obtained according to the GIS methodology, which indicates that the assessment made in the hunting ground management plans is adequate.

4. Discussion

Vegetation provides food and shelter for game and is one of the most important factors in the hunting ground. This habitat factor includes all existing vegetation in the hunting ground, regardless of whether it is on agricultural, forest or non-arable lands. Vospernik et al. (2007) have noted the importance of vegetation presence in habitats for roe deer. The main importance of vegetation is noted for forage, cover from predators, shelter from adverse weather and daytime loafing area for this species. Similar can be applied for other types of game.

In Serbia methodology used for habitat evaluation in hunting grounds dates to period of former Yugoslavia. The methodology itself differs from the methodologies throughout Europe.Two types of habitat evaluation methods can be mentioned (Srdić 1955; Car 1961) in which the habitat evaluation and determination of hunting capacity is calculated for the main species of small and big game. The basis, from which these habitat evaluation methods were elaborated, was mainly based on the Uckermann method (Drenić 1997) where habitat evaluation was rated based on five to seven factors. The total number of points ranges from 40-100, with the habitat quality of hunting grounds being divided into four, and not to three grades as in Uckermann method. Based on this rating, the capacity of hunting grounds is determined according to the scale given for each species of game. It can be seen that this methodology is quite dated and wasn't improved for decades.

The current methodology used for evaluating the vegetation factor is based on subjective assessment made by the evaluator according to the written instructions. The question arises as to what extent the assessment of the factors involves the subjectivity of the evaluators themselves, since the scoring is based only on description of each factor? Which method could include a more accurate assessment of the factors? For breeding the game, it is crucial that hunting management documentation objectively appreciate all facts from the field (Ristić et al. 2014).

Although remote sensing technology has recently emerged to support data collecting and analysis in forest management (Paivinen et al. 2009, Kuvan et al. 2011, Kalamucka et al. 2016), it is still not sufficiently used, especially in fields of hunting ground management (Franklin 2001). Osborne et al. (2001) have applied NDVI on habitat modeling of great bustards. Even though a different methodology was used it was seen that NDVI is a reliable source for vegetation estimate. Due to importance and complexity of the vegetation evaluation process, we have indicated that NDVI can establish clear mechanism for provision of essential information about vegetation conditions in hunting ground. Through our analysis of NDVIs, controlled by fieldwork measurements, it has become evident that we have obtained reliable results.

According to the methodology of habitat evaluation for big and small game used in the Republic of Serbia, the minimum number of points can be given for the abundance of vegetation is 8, while given a maximum of 20 points it is considered that the hunting ground has exceptional conditions for survival and keeping of game when it comes to vegetation. In this paper, the assessment of vegetation factor was done by processing satellite images for two periods of the year – May and December/January. In May, most wildlife in hunting grounds in Serbia brings up their offspring, so it is extremely important to have the information about the presence of vegetation. Vegetation at that time serves to hide youngling from predators and disasters, but also to ensure protection from disturbance. For the second period, December and January are taken as part of the year when vegetation coverage is minimal due to winter, and therefore game is depleted of natural sources of food. During this period it is necessary that management of hunting ground organizes the providing of food and salt on a regular basis. It is important to emphasize is that feeders for game are positioned precisely in forests and areas of hunting grounds that have a lot of vegetation. This way, the game is ensured to have calmness while taking food and salt, which in the winter months can be a key factor in the survival of wildlife in the hunting ground.

5. Conclusion

The former method of evaluation of crucial factors in the hunting ground proved as very subjective and often imprecise. On the basis of such estimates, it was not possible to get the right state of the hunting grounds, which is proved by the incompatibility of the planned number of game with the number of game calculated during spring counts. With this in mind, it can be concluded that then there is a wrong assessment in the preparation of planning documents and that consequently influences the game management process. The abundance of vegetation is one of the most important factors of the presence, quantity, and quality of game in one habitat or hunting ground. Having numerous, healthy and game with strong trophies is one of the main objectives of hunting management, the need for precise estimates related to the habitat is clear.

This paper proposes a new method by using GIS technology. Using satellite imagery detailed vegetation coverage assessment is enabled in different periods of the year. After the analysis, maps of the hunting ground were made showing the detail dispersion of the vegetation in the hunting ground. In addition, the percentage range is obtained for each of these months. The fieldwork control measurements show the high percentage of reliability of this method for vegetation assessment.

This methodology can be used in both big and small game. Also, one of the advantages over the previous method of assessing vegetation factor is that there is the possibility of making maps of the hunting ground which show the vegetation distribution in the hunting ground, which was not the case with the classical method of evaluation. Besides that, the assessment is much more accurate, since it is done on the basis of the digitization of the hunting ground, therefore it is determined much more precisely. Access to each of the factors in this way will allow evaluation with a lot of data on the actual situation in the hunting ground. Given the widespread degradation of the habitat, new ways for better management of hunting grounds and conservation of game must be sought, and that is the use of GIS for this purpose. NDVI can be of great help in acquiring new and improving data about the state of vegetation. Taking into consideration that NDVI is relatively cheap and quick, it is easy to be implemented. In order to properly manage with hunting grounds, a more comprehensive analysis of natural conditions as vegetation through the applications of NDVI offers to hunting stakeholders more sophisticated possibilities for hunting ground management.

The paper has proven that there are differences in results between the old and proposed new methods of vegetation evaluation. It can be noted that the difference in the results is not very prominent, but even that can make a difference in the field during the hunting management process. Further research is necessary and other types of hunting grounds need to be included to confirm this methodology.

References

Andersen, R., Hervindal, I., Seather, B.E. (2004). When range expansion rate is faster in marginal habitats. *Oikos*, *107*, 210-214.

Boone, R., B., Thirgood, S., J., Hopcraft J., G., C. (2006). Serengeti wildebeest migratory patterns modeled from rainfall and new vegetation growth. *Ecology, 87*, 1987-1994.

Car, Z.(1961). *Bonitiranje lovišta za jelena, srnu, divokozu i tetrijeba*. Lovačka knjiga, Zagreb.

Chan-Ryul, P., Woo-Shin, L. (2003). Development of a GIS-based habitat suitability model for wild boar *Sus scrofa* in the Mt. Baekwoonsan region, Korea. *Mammal Study*, 2003, *28*(1), 17-21.

Clevenger, A. P., Wierzchowski, J.,Chruszcz, B., Gunson, K. (2002). GIS-Generated, Expert-Based Models for Identifying Wildlife Habitat Linkages and Planning Mitigation Passages. *Conservation Biology*, *16*, 503-514.

Drenić, M. (1997). *Planiranje gazdovanja lovištima*. Šumarska škola Kraljevo.

Đorđević, N., Grubić, G., Popović, Z., Beuković, M.(2010). *Gazdovanje populacijama srna i divljih svinja u cilju smanjenja šteta u poljoprivredi i šumarstvu Srbije*. Radovi sa XXIV savetovanja agronoma, veterinara i tehnologa, Beograd, *16*(3-4), 189-200.

Edwards, P.J., Fletcher, M.R., Berny, P.(2000). Review of the factors affecting the decline of the European brown hare, Lepus europaeus (Pallas, 1778) and the use of wildlife incident data to evaluate the significance of paraquat. *AgrEcosyst Environ, 79*, 95-103.

Franklin, S. (2001). Remote sensing for sustainable forest management. *Lewis Publisher*, New York.

Gerrard, R., Stine, P., Church, R., Gilpin, M. (2001). Habitat evaluation using GIS: a case study applied to the San Joaquin Kit Fox. *Landscape and Urban Planning, 52*, 239-255.

Hamel, S., Garel, M., Festa-Bianchet, M., Gaillard, J., M., Côté, S., D. (2009). Spring normalized difference vegetation index (NDVI) predicts annual variation in timing of peak faecal crude protein in mountain ungulates. *J ApplEcol, 46*, 582-589.

Jaskula, J., Sojka, M., Wicher-Dysarz, J. (2018). Analysis of the vegetation Process in a Two-stage Reservior on the Basis of Satellite Imagery – a Case Study: Razyny Reservior on the Sama River. *Rocznik Ochrona Środowiska*, *20*. 203-220.

Jepsen, J.U., Topping, C.J. (2004). Modelling roe deer (*Capreoluscapreolus*) in a gradient of forest fragmentation: behavioural plasticity and choice of cover. *Canadian Journal of Zoology*, *82*(9), 1528-1541.

Jovanović, M., Milanović, M. (2015). Normalized Difference Vegetation Index (NDVI) as the Basis for Local Forest Management. Example of the Municiality of Topola, Serbia. *Pol. J. Environ. Stud*., *24*(2) 529-535.

Kalamucka, W., Kalamucki, K., Tsebrykove P., Cygan, J. (2016). Changes in the size and spatial structure of the forest cover and the development of a network of protected areas in Roztocze in the twentieth century. *Rocznik Ochrona Środowiska*, *18*, 363-374.

Kunovac, S., Omanović, M. (2012).*Game habitats modeling*. International Conference Structure and dynamics of ecosystems Dinarides – status, possibilities and prospects“ 15-16. June 2011, Sarajevo, Bosnia and Herzegovina, Department of Natural Sciences and Mathematics, Proceedings, *23*, 127-134.

Kushwaha, S., P., S., Roy, P., S. (2002). Geospatial technology for wildlife habitat evaluation. *Tropical Ecology*, *43*(1), 137-150.

Kuvan, Y., Erol, Y.S., Yildirim, H.T. (2011). Forest Managers' Perceptions of the Foremost Forestry Issues and Functions in Tukrey. *Pol. J. Environ. Stud*., *20*(2), 393-403.

Maringer, A. & Slotta-Bachmayr, L. (2006). A GIS-based habitat-suitability model as a tool for the management of beaversCastor fiber. *ActaTheriol, 51*, 373.

Marković, V., Klaučo, M., Stankov, U., Jovanović, T., Ristić, Z. (2014). Evaluation of Human Impact on the Land Cover Trough Landscape Metrics: Nature Park „Šragan-Mokra Gora“ (Serbia). *Rocznik Ochrona Środowiska*, *16*, 52-73.

Nađ, I., Marković, V., Pavlović, M., Stankov, U., Vuksanović, G. (2018). Assessing inland excess water risk in Kanjiza (Serbia). *Geografie, 123*(2), 141-158.

Osborne, P., Alonso, J., Bryant, R. (2001). Modelling landscape-scale habitat use using GIS and remote sensing: a case study with great bustards. *Journal of Applied Ecology*, *38*, 458-471.

Paivinen, R., Brusselan, J.,V., Schuck, A. (2009). The growing stock of European forests using remote sensing and forest inventory data. *Forestry, 82*(5), 479-490.

Pettorelli, N., Vik, J.O., Mysterud, A., Gaillard, J.M.., Tucker, C., B., Stenseth, N. (2005). Using the satellite-derived NDVI to assess ecological responses to environmental change. *Trends in Ecology and Evolution*, *20*(9): 503-510.

Pettorelli, N., Mysterud, A., Yoccoz, N., G., Langvatn, R., Stenseth, N., C. (2005b). Importance of climatological downscaling and plant phenology for red deer in heterogeneous landscapes. *ProcBiolSci, 272*, 2357-2364.

Pettorelli, N., Pelletier, F., von Hardenberg, A., Festa-Bianchet, M., Cote, S., D. (2007a). Early onset of vegetation growth versus rapid green-up: impacts on juvenile mountain ungulates. *Ecology, 88*, 381-390.

Pettorelli, N., Ryan, S., Mueller, T., Bunnefeld, N., Jędrzejewska, B., Lima, M., Kausrud, K. (2011). The Normalized Difference Vegetation Index (NDVI): unforeseen successes in animal ecology. *Climate research*, *46*, 15-27.

Radeloff, V., C., Pidgeon, A., M., Hostert. P. (1999). Habitat and population modelling of roe deer using an interactive geographic information system. *Ecological Modelling*, *114*(2-3), 287-304.

Ristić, Z., Đan, M., Davidović, N., Marković, V., Kovačević, M, Matejević, M.(2014). Determination of the ideal and real growth for the roe deer (Capreolus capreolus, 1758) in the hunting grounds of Vojvodina. *Contemporary Agriculture*, *63*(4-5): 425-432.

Srdić, D.(1955). *Bonitiranje lovišta za zečeve, fazane, kamenjarke i trčke*. Institut za šumarstvo i lovačka istraživanja, Zagreb.

Suchant, R., Baritz, R., Braunisch, V. (2003). Wildlife habitat analysis: a multidimensional habitat management model. *J. Nat. Conserv*. *10*, 253-268.

Tomašević, B., Radosavljević, L., Ćeranić, A. (1997). *Bonitiranje lovišta*. Lovačka biblioteka Sv. Evstatije, Beograd.

Vospernik, V., Bokalo, M., Reimoser, F., Sterba, H. (2007). Evaluation of a vegetation simulator for roe deer habitat predictions. *Ecological Modelling*, *202*(3-4), 265-280.

Vospernik, S., Reimoser, S. (2008). Modelling changes in roe deer habitat in response to forest management. *Forest Ecology and Management*, *255*(3-4), 530-545.

Weiers, S., Bock, M., Wissen, M., Rossner, G. (2004). Mapping and indicator approaches for the assessment of habitats at different scales using remote sensing and GIS methods. *Landscape and Urban Planning*, *67*(1), 43-65.

Young, K., D., Ferreira, S., M., van Aarde, R., J. (2009). Elephant spatial use in wet and dry savannas of southern Africa. *J Zool (Lond)* 278, 189-205.

Abstract

Recent researches have determined that vegetation is one of the essential factors for game habitat quality. Vegetation is important in the form of the following components: as a food supplier, as a shelter provider, as the creator and regulator of the micro-climate of the habitat, etc. Past practice has shown that the classical methods for evaluating habitat factors involve a lot of subjectivity and often lead to an unrealistic estimate of hunting ground capacity that can affect sustainable game management. Instead of the classical analyses, paper proposes assessment of this factor using Geographic Information System (GIS). NDVI – normalized difference vegetation index is a graphical indicator that can be used to analyze images obtained by remote sensing and is used for these purposes. The researched area was hunting ground "Kapetanski rit" – Kanjiža, Serbia. In order to assess the vegetation factor, the analysis of satellite images is done for two periods of the year (May and December/January). In May the game prepares shelters for bringing an offspring and the period December/January is taken as part of the year when vegetation coverage is minimal due to winter and game is in need of additional food and shelter. Based on the results and maps, the user of the hunting ground can have a clearer view of the vegetation types and distribution, hence assistance in planning and analyzing the territorial distribution of the game. Comparing classical methods for evaluating vegetation and the use of GIS for this purpose shows the advantages of new improved GIS methodology.

Keywords:
habitat evaluation, vegetation, GIS, NDVI, hunting ground