PAPER • OPEN ACCESS

Environmental threats to beekeeping in the Western Balkan countries - beekeepers' perceptions

To cite this article: Bojana Bekić Šarić *et al* 2023 *Environ. Res. Commun.* **5** 065003

Environmental Research Communications

PAPER

Environmental threats to beekeeping in the Western Balkan countries - beekeepers' perceptions

Bojana Bekić Šarić[1,*], **Etleva Dashi Muça**[2], **Jonel Subić**[1], **Irena Džimrevska**[3] and **Slađan Rašić**[4]

[1] Institute of Agricultural Economics Belgrade 11060, Serbia
[2] Department of Economy and Rural Development Policies, Faculty of Economy and Agribusiness, Tirana 1000, Albania
[3] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Skopje 1000, Republic of North Macedonia
[4] Faculty of Ecological Agriculture, Educons University, Sremska Kamenica 21208, Serbia
[*] Author to whom any correspondence should be addressed.

E-mail: bojanabekic@yahoo.com, evadashi@ubt.edu.al, jonel_s@iep.bg.ac.rs, irena.djimrevska@giz.de and rasic.sladjan@gmail.com

Keywords: honeybees, climate change, survey

OPEN ACCESS

RECEIVED
17 January 2023

REVISED
18 April 2023

ACCEPTED FOR PUBLICATION
25 May 2023

PUBLISHED
5 June 2023

Abstract

The subject of the paper refers to the research on beekeepers' perceptions of environmental threats to beekeeping in the Western Balkan region. The following environmental threats were supposed to be the most pronounced: cutting of melliferous perennial plants and clearing of forests, urbanisation and environmental pollution, use of pesticides in agricultural production, pests and agents of bees' diseases, climate changes. The aim of the research was to find out how beekeepers perceived these threats, to determine the presence of the threats and to define their intensity as well as their mutual relationship. For the purpose of this research, the authors created a structured questionnaire which was filled in by randomly selected beekeepers living in the Western Balkans. The research results show that most beekeepers in the studied area evaluated the assumed threats as strong to very strong, while the greatest percentage of beekeepers believes that climate change represents the greatest threat to beekeeping in the region. All assumed environmental threats show the same tendency, while they have the most serious effect on large apiaries with more than 150 bee colonies, located in lowland areas up to 200 meters above sea level with intensive farming. Findings of this research are important in order to adapt the current beekeeping practice in the region to more sustainable solutions, through improvement of the existing beekeeping legislation and advisory services.

1. Introduction

The honey bee (*Apis mellifera* L) is an insect which is extremely significant for humans since it is the main pollinator of agricultural crops intended for human and animal nutrition [1]. This species is the most frequent visitor of flowering agricultural crops and spontaneous vegetation worldwide, and its pollination of flowers enables the ecosystem functioning [2]. The honey bee is a generalist pollinator with large perennial colonies which ensure pollination during the whole season [3]. In addition to their influence on the crop yield stability and reproduction of wild plant populations, honey bees also provide a series of other benefits to people, such as making honey and other bee products, aesthetic and cultural values [4]. During the last decade, there has been a significant decrease in the number of honey bee colonies in certain areas in the world, especially in North America and Europe [5, 6]. Numerous authors have studied the causes of this decrease, i.e. threats to beekeeping in specific areas or at the global level [7–10]. The largest number of studies are related to the relationship between climate change and beekeeping [11–14], as well as the impact of urbanisation and changes regarding land use [15, 16], environmental pollution [17], agriculture [18, 19], and diseases and pests [20] on the honey bee. Endangering honey bee populations by numerous threats may have a negative influence on the reproduction of plants, which might lead to changes in the floristic composition of plant communities and consequently to

changes in the ecosystem services provided by these plant communities [2]. Also, endangering honey bee populations could lead to the disturbances in the agricultural crop production due to the gap between the requirements for crop pollination and availability of pollinators [21].

According to Steinhauer *et al* [9], long-term success in beekeeping depends on the continuous monitoring of numerous environmental factors which constantly change and affect the honey bee health. The activities that beekeepers undertake in their apiaries depend on their perception of the environment. According to López-Uribe and Simone-Finstrom [22], the survival of honey bee colonies depends on the actions taken by beekeepers to respond to environmental threats. Understanding people's perceptions is crucial for understanding behaviours and development of efficient management practices with the aim of maintenance, conservation and improvement of biodiversity, ecosystem services and well-being of people [23]. Beekeepers are determinant in the maintenance of domesticated honey bees in nature [24]. Therefore, it is important to understand beekeepers' perception of risks affecting honey bee health and mortality in order to analyse the reasons for adopting or rejecting some beekeeping management practices [25].

When setting up the research, the main starting hypothesis was that beekeeping in the Western Balkan region was exposed to numerous environmental threats. Based on authors' expert opinion, the following environmental threats were supposed to be the strongest: cutting of melliferous perennial plants and clearing of forests, urbanisation and environmental pollution, use of pesticides in agricultural production, pests and agents of bees' diseases, and climate change. The aim was to determine whether the mentioned threats were present in the Western Balkans, what their intensity was and what their mutual relationships were like. This was conducted by examining the perceptions of beekeepers as the main subjects in the field of honey bee keeping. In addition, since the research included a larger number of variables defining the production conditions in beekeeping and demographic characteristics of beekeepers, the authors were interested in finding out which of the variables had the most significant contribution in forming the beekeepers' attitudes about the impact of environmental threats on the production in the Western Balkans.

The limitation of the study lies in the fact that the obtained results represent subjective opinions of the respondents. However, this is typical of all social studies where objectivity is difficult to confirm [26]. Nevertheless, the subjective opinions of the respondents represent valuable inputs for policy makers, as well as for confirming scientific findings and theoretical research.

So far, no comprehensive study on the impact of environmental threats on beekeeping practices in the Western Balkans has been conducted. Therefore, this study represents an addition to the studies in this field conducted worldwide.

2. Beekeeping in WBCs' national policies

Beekeeping is traditionally a small production sector in the countries of the Western Balkans, but in recent years it has gained more and more importance and it is considered an increasingly profitable business [27]. The policy in the field of agriculture and rural development in the countries of the region is the result of requirements related to the process of joining the EU27, but also the pressures of domestic actors, that is, various interest groups [28]. In the EU27, each country is obliged to draw up a three-year national apiculture program in which is defined what needs to be done and financed in the beekeeping sector at national level [29]. In the countries of the Western Balkans, there are no such programs yet, but beekeeping is recognized as a sector of the economy in strategic documents related to the development of agriculture and rural areas.

Beekeepers in the Western Balkan countries are supported by the relevant ministries with direct payments, i.e. by subsidies per beehive, in the amount which varies depending on the country [30]. By providing subsidies per beehive, market-oriented commercial households are supported, i.e. households which already have experience in beekeeping and meet legal requirements for receiving subsidies. In addition to direct payments, beekeeping is also recognized in national rural development measures for financing investment in physical assets, product certification, development of organic production, processing and marketing of agricultural products, etc [28].

In the coming period, the national policies of Western Balkans countries are expected to further adapt to the EU27 CAP, which considers redefining the current policy of incentives, as well as the introduction of new measures, such as agri-environment measures, support for farmers' association, promotion and development of local markets and short supply chains, etc.

Figure 1. Geographic position of the Western Balkans (according to https://www.mapchart.net/europe.html).

3. Materials and methods

3.1. Research area

The Western Balkan region includes Serbia, Montenegro, Bosnia and Herzegovina, North Macedonia, Albania, and Kosovo*[5] (figure 1). The whole area is rich with biodiversity, natural resources and cultural landscapes [31]. The agricultural sector has an important role when it comes to the employment of local inhabitants in the region [30, 32, 33]. However, agricultural activities greatly 'rely' on the overexploitation of natural resources, which degrades the environment [34, 35]. Agricultural and rural development policies in the Western Balkans have not yet recognised the importance of finding links between agriculture and environmental protection [36]. About 59% of the total agricultural land in the Western Balkans is occupied by small farms [37], which are either being abandoned or adopting intensified production [38].

As a sector of agriculture, beekeeping is most commonly a family business with a long-standing tradition [39, 40]. Despite numerous challenges [41, 42], it shows a growing trend [43]. There are favorable natural resources for the development of commercial beekeeping in the region [44]. However, there is a large share of non-professional beekeepers in the total number of beekeepers in the area and the number of beehives per beekeeper is small [37]. In the area, the main product of beekeeping is honey, whose production is profitable and competitive on the foreign market. It requires low initial investment and offers possibilities for independent production and employment of the young and unemployed [45, 46]. Beekeeping is most commonly a part-time job which provides additional income to households [47, 48].

3.2. Applied instrument

The research method applied in this study was a survey, which has been frequently applied in previous examinations of attitudes, perceptions or opinions of a target group regarding a selected topic [13, 49–51]. A structured questionnaire was created in both print and electronic versions and it was applied in the region of the Western Balkans. The questionnaire was translated into the languages of the countries in the region and distributed in the period from December 2021 to February 2022. The beekeepers' contact information was obtained through local and national beekeepers' associations, social networks, personal contacts and recommendations. The link leading to the questionnaire was posted on the website of the Association of the Beekeeping Organisations in Serbia (Savez pčelarskih organizacija Srbije - SPOS) and it was available to a large number of beekeepers in the region. The final version of the survey was preceded by a pilot study using a sample

[5] *This designation is without prejudice to positions on status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo declaration of independence.

of ten beekeepers in order to eliminate possible uncertainties and logical miSunderstandings which might occur while filling in the questionnaire.

The questionnaire applied contained a series of questions which were expected to be answered by beekeepers. The first group of questions referred to general demographic and professional categories: (a) age group (up to 25, 26–40, 41–65, over 65), (b) experience in the field of beekeeping (up to two years of experience, 3–10 years of experience, 11–20 years of experience, over 20 years of experience), (c) location of the household/holding (urban settlement, suburban settlement, rural settlement of medium-level and high-level development, undeveloped, sparsely populated and inaccessible rural settlement, tourist centre), (d) altitude of the apiary (up to 200 m, 201–500 m, 501–1000 m, over 1000 m), (e) area surrounding the apiary (intensive crop and vegetable production, intensive fruit production, intensive animal farming, extensive farming, non-agricultural area), (f) number of production colonies (up to 30, 31–90, 91–150, over 150).

The second part of the questionnaire included the questions related to the beekeepers' opinions about the strength of five offered environmental threats to beekeeping practices in the places where they lived and kept bees: (1) cutting of melliferous perennial plants and clearing of forests, (2) urbanisation and environmental pollution, (3) use of pesticides in agricultural production, (4) pests and agents of bees' diseases (ticks, bacteria, viruses, etc), (5) climate change (extreme droughts, natural disasters and alike). Each individual threat was assigned a 7-point scale of evaluation: 1- not a threat, 2- very weak threat, 3 - weak threat, 4 - moderate threat, 5 - moderately strong threat, 6 - strong threat, 7 - very strong threat.

3.3. Survey sample

The sample of the respondents involved 1080 beekeepers who filled in the complete questionnaire. Beekeepers from all countries of the Western Balkans responded to the survey: 566 from Serbia, 267 from Albania, 118 from Macedonia, 57 from Bosnia and Herzegovina, 50 from Montenegro and 22 from Kosovo. All the respondents completed the questionnaire voluntarily and anonymously. The answers could be provided only once. The consent for filling out the questionnaire was gained from all respondents.

3.4. Statistical procedures

The data obtained in the research were processed in accordance with the objectives of the research. The basic idea was to use specific multivariate analysis to determine the relationship among the environmental threats, demographic variables and variables for evaluating production conditions in beekeeping. The choice of applied statistical methods was adapted to the nature and the type of data obtained through survey questionnaire.

In the first step, frequencies and percentage share of individual categories were determined for all questionnaire items, which served as a base for description of the results of the survey questionnaire.

The structure and reliability of variables formed at the Environmental Threats scale were analyzed with Multiple correspondence analysis (MCA), due to the ordinal nature of the data and significant deviation of the data from normal distribution. Two latent dimensions and their discrimination measures were defined; the correlation coefficients of the transformed variables were calculated and Cronbach's alpha coefficients of reliability of the isolated dimensions were determined. Since this analysis showed that the applied scale of environmental threats was one-dimensional, the scale value was determined by the simple summation of results for the individual scale variables.

A two-step cluster analysis was applied to analyze the classification of respondents based on the scale value of environmental threats. The analysis established the presence of two characteristic clusters: a cluster of respondents with higher scale values and a cluster of respondents with low scale values. Cluster membership was determined for each respondent and a variable was formed with the codes belonging to the corresponding cluster.

The basic descriptive statistics were determined for the scale value of the entire sample and cluster groups: the arithmetic mean, standard deviation, minimum and maximum results. The normality of distribution of the scale value results was tested by means of the Shapiro-Wilk test.

Given that the natural classification of respondents into two clusters was established, the analysis of the influence of demographic characteristics of beekeepers and production conditions in beekeeping was performed using Binary logistic regression analysis. The cluster membership variable was used as a criterion variable. The predictor system of variables in this analysis consisted of variables: apiary altitude, apiary location, beekeeper age, beekeeper experience and number of production colonies. The authors were interested in finding out which variables had the most significant contribution to forming the beekeepers' attitudes on the impact of environmental threats on the production in the Western Balkans.

The data were processed using the statistical software Statistical Package for the Social Sciences (SPSS).The alpha level of 0.05 was used when determining the statistical significance.

Table 1. Correlations of the transformed variables and eigenvalue of matrix.

Variables	1	2	3	4	5
1. Cutting of melliferous perennial plants and clearing of forests	1.00				
2. Urbanisation and environmental pollution	0.61	1.00			
3. Use of pesticides in agricultural production	0.48	0.56	1.00		
4. Pests and agents of bees' diseases (ticks, bacteria, viruses, etc)	0.39	0.40	0.37	1.00	
5. Climate change (extreme droughts, natural disasters and alike)	0.42	0.44	0.39	0.48	1.00
Dimension	1	2	3	4	5
Eigenvalue	2.824	0.762	0.528	0.511	0.375

4. Results

The research results showed that most beekeepers believed that climate change (extreme droughts, natural disasters, etc) were the greatest threat to beekeeping. 70.6% of the respondents evaluated it as a strong to very strong threat to beekeeping. Out of the total number of the respondents, only 3.6% did not perceive climate change as a threat to beekeeping in their place of residence, i.e. they evaluated this threat as not present or very weak. The beekeepers reported that decrease of areas covered by vegetation (cutting of melliferous perennial plants and clearing of forests) had the second-greatest negative impact on beekeeping practices. In other words, 60.3% of the respondents evaluated this threat as strong to very strong, while only 12.2% of the respondents stated that this environmental threat was not present or that it was present to a very small degree in the place where they kept bees. The following threats were evaluated as strong to very strong by the beekeepers: urbanisation and environmental pollution (59.4% of the respondents), use of pesticides in agricultural production (58.5% of the respondents), and pests and agents of bees' diseases - ticks, bacteria, viruses (46.3% of the respondents). Out of the total number of the respondents, less than one quarter stated that urbanisation and environmental pollution, pesticides and pests and diseases did not represent a threat or represented a weak threat to the honey bee in the places where they lived and kept bees.

The multiple correspondence analysis (MCA) was applied in order to determine mutual relationships and structure of the systems of the variables obtained by means of the Environmental Threats scale. Two dimensions encompassing the total variance of the predictors were defined. The first dimension had greater reliability (Cronbach's alpha = 0.81) and encompassed 56% of the variance, while the second dimension had the reliability of alpha = 0.68 and encompassed 44% of the variance. Correlations among the transformed variables had positive and moderate correlation coefficients (table 1). The first dimension had a significantly greater eigenvalue than other dimensions, which indicated that it was the most important in defining the correlations between the variables and that the applied system of the variables of environmental threats was one-dimensional.

Based on the graphical representation of discrimination measures (figure 2), it can be concluded that all the environmental threat variables have the same direction and the same subject of estimation. This confirms the above-mentioned conclusion regarding the one-dimensional nature of the analysed variables' system. The variables named cutting of melliferous perennial plants and clearing of forests, urbanisation and environmental pollution and use of pesticides in agricultural production had the highest projections on the first dimension presented on the *x*-axis and they defined this dimension best.

Figure 3 shows the distribution of the scale value of environmental threats which had a statistically significant deviation from the normal value (Shapiro-Wilk = 0.95; p = 0.001) with a significant asymmetry of distribution towards the zone of higher values. This means that most of the respondents estimated the mentioned environmental threats as strong or very strong. This is also shown by the significantly greater average value of the scale (26.64) in comparison to the theoretical mean value (17.5).

The two-step cluster analysis was applied in order to analyse grouping of the beekeepers based on the scale value of environmental threats. Two homogeneous clusters were registered in the beekeeper sample. A greater cluster included the beekeepers who estimated the threats as strong or very strong, so this cluster was defined as Strong Threats. The other cluster was defined as Weak Threats and it involved the beekeepers who estimated the analysed threats as weak or moderately weak. Table 2 shows basic statistics of the scale values of the isolated beekeeper clusters.

The Binary logistic regression analysis (table 3) showed that the applied set of predictor variables had a statistically significant impact on forming the beekeepers' attitudes about environmental threats on the production (X2 = 82.45; p = 0.001).

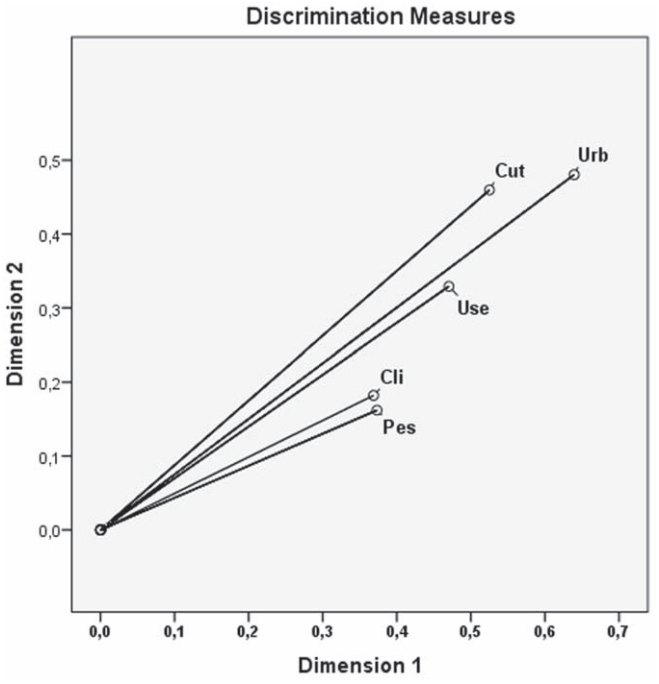

Figure 2. Discrimination measures of the Environmental Threat Variables: Cut - Cutting of melliferous perennial plants and clearing of forests; Urb - Urbanisation and environmental pollution; Use - Use of pesticides in agricultural production; Pes - Pests and agents of bees' diseases (ticks, bacteria, viruses, etc); Cli - Climate change (extreme droughts, natural disasters and alike).

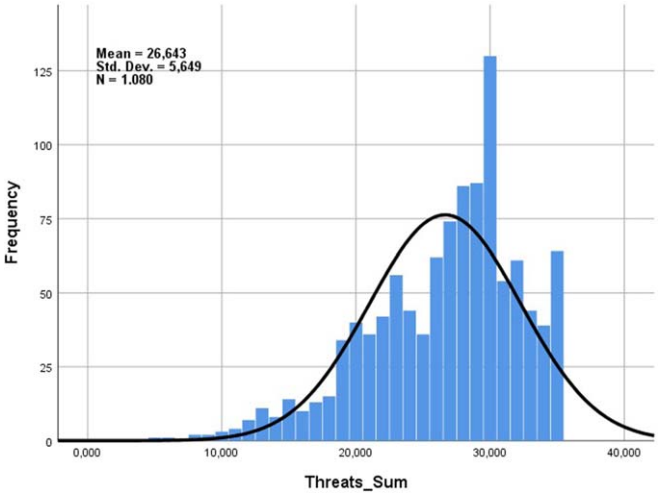

Figure 3. Distribution of the results of the scale value of Environmental Threats.

Table 2. Basic statistics of the scale values of the isolated beekeeper clusters.

Clusters	N	Min.	Max.	Mean	Std.	SW
Strong Threats	701	26	35	30,08	2,67	0.001**
Weak Threats	379	5	25	20,29	3,93	0.007**
Scale value	1080	5	35	26,64	5,65	0,001**

Legend: N-number of respondents; Min.—minimal value; Max.—maximal value; Mean—arithmetic mean; Std.—standard deviation; SW—Shapiro-Wilk test of normal deviation.

** significant value $\alpha \leqslant 0.01$.

Table 3. Results of the binary logistic regression analysis.

Variables and categories	Wald	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Altitude of the apiary	13.3	0.001			
Lowland area (up to 200 m) **	**12.415**	**0.001**	**1.935**	**1.34**	**2.792**
Hilly area (201–500 m)	1.378	0.241	1.22	0.875	1.699
Mountainous area (above 500 m) (reference)					
Location of the household/holding	3.967	0.138			
Urban settlement and suburban Settlement *	**3.967**	**0.046**	**0.73**	**0.536**	**0.995**
Rural settlement of medium-level and high-level development	0.61	0.435	0.87	0.613	1.234
Undeveloped, sparsely populated and inaccessible rural settlement (reference)					
Age group	2.039	0.361			
Young beekeepers (up to 40 years)	1.405	0.236	1.346	0.823	2.2
Mature beekeepers (41–65)	2.012	0.156	1.35	0.892	2.045
Over 65 (reference)					
Experience in the field of beekeeping	0.741	0.69			
Less experienced (up to 10 years)	0.000	0.995	0.999	0.68	1.466
Medium experienced (11–20 years)	0.493	0.482	1.143	0.788	1.658
Over 20 years of experience (reference)					
Area surrounding the apiary	6.419	0.04			
Intensive farming*	**4.184**	**0.041**	**1.485**	**1.017**	**2.169**
Extensive farming	0.062	0.803	1.049	0.718	1.533
Non-agricultural area (reference)					
Number of production colonies	15.989	0.001			
Hobbyists (up to 30 colonies) **	**12.244**	**0.001**	**0.414**	**0.253**	**0.679**
Part time beekeepers (31–150 colonies)	2.495	0.114	0.7	0.45	1.09
Professsionals (over 150 colonies) (reference)					

Legend: * - significant at alpha level 0.05.
** - significant at alpha level 0,01; Wald - X2 test.
Sig. - statistical significance; Exp(B) - odds ratio; 95% C.I. for EXP(B) - confidence interval for odds ratio.

Out of the applied predictor variables, the following variables had a statistically significant impact on forming the beekeepers' attitude about environmental threats: altitude of the apiary, description of the area surrounding the apiary in terms of the development of agricultural production and number of bee colonies.

The results showed that the beekeepers from the lowlands had two times (1.935) higher chances to estimate environmental threats as Strong Threats than the beekeepers whose apiaries were in the mountainous areas. The beekeepers who operate in the areas with intensive farming have 1.5 times (1.485) higher chances to estimate environmental threats as Strong Threats than the beekeepers from non-agricultural areas. Hobbyist beekeepers with approximately 30 or fewer bee colonies are 30% less likely to estimate environmental threats as Strong Threats than professional beekeepers. Beekeepers from urban and suburban settlements are 42% less likely to rate environmental threats as strong threats, than beekeepers from undeveloped, sparsely populated and inaccessible settlements.

5. Discussion

The results of this research showed that climate change represented a great threat to beekeeping in the region of the Western Balkans. Numerous authors studied the impact of climate change on beekeeping in other areas of the world and reached the same conclusions [11, 14, 52]. Thus, Brown and Paxton [53] stated that climate change could be the major future threat for beekeeping.

As for the altitude where bees are kept, it was concluded in the research that apiaries in the lowlands were more exposed to environmental threats than apiaries in mountainous area. The authors believe that one of the reasons for this might be the appearance of more pronounced droughts in the lowlands due to climate change. This research showed that large apiaries in the lowlands were more endangered than apiaries with a smaller number of colonies. This can be explained by the quantity of food or nectar which has to be provided for successful overwintering and satisfying yield, which is uncertain due to the strong impact of climate change in the lowlands. Newman *et al* [54] reached the same conclusion. They state that due to frequent droughts, nectar exudation and availability represent the main problems of beekeepers at lower altitudes. Similarly, Vercelli *et al* [55] analysed beekeeping practices in the northern areas of Italy and found that beekeepers were more endangered in lowlands, most probably due to stronger consequences of climate change. These authors state that beekeepers consequently move to higher altitudes during foraging season. Humidity is higher and droughts are less pronounced in these areas, so plants produce more nectar.

Destruction of vegetation by burning or cutting represents a strong threat to beekeeping worldwide [56–59]. This study showed that cutting forests and decreasing areas covered by melliferous plants represented a strong to very strong threat to beekeeping in the Western Balkans. Our research showed that decrease of the areas covered by vegetation was closely correlated with urbanisation, environmental pollution and agricultural intensification. This is similar to the studies of other authors [60] who state that the change in the manner of land use (development of agriculture, spreading of urban areas and infrastructure, soil degradation) represents one of the greatest threats to beekeeping in many parts of the world. The negative impact of these activities on beekeeping was also studied by some other authors [16], who stated that mortality of bee colonies was higher in the areas with more expressed anthropogenic activities. In addition, urbanisation increases air pollution. The research by McFrederick *et al* [17] showed that air pollution caused the decomposition of scent signals produced by plants, which along with vegetation fragmentation results in pollinator insects spending much more time searching for nectar and bringing less food to beehives.

Our research showed that pesticides represented a strong threat to a large number of the beekeepers in the region. The situation is similar in other areas of the world [19, 59]. The research conducted in this paper showed that the apiaries surrounded by intensively grown crops were more affected by environmental threats than the apiaries in non-agricultural areas. This conclusion can be correlated with the findings of other authors who state that intensive agricultural practices have a significant negative impact on the strength and survival of bee colonies [15, 61]. The intensity of farming is correlated with the use of pesticides [62]. Poisoning of bee colonies by pesticides is more expressed if they are located near intensively grown crops than in other areas [18]. According to Porrini *et al* [63], the mortality rate of the honey bee is positively correlated with the percentage of agricultural land surrounding the apiary. However, some studies underline that the loss of bee colonies in the areas with intensive agriculture is not greater than in the areas with more traditional forms of agricultural practices [51].

Less than a half of the respondents in the studied region evaluated pests and agents of bees' diseases as strong to very strong threats to beekeeping. Regardless of the fact that the smallest percentage of the beekeepers evaluated this threat as strong, it still represents a strong threat to a 46.3% of the beekeepers. This is in concordance with the studies of other authors, who state that pests and diseases are a significant factor affecting bee populations in other regions of the world. The disease named varroosis is considered to be a great problem faced by beekeepers [7, 50]. Jacques *et al* [64] state that beekeepers' experience and knowledge represent the most significant factors in the protection of bee colonies from diseases. According to Mezher *et al* [65], beekeepers in Europe know how to recognise and treat most of bee diseases. Bearing in mind the location of the Western Balkans in Europe, the authors suppose that the beekeepers in the Region do not lack knowledge required for recognising bee diseases and presence of pests and that they treat them in an adequate manner, thus reducing harmful effects. However, this is just a supposition which should be tested in future studies.

6. Conclusion

It is estimated that there are almost 2.5 million bee colonies in the Western Balkans. In this region, beekeeping represents a source of income for a large number of households. Consequently, the factors affecting this activity are extremely important not only from the environmental but also from the socio-economic point of view.

On the basis of the conducted research, it can be concluded that beekeeping in the Western Balkans is exposed to numerous environmental threats, among which climate change is estimated to be the strongest one. All analysed environmental threats show the same tendency and they are correlated. The strongest correlation was found between urbanisation, environmental pollution, use of pesticides in agricultural production and destruction of melliferous vegetation. Environmental threats have the greatest negative impact on the biggest

apiaries (with more than 150 bee colonies) located in lowlands (up to 200 metres above sea level) with intensive farming.

In order to provide greater sustainability of beekeeping in the observed area, future research should expand the list of the observed threats to include socio-economic threats to the beekeeping sector. In addition, a thorough analysis of the evaluation of individual environmental threats for individual countries or smaller areas within the Region can help to map the locations which are more endangered by certain threats. In this manner, specific public policy measures could be used more accurately in order to alleviate the mentioned threats.

Acknowledgments

Paper is a part of research financed by the MSTDI RS as agreed in decision no. 451-03-47/2023-01/200009 from 03.02.2023.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

ORCID iDs

Bojana Bekić Šarić https://orcid.org/0000-0001-9763-236X

References

[1] Klein A M, Boreux V, Fornoff F, Mupepele A C and Pufal G 2018 Relevance of wild and managed bees for human wellbeing *Curr. Opin. Insect. Sci.* **26** 82–8
[2] Hung K L J, Kingston J M, Albrecht M, Holway D A and Kohn J R 2018 The worldwide importance of honey bees as pollinators in natural habitats *Proc. Royal Soc.* B **285** 20172140
[3] De la Rúa P, Jaffé R, Dall'Olio R, Muñoz I and Serrano J 2009 Biodiversity, conservation and current threats to European honeybees *Apidologie* **40** 263–84
[4] Dicks L V *et al* 2021 A global-scale expert assessment of drivers and risks associated with pollinator decline *Nat. Ecol. Evol.* **5** 1453–61
[5] Dainat B, Vanengelsdorp D and Neumann P 2012 Colony collapse disorder in Europe *Environ. Microbiol. Rep.* **4** 123–5
[6] Steinhauer N A *et al* 2014 A national survey of managed honey bee 2012-2013 annual colony losses in the USA: results from the bee informed partnership *J. Apic. Res.* **53** 1–18
[7] El Agrebi N, Steinhauer N, Renault V, de Graaf D C and Saegerman C 2022 Beekeepers' perception of risks affecting colony loss: a pilot survey *Transbound. Emerg. Dis.* **69** 579–90
[8] Erhabor T A, Ukanyirioha C J, Nwosu R I, Baba G O, Yakubu C K and Sulaiman Y D 2021 Threats to honeybees and beekeeping practices in mangu local government area, Plateau state, Nigeria Australian *J. Sci. Technol.* **5** 544–7
[9] Steinhauer N, Kulhanek K, Antúnez K, Human H, Chantawannakul P and Chauzat M P 2018 Drivers of colony losses *Curr. Opin. Insect. Sci.* **26** 142–8
[10] Bekić B, Jeločnik M and Subić J 2014 Honey bee colony collapse disorder (*Apis mellifera* L) - Possible causes scientific papers series management, economic engineering in agriculture and rural *Development* **14** 13–8
[11] Degu T K 2022 Beekeeping in the face of climate change in Ada Berga District, Oromia, Ethiopia *Int. J. Environ. Stud.* **79** 450–61
[12] Flores J M, Gil-Lebrero S, Gámiz V, Rodríguez M I, Ortiz M A and Quiles F J 2019 Effect of the climate change on honey bee colonies in a temperate Mediterranean zone assessed through remote hive weight monitoring system in conjunction with exhaustive colonies assessment *Sci. Total Environ.* **653** 1111–9
[13] Gadédjisso-Tossou A 2015 Understanding farmers' perceptions of and adaptations to climate change and variability: the case of the Maritime, Plateau and Savannah Regions of Togo *Agric. Sci.* **6** 1441
[14] Gallardo-López F, Castellanos-Potenciano B P, Díaz-Padilla G, Pérez-Vásquez A, Landeros-Sánchez C and Sol-Sánchez Á 2021 Cognitive dissonance in the face of climate change in beekeepers: A case study in Mexico *Rev. Mex. Cienc. Pecu* **12** 238–55
[15] Samuelson A E, Gill R J and Leadbeater E 2020 Urbanisation is associated with reduced Nosema sp. infection, higher colony strength and higher richness of foraged pollen in honeybees *Apidologie* **51** 746–62
[16] Clermont A, Eickermann M, Kraus F, Hoffmann L and Beyer M 2015 Correlations between land covers and honey bee colony losses in a country with industrialized and rural regions *Sci. Total Environ.* **532** 1–13
[17] McFrederick Q S, Kathilankal J C and Fuentes J D 2008 Air pollution modifies floral scent trails *Atmos. Environ.* **42** 2336–48
[18] Calatayud-Vernich P, Calatayud F, Simó E, Aguilar J A , P and Picó Y 2019 A two-year monitoring of pesticide hazard in-hive: high honey bee mortality rates during insecticide poisoning episodes in apiaries located near agricultural settings *Chemosphere* **232** 471–80
[19] Dauda A M, Abbati Nasiru M S and Suleiman M 2019 The impact of some agricultural practices on populationstatus of honey bee, Apis mellifera L. in Katsina State, Nigeria *Int. J. Entomol. Res.* **4** 32–5
[20] Alonso-Prados E, González-Porto A V, Bernal J L, Bernal J, Martín-Hernández R and Higes M 2021 A case report of chronic stress in honey bee colonies induced by pathogens and acaricide residues *Pathogens* **10** 955
[21] Aizen M A and Harder L D 2009 The global stock of domesticated honey bees is growing slower than agricultural demand for pollination *Curr. Biol.* **19** 915–8
[22] López-Uribe M M and Simone-Finstrom M 2019 Honey bee research in the US: current state and solutions to beekeeping problems *Insects* **10** 22
[23] Shackleton R T *et al* 2019 Explaining people's perceptions of invasive alien species:a conceptual framework *J. Environ. Manage.* **229** 10–26

[24] Potts S G, Roberts S P, Dean R, Marris G, Brown M A, Jones R, Neumann P and Settele J 2010 Declines of managed honey bees and beekeepers in Europe *J. Apic. Res.* **49** 15–22
[25] El Agrebi N, Steinhauer N, Renault V, de Graaf D C and Saegerman C 2022 Beekeepers' perception of risks affecting colony loss: a pilot survey *Transbound. Emerg. Dis.* **69** 579–90
[26] Shipman M D 2014 *The Limitations of Social Research* 4th edn (London, England: Routledge)
[27] Milosevic S D, Möllers J, Di Marcantonio F and Ciaian P 2021 *The Best Practices and Potential of Smallholders' Participation in Short Value Chains in the Western Balkans and Turkey* (Luxembourg: Publications Office of the European Union) (https://doi.org/10.2760/921512)
[28] Erjavec E, Volk T, Rednak M, Ciaian P and Lazdinis M 2021 Agricultural policies and European Union accession processes in the Western Balkans: aspirations versus reality *Eurasian Geography and Economics* **62** 46–75
[29] Novelli S, Vercelli M and Ferracini C 2021 An easy mixed-method analysis tool to support rural development strategy decision-making for beekeeping *Land* **10** 675
[30] Volk T *et al* 2019 *Agricultural Policy Developments and EU Approximation Process in the Western Balkan Countries* (Luxembourg: Publications Office of the European Union) (https://doi.org/10.2760/583399)
[31] Volk T *et al* 2017 *Monitoringof Agricultural Policy Developments in the Western Balkan Countries* (Luxembourg: Publications Office of the European Union) (https://doi.org/10.2760/146697)
[32] Nikolić R, Fedajev A, Stefanović V and Ilić S 2017 The agriculture sector in Western Balkans - some characteristics of development *Ekonomika poljoprivrede* **64** 275–93
[33] Sanfey P and Milatovic J 2018 *The Western Balkans in Transition: Diagnosing the Constraints on the Path to a Sustainable Market Economy* (London England: European Bank for Reconstruction and Development)
[34] Kotevska A *et al* 2015 *The Impact of Socio-Economic Structure of Rural Population on Success of Rural Development Policy. Macedonia, Serbia and Bosnia and Herzegovina* (Skopje: Association of Agricultural Economists of Republic of Macedonia)
[35] Bogdanov N 2007 *Small Rural Households in Serbia and Rural Non-Farm Economy* (Serbia: Report UNDP Belgrade)
[36] Volk T *et al* 2017 *Monitoringof agricultural policy developments in the Western Balkan countries JRC Technical reports European Commission* (Luxembourg: Publications Office of the European Union)
[37] Djordjevic-Milosevic S, Möllers J, di Marcantonio F and Ciaian P 2021 *The best practices and potential of smallholders' participation in short value chains in the Western Balkans and Turkey Joint Research Centre (JRC) the European Commission's science and knowledge service* (Luxembourg: Publications Office of the European Union)
[38] Kazakova Y and Stefanova V 2010 *High nature vakkue farming in the Western Balkans: Current status and key challenges-a scoping document* (Bulgaria: The European Forum on Nature Conservation and Pastoralism (EFNCP))
[39] Bislimi K 2020 Determinants of family entrepreneurship in the beekeeping sector *J. Fam. Bus. Manag.* **12** 106–19
[40] Chauzat M P, Cauquil L, Roy L, Franco S, Hendrikx P and Ribiere-Chabert M 2013 Demographics of the European apicultural industry *PLoS One* **8** e79018
[41] Durazzo A, Lucarini M, Plutino M, Lucini L, Aromolo R, Martinelli E, Souto E B, Santini A and Pignatti G 2021 Bee products: a representation of biodiversity, sustainability, and health *Life* **11** 970
[42] Kouchner C, Ferrus C, Blanchard S, Decourtye A, Basso B, Le Conte Y and Tchamitchian M 2019 Bee farming system sustainability: an assessment framework in metropolitan France *Agric. Syst.* **176** 102653
[43] Rivard A G, Cane D, Ostrowski J E and Dawe M A 2014 *Value added products for beekeepers in Albania* (Worcester Polytechnic Institute Project Number PRC 3249) (https://core.ac.uk/download/pdf/212980752.pdf)
[44] Dedej S, Delaplane K S and Gocaj E 2000 A technical and economic evaluation of beekeeping in Albania *Bee World.* **81** 87–97
[45] Ignjatijević S, Ćirić M and Čavlin M 2015 Analysis of honey production in Serbia Aimed at improving the international competitiveness *Custos Agronegocio On Line* **11** 194–213
[46] Nedić N M, Nikolić M M and Hopić S E 2019 Economic justification of honey production in Serbia *J. Agric. Sci.* **64** 85–99
[47] Ramadani V, Hisrich R D, Dana L P, Palalic R and Panthi L 2019 Beekeeping as a family artisan entrepreneurship business *Int. J. Entrepreneurial Behav. Res.* **25** 717–30
[48] Shahu E, Ninga E, Hoxha F and Mara V 2019 Physichochemical characteristics of honey produced in different districts of Albania *J. multidiscip. eng. sci. technol.* **6** 11108–11
[49] El Agrebi N, Steinhauer N, Renault V, de Graaf D C and Saegerman C 2022 Beekeepers' perception of risks affecting colony loss: a pilot survey *Transbound. Emerg. Dis.* **69** 579–90
[50] Essayah A M, Gunduz S, Lagili H S A and Bamisile O 2019 Community perception on honeybee and beekeeping practices and constraints in tripoli *Indian. J. Sci. Technol.* **12** 1–9
[51] Fedoriak M, Kulmanov O, Zhuk A, Shkrobanets O, Tymchuk K, Moskalyk G, Olendr T, Yamelynets T and Angelstam P 2021 Stakeholders' views on sustaining honey bee health and beekeeping: the roles of ecological and social system drivers *Landsc. Ecol.* **36** 763–83
[52] Ladányi Mand Horváth L 2010 A review of the potential climate change impact on insect populations - general and agricultural aspects *Appl. Ecol. Environ. Res.* **8** 143–52
[53] Brown M J and Paxton R J 2009 The conservation of bees: a global perspective *Apidologie* **40** 410–6
[54] Newman R J S, Marchant R, Enns C and Capitani C 2021 Assessing the impacts of land use and climate interactionson beekeeping livelihoods in the Taita Hills, Kenya *Dev. Pract.* **31** 446–61
[55] Vercelli M, Novelli S, Ferrazzi P, Lentini G and Ferracini C 2021 A qualitative analysis of beekeepers' perceptions and farm management adaptations to the impact of climate change on honey bees *Insects* **12** 228
[56] Erhabor T A, Ukanyirioha C J, Nwosu R I, Baba G O, Yakubu C K and Sulaiman Y D 2021 Threats to honeybees and beekeeping practices in Mangu Local Government Area, Plateau state, Nigeria *Australian Journal of Science and Technology* **5** 544–7
[57] Patel V, Biggs E, Pauli N and Boruff B 2020 Using a socialecological system approach to enhance understanding of structural interconnectivities within the beekeeping industry for sustainable decision making *Ecol. Soc.* **25** 24
[58] Dauda A M, Abbati Nasiru M S and Suleiman M 2019 The impact of some agricultural practices on populationstatus of honey bee, Apis mellifera L. in Katsina *State, Nigeria Int. J. Entomol. Res.* **4** 32–5
[59] Newman R J S, Marchant R, Enns C and Capitani C 2021 Assessing the impacts of land use and climate interactionson beekeeping livelihoods in the Taita Hills, Kenya *Dev. Pract.* **31** 446–61
[60] Martins D J 2021 Best practice for protecting pollinators *Nat. Ecol. Evol.* **5** 1336–7
[61] Guenat S, Kunin W E, Dougill A J and Dallimer M 2019 Effects of urbanisation and management practices on pollinators in tropical Africa *J. Appl. Ecol.* **56** 214–24

[62] Newman R J S, Marchant R, Enns C and Capitani C 2021 Assessing the impacts of land use and climate interactionson beekeeping livelihoods in the Taita Hills, Kenya *Dev. Pract.* **31** 446–61
[63] Porrini C *et al* 2016 The status of honey bee health in Italy: Results from the nationwide bee monitoring network *PLoS One* **11** e0155411
[64] Jacques A, Laurent M, Epilobee Consortium, Ribière-Chabert M, Saussac M, Bougeard S, Budge G E, Hendrikx P and Chauzat M P 2017 A pan-European epidemiological study reveals honey bee colony survival depends on beekeeper education and disease control *PLoS One* **12** e0172591
[65] Mezher Z, Bubnic J, Condoleo R, Jannoni-Sebastianini F, Leto A, Proscia F and Formato G 2021 Conducting an international, exploratory survey to collect data on honey bee disease management and control *Appl. Sci.* **11** 7311