

Model for Evaluating the Impact of the Illegal Wildlife Trade

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Abstract. The calculation of the impact score of illegal wildlife trade is of great significance for the protection of wildlife. In order to accurately calculate the illegal wildlife trade impact score, this paper constructs the illegal wildlife trade impact (SEN) evaluation model based on the combined weighting method of hierarchical analysis, coefficient of variation method and CRITIC weighting method, and selects 11 second-level indexes from the three aspects of society, economy and nature. The model calculation shows that from 2009 to 2023, the scores of social, economic and natural develop in a decreasing trend from 73, 63 and 56, respectively.

Keywords: Illegal wildlife trade, SEN Evaluation Model, portfolio weighting approach.

1. Introduction

Calculation of impact scores of illegal wildlife trade is important for public health, economic development and wildlife resource conservation, and through a deeper understanding of its impacts, more effective countermeasures can be formulated so as to reduce the damage caused by illegal wildlife trade to nature and human society [1-2]. Traditional research methods based on social participation and law enforcement actions explain that illegal wildlife trade has a negative impact on the international community, but they consider fewer factors and still suffer from the shortcomings of a one-sided understanding of the impact of illegal trade [3-6]. In this paper, through the SEN evaluation model based on the combined weighting method, the scores of social, economic and natural aspects can be obtained separately, which provides a more intuitive and comprehensive understanding of the impact of illegal wildlife trade [7-14].

2. Fundamentals of the Illegal Wildlife Trade (SEN) Evaluation Model

2.1. Selection of evaluation indicators

In order to more accurately and comprehensively evaluate the impact of the illegal wildlife trade, 11 secondary indicators have been refined from the social, economic and natural dimensions. The social dimension includes markets, awareness-raising and education, arms trafficking and human trafficking; the economic dimension includes illegal revenues, ecological restoration costs, and gross ecotourism product; and the natural dimension includes biodiversity, disease transmission, species invasion and climate change.

2.2. Calculation of portfolio weights

(1) Using AHP to find the weights of the indicators

The judgment matrix is first constructed, and then the weight of each indicator relative to the other indicators is determined by the eigenvectors and maximum eigenvalues, and the formula for the weight of the first indicator is as follows.

$$w_{AHP-j} = \frac{\lambda_j}{\sum_{j=1}^n \lambda_i} \quad (1)$$

(2) Using CVM to find the weights of the indicators

Firstly, the matrix is constructed, using the method of standardization of deviation, the original matrix is standardized to obtain the matrix, then the coefficient of variation is calculated by the mean and standard deviation of the indicators, and finally the coefficient of variation of each indicator is divided by the sum of the coefficients of variation of all the indicators, and the ratio obtained is the weight of each indicator:

$$\omega_{CVM-j} = \frac{CV_j}{\sum_{j=1}^n CV_j} \tag{2}$$

(3) Using CRITIC to find the weights of the indicators

First correlate the data and construct a matrix. Variability is represented by the standard deviation of the data in each column, then the contrast of each indicator is calculated, and the correlation coefficient is used to represent the contradiction of the indicators. Multiply the indicator contrast and indicator contradiction to obtain the information carrying capacity, and then derive the objective weights.

$$\omega_{CRITIC-j} = \frac{C_j}{\sum_{j=1}^n C_j} \tag{3}$$

(4) Weighted combination of AHP, CVM and CRITIC

In this paper, a combined weighting formula is used to obtain a composite weight value, which is calculated as follows, where, $\alpha = 0.3, \beta = 0.3$:

$$W_j = \alpha \cdot W_{AHP-j} + \beta \cdot W_{CVM-j} + (1 - \alpha - \beta) \cdot W_{CRITIC-j} \tag{4}$$

2.3. Calculation of the Illegal Wildlife Trade Impact Index

In order to quantify the impact of illegal wildlife trade on society, economy and nature, combined with the weights of the indicators derived earlier, this paper constructs the formula for S, E and N:

$$\begin{cases} S = \omega_{S_1} \cdot S_1' + \omega_{S_2} \cdot S_2' + \omega_{S_3} \cdot S_3' + \omega_{S_4} \cdot S_4' \\ E = \omega_{E_1} \cdot E_1' + \omega_{E_2} \cdot E_2' + \omega_{E_3} \cdot E_3' \\ N = \omega_{N_1} \cdot N_1' + \omega_{N_2} \cdot N_2' + \omega_{N_3} \cdot N_3' + \omega_{N_4} \cdot N_4' \end{cases} \tag{5}$$

Of these, $S_1', S_2', S_3', S_4', E_1', E_2', E_3', N_1', N_2', N_3', N_4'$ indicator data were obtained from $S_1, S_2, S_3, S_4, E_1, E_2, E_3, N_1, N_2, N_3, N_4$ through normalization.

3. Results

3.1. Calculation of portfolio weights

Through the combined weighting method based on hierarchical analysis (AHP), coefficient of variation method (CVM) and CRITIC weighting method, substituting the data of each indicator, the weight of each indicator can be calculated separately, the results are shown in Figure 1:

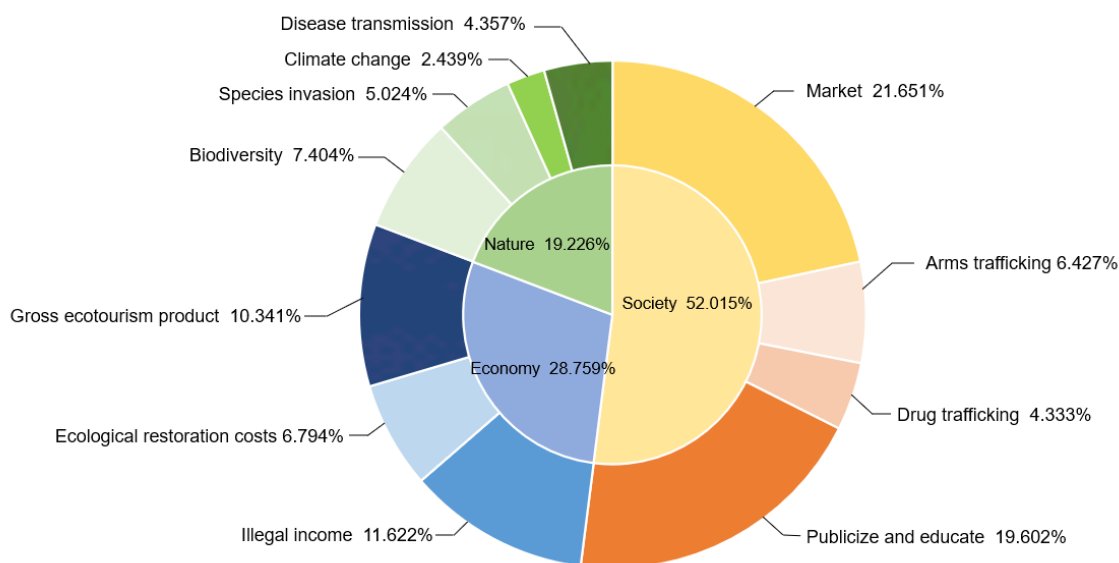


Figure 1 Weighting chart of evaluation indicators

3.2. Analysis of model results

Substituting the indicator data for a total of 15 years from 2009 - 2023 into the SEN evaluation model, the social, economic and natural scores can be obtained as shown in Figure 2:

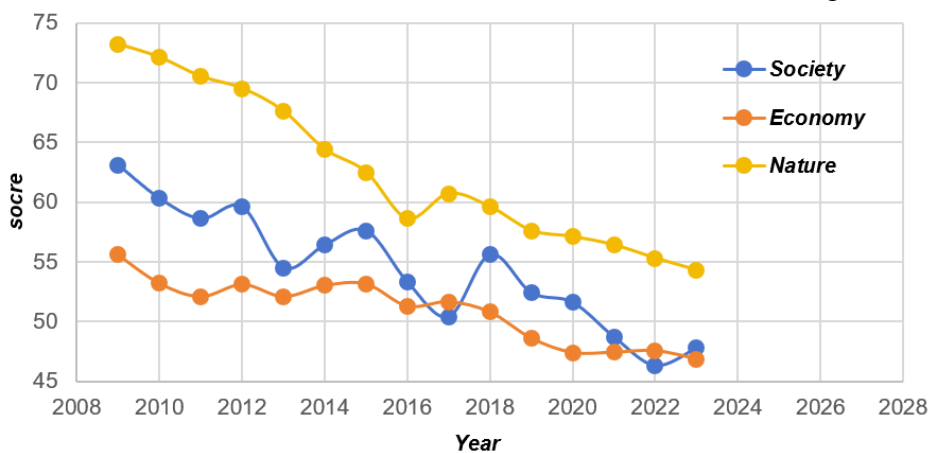


Figure 2 Illegal Wildlife Trade Impact Score

As can be seen from the figure, the overall trend of the scores of society, economy and nature is decreasing over time, indicating that the occurrence of illegal wildlife trade is getting more and more serious, which negatively affects all aspects of the globe. The calculation results are in line with the actual, indicating that the model has good performance and relatively small error.

4. Conclusions

The impact index of illegal wildlife trade provides a basis for the formulation and implementation of wildlife protection policies, but the traditional evaluation methods cannot comprehensively and accurately represent the impact of illegal wildlife trade. This paper establishes a SEN evaluation model based on the combined weight method from the social, economic and natural aspects, which makes up for the defects of the single evaluation of the traditional method. As shown by the experimental results, the model has good performance and has certain practical application value.

References

- [1] Rush E R, Dale E, Aguirre A A. Illegal wildlife trade and emerging infectious diseases: pervasive impacts to species, ecosystems and human health[J]. *Animals*, 2021, 11(6): 1821.
- [2] Hughes L J, Morton O, Scheffers B R, et al. The ecological drivers and consequences of wildlife trade[J]. *Biological Reviews*, 2023, 98(3): 775-791.
- [3] Hu S, Cheng Y, Pan R, et al. Understanding the social impacts of enforcement activities on illegal wildlife trade in China[J]. *Ambio*, 2022, 51(7): 1643-1657.
- [4] Easter T, Trautmann J, Gore M, et al. Media portrayal of the illegal trade in wildlife: The case of turtles in the US and implications for conservation[J]. *People and Nature*, 2023.
- [5] Adhiasto D N, Exploitasia I, Fahlapie P, et al. A criminal justice response to address the illegal trade of wildlife in Indonesia[J]. *Conservation Letters*, 2023: e12937.
- [6] Mozer A, Prost S. An Introduction to Illegal Wildlife Trade and its Effects on Biodiversity and Society[J]. *Forensic Science International: Animals and Environments*, 2023: 100064.
- [7] Jiao Y, Lee T M. The global magnitude and implications of legal and illegal wildlife trade in China[J]. *Oryx*, 2022, 56(3): 404-411.
- [8] Kaymaz Ç K, Birinci S, Kızılkınan Y. Sustainable development goals assessment of Erzurum province with SWOT-AHP analysis[J]. *Environment, Development and Sustainability*, 2022, 24(3): 2986-3012.
- [9] Challender D W S, Brockington D, Hinsley A, et al. Mischaracterizing wildlife trade and its impacts may mislead policy processes[J]. *Conservation Letters*, 2022, 15(1): e12832.
- [10] Novák L, Novák D. Estimation of coefficient of variation for structural analysis: The correlation interval approach[J]. *Structural Safety*, 2021, 92: 102101.
- [11] Krishnan A R, Kasim M M, Hamid R, et al. A modified CRITIC method to estimate the objective weights of decision criteria[J]. *Symmetry*, 2021, 13(6): 973.
- [12] Kelley K. Sample size planning for the coefficient of variation from the accuracy in parameter estimation approach[J]. *Behavior Research Methods*, 2007, 39(4): 755-766.
- [13] Phelps J, Biggs D, Webb E L. Tools and terms for understanding illegal wildlife trade[J]. *Frontiers in Ecology and the Environment*, 2016, 14(9): 479-489.
- [14] Van Uhm D P, Moreto W D. Corruption within the illegal wildlife trade: a symbiotic and antithetical enterprise[J]. *The British Journal of Criminology*, 2018, 58(4): 864-885.