Scholar Publishing Group
Nature Environmental Protection
https://doi.org/10.38007/NEP.2020.010103
ISSN 2790-2684 Vol. 1, Issue 1: 18-26

Evaluation Natural Environment Protection System Based on IPA Algorithm

Nikolaos Th. Fourniotis*

Institute of Environmental Sciences and Engineering (IESE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Islamabad 44000, Pakistan

**corresponding author*

Keywords: Nature Reserves, Environmental Protection, System Assessment and Optimisation, Forest Ecosystems

Abstract: At present, more and more countries are beginning to attach importance to the construction and development of nature reserves, which are special management areas where biodiversity and ecosystem services are fundamentally safeguarded by the state in order to protect the natural environment and natural resources. Deepening the understanding of the ecological benefits of various ecological assets in nature reserves and quantifying their intrinsic value is conducive to the protection of natural environment in nature reserves and the realisation of This paper uses the F nature reserve as an example. Therefore, this paper takes Nature Reserve F as an example to evaluate and optimise the nature conservation system based on IPA. The paper begins with a brief description of the principles of selecting assessment indicators and the IPA analysis method, followed by the design and construction of the management system and the forest ecosystem energy flow model, and finally the analysis of the IPA and assessment results, and finally the proposed ecological management strategy.

1. Introduction

The impact of human activities and technological developments on natural ecosystems has increased over the last two decades, and the valuation of services in nature reserves, which are primarily concerned with the protection of special representative ecosystems, has become an important part of the process of aligning the ecological, social and economic benefits of the system [1-2]. In nature reserves, the value of commodity services that enter the market directly and the value of indirect services that do not enter the market are assessed by common accounting methods into monetary values that people can clearly perceive, which helps to significantly increase public awareness of ecological protection [3-4]. Scientific accounting of the value of forest ecosystem services can provide an important reference basis for a comprehensive and systematic

understanding of the value of forest services, grasp the status and role of forestry, formulate and assess regional socio-economic development goals, and thus fully realise national sustainable development strategies [5-6].

Ecosystems are the basis for our survival and continuous development, and more and more scholars are beginning to study natural environmental protection systems [7]. For example, Konstantinos Mitropoulos et al. proposed an automated and transferable procedure that combines a validation method based on local curve fitting and local derivatives to generate plant phenology information using time series, and the results showed that smooth vegetation curves and temporal statistics can highlight seasonal gradients and leaf type characteristics, and this study highlighted the importance of integrated data and methods importance for supporting vegetation identification and monitoring activity processes [8].Apoorva Lakshman et al. assessed the spatial and temporal dynamics of ecosystem carbon storage based on shared socio-economic pathways and representative concentration pathway scenarios provided by coupled models.Future simulations suggest that by controlling population and economic growth, balancing urban expansion and ecological conservation, and increasing woodland area, it is possible to increase ecosystem carbon stocks [9]. The assessment and optimisation of natural environmental protection systems is beneficial to the development of nature reserves.

Nature reserves play an important role in the construction of national ecological security and ecological civilisation, so this paper conducts research on the environmental protection system of nature reserves based on the IPA algorithm [10-11]. The second part is the design of the environmental system, which is divided into two parts: the design of a multi-source information management system for natural environment protection and the construction of an energy flow model of the forest ecosystem; the third part is the analysis of the system, which consists of three parts, namely IPA comprehensive analysis, comparative analysis of assessment results and ecological management strategies for nature reserves, and conclusions are drawn through the analysis.

2. Basic Overview

2.1 Principles for the selection of assessment indicators

In order to assess the quality of nature reserve ecosystems, ideally these indicators should represent key information on the structure and function of the ecosystem, and the more indicators selected, the broader the coverage. In practice, however, this is often unrealistic due to many constraints such as economic costs and accessibility [12-13]. Therefore, this paper suggests that only a few representative indicators should be selected for inclusion in the assessment system. Principles for the selection of key ecological indicators.

(1) Key indicators need to be simple and intuitive, reflective of what the public perceives, and scientifically reflective of ecosystem quality.

(2) Key indicators should be parameters that can be quantified.

(3) The key indicators should reflect the environmental pressures or coercion of the nature reserve.

(4) The key indicators should be feasible and cost effective to obtain

(5) Key indicators should be available on a long-term or regular basis and be relatively comparable [14].

2.2. IPA analysis

The IPA method is a systematic environmental assessment model that does not have a clear

definition of the indicators to be used in the assessment. The analysis steps are as follows.

(1) List the assessment indicators for the assessment of the environmental protection system of the nature reserve and score the nature reserve in the form of a questionnaire in which each assessment indicator should be scored in terms of importance and satisfaction respectively [17].

(2) After the questionnaire data were tallied, the median scores of each assessment indicator for importance and satisfaction were determined, with importance as the vertical axis and satisfaction as the horizontal axis, forming a quadratic graph, as shown in Figure 1.

(3) According to the actual scores of each assessment indicator, they were positioned in the corresponding positions of the four quadrants one by one [18].

(4) According to the quadrant position attributes, the current situation is clarified and countermeasures are analysed.

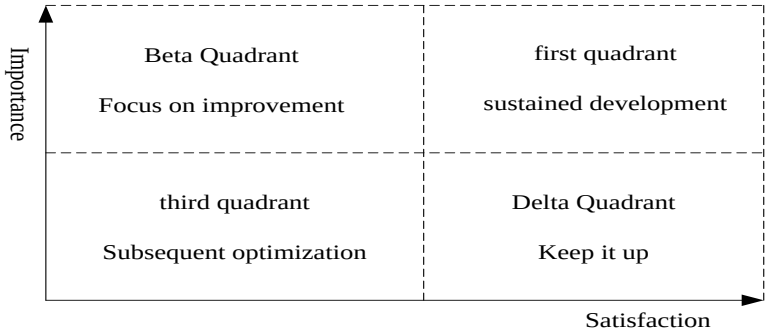

Figure 1. Schematic diagram of the structure of IPA analysis

The method of weighted summation of the quantitative values of the factors of the evaluation unit is used to evaluate the ecosystem health of the F nature reserve and to obtain the comprehensive evaluation index value of the evaluation unit, which mainly consists of two steps: standardisation of indicators and determination of weights, and finally the overall evaluation of the ecosystem health of each reserve with reference to the ecosystem health index grading table. Standardisation of indicators: the data were processed using the standardisation of deviations, and then the factors in the range of 0-100 were standardised, and special values such as too large and too small were manually screened, with the oversized values assigned to 100 and the undersized values assigned to 10. If the quantitative value of an evaluation indicator is negatively correlated with the health of the ecosystem in the study area, then the evaluation indicator is assigned using equation (2).

$$D_a = \frac{r_a - r_{\min}}{r_{\max} - r_{\min}} \times 100 \tag{1}$$

$$D_a = \left(1 - \frac{r_a - r_{\min}}{r_{\max} - r_{\min}}\right) \times 100 \tag{2}$$

3. System Design

3.1. Management System Design

The overall design concept is to make full use of software and hardware to develop management system solutions and to further improve the application and technology development of the existing hardware and software facilities. In order to meet the needs of natural resource information

management in the F Protected Area, a number of rules and regulations will be applied to the operation of the system. The system's functional modifications and maintenance will be achieved through a method of programming for usability, security and convenience as well as the use of a modular design approach to maintain the functions of the system's database as defined by the relevant legislation. The functional design of the system is based on the overall objectives of the task and system development design has been further completed. The functional design of each module is shown in Figure 2. Data Management is a functional module for data management, where system managers can manage all new plant information in real time at any time, which mainly includes adding plant data information, modifying plant data information and deleting plant data information. By clicking on the data browsing button, you can already add and delete information. The classification base management module is designed for all plant data in the nature reserve and allows managers to manage the classification of all plants at any time, including adding, deleting or modifying queries.

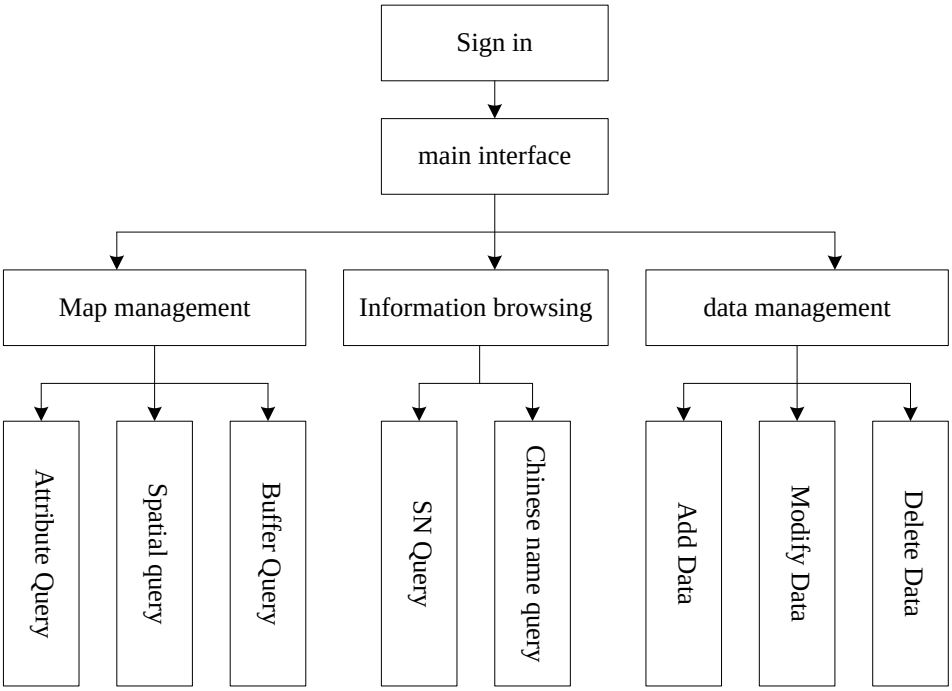

Figure 2. Functional diagram of the management system

3.2. Forest Ecosystem Energy Flow Model Construction

The forest ecosystem energy flow system model for protected areas mainly consists of input energy flows from renewable resources and output energy flows that receive artificial feedback. The "energy system language" legend can be used to clearly explain the process of symbolizing the energy flow, monetary flow and ecological flow in the system, and to calculate and analyze the energy value on this basis.

(1) Input energy flow.

The nature reserve is well managed, the forest ecosystem is strictly protected and intact, and only human activities such as forest conservation, tourism and leisure and infrastructure construction are carried out, with less disturbing energy flows such as improper development and production. In this paper, we only consider two types of economic and social energy flow inputs, namely monetary investment and labour production, and divide the natural energy flow inputs into renewable and non-renewable resource inputs.

(2) Output energy flows.

After low quality energy flows are input into the forest ecosystem of the reserve, the forests and meadows within the system can produce organic matter and energy through their own photosynthesis and act on the soil, atmosphere and water bodies, providing food, habitat and biogenetic carriers for organisms, which are eventually converted into high quality energy flows through internal flow and output. The output energy flow of the reserve can be divided into the tangible output of raw material supply, organic matter production and recreation, and the intangible output of water conservation, air purification and carbon sequestration and oxygen release.

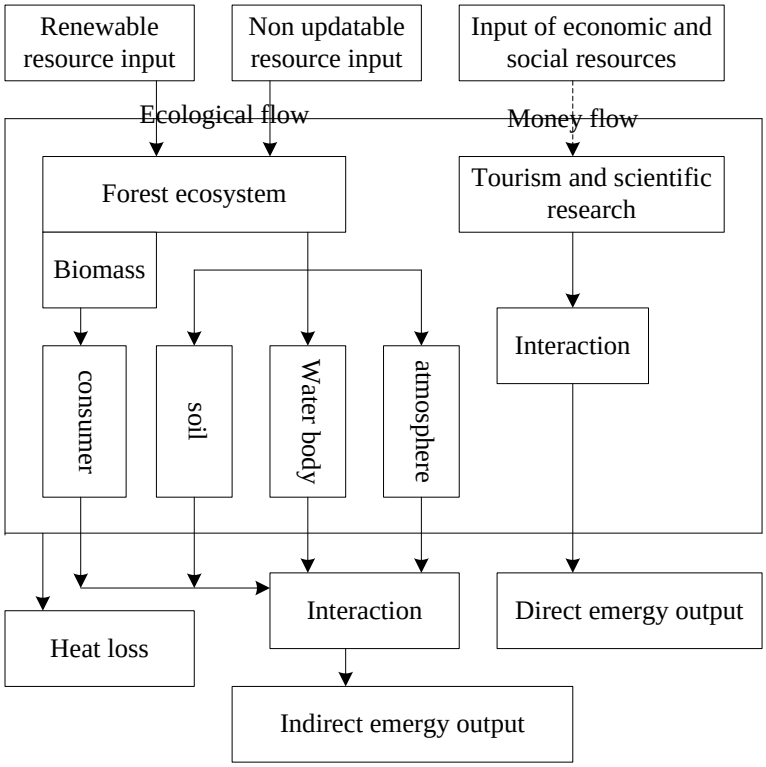

Figure 3. Ecosystem energy structure

4. System Analysis

4.1. IPA Comprehensive Analysis

The environmental interpretation system is conducive to the protection of the ecological environment in the F Nature Reserve. Therefore, this paper uses IPA to evaluate the environmental interpretation system in the F Nature Reserve, and the results of the analysis are shown in Table 1. The results of the analysis are shown in Table 1. The results of the analysis should be used as a basis for the optimization and improvement of the natural environment interpretation system.

As can be seen from Table 1, the interpretation by the interpreters in the F reserve is easy to understand, but the interpreters cannot respond well to visitors' random questions, their knowledge base is incomplete, their service attitude is rather indifferent, and their Mandarin language level needs to be improved. The interpretation process focuses more on the introduction of scenic spots and the explanation of humanistic legends, and conveys less of the concept of environmental protection, which does not reflect the resources and conservation characteristics of the nature reserve. There are sufficient warning and fire prevention signs in the reserve, and there are also some explanatory signs for attractions, but the number of explanatory signs about species is very

small, and some of the signs are old and serious, with blurred handwriting, and the reserve should be updated and supplemented in time. Most of the interpretation signs in the reserve are made of metal, which is a little abrupt compared to the surrounding green forest environment and does not blend in well with the reserve. The multimedia facilities in the reserve are mostly audio-visual playback equipment, which is easy to operate and has attractive content, but is more oriented towards entertainment functions and not fully developed for educational functions. The reserve can increase multimedia educational equipment to provide visitors with richer interpretation services while ensuring that other indicators are perfect. The type and frequency of participatory activities in the reserve should be improved, and the conservation characteristics of the reserve should be reflected in the activities to make them educational.

Table 1. Comprehensive IPA analysis of the environmental interpretation system

	sustained development	Focus on improvement	Subsequent optimization	Keep it up
narrator	The language is vivid and easy to understand	Rich professional knowledge	Moderate speaking speed and clear expression	
Explanation Board	Clearly indicate the tour route	Rich content and sufficient quantity	The location is appropriate and coordinated with the environment	Image text combination，bilingual Chinese and foreign languages
Multimedia facilities	Easy to use and operate		Various types of educational equipment	Played content focuses on protecting objects
Participatory activities	Special projects for different audiences	There are many kinds of projects and they are carried out frequently	The theme highlights the characteristics of the Reserve	

4.2. Comparative Analysis .of Assessment Results

In order to better understand the level of development of forest ecosystem energy value and the problems that exist in F protected area, a comparison was made with other areas, and the results of the comparison are shown in Table 2. From Table 2, it can be seen that the energy value output rates of forest ecosystems in F protected areas are all higher than those of other nature reserves, indicating that the efficiency of energy value use in the system is higher, on the one hand because the energy value output rate is closely related to the area and the protected areas are larger, on the other hand, the energy value output rate is positively related to economic and social development, and in recent years the national economy has been developing at a high speed while the time for assessing the energy value of protected areas is later than that of other protected areas, and the energy value output rate is more influenced by the time factor. The rate of investment in energy value in F protected area is low, second only to H nature reserve, and it is necessary to increase the economic energy value feedback through the construction of national parks in F protected area in the future. The lower energy self-sufficiency rate in reserve F compared to other reserves indicates that the forest ecosystem in reserve F mainly relies on the natural resources in the system for energy supply, and the conversion efficiency of the input energy is relatively low, which is also related to

the incomplete calculation due to the limited selection of energy indicators in this paper. This indicates that the protected area is in a primitive level of sustainability, with good natural environmental protection and low environmental pressure but still relatively economically backward at present.

Table 2. Comparison of the value of forest ecosystem services in nature reserves

	H	J	Z	F
Energy output rate	2.45	3.12	3.28	4.75
energy investment ratio	0.66	1.39	2.75	0.23
Energy self-sufficiency rate	0.96	0.93	0.97	0.84
Environmental load rate	1.23	0.75	1.44	0.66
Sustainability index	15.34	11.67	2.48	25.89

4.3. Ecological Management Strategies for Nature Reserves

By designing the environmental system of nature reserves, the economic value of nature reserves can be realised while protecting the environment. Managers of nature reserves, therefore, need to design different programmes for different groups to meet the different needs of their clients, and management agencies need to introduce innovative and diverse programming arrangements to attract people interested in nature tourism and thus gain their support. Conservation area interpretation needs to be designed to really influence visitors' attitudes towards the environment and to deliver powerful messages, and needs to allow the theme of the message to be integrated with the character of the activity. The richness of the types of ecotourism services, the casual nature of the tours and the changing nature of visitor numbers make it possible for nature reserves to ensure that relevant information is accessible and comprehensive, that signage systems are clear and unambiguous, and that visitors are provided with a systematic and thoughtful information service. It also ensures that the information is authentic, practical, comprehensive, authoritative and free of charge, among other attributes. As a natural place for environmental education, nature reserves should enhance the transfer of knowledge and even change the behaviour of tourists in terms of environmental protection. When visitors are informed about the location of closed areas and why they are closed, they are more impressed with the character of the reserve, so the arrangement of interpretation is a powerful aid in regulating visitor behaviour.

5. Conclusion

Establishing a comprehensive evaluation method for ecosystem quality can help to improve the assessment of the effectiveness of nature reserve protection, therefore, this paper is based on PIA to evaluate and optimise the natural environment protection system. Nature reserves have an outstanding contribution in maintaining ecological balance, etc. Environmental interpretation is both a service and a kind of propaganda and communication, which is an important tool for implementing management of nature reserves. In the IPA synthesis section, this paper uses IPA to analyse the environmental interpretation system and, through this analysis, proposes improvements to the environmental interpretation system of the F Nature Reserve. The paper compares the forest ecosystem performance values of F Nature Reserve with other nature reserves and finds that F Nature Reserve has better natural environment protection and less environmental pressure but is still relatively economically backward and needs to make some changes in terms of economic benefits. There are many shortcomings in this paper that need to be improved.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1]Sonia N, Kenneth R. Bundy, T W, Ali A, Aaron W, Alexandra C. Sharing Wireless Spectrum in the Forest Ecosystems Using Artificial Intelligence and Machine Learning. Int. J. Wirel. Inf. Networks (2020) 29(3): 257-268.

[2] Tobias E, Martin P, D T. Automation of Maritime Shipping for More Safety and Environmental Protection. Autom. (2020) 70 (5): 406-410.

[3] Eleni S. Adamidi, E N. Gazis, K S. Nikita. A Safety System for Human Radiation Protection and Guidance in Extreme Environmental conditions. IEEE Syst. (2020) 14 (1): 1384-1394. https://doi.org/10.1109/JSYST.2019.2920135

[4] Maninderpal S, Gagangeet S A, Rasmeet S B. Derived Blockchain Architecture for Security-Conscious Data Dissemination in Edge-Envisioned Internet of Drones Ecosystem. Clust. Comput. (2020) 25(3): 2281-2302.

[5] Florian B, Michael C O, Iraklis D, Naila K, Nikolaos L, loannis M, Lina M C, Vassilios P, Brecht W. towards A Standard-Based Open Data Ecosystem: Analysis of DCAT-AP Use At National and European Level. Electron Gov. an Int. J. (2020) 18(2): 137-180.

[6] Sandip M O, Jason W. The Emergence and Evolution of a Disruptive Platform Ecosystem: Evidence from the Indian Mobile Services Industry. Electron Mark (2020) 32(2): 669-686.

[7] Saeid B, Farhad P, Simin R S. HMPA: an Innovative Hybrid Multi-Population Algorithm Based on Artificial Ecosystem-Based and Harris Hawks Optimization Algorithms for Engineering Problems. Eng. Comput. (2020) 38(2): 1581-1625. https://doi.org/10.1007/s00366-020-01120-w

[8] Konstantinos M, Vasileios G V, Kyriakos G, Dimitrios K. an Experimental Comparison of Single-Agent and Multi-Agent Learning-And-Playing Algorithms in A Gaming Ecosystem. Intell. Decis. Technol. (2020) 16(2): 431-439. https://doi.org/10.3233/IDT-210212

[9] Apoorva L, Parkala V B B, Gaurav B, Chiranjoy C. A Novel Security Framework for Medical Data in loT Ecosystems. IEEE Multim. (2020) 29(2): 34-44.

[10] Hector C R, Miguel A O E, Jaime M A. Use of Learning Paths through a Digital Ecosystem to Support Children with Learning Problems in Basic Math. Rev. Iberoam. de Tecnol. del Aprendiz. (2020) 17(1): 79-88.

[11] Mohammad R F. Presenting a Paradigmatic Model for Conceptualisation of Open Innovation Ecosystem in Start-Ups Using Meta-Synthesis Approach. Int. J. Technol. Manag. (2020) 88 (1): 13-33.

[12] Jian W Y, Meng X, Shui G D, Si W T, Jin T C, Yong N W, Zhao H W, Schahram D. A Service Pattern Oriented Computing Architecture for Service Ecosystems. ieee Internet Comput. (2020) 26(1): 51-59.

[13] Ken F, Dale S, Chong G W. A Scalable, Standards-Based Approach for loT Data Sharing and Ecosystem Monetization. IEEE Internet Things J. (2020) 9 (8): 5645-5652. https://doi.org/10.1109/JIOT.2020.3023035

[14] Farshad F, Bahareh J F, Mahmoud D, Cesare P. Guest Editorial Special Issue on Al-Driven loT Data Monetization: A Transition from Value Islands to Value Ecosystems. IEEE Internet Things J. 9(8): 5578-5580 (2020).

[15] Peter B, Trilce N, Anne O. Museum Open Data Ecosystems: a Comparative Study. J. Documentation (2020) 78(4): 761-779.

[16] Prinolan G, Absalom E. Ezugwu: Boosting Symbiotic Organism Search Algorithm with Ecosystem Service for Dynamic Blood Allocation in Blood Banking System. J. Exp. Theor. Artif. Intell. (2020) 34(2): 261-293.

[17] Arun M, Puneet K, Alberto M, Amandeep D. The Innovation Ecosystem in Rural tourism and Hospitality a Systematic Review of Innovation in Rural Tourism. J. Knowl. Manag. (2020) 26 (7): 1732-1762.

[18] Marcos T, Jorge B. Watch Over Your TV: A Security and Privacy Analysis of the Android TV Ecosystem. Proc. Priv. Enhancing Technol. (2020) 2020 (3): 692-710.