DIJEMSS: Dinasti International Journal of Education Management and Social Science
E-ISSN: 2686-6331
P-ISSN: 2686-6358
https://dinastipub.org/DIJEMSS dinasti.info@gmail.com +62 811 7404 455
DINASTI PUBLISHER

DOI: https://doi.org/10.38035/dijemss.v6i3

Formulating a User-Friendly Toolkit for Assessing Sustainable Ecotourism Potential in Protected Areas: A Case Study of Xuan Thuy Ramsar Site

Le Phu Tuan[1], Takaaki Nihei[2], Zaheer Ahmed[3], Najaf Ali[4], Vu Thi Kim Oanh[5]
[1]University of Transport Technology, Hanoi, Vietnam, tuanlp@utt.edu.vn
[2]Tokyo Metropolitan University, Tokyo, Japan, ntakaaki@pb3.so-net.ne.jp
[3]Tokyo Metropolitan University, Tokyo, Japan, zaheerbaltiskd@gmail.com
[4]Tokyo Metropolitan University, Tokyo, Japan, najafaliameen11@gcuf.edu.pk
[5]Vietnam National University of Forestry, Hanoi, Vietnam, vuthikimoanh@ifee.edu.vn

Corresponding Author: tuanlp@utt.edu.vn[1]

Abstract: This study aims to assess the sustainable ecotourism potential of a protected area such as Xuan Thuy Ramsar Site using a user-friendly toolkit that can be used by anyone. The Analytic Hierarchy Process (AHP) was employed to evaluate the potential of sustainable ecotourism by prioritizing ten criteria. Expert interviews and data analysis were conducted to determine criteria weights, followed by criteria-specific assessments. The assessment identified "Natural Sustainability" as the most critical factor for ecotourism, followed by "The Uniqueness of the Natural Landscape" and "Stakeholder Engagement." Xuan Thuy Ramsar Site scored a total of 7.32, indicating high potential for sustainable ecotourism development. Challenges such as infrastructure limitations and accessibility issues were also highlighted. In addition, a toolkit consisting of 10 criteria and the weights of each criterion was also developed to be applied in the periodic assessment of sustainable ecotourism potential according to scenarios. The study introduces a user-friendly AHP-based toolkit for assessing sustainable ecotourism potential, which can be adapted for other protected areas. The findings provide actionable insights for policymakers, conservationists, and local stakeholders to prioritize interventions and foster sustainable tourism practices.

Keywords: Potential Assessment, Ecotourism Potential, Sustainable Development, Xuan Thuy Ramsar Site, Analytic Hierarchy Process, AHP

INTRODUCTION

Ecotourism has been recognized as a potential avenue for sustainable development in protected areas around the world. Various studies have been conducted to assess the ecotourism potential of different regions and the impacts on local communities and the environment. The Ecotourism Sustainability Maximization (ESM) model was introduced by Ashok et al. (2020), aiming to determine the elements influencing ecotourism spots. Meanwhile, Braunović et al. (2020) concentrated on evaluating the ecotourism possibilities within Fruška Gora National Park and its influence on rural advancement. Buaxaiya et al.

(2021) employed GIS data analysis to locate potential ecotourism areas in Xaisomboun, located in Central Laos. Ramaano (2021) emphasized the crucial role of ecotourism in improving the livelihoods of people in Musina Municipality, South Africa, utilizing surveys and interviews for data collection. Ahmed and Nihei underscored the importance of minimizing negative impacts and maximizing community benefits for promoting sustainable tourism in high-altitude areas (Ahmed & Nihei, 2024). The research by Chlachula et al. (2021) covered the sustainable tourism possibilities in the Southern Altai Area of Kazakhstan, highlighting the plethora of historical and archaeological attractions in the locale. Hidyarko et al. (2021) explored how conservation and tourism sustainability are practiced in Komodo National Park, which adopts an ecotourism-centered management style. Sobhani et al. (2022) measured the ecotourism carrying capacity of protected locations in Iran using the ETCC model, bringing to light potential negative effects and underscoring the need for sustainable resource management. Sahahiri et al. (2023) conducted a comprehensive literature review concerning Ecotourism Opportunities Measurements (EOMs) to offer actionable insights for further academic inquiry in this sector. Afifah et al. (2023) researched the development of ecotourism as a conservation initiative driven by the community in Ayah Mangrove Forest in Central Java, Indonesia. Lastly, Withanage et al. (2024) crafted an Ecotourism Suitability Index employing GIS-multi Criteria Decision Analysis Techniques specifically for a World Heritage City. Together, these investigations enhance the comprehension of ecotourism's potential for fostering sustainable development in preserved areas, stressing the significance of engaging communities, conservation initiatives, and responsible resource use.

The assessment of ecotourism potential for sustainable development is a crucial aspect of ensuring the preservation of natural resources while promoting economic growth. Various methods have been employed to evaluate the viability of ecotourism in different regions around the world. Latinopoulos (2020) developed a hybrid travel cost model to assess the recreational values and benefits of ecotourism in the Prespa National Park in Greece, highlighting the use of the travel cost method (TCM) for non-market valuation. Hajizadeh et. al. (2020) utilized scenario design and the FUZZY-OWA algorithm to evaluate ecotourism capability, integrating criteria according to the OWA model and fuzzy quantifiers. Braunović et. al. (2020) conducted literature and field research to identify factors for ecotourism development in the Fruška Gora National Park, aiming to predict benefits for rural economic growth. Abrehe et. al. (2021) employed Geographic Information System and the Analytical Hierarchy Process method to identify potential ecotourism sites in the Kafta Sheraro National Park in Ethiopia. Chaudhary et. al. (2021) utilized the Analytical Hierarchy Process and Geographical Information System-Remote Sensing techniques to identify potential ecotourism sites in the Garhwal Himalayan region. Yee et. al. (2021) focused on the socio-geographical evaluation of ecosystem services in the Tram Chim National Park in Vietnam. Acharya et. al. (2022) explored the geospatial analysis of geo-ecotourism site suitability in West Bengal, emphasizing the use of the AHP method and GIS for sustainable tourism planning. Sahahiri et. al. (2023) conducted a systematic literature review on Ecotourism Opportunities Measurements (EOMs) to provide insights into research trends in this area. Djuwendah et. al. (2023) examined the sustainability and responsiveness of factors influencing community-oriented agro-ecotourism in West Java, Indonesia, by employing a survey approach. Overall, these studies demonstrate the diverse methods and approaches used to assess ecotourism potential for sustainable development in various regions, highlighting the importance of balancing environmental conservation with economic growth in ecotourism planning and management.

The Analytic Hierarchy Process (AHP) is a valuable tool for assessing ecotourism potential to enhance decision-making. AHP facilitates the prioritization of various criteria essential for sustainable tourism development, allowing for a structured evaluation of potential sites. The use of the Analytic Hierarchy Process (AHP) method for assessing

ecotourism potential has been a popular approach in recent literature. The Chamoli district study utilized AHP to create a potential ecotourism map, considering factors like elevation and proximity to protected areas (Das et al., 2023). Chaudhary et. al. (2021) utilized AHP and Geographical Information System-Remote Sensing (GIS-RS) techniques to identify potential ecotourism sites in the Garhwal Himalayan region. Similarly, Acharya et. al. (2022) focused on the geospatial analysis of geo-ecotourism site suitability in West Bengal using the AHP method and GIS. These studies highlight the importance of incorporating AHP in assessing the suitability of ecotourism sites based on various parameters. Nguyen et. al. (2022) also applied the AHP method to evaluate the sustainability of community-based ecotourism destinations in Central Vietnam. By developing a sustainable ecotourism index (SEI) with fourteen criteria, the study emphasized the significance of environmental conservation, economic benefits, community participation, cultural preservation, and empowerment in sustainable ecotourism practices. This aligns with the approach taken by Chaudhary et. al. (2021) and Acharya et. al. (2022) in assessing ecotourism potential using AHP. Furthermore, the literature review by Pasaribu et. al. (2023) focused on assessing potential hydrometeorological disasters using the AHP method. While the study does not directly relate to ecotourism, it demonstrates the versatility of AHP in evaluating various environmental factors. This highlights the potential for incorporating AHP in assessing the environmental impact and sustainability of ecotourism sites. Overall, the literature reviewed emphasizes the effectiveness of the AHP method in assessing ecotourism potential by considering multiple criteria and parameters. By integrating AHP with geospatial technologies and sustainability indicators, researchers can make informed decisions regarding the development and management of ecotourism sites.

The benefits of AHP when using in Ecotourism that AHP provides a systematic approach to evaluate multiple criteria, ensuring that ecological and community needs are balanced (Wang et al., 2023), and it supports the development of resilient policies for sustainable tourism, as demonstrated in various regions (Habibur et al., 2023) (Jeetendra et al., 2023). Conversely, while AHP is effective, it may not capture the dynamic nature of ecotourism potential, as local community input and changing environmental conditions can significantly influence outcomes. Thus, integrating qualitative assessments alongside AHP could enhance the robustness of ecotourism evaluations.

AHP can be applied as a standalone methodology or combining with other tools. In the context of ecotourism, the standalone AHP is particularly effective in assessing and comparing factors such as environmental, cultural, and economic impacts to guide sustainable development. When combined with other tools, such as Geographic Information Systems (GIS) or Multi-Criteria Decision Analysis (MCDA), AHP becomes even more powerful, allowing for spatial analysis and the integration of diverse datasets. However, in this case, the combined AHP requires the user to have technical and engineering skills.

Subramanian’s research group surveyed the number of scientific works using two types of AHP from 1990 to 2009 (Subramanian et al, 2012). The results showed that there was no significant difference between them (the proportions of Combined AHP and standalone AHP were 51% and 49%, respectively). Therefore, the choice of which type of AHP depends on the purpose of the user. With the practical requirement of building a user-friendly toolkit that anyone can use, this study chose standalone AHP as very reasonable.

With the aim of providing a simple, easy-to-use model to support local people and the Management Board in assessing the ecotourism potential of Xuan Thuy Ramsar site (XTRS), this article focuses on using Analytic Hierarchy Process method (AHP) for assessing the ecotourism potential to explore XTRS's role in achieving sustainable development goals. By evaluating criteria as the site's natural, cultural, and operational resources, the study aims to identify opportunities and challenges for ecotourism development. The findings will provide

insights into how ecotourism can serve as a driving force for both conservation and sustainable livelihoods in protected areas.

Assessing ecotourism potential for sustainable development at the Xuan Thuy Ramsar site as a case study is examined in this paper, which is structured as follows: The first section includes a review of existing literature, the second section outlines the location and the methods for gathering data; criteria weighting along with outcomes regarding tourism potential can be found in the third section; and lastly, the fourth section presents conclusions and suggestions for prioritizing tourism developments.

METHOD

Study Area

Xuan Thuy Ramsar site or Xuan Thuy National Park (20°13′48″N, 106°31′0″E) is located in Nam Dinh province (Figure 1). Since January 1989, Xuan Thuy became the first wetland in Southeast Asia to be part of the RAMSAR International Convention (Ramsar, Iran, 1971). In January 2003, the Prime Minister approved Decision No. 01/2003/QD-TTg, which officially changed Xuan Thuy Wetland Nature Reserve to Xuan Thuy National Park. In December 2004, UNESCO recognized Xuan Thuy National Park as the main area of the World Biosphere Reserve in the coastal region of the Red River Delta.

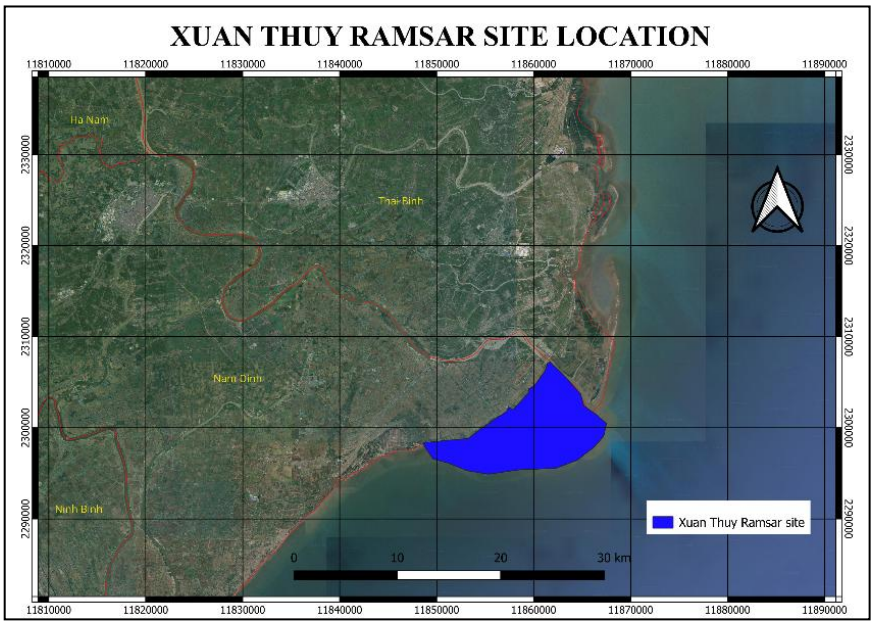

Figure 1 Location of Xuan Thuy Ramsar site (Qgis in 2025)

According to the annual report of the Management Board, Xuan Thuy National Park covers a total area of 12,000 ha at the mouth of the Red River, mainly within Giao Thien commune, Giao Thuy district, Nam Dinh, including Con Lu, Con Ngan, and Con Xanh. Specifically, the core zone is 7,100 ha, home to 120 plant species, over 500 animal species, and 30 types of reptiles and amphibians. The fertile sediment from the Red River combined with the coastal region has made this area a nature reserve with unique wetland habitats filled with diverse wildlife, plants, and rare migratory species. Each year, from October to March, tens of thousands of migratory birds from the North come to Xuan Thuy National Park to rest and feed. Among the more than 200 bird species found in the park, many are listed in the international red book. At times, over 40,000 birds can be spotted in Xuan Thuy National Park. Additionally, the forests of tigers and parrots in Xuan Thuy are home to various species of birds, sea cats, sea foxes, otters, and more. Underwater, there are many kinds of shrimp, fish, crabs, snakes, clams, and cockles, providing abundant food for the birds. During the black tiger

flower season, the cool scent attracts many honey bees. This wetland region is important locally, nationally, and globally as a home for migratory birds and for the benefits it provides to the ecosystem. Moreover, Xuan Thuy holds considerable economic importance. The well-being of the local community is closely connected to the vitality of the mangrove forest. As a result, the National Park is striving to encourage sustainable living methods, ranging from agro-forestry to environmentally friendly shrimp farms. The criteria evaluation of the tourism potential of this region is a necessity.

Criteria assessment for Ecotourism potential

Assessment criteria selection

To select the criteria, the research team interviewed experts in person. The number of experts interviewed is shown in Table 1:

Table 1 Number of experts interviewed

Expert	Characteristic	Quantity
Scientist	Conducted research at Xuan Thuy Ramsar site	15
Manager	Over 5 years of experience managing issues related to Xuan Thuy Ramsar site	5
Tourist	Have visited Xuan Thuy Ramsar site at least 5 times	5
Other *(Local people, businessman, etc)*	Over 5 years of experience with Xuan Thuy Ramsar site	5
Total		**30**

Table 2 lists the criteria for assessing the tourism potential. In total, 10 criteria are selected. Based on previous research related to criteria evaluation of tourism resources, four assessment scales are classified for each criterion, with rating scores of 10 (very high), 7 (high), 4 (medium), and 1 (low) (Feng el at, 2010; Yu el at, 2002).

Table 2 Selected criteria for tourism potential evaluation of Xuan Thuy Ramsar site

Selected Criteria	Evaluation Scale (W)	Rating (S)
The uniqueness of the natural landscape (Y1)	Very high High Medium Low	10 7 4 1
Indigenous cultural-historical value (Y2)	Very high High Medium Low	10 7 4 1
Quality of infrastructure and facilities for tourism (Y3)	Excellent Good Average Poor	10 7 4 1
Tourist capacity (Y4)	> 1500 (People) 1000 – 1500 (People) 500 – 1000 (People) < 500 (People)	10 7 4 1
Local tourism development policy (Y5)	Very high High Medium Low	10 7 4 1
Connectivity (Y6)	Very high High Medium	10 7 4

	Low	1
Accessibility (Y7)	Very high High Medium Low	10 7 4 1
Natural sustainability (Y8)	Very high High Medium Low	10 7 4 1
Indigenous cultural-historical sustainability (Y9)	Very high High Medium Low	10 7 4 1
Stakeholder engagement (Y10)	Very high High Medium Low	10 7 4 1

The value of the criteria "The uniqueness of the natural landscape", "Indigenous cultural-historical value", "Connectivity", "Accessibility", "Natural sustainability", "Indigenous cultural-historical sustainability" and "Stakeholder engagement" is divided into degrees: very high, high, medium, and low. The criterion of "Quality of infrastructure and facilities for tourism" is based on the annual report of XTRS's Management Board and the statistics of the General Statistic Office of Nam Dinh province. The criterion of "Tourist capacity" involves managing the balance between tourism activities and the preservation of natural and cultural resources. Proper assessment and regulation of tourist capacity ensure sustainable use of the area, preventing over-tourism, habitat degradation, and cultural disruption while maintaining a positive experience for both visitors and locals.

The detail explanation for the selected criteria is shown in Table 3.

Table 3 Selected criteria explanation

Selected Criteria	Explanation
The uniqueness of the natural landscape (Y1)	Refers to the distinct and exceptional natural features of an area that make it attractive and appealing to visitors. This includes rare ecosystems, striking geological formations, diverse flora and fauna, and scenic beauty that cannot be easily found elsewhere. Such uniqueness enhances the area's value as an ecotourism destination, providing visitors with a memorable and educational experience while fostering appreciation and awareness of the need for conservation.
Indigenous cultural-historical value (Y2)	Refers to the unique traditions, customs, knowledge, and heritage of local or indigenous communities within a destination. This criterion emphasizes the importance of preserving and showcasing the cultural identity of these communities through authentic experiences such as traditional crafts, ceremonies, storytelling, and local cuisines. Integrating indigenous cultural value into ecotourism enhances visitor understanding, promotes cultural exchange, and supports the economic and social well-being of the host communities while respecting their way of life.
Quality of infrastructure and facilities for tourism (Y3)	Refers to the adequacy, functionality, and sustainability of physical and service structures that support tourism activities. This includes transportation systems, accommodations, visitor centers, trails, signage, and waste

	management systems designed to enhance visitor experience while minimizing environmental impacts. High-quality infrastructure and facilities ensure safety, accessibility, and comfort for tourists, while aligning with ecotourism principles by promoting eco-friendly practices and supporting the conservation of natural and cultural resources.
Tourist capacity (Y4)	Refers to the maximum number of visitors a destination can accommodate without causing significant negative impacts on the environment, local communities, or the quality of the visitor experience. It involves managing the balance between tourism activities and the preservation of natural and cultural resources. Proper assessment and regulation of tourist capacity ensure sustainable use of the area, preventing over-tourism, habitat degradation, and cultural disruption while maintaining a positive experience for both visitors and locals.
Local tourism development policy (Y5)	Refers to the strategic guidelines and regulations implemented by local authorities to promote sustainable tourism practices. These policies aim to balance tourism growth with the conservation of natural and cultural resources, ensure community participation, and distribute economic benefits equitably. A strong local tourism development policy supports infrastructure planning, visitor management, environmental protection, and capacity building, creating a framework for responsible tourism that benefits both the destination and its stakeholders.
Connectivity (Y6)	Refers to the ease and efficiency of access to a destination through transportation networks and communication systems. It encompasses the availability of roads, public transport, airports, and digital connectivity, ensuring that tourists can reach and navigate the area conveniently. Good connectivity enhances a destination's accessibility while supporting sustainable travel options, such as eco-friendly transportation. It also facilitates engagement with visitors, promoting awareness and seamless trip planning, which are essential for successful ecotourism development.
Accessibility (Y7)	Refers to the extent to which all individuals, including those with disabilities, can reach, explore, and enjoy a destination. It includes physical access to natural and cultural attractions, availability of facilities like ramps and pathways, and clear signage for guidance. Accessibility also considers financial and informational access, ensuring that tourism experiences are inclusive and available to diverse audiences. Enhancing accessibility aligns with the principles of ecotourism by promoting equal opportunities and fostering a welcoming environment for all visitors.
Natural sustainability (Y8)	Refers to the ability of a destination to maintain its ecological balance while accommodating tourism activities. It emphasizes the preservation of biodiversity, ecosystems, and natural resources to ensure they remain healthy and functional over time. Practices like limiting visitor numbers, minimizing waste, and promoting eco-friendly operations are crucial for protecting the area's natural assets. By prioritizing natural sustainability, ecotourism supports long-term

	conservation efforts and ensures the destination's environment continues to thrive for future generations.
Indigenous cultural-historical sustainability (Y9)	Refers to the preservation and promotion of the traditions, practices, and heritage of indigenous communities in a way that respects their authenticity and integrity. It involves protecting cultural knowledge, rituals, and lifestyles from exploitation or degradation caused by tourism activities. By fostering respectful interactions and supporting community-led initiatives, ecotourism ensures that indigenous cultures are celebrated, economically empowered, and preserved for future generations while maintaining their social and cultural significance.
Stakeholder engagement (Y10)	Refers to the active involvement and collaboration of all parties affected by or contributing to tourism activities, including local communities, government agencies, conservation organizations, and tourists. Effective engagement ensures that diverse perspectives are considered in decision-making, fostering shared responsibility for sustainable tourism development. It promotes transparency, builds trust, and encourages cooperation to balance economic, environmental, and social goals, ultimately leading to more inclusive and successful ecotourism initiatives.

Determining the weight of the evaluation criteria method

To thoroughly evaluate the tourism capacity of a location, it is essential to ascertain how much each criterion contributes and its relevance within that specific site (Saaty, 1990). Consequently, this research identifies the weights assigned to the criteria during the ranking process of potential and conducts a comprehensive evaluation. There are various techniques to assign weights: some rely on expert judgments, others use regression analysis, economic factor assessments, or derive weights through triangular matrix analysis, and the weightings are determined using the Analytical Hierarchy Process method (AHP) (Saaty, 1990). The assigned weights play a crucial role in establishing the significance of each criterion during the assessment; they reveal a distinct order and the degree of impact on tourism advancement. In this research, the AHP analysis methodology is applied to ascertain the weights of factors necessary for assessing the ecotourism potential in XTRS, as AHP aids in identifying and prioritizing criteria based on their importance, thereby leading to the most sensible conclusion. Developed by Saaty (1990), the AHP framework has been enhanced to assess the weighting of evaluation criteria. To determine the weights for the criteria for assessing ecotourism for sustainable development, the research team interviewed 30 experts to compare the importance of these criteria. The flowchart for AHP method is shown in Figure 2.

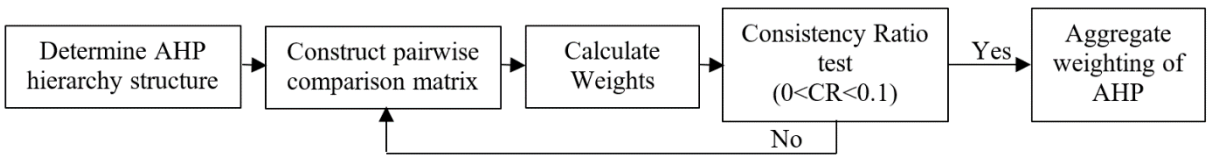

Figure 2 Flowchart for AHP method

The following judgment matrix is used to calculate the priorities of the criteria:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

where a_{xy} is the pairwise comparison rating between criterion x and criterion y of a level with respect to the upper level. The entries a_{xy} are subject to the following rules:

$$a_{xy} > 0;\ a_{xy} = \frac{1}{a_{yx}};\ a_{xx} = 1\ with\ \forall x \quad (2)$$

The importance of the criteria can be determined by calculating the main eigenvector W of matrix A (Erfani et al, 2015). Once vector W is made into a unit vector, it represents the priority vector of the criteria at a specific level in relation to the higher level, as shown below:

$$AW = Lamda_{max}W \quad (3)$$

where $Lamda_{max}$ is the maximum eigenvalue of the matrix A.
When the matrix used for pairwise comparisons meets the criteria of transitivity for every comparison made, it is deemed consistent and confirms the following relationship:

$$a_{xy} = a_{xz} * a_{zy}\ \forall x, y, z \quad (4)$$

Table 4 The Analytic Hierarchy Process (AHP) pairwise comparison scale (Saaty, 1980)

Value of a_{xy}	Interpretation
1	x and y are equally important
3	x is slightly more important than y
5	x is more important than y
7	x is strongly more important than y
9	x is absolutely more important than y
2, 4, 6, 8	Intermediate value between the two adjacent scale value

AHP permits some inconsistency, but it also offers a way to gauge the inconsistency within every collection of evaluations. The judgment matrix's consistency is assessed through the Consistency Ratio (CR), which is described as:

$$CR = \frac{CI}{RI} \quad (5)$$

where CI is the Consistency Index; RI is the Random Index.
Average consistencies of randomly generated matrices are provided in Table 3 (Saaty, 1980; Saaty, 2000). CI for a matrix of order n is defined as:

$$CI = \frac{Lamda_{max} - n}{n - 1} \quad (6)$$

n is number of factors (criteria)

Table 5 The average consistencies of random matrices (Saaty, 1980; Saaty, 2000)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Assessing of ecotourism potential for sustainable development

A consistency ratio of 0.1 or lower is deemed satisfactory. If the figure exceeds this, it may indicate that the assessments are unreliable and should be gathered once more (shown in Figure 2).

Once the weighted values of the criteria are available, in order to measure the potential of ecotourism for sustainable development of Xuan Thuy Ramsar site, each criterion is

classified in 4 levels: “Very hight or Excellent” (Rating 10), “High or Good” (Rating 7), “Medium or Average” (Rating 4), and “Low or Poor” (Rating 1) (Table 1). According to this classification, the score of each criterion of the XTRS is calculated using the following formula:

$$SC_i = S_i x W_i \quad (7)$$

Finally, the total score of Xuan Thuy Ramsar site is calculated with the aid of the formula below:

$$TSC = \sum_{i=1}^{n} SC_i = \sum_{i=1}^{n} S_i x W_i \quad (8)$$

where SC_i is the score of criterion i; TSC is the total score of the Ramsar site; W_i is the weighted score of the criterion i; and S_i is the rating score of the criterion i that is derived from Table 1.

Based on the total score (TSC), the potential ecotourism for sustainable development can be divided into four groups as follows (Table 6):

Table 6 The classification of ecotourism potential for sustainable development

Value range	Value range code	Classification
TSC ≥ 8	1	Very high ecotourism exploitation potential
5 ≤ TSC<8	2	High ecotourism exploitation potential
3 ≤ TSC<5	3	Medium ecotourism exploitation potential
TSC < 3	4	Low ecotourism exploitation potential

The results of the research are presented in detail in the next section.

RESULTS AND DISCUSSION

Results of the weight of the evaluation criteria method

The evaluation matrix derived from experts’ opinions along with the weighted scores for each criterion (after matrix normalization step) is presented in Table 7. "Natural sustainability" has the highest weight score (0.22), which indicates that, to a certain extent, the natural sustainability of the resources determines where exploitation can best be carried out. This shows a positive change in tourist behavior. Tourists have become more concerned with the sustainability of nature than their own needs. The ecotourism potential is largely determined by the natural and cultural-historical sustainability values of Xuan Thuy Ramsar site, as the weight score of "The uniqueness of the natural landscape" is 0.17, the weight score of "Indigenous cultural-historical sustainability" is 0.14, followed by "Stakeholder engagement" with a weight score of 0.12. Thus, stakeholder engagement is also a very important criterion in the sustainable development of community-based ecotourism. After all of them, "Indigenous cultural-historical value", "Connectivity", "Accessibility", "Local tourism development policy", "Quality of infrastructure and facilities for tourism", "Tourist capacity" come with the weight scores of 0.12, 0.07, 0.06, 0.06, 0.04, 0.03, respectively.

Table 7 The judgment matrix and weight scores of criteria

Criteria	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y8	Y10	Weight score
The uniqueness of the natural landscape (Y1)	1.00	4.10	5.20	4.90	4.10	4.20	3.80	0.20	0.33	1.00	0.17
Indigenous cultural-historical value (Y2)	0.24	1.00	2.02	1.98	1.03	0.51	3.02	0.98	1.04	1.03	0.12
Quality of infrastructure and facilities for tourism (Y3)	0.19	0.50	1.00	2.01	0.97	0.52	0.51	0.25	0.53	0.33	0.04
Tourist capacity (Y4)	0.20	0.51	0.50	1.00	0.48	0.52	0.51	0.25	0.33	0.33	0.03
Local tourism development policy (Y5)	0.24	0.97	1.03	2.08	1.00	1.99	0.53	0.25	0.33	0.52	0.06
Connectivity (Y6)	0.24	1.96	1.92	1.92	0.50	1.00	2.03	0.33	0.33	0.33	0.07
Accessibility (Y7)	0.26	0.33	1.96	1.96	1.89	0.49	1.00	0.25	0.52	0.53	0.06
Natural sustainability (Y8)	5.00	1.02	4.00	4.00	4.00	3.03	4.00	1.00	2.02	1.99	0.22
Indigenous cultural-historical sustainability (Y9)	3.03	0.96	1.89	3.03	3.03	3.03	1.92	0.50	1.00	1.03	0.14
Stakeholder engagement (Y10)	1.00	1.00	3.03	3.03	1.92	3.03	1.89	0.50	0.97	1.00	0.12

Check the data consistency:
The maximum eigenvalue of the comparison matrix: $Lamda_{max}$ = 11.2
Number of factors (n) = 10 (in Table 1)
Random Index (RI) = 1.49 (in Table 5)
Consistency Index (CI):

$$CI = \frac{Lamda_{max} - n}{n - 1} = \frac{11.2 - 10}{10 - 9} = 0.12$$

Consistency Ratio (CR) = 0.088.

$$CR = \frac{CI}{RI} = \frac{0.12}{1.49} = 0.08$$

In conclusion, the CR of 0.08 (<0.1) is satisfactory for the evaluation of the ecotourism potential for sustainable development of Xuan Thuy Ramsar site.

Results of assessing ecotourism potential for sustainable development

Results of assessing Ecotourism potential for sustainable development in Xuan Thuy Ramsar site is shown in Table 8. The research indicates that the potential for ecotourism in XTRS is influenced by factors, including the uniqueness of the natural sustainability, the uniqueness of the natural landscape, stakeholder engagement, Indigenous cultural-historical sustainability, Indigenous cultural-historical value. Xuan Thuy Ramsar site is a typical wetland

with high biodiversity, distinct biodiversity, favorable location, easy connection, etc. They are the factors that need to focus on preserving, conserving, and exploiting to become the strength of tourism development of the locality. For ecotourism, the Indigenous cultural value and the readiness of the local community have an important influence on the formation and development of this type. Because this is a nature reserve, the expectations of visitors regarding tourist facilities are relatively modest (such as lodging and services), but they request high quality of experience, especially types of experiences with nature, bird watching, relaxation, etc.

Table 8 Results of assessing sustainable ecotourism potential in XTRS

Criteria	Weight score (W)	Rating (SC)	Score (W*SC)
The uniqueness of the natural landscape (Y1)	0.17	7.5	1.27
Indigenous cultural-historical value (Y2)	0.10	5	0.50
Quality of infrastructure and facilities for tourism (Y3)	0.05	6.25	0.28
Tourist capacity (Y4)	0.03	5	0.17
Local tourism development policy (Y5)	0.06	7.5	0.43
Connectivity (Y6)	0.07	5	0.34
Accessibility (Y7)	0.06	7.5	0.44
Natural sustainability (Y8)	0.22	10	2.18
Indigenous cultural-historical sustainability (Y9)	0.13	6.25	0.84
Stakeholder engagement (Y10)	0.12	7.5	0.86
Total score (TSC)			7.32

With the total score (TSC) is 7.32, belongs to the value range code of 2 ($5 \leq TSC<8$), so Xuan Thuy Ramsar site has an Ecotourism potential for sustainable development.

Thus, the toolkit for assessing sustainable ecotourism potential for XTRS includes 10 criteria and the weights of the criteria as shown in Table 8. Using this toolkit is simple, users only need to change the scores of the criteria (Rating - SC). This toolkit can be used to assess sustainable tourism potential when input factors (related to each criterion) change, such as investment projects, new policies, or can be adjusted according to climate change scenarios, land use change, population growth, etc., where those changes have an impact on one or several criteria. Or users can use this toolkit to periodically assess sustainable ecotourism potential to promptly make adjustments to suit the actual situation.

It should be emphasized that this is only the result of assessment of ecotourism development potential in Xuan Thuy Ramsar site. Therefore, to achieve the results for sustainable development of ecotourism, many different solutions need to be implemented. Sustainable ecotourism development in Xuan Thuy Ramsar site requires a balanced approach that prioritizes environmental conservation, community involvement, and visitor management. Strengthening conservation efforts, such as habitat restoration and zoning, can protect the area's biodiversity and reduce ecological disturbances. Engaging local communities is crucial, empowering them through training and employment opportunities in eco-friendly tourism activities. Developing sustainable infrastructure, like eco-lodges and low-impact visitor facilities, ensures minimal environmental harm. Implementing carrying capacity limits and monitoring systems can prevent over-tourism and maintain the site's natural integrity. Educational programs and cultural experiences that incorporate indigenous knowledge can enhance visitor awareness and appreciation for the site's unique ecological and cultural value. Collaborative governance and clear policies, coupled with awareness campaigns, can attract responsible travelers while fostering partnerships among stakeholders. These measures

collectively ensure that ecotourism at Xuan Thuy supports long-term biodiversity preservation, cultural sustainability, and socio-economic benefits for local communities.

CONCLUSION

The assessment of ecotourism potential at Xuan Thuy Ramsar site reveals its significant capability to support sustainable tourism development, leveraging its unique natural landscapes, rich biodiversity, and indigenous cultural values. The study confirms that the site holds high ecotourism potential, as reflected in its strong scores for natural sustainability and stakeholder engagement. The application of the Analytic Hierarchy Process (AHP) has proven to be an effective method for evaluating and prioritizing criteria critical to sustainable tourism planning. However, challenges such as limited infrastructure, accessibility issues, and the need for stronger local tourism policies highlight the necessity of strategic interventions to unlock the site's full potential. Additional, a toolkit designed for evaluating the potential of sustainable ecotourism for XTRS, incorporates ten criteria, along with their respective weights that were established. The utilization of this toolkit is straightforward; users simply need to modify the scores for each criterion (Rating). This tool can be employed to evaluate sustainable tourism potential when input variables (linked to each criterion) are altered, such as investment endeavors, new regulations, or modifications made in response to climate change, land use change, population increases, and so forth, which could affect one or more criteria.

To realize sustainable ecotourism at Xuan Thuy Ramsar site, the following recommendations are proposed:

Strengthen Conservation Efforts: Focus on preserving natural habitats and biodiversity through habitat restoration, regular monitoring, and strict zoning regulations to prevent environmental degradation.

Enhance Community Participation: Empower local communities through training programs, employment opportunities, and active roles in decision-making processes to ensure inclusive development.

Develop Eco-Friendly Infrastructure: Invest in low-impact tourism facilities such as eco-lodges, guided trails, and visitor centers to enhance visitor experiences while minimizing environmental harm.

Improve Connectivity and Accessibility: Upgrade transportation networks and ensure facilities are inclusive, catering to diverse tourist groups, including those with disabilities.

Implement Carrying Capacity Limits: Establish and enforce visitor limits to maintain ecological balance and ensure high-quality visitor experiences.

Strengthen Policy Frameworks: Develop clear and actionable tourism policies that promote sustainable practices, regulate tourism activities, and foster collaboration among stakeholders.

Promote Environmental Education and Awareness: Create programs to educate tourists on the ecological and cultural importance of the site, encouraging responsible behavior.

By addressing these areas, Xuan Thuy Ramsar site can achieve a harmonious balance between ecological preservation, cultural sustainability, and economic growth, serving as a model for sustainable ecotourism in protected areas.

REFERENCES

Abrehe, Salamawi & Gebrekidan, Atkilt Girma & Nigusse, Amare. (2021). Potential ecotourism site suitability evaluation for sustainable natural resource management in Kafta Sheraro National Park (KSNP), north-western Tigray, Ethiopia. Journal of Ecotourism. 20. 341-370. 10.1080/14724049.2021.1897599.

Acharya, A., Mondal, B. K., Bhadra, T., Abdelrahman, K., Mishra, P. K., Tiwari, A., & Das, R. (2022). Geospatial Analysis of Geo-Ecotourism Site Suitability Using AHP and GIS

for Sustainable and Resilient Tourism Planning in West Bengal, India. Sustainability, 14(4), 2422. https://doi.org/10.3390/su14042422

Afifah, Ratih & Putri, Aisyah & Hartanti, Andini & Indah, Snada & Negari, Tuk & Syavy, Muhammad & Pratama, Reza & Astuti, Puji & Zuaini, Kiswantari & Risfathoni, Ahsan & Madani, A & Bebi, Sylvia & Muryanto, & Muhammad, Farhan & Astikasari, Luna & Indriyani, Sisca & Kurniawati, Indah & Sunarto, & Kusumaningrum, Lia & Setyawan, Ahmad. (2023). Ecotourism development as a community-based conservation effort in Ayah Mangrove Forest, Kebumen, Central Java, Indonesia. Asian Journal of Forestry. 7. 37-44. 10.13057/asianjfor/r070105.

Ahmed, Zaheer & Nihei, Takaaki. (2024). Assessing the environmental impacts of adventure tourism in the world's highest mountains: a comprehensive review for promoting sustainable tourism in high-altitude areas. Journal of Advanced Research in Social Sciences and Humanities. 9. 1-15. 10.26500/JARSSH-09-2024-0201.

Ashok, Smriti & Behera, Mukunda & Tewari, H. (2020). Evaluating the applicability of ESM (Ecotourism Sustainability Maximization) model to assess, monitor, and manage the ecotourism sustainability in mountain ecosystem (Mt. Kangchendzonga Base Camp Trek, India). Environmental Monitoring and Assessment. 191. 10.1007/s10661-019-7702-y.

Braunović, Sonja & Jovanović, Filip. (2020). Assessing ecotourism potential of the Fruška Gora N.P. and the impacts on rural development. Tourism International Scientific Conference Vrnjačka Banja - TISC. 5. 41-58. 10.52370/TISC2041SB.

Buaxaiya, S. , Phompila, C. , Phengsopha, K. , Chanthavong, B. , Nanthavongduangsy, K. , Thongmanivong, S. and Baral, H. (2021) Assessment of Potential Ecotourism Site in Xaisomboun, Central Laos. Journal of Service Science and Management, 14, 680-695. doi: 10.4236/jssm.2021.146043.

Chaudhary, Shairy & Diwakar, Atul & Pramanik, Malay & Negi, Mahabir. (2021). Land evaluation and sustainable development of ecotourism in the Garhwal Himalayan region using geospatial technology and analytical hierarchy process. Environment Development and Sustainability. 10.1007/s10668-021-01528-4.

Chlachula, J., Zhensikbayeva, N. Z., Yegorina, A. V., Kabdrakhmanova, N. K., Czerniawska, J., & Kumarbekuly, S. (2021). Territorial Assessment of the East Kazakhstan Geo/Ecotourism: Sustainable Travel Prospects in the Southern Altai Area. Geosciences, 11(4), 156. https://doi.org/10.3390/geosciences11040156.

Das, Rahul & Singh, Mohit & Malhotra, Vipul & Roy, Soumyadeep & Pandey, Kamal & Karnatak, Harish. (2023). Identification of suitable ecotourism sites in Himalayan mountainous setting using Analytical Hierarchy Process (AHP) and GIS: A case study of Chamoli district, Uttrakhand. Journal of Geomatics. 17. 22-36. 10.58825/jog.2023.17.1.35.

Djuwendah, E., Karyani, T., Wulandari, E., & Pradono, P. (2023). Community-Based Agro-Ecotourism Sustainability in West Java, Indonesia. Sustainability, 15(13), 10432. https://doi.org/10.3390/su151310432

Erfani, M., Afrougheh, S., Ardakani, T., & Sadeghi, A. (2015). Tourism positioning using decision support system (case study: Chahnime—Zabol, Iran). Environmental Earth Sciences, 74, 3135-3144.

Feng, Xian-hua, Ju, & Chun-yan (2010). Evaluation and analysis on the tourism resources in Hami Region based on GIS mapping technology.

Habibur, Rahman, Habib., Mahfujur, Rahman., M., Uddin., Nusrat, Jahan, Shimu., Mahmudul, Hasan., Jobaer, Alam., Mir, Shariful, Islam. (2023). Application of AHP and Geospatial Technologies to Assess Ecotourism Suitability: A Case Study of Saint Martin's Island in Bangladesh. Regional Studies in Marine Science, doi: 10.1016/j.rsma.2023.103357

Hajizadeh, Najmeh & Poshidehro, Marzieh & Yousefi, Elham. (2020). Scenario-based capability evaluation of ecotourism development – an integrated approach based on WLC, and FUZZY – OWA methods. Asia Pacific Journal of Tourism Research. 25. 627-640. 10.1080/10941665.2020.1752752.

Hidyarko AIF, Gayatri AC, Rifa VA, Astuti A, Kusumaningrum L, Mau YS, Rudiharto H, Setyawan AD. (2021). Reviews: Komodo National Park as a conservation area for the komodo species (Varanus komodoensis) and sustainable tourism (ecotourism). International Journal of Tropical Drylands. 5: 27-40. 10.13057/tropdrylands/t050105.

Jeetendra, Kumar, Patel., Raj, Bahadur, Anuragi. (2023). Identifying the Ecotourism Potential Locations using AHP and Weighted Overlay Analysis: A case of Bundelkhand region in Central India. Papers in applied geography, 10(1):17-33. doi: 10.1080/23754931.2023.2254786

Latinopoulos, Dionysis. (2020). The Role of Ecotourism in the Prespa National Park in Greece. Evidence from a Travel Cost Method and Hoteliers' Perceptions. Journal of Environmental Management and Tourism. 10. 1731-1741. 10.14505//jemt.v10.8(40).03.

Nguyen, T.D., Hoang, H.D., Nguyen, T.Q., Fumikazu, U., Vo, T.P.T., & Nguyen, C.V. (2022). A multicriteria approach to assessing the sustainability of community-based ecotourism in Central Vietnam. APN Science Bulletin, 12(1). doi:10.30852/sb.2022.1938

Pasaribu, Octo & Kertopermono, Aris & Lestari, Andrian Andaya & Prihanto, Yosef & Supriyadi, Asep & Trismadi,. (2023). AHP Scoring and Weighting Main Criteria For Assessment of Potential Hydrometeorological Disasters: A Literature Study. Journal of Applied Geospatial Information. 7. 755 - 761. 10.30871/jagi.v7i1.5127.

Ramaano, Azwindini. (2021). Potential of ecotourism as a mechanism to buoy community livelihoods: the case of Musina Municipality, Limpopo, South Africa. Journal of Business and Socio-economic Development. 1. 47-70. 10.1108/JBSED-02-2021-0020.

Saaty, T. L. (1990). How to make a decision: The analytic hierarchy process. European Journal of Operational Research, 48(1), 9–26. https://doi.org/10.1016/0377-2217(90)90057-I.

Saaty, T.L. (1980) The Analytic Hierarchy Process: Planning, Priority Setting, Resources Allocation. Mcgraw-Hill, New York.

Saaty, T.L. (2000) Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process (Analytic Hierarchy Process Series, Vol. 6). RWS Publications, Pittsburgh.

Sahahiri, R.M., Griffin, A.L., & Sun, Q. (2023). Investigating Ecotourism Opportunities Measurements in a Complex Adaptive System: A Systematic Literature Review. Sustainability.

Sobhani, P., Esmaeilzadeh, H., Sadeghi, S. M. M., & Marcu, M. V. (2022). Estimation of Ecotourism Carrying Capacity for Sustainable Development of Protected Areas in Iran. International Journal of Environmental Research and Public Health, 19(3), 1059. https://doi.org/10.3390/ijerph19031059.

Subramanian, Nachiappan & Ramakrishnan, Ramanathan. (2012). A review of applications of Analytic Hierarchy Process in operations management. International Journal of Production Economics. 138. 215–241. 10.1016/j.ijpe.2012.03.036.

Wang, Dongliang., Liu, Qiongying., Huang, Shiwei. (2023). Study on the Exploitation Potential of Ecotourism in Leshan City based on a Multi-Hierarchy Grey Method. Journal of resources and ecology, 14(2):321-330. doi: 10.5814/j.issn.1674-764x.2023.02.010

Withanage, W.K.N.C. & Wijesinghe, Dilnu & Mishra, Prabuddh & Abdelrahman, Kamal & Mishra, Vishal & Fnais, M.. (2024). An Ecotourism Suitability Index for a World Heritage City Using GIS-Multi Criteria Decision Analysis Techniques. Heliyon. 10.1016/j.heliyon.2024.e31585.

Yee, Jie & Loc, Ho & Poh, Yi Le & Vo-Thanh, Tan & Park, Edward. (2021). Socio-geographical evaluation of ecosystem services in an ecotourism destination: PGIS application in Tram Chim National Park, Vietnam. Journal of environmental management. 291. 112656. 10.1016/j.jenvman.2021.112656.

Yu, Tao-fang & Gu, Chao-lin & Wang, Hong & Duan, Xue-jun & Yi, Xiao-feng. (2002). The evaluation and analysis of the tourism resources in Jilin Province. Chinese Geographical Science - CHIN GEOGR SCI. 12. 186-192. 10.1007/s11769-002-0030-z.