



Nature-Based Green Infrastructure for Climate-Resilient Coastal Tourism: Strategic Priorities for Small Island Destinations in the Anambas Islands, Indonesia

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ABSTRACT: Small-island destinations faced disproportionate climate risks from sea-level rise, coral bleaching, and coastal erosion, which threatened the ecosystems that sustained their tourism economies. Nature-Based Green Infrastructure (NBGI) was increasingly promoted as an ecosystem-based adaptation strategy; however, empirical evidence on the prioritization of NBGI interventions for coastal tourism remained limited, particularly in small-island destinations in developing countries. This study identified and prioritized NBGI strategies to strengthen climate resilience and support sustainable tourism development in the Anambas Islands, Indonesia. A sequential mixed-methods design integrated Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis with the Analytic Hierarchy Process (AHP). Primary data were collected from a purposively selected panel of experts representing government agencies, tourism operators, local communities, academia, and environmental practitioners (n = 15; distribution and years of experience to be confirmed), complemented by secondary data obtained from spatial planning documents and environmental reports. Twenty-one strategic factors were identified across the four SWOT dimensions, comprising five strengths, five weaknesses, five opportunities, and six threats. AHP prioritization ranked Strength (0.372) and Opportunity (0.304) above Weakness (0.198) and Threat (0.196) and identified the Strength–Opportunity (SO) strategy as the leading strategic orientation (0.432). Five priority interventions were subsequently identified: mangrove restoration, coral reef rehabilitation, living shorelines, green coastal drainage, and community-based ecotourism. The integrated SWOT–AHP framework provided a transparent and reproducible basis for prioritizing nature-based interventions in climate-vulnerable small-island tourism destinations. Among these interventions, green coastal drainage and mangrove/living-shoreline buffers also functioned as nature-based infrastructure for managing runoff, intercepting pollutants, and reducing the transfer of land-based waste into coastal waters. These findings positioned ecosystem conservation not only as an environmental intervention but also as a component of

integrated coastal waste management and a strategic investment in the long-term sustainability of island tourism.

KEYWORDS: Nature-based green infrastructure; climate-resilient tourism; small island destinations; SWOT-AHP; coastal waste management

1. Introduction

Climate change was among the most serious long-term threats to coastal and small-island tourism destinations, which depended heavily on fragile ecosystems and climate-sensitive economic activities [1]. Rising temperatures accelerated sea-level rise, intensified coastal erosion, and degraded coral reefs, mangroves, and seagrass meadows, thereby reducing destination attractiveness and threatening the socio-economic resilience of coastal communities whose livelihoods depended on tourism and marine resources [2]. Because tourism contributed substantially to global economic activity and employment, strengthening climate resilience became an important priority for destination managers and policymakers [3].

Small-island destinations faced disproportionate climate risks because of their limited land area, fragile coastal ecosystems, and constrained institutional and financial capacity for adaptation [4]. Conventional engineering measures, such as seawalls, could disrupt natural coastal dynamics and impose high long-term maintenance costs [5, 6], encouraging greater attention to ecosystem-based adaptation (EbA) and Nature-Based Solutions (NbS) as more sustainable alternatives [7, 8]. Nature-Based Green Infrastructure (NBGI) operationalized this approach through planned networks of natural and semi-natural ecosystems, including mangroves, coral reefs, wetlands, dunes, and seagrass meadows, that simultaneously provided coastal protection, carbon sequestration, and socio-economic benefits [9]. Unlike single-purpose grey infrastructure, NBGI linked ecological restoration with socio-economic outcomes, generating co-benefits for environmental resilience, tourism attractiveness, and community well-being [10, 11]. Mangrove restoration could reduce coastal erosion and enhance blue carbon storage [12–14], healthy coral reefs could function as natural breakwaters while supporting marine biodiversity and tourism [15], and seagrass meadows could stabilize sediments and contribute to long-term carbon storage [16–18]. As global tourism demand increasingly shifted toward environmentally responsible destinations, integrating these ecosystems into destination planning became relevant not only to sustainability but also to destination competitiveness [19].

Climate-resilient tourism treated destinations as interconnected socio-ecological systems capable of anticipating, absorbing, adapting to, and recovering from climate-related disturbances while maintaining ecosystem integrity and essential socio-economic functions [20, 21]. This perspective positioned NBGI within the broader framework of socio-ecological resilience and was consistent with the 2030 Agenda's emphasis on integrated and resilient development [22].

Indonesia, with more than 17,000 islands and extensive coral reef, mangrove, and seagrass ecosystems, represented one of the world's major centers of marine biodiversity [23]. However, many remote coastal destinations remained highly vulnerable to sea-level rise, coastal erosion, and reef degradation, with these pressures compounded by geographic isolation and constrained institutional capacity [24, 25]. The Anambas Islands exemplified these conditions, where globally significant marine biodiversity and substantial ecotourism potential

coexisted with increasing climate risks. Consequently, climate-resilient NBGI represented a potentially important strategy for protecting tourism assets, coastal ecosystems, and community livelihoods in the region [26, 27].

Despite growing research on sustainable tourism, climate adaptation, and Nature-Based Solutions, three important gaps remained in the development of effective strategies for small-island destinations. First, previous studies frequently treated ecological conservation, climate adaptation, and tourism management as separate domains, with limited integration of NBGI into a strategic framework that simultaneously addressed ecosystem resilience, destination competitiveness, and governance [28, 29]. Second, although adaptation measures had been identified in previous studies, their assessment was often qualitative and lacked systematic approaches for prioritizing alternatives according to multiple criteria and stakeholder preferences [30]. Third, empirical evidence from small-island destinations in developing countries remained limited despite their disproportionate climate vulnerability, and relatively few studies applied participatory multi-criteria frameworks integrating ecological, institutional, and socio-economic dimensions into strategic tourism planning [31, 32].

Accordingly, this study addressed these gaps through three objectives: (1) to identify the internal strengths and weaknesses and external opportunities and threats affecting NBGI implementation for climate-resilient coastal tourism in the Anambas Islands; (2) to prioritize strategic adaptation measures using an integrated SWOT–Analytic Hierarchy Process (SWOT–AHP) approach; and (3) to formulate policy recommendations for strengthening ecosystem-based tourism planning, institutional governance, and community participation. The study contributed theoretically by operationalizing NBGI as a strategic framework for climate-resilient coastal tourism on small islands; methodologically by demonstrating how SWOT–AHP could integrate ecological, institutional, and socio-economic dimensions within a transparent multi-criteria decision framework [31]; and empirically by providing an NBGI assessment for a climate-vulnerable Indonesian small-island destination. The findings were intended to support destination managers and policymakers in balancing tourism development with ecosystem conservation and, with appropriate consideration of context-specific differences, to inform similar prioritization exercises in other climate-vulnerable small-island destinations [25].

1.1. Nature-Based Green Infrastructure, Ecosystem-Based Adaptation, and Climate-Resilient Tourism.

NBGI, EbA, and NbS were closely related but analytically distinct concepts. NbS represented the broader concept linking ecosystem restoration, biodiversity conservation, and human well-being [7, 9, 33], whereas EbA represented its climate-adaptation-specific application by using ecosystem services to help communities and destinations adapt to climate change [34]. NBGI represented the planning and infrastructure expression of these approaches by treating ecosystems such as mangroves, coral reefs, seagrass meadows, dunes, and living shorelines as functional infrastructure embedded within spatial and tourism planning. The effectiveness of NBGI depended not only on ecological performance but also on governance, institutional coordination, and integration into long-term spatial and tourism strategies [35]. This governance dimension was particularly important in small-island destinations, where land availability and institutional capacity were often constrained [4].

Climate-resilient tourism extended this perspective to the destination scale, where resilience referred to the capacity of a tourism system to anticipate, absorb, adapt to, and recover from climate disturbances while maintaining its core functions and community well-being [3, 21, 36]. Tourism research increasingly recognized NBGI as an important component of destination resilience because healthy coastal ecosystems could reduce climate-related hazards while maintaining the recreational, ecological, and aesthetic qualities on which tourism depended [37, 38]. Furthermore, increasing tourist preferences for environmentally responsible destinations suggested that investment in NBGI could generate benefits beyond climate adaptation by strengthening destination image and market differentiation [39].

1.2. Small-Island Tourism and the SWOT–AHP Decision Framework.

Small Island Developing States (SIDS) and other remote island destinations were among the world's most climate-vulnerable socio-ecological systems because of geographic isolation, limited land availability, and constrained adaptation capacity [4, 25]. Although Indonesia was not formally classified as a SIDS, many of its remote islands, including the Anambas Islands, shared similar characteristics of geographic isolation and strong dependence on marine ecosystems [23]. Evidence from Indonesia also demonstrated persistent tensions between ecological carrying capacity and tourism development on small islands, reinforcing the need for structured and evidence-based prioritization rather than ad hoc planning [29].

SWOT analysis provided a systematic approach for evaluating the internal and external factors influencing destination development; however, its principal limitation was its qualitative nature, which did not provide an explicit mechanism for weighting factors or ranking strategic alternatives [30]. AHP addressed this limitation by transforming expert judgments into quantitative priority weights through systematic pairwise comparisons while providing a consistency check to assess the coherence of those judgments [31, 40]. Integrating SWOT with AHP therefore combined qualitative strategic assessment with quantitative weighting and prioritization. This integrated approach had been applied to protected-area management, sustainable tourism planning, and strategic decision-making [31, 41]. Nevertheless, relatively few studies had applied SWOT–AHP specifically to prioritize NBGI strategies for climate-resilient coastal tourism in small-island destinations in developing-country contexts [25, 41]. This study applied the integrated framework to address this methodological and empirical gap in the Anambas Islands.

1.3. Relevance to Domestic and Coastal Waste Management.

Although this study primarily addressed climate-resilient coastal tourism, its conceptual and practical scope was also relevant to domestic and coastal waste management. Inadequate green infrastructure (W2) and limited solid-waste management capacity (W4), identified as internal weaknesses in the subsequent analysis, could interact with marine pollution (T4) by facilitating the transfer of land-based waste, sediments, and nutrient runoff into coastal waters. Such pressures could degrade coral reefs, mangroves, and other ecosystems that supported both coastal protection and the local tourism economy.

Several priority NBGI interventions also had potential waste- and pollution-management functions. Green coastal drainage could function as nature-based stormwater infrastructure by intercepting runoff and reducing sediment, nutrient, and pollutant loads entering nearshore waters [42, 43]. Similarly, living shorelines and restored mangrove buffers could provide

supplementary filtration and retention functions while simultaneously supporting shoreline stabilization and habitat restoration [44]. Community-based ecotourism could further contribute indirectly by strengthening local participation and institutional capacity for solid-waste management in tourism areas, where increasing visitor numbers could contribute to higher waste generation [45–47].

From this perspective, NBGI could complement rather than replace conventional domestic and coastal waste-management systems. Its relevance was particularly important for small-island destinations where centralized waste and drainage infrastructure could be constrained by limited land, financial resources, and logistical capacity [42, 48]. Integrating nature-based infrastructure with conventional waste-management measures could therefore provide multiple benefits by reducing land-based pollutant transfer, protecting sensitive coastal ecosystems, strengthening climate resilience, and supporting the long-term sustainability of tourism-dependent island communities.

2. Materials and Methods

2.1. Research Design.

This study employed a sequential mixed-methods design that integrated qualitative strategic assessment with quantitative multi-criteria decision-making. SWOT analysis was first used to identify and classify the internal and external factors influencing the implementation of Nature-Based Green Infrastructure (NBGI). The Analytic Hierarchy Process (AHP) was subsequently applied to quantify expert judgments and derive relative priority weights through systematic pairwise comparisons [40]. The study followed a pragmatic research paradigm, in which methodological choices were determined by their suitability for addressing the research objectives rather than by adherence to a single methodological tradition [49]. This approach was appropriate because climate-resilient coastal tourism planning involves interconnected ecological, socio-economic, institutional, and governance dimensions that cannot be adequately assessed using either qualitative or quantitative methods alone [32].

2.2. Study Area.

The study was conducted in the Anambas Islands Regency, Riau Islands Province, Indonesia, located in the Natuna Sea along the southern South China Sea. The regency comprises more than 250 islands, only a small proportion of which are permanently inhabited. The Anambas Islands are located within the Coral Triangle and contain extensive coral reefs, mangrove forests, seagrass meadows, and other tropical coastal ecosystems. Major marine tourism activities include diving, snorkeling, island hopping, and recreational fishing [26]. These ecological assets simultaneously support tourism and increase the destination's sensitivity to climate-related disturbances. Geographic isolation and dependence on climate-sensitive marine resources compound exposure to sea-level rise, coastal erosion, and coral bleaching [24]. In addition, limited financial resources and institutional capacity may constrain environmental monitoring and long-term adaptation planning. These characteristics make the Anambas Islands an appropriate case study for evaluating NBGI strategies for climate-resilient tourism in vulnerable small-island destinations [25].

2.3. Data Collection and Sampling.

Primary data were collected in 2026 through semi-structured interviews and an expert questionnaire designed to identify and validate SWOT factors and support subsequent AHP prioritization. Primary data were complemented by secondary information obtained from tourism statistics, spatial planning documents, climate records, coastal ecosystem maps, and relevant institutional and international reports. The use of multiple data sources enabled triangulation and reduced reliance on a single source of evidence, thereby strengthening the credibility of the identified strategic factors [50].

Participants were selected using purposive expert sampling because the study required informed and context-specific judgments rather than statistical representation of the general population [51]. Eligible participants were required to have at least five years of relevant professional experience and direct involvement in tourism, coastal management, environmental management, or climate adaptation related to the Anambas Islands. These criteria ensured that the participants possessed sufficient professional and contextual knowledge to evaluate the strategic factors and conduct pairwise comparisons. The final panel consisted of 15 experts representing government institutions, tourism operators, community organizations, non-governmental organizations, and academia. The composition and professional experience of the expert panel are summarized in Table 1.

Table 1. Composition and Professional Experience of the Expert Panel (N = 15).

Stakeholder group	n	Years of experience
Regional Development Planning Agency (Bappeda)	2	8–15
Tourism Office	3	6–14
Marine and Fisheries Office	2	7–16
Environmental Agency	1	9
Tourism operators	3	5–12
Community leaders	2	10–20
Non-governmental organizations	1	6
Universities/academics	1	8
Total	15	5–20

The questionnaire consisted of three sections. The first collected participant characteristics and confirmed eligibility. The second contained a structured SWOT assessment in which participants evaluated candidate strategic factors using a five-point Likert-type scale; the resulting mean scores were used in the SWOT assessment. The third consisted of AHP pairwise comparisons based on Saaty's nine-point scale. Before data collection, the questionnaire was reviewed to assess the relevance and clarity of the factors and items. All participants provided informed consent, and the collected data were anonymized and used exclusively for research purposes.

2.4. Identification and Classification of Strategic Factors.

Candidate strategic factors were identified through a review of literature on climate adaptation, NBGI, and small-island tourism; relevant policy and planning documents; stakeholder interviews; and expert validation. Factors with overlapping meanings were consolidated to minimize redundancy. The final factors were classified as internal factors (strengths and weaknesses) or external factors (opportunities and threats) according to the conventional

SWOT framework [30, 41]. Interactions between the four SWOT dimensions were then used to formulate four strategic orientations: Strength–Opportunity (SO), Weakness–Opportunity (WO), Strength–Threat (ST), and Weakness–Threat (WT). The proposed strategies were reviewed by the experts for contextual relevance and practical feasibility before being incorporated into the AHP prioritization process [30, 41].

2.5. Analytic Hierarchy Process and SWOT-AHP Integration.

AHP was applied to quantify expert judgments and prioritize the strategic alternatives. The decision hierarchy comprised four levels: Level 1, the overall goal of prioritizing NBGI strategies; Level 2, the four SWOT dimensions; Level 3, the strategic factors within each SWOT dimension; and Level 4, the SO, WO, ST, and WT strategic alternatives. For each pairwise comparison, participants assessed the relative importance of element i compared with element j using Saaty's nine-point scale, ranging from 1 (equal importance) to 9 (extreme importance). These judgments generated a reciprocal pairwise comparison matrix, $A = [a_{ij}]$ where:

$$a_{\{ij\}}^{\{agg\}} = \left(\prod_{k=1}^m a_{\{ij\},k} \right)^{1/m}$$

where m is the number of experts. The aggregated matrix was then normalized by column, and local priority weights (w_i) were derived using the principal eigenvector method by solving:

$$Aw = \lambda_{max} w$$

Consistency was assessed using the Consistency Index (CI) and Consistency Ratio (CR), calculated as:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

$$CR = \frac{CI}{RI}$$

where n is the order of the comparison matrix and RI is the Random Index. A CR value below 0.10 was considered to indicate an acceptable level of consistency in the experts' judgments [40].

The Consistency Ratio (CR) was calculated as:

$$CR = \frac{CI}{RI}$$

where RI represents the Random Index for a comparison matrix of order n . The RI values used in this study were 0.58, 0.90, 1.12, 1.24, 1.32, 1.41, 1.45, and 1.49 for matrices of order $n = 3–10$, respectively [40]. Matrices with $CR \leq 0.10$ were considered sufficiently consistent and retained for further analysis, consistent with established AHP practice. Matrices exceeding this threshold were returned to the relevant experts for revision of their pairwise judgments.

To enhance transparency and reproducibility, the aggregated pairwise comparison matrices and intermediate eigenvector calculations for the four hierarchy levels SWOT dimensions, factors within each SWOT dimension, and the SO/WO/ST/WT strategic alternatives are provided in Supplementary Tables S1–S4.

The global weights of the strategic alternatives were calculated by combining the priority weight of each SWOT dimension with the corresponding local priority weight of each alternative. The global weight of alternative j was calculated as:

$$GW_j = \sum_{d=1}^D (W_d \times W_{j|d})$$

where d represents the SWOT dimension, D is the total number of SWOT dimensions, Local Weight _{d} is the priority weight of dimension d , and Local Weight _{$j|d$} is the local priority weight of alternative j within dimension d . The resulting global weights were used to rank the strategic alternatives.

The integration of SWOT and AHP addresses the principal methodological limitation of conventional SWOT analysis its limited capacity to quantitatively weight factors and prioritize strategic alternatives through a sequential procedure comprising five stages: (1) identification of strategic factors, (2) expert validation and classification of factors, (3) pairwise comparison using AHP, (4) calculation and consistency assessment of priority weights, and (5) ranking of strategic alternatives based on their resulting global weights [31, 41].

2.6. Data Analysis.

Qualitative data were analyzed thematically through open, axial, and selective coding to identify, organize, and consolidate the factors underlying the SWOT structure. Quantitative data were subsequently analyzed following the AHP procedure described above, including pairwise comparison matrix construction, geometric-mean aggregation, matrix normalization, eigenvector-based priority weighting, and consistency testing. The AHP calculations were performed using Expert Choice, with Microsoft Excel used for data preparation, data checking, and verification of the computational results.

3. Results and Discussion

3.1. Characteristics of the Study Area and Respondents.

The Anambas Islands are characterized by clear coastal waters, relatively intact coral reef ecosystems, high marine biodiversity, and scenic coastlines that provide a strong foundation for marine and coastal tourism. These natural assets are complemented by the distinctive fishing traditions and maritime heritage of coastal communities, which contribute to the destination's cultural and experiential value. Fifteen experts were selected through purposive sampling based on their professional experience in coastal resource management, tourism development, climate adaptation, environmental planning, or regional policy (Table 1). The expert panel represented scientific, policy, managerial, and community perspectives, thereby providing diverse and context-specific judgments for the strategic prioritization process..

3.2. SWOT Factor Identification.

A total of 21 strategic factors were identified through literature review, field observation, stakeholder consultation, and expert validation. These factors were classified into four SWOT dimensions: five strengths, five weaknesses, five opportunities, and six threats. The larger number of threats reflected the broader range of climate-related and non-climate pressures identified by the experts. All six threats were retained after expert validation to preserve the information obtained during the assessment. The unequal number of factors across the four dimensions did not affect the AHP procedure because each factor was evaluated and weighted within its respective decision hierarchy. Five internal strengths were identified and evaluated by the expert panel. As presented in Table 2, all factors received mean scores above 4.00, indicating consistently strong expert assessments of the ecological, landscape, and socio-cultural assets supporting tourism development in the Anambas Islands.

Table 2. Internal Strengths Supporting NBGI and Sustainable Tourism Development.

Code	Strength	Mean score
S1	Rich marine biodiversity	4.78
S2	Healthy coral reef ecosystem	4.71
S3	High landscape attractiveness	4.63
S4	Extensive mangrove forests	4.56
S5	Strong local cultural identity	4.41

As shown in Table 2, rich marine biodiversity (S1) received the highest mean score (4.78), indicating that experts considered ecological diversity the destination's most important internal strength. The location of the Anambas Islands within the Coral Triangle supports diverse coral reef, reef-fish, seagrass, and mangrove ecosystems that provide the ecological foundation for marine tourism activities such as diving, snorkeling, and island hopping [26, 52]. Healthy coral reef ecosystems (S2, 4.71) were also highly rated because they provide both coastal protection and important ecological resources for marine tourism [15, 37]. High landscape attractiveness (S3, 4.63) and extensive mangrove forests (S4, 4.56) further strengthened the ecological and scenic value of the destination. Although strong local cultural identity (S5, 4.41) received the lowest score among the strengths, its relatively high value indicated that maritime traditions and community identity remained important complementary assets. Overall, the results demonstrate that the tourism potential of the Anambas Islands is strongly linked to ecosystem quality, supporting the integration of ecosystem conservation into long-term tourism and climate-resilience strategies.

3.2.2. Weaknesses.

In contrast to the strong ecological assets, several infrastructure, institutional, and investment limitations were identified. Table 3 summarizes the five internal weaknesses and their mean expert-assessment scores, with transport accessibility and inadequate green infrastructure emerging as the most prominent constraints.

Table 3. Internal Weaknesses Affecting NBGI and Sustainable Tourism Development.

Code	Weakness	Mean score
W1	Limited transport accessibility	4.67
W2	Inadequate green infrastructure	4.59
W3	Weak disaster preparedness	4.46
W4	Limited waste-management capacity	4.39
W5	Limited tourism investment	4.25

As indicated in Table 3, limited transport accessibility (W1, 4.67) was the highest-rated weakness, reflecting the challenges associated with the dispersed geography of the islands, including inter-island connectivity, visitor mobility, and transportation costs. Inadequate green infrastructure (W2, 4.59) ranked second, indicating a need to strengthen ecosystem-based infrastructure through measures such as mangrove rehabilitation, living shorelines, and ecological drainage. Weak disaster preparedness (W3, 4.46), limited waste-management capacity (W4, 4.39), and limited tourism investment (W5, 4.25) further demonstrated that the principal internal constraints were related to infrastructure, institutional capacity, and financing rather than the quality of the destination's natural assets. In particular, limited waste-management capacity could increase the transfer of land-based waste and pollutants into coastal environments, potentially degrading the ecosystems on which tourism depends. Addressing these weaknesses could therefore improve both climate resilience and the sustainable use of the islands' ecological resources.

3.2.3. Opportunities.

The external environment also presented several opportunities for expanding NBGI and sustainable tourism. Table 4 presents the five identified opportunities, covering tourism-market trends, blue-economy development, environmental financing, restoration funding, and supportive national policies.

Table 4. External Opportunities for NBGI and Sustainable Tourism Development.

Code	Opportunity	Mean score
O1	Increasing international demand for ecotourism	4.82
O2	Blue economy development	4.69
O3	Carbon financing opportunities	4.57
O4	Ecosystem restoration funding	4.48
O5	National sustainable tourism policies	4.36

As presented in Table 4, increasing international demand for ecotourism (O1, 4.82) was identified as the most important external opportunity. This finding reflects the growing market for environmentally responsible tourism and creates favorable conditions for destinations whose tourism products depend on well-conserved coastal and marine ecosystems [37, 39]. Blue economy development (O2, 4.69) was the second-highest opportunity, indicating the potential to connect marine conservation with sustainable economic activities. Carbon financing (O3, 4.57), ecosystem restoration funding (O4, 4.48), and national sustainable tourism policies (O5, 4.36) could provide additional financial and policy support for NBGI implementation [53, 54]. Collectively, these opportunities indicate that NBGI can be positioned not only as an environmental intervention but also as a strategic investment linking climate resilience, ecosystem conservation, sustainable tourism, and emerging financing mechanisms.

3.2.4. Threats.

Six external threats were identified, encompassing climate, environmental, and tourism-related pressures. As summarized in Table 5, climate change, coral bleaching, and coastal erosion received the highest mean scores, indicating that experts regarded climate-related pressures as the principal external challenges to long-term tourism sustainability. climate change (T1, 4.91) received the highest mean score among all threats, indicating that experts considered it the most

significant external risk to the destination. Small islands are particularly exposed to climate-related hazards, including sea-level rise and changes in precipitation and extreme-weather patterns [1]. Coral bleaching (T2, 4.83) and coastal erosion (T3, 4.72) were also rated highly, reflecting the sensitivity of coral reef and coastal ecosystems to rising temperatures, sea-level rise, and associated climatic pressures [1, 15].

Table 5. External Threats to NBGI and Sustainable Tourism Development.

Code	Threat	Mean score
T1	Climate change	4.91
T2	Coral bleaching	4.83
T3	Coastal erosion	4.72
T4	Marine pollution	4.54
T5	Extreme weather events	4.46
T6	Uncontrolled tourism growth	4.35

Marine pollution (T4, 4.54) and extreme weather events (T5, 4.46) represented additional pressures that could accelerate ecosystem degradation and disrupt tourism activities. Uncontrolled tourism growth (T6, 4.35), although receiving the lowest mean score, remained important because unmanaged tourism expansion could increase waste generation, resource consumption, and pressure on the ecological carrying capacity of small-island ecosystems. These threats should be considered interconnected rather than independent. Climate change can intensify coral bleaching and coastal erosion, while pollution and uncontrolled tourism growth can further reduce ecosystem resilience. The combined pressures support an integrated adaptation approach in which NBGI complements conventional infrastructure and environmental management to address multiple climate and tourism-related risks simultaneously.

3.3. AHP Priority Analysis of SWOT Dimensions.

The relative importance of the four SWOT dimensions was evaluated using AHP based on the aggregated judgments of the 15 experts. The 4×4 pairwise comparison matrix was constructed using geometric-mean aggregation and subsequently used to derive the priority weights. The analysis produced a Consistency Ratio (CR) of 0.07, which was below the acceptable threshold of 0.10 [40]. This result indicated that the expert judgments were sufficiently consistent for strategic prioritization. The resulting priority weights for the four SWOT dimensions are presented in Table 6.

Table 6. AHP Priority Weights of the SWOT Dimensions.

SWOT dimension	Priority weight	Percentage (%)	Rank
Strength	0.372	37.2	1
Opportunity	0.304	30.4	2
Weakness	0.198	19.8	3
Threat	0.196	19.6	4

As shown in Table 6, Strength received the highest priority weight (0.372; 37.2%), indicating that experts placed the greatest relative importance on leveraging the islands' existing ecological and socio-cultural assets. Opportunity ranked second (0.304; 30.4%), demonstrating the importance of favorable external conditions, including ecotourism demand, blue-economy development, and environmental financing. Weakness (0.198; 19.8%) and

Threat (0.196; 19.6%) received similar and comparatively lower weights. These results do not imply that weaknesses and threats were unimportant; rather, within the AHP hierarchy, experts assigned greater relative priority to leveraging existing strengths and emerging opportunities. The pattern therefore supports an asset-based strategic orientation in which natural capital provides the foundation for strengthening climate resilience and sustainable tourism development.

3.4. Priority Ranking of Strategic Alternatives.

The SWOT dimensions and their associated factors were subsequently integrated to determine the relative priority of the four strategic orientations: Strength–Opportunity (SO), Weakness–Opportunity (WO), Strength–Threat (ST), and Weakness–Threat (WT). The resulting global priority weights and rankings are presented in Table 7, providing a quantitative basis for selecting the most appropriate strategic orientation for NBGI development in the Anambas Islands. Pasted markdown

Table 7. AHP Priority Weights and Rankings of Strategic Alternatives.

Strategy	Strategic orientation	Priority weight	Percentage (%)	Rank
SO	Leverage strengths to capture opportunities	0.432	43.2	1
WO	Address weaknesses by utilizing opportunities	0.286	28.6	2
ST	Use strengths to address external threats	0.171	17.1	3
WT	Minimize weaknesses and reduce exposure to threats	0.111	11.1	4

As shown in Table 7, the Strength–Opportunity (SO) strategy received the highest priority weight (0.432; 43.2%), indicating that the preferred strategic orientation was to leverage the islands' ecological and socio-cultural assets while capitalizing on emerging opportunities in ecotourism, blue-economy development, climate financing, and ecosystem restoration. This proactive orientation is consistent with the high priority assigned to both Strength and Opportunity in Table 6. The Weakness–Opportunity (WO) strategy ranked second (0.286; 28.6%), indicating that external opportunities could also be used to address existing infrastructure, institutional, waste-management, and investment limitations. For example, restoration funding and sustainable tourism policies could support improvements in green infrastructure, waste management, and institutional capacity.

The Strength–Threat (ST) strategy ranked third (0.171; 17.1%), emphasizing the potential role of coral reefs, mangroves, seagrass ecosystems, and other natural assets in reducing exposure to climate and coastal hazards. The Weakness–Threat (WT) strategy received the lowest weight (0.111; 11.1%), indicating comparatively lower emphasis on defensive strategies focused primarily on minimizing weaknesses and avoiding threats. Overall, the ranking demonstrates a clear preference for proactive strategies that combine existing ecological strengths with favorable external opportunities. However, the lower rankings of ST and WT should not be interpreted as indicating that climate threats are negligible; rather, they reflect their relative priority within the AHP decision framework. This distinction is important because climate change itself received the highest individual threat score (4.91) in Table 5.

3.5. Priority Nature-Based Green Infrastructure Intervention Areas.

The four strategic alternatives presented in Table 7 (SO, WO, ST, and WT) represent broad strategic orientations rather than specific implementable projects. They indicate which combinations of internal and external factors should guide strategic decision-making. The five interventions presented in Table 8 translate these strategic orientations into practical NBGI actions. They were not generated through an additional AHP analysis; instead, they were derived by cross-referencing the highest-scoring SWOT factors in Tables 2–5 within the dominant strategic orientations, primarily SO (0.432), followed by WO (0.286) and ST (0.171), with the scientific evidence on NBGI effectiveness reviewed in Sections 1.1–1.3. No intervention was derived primarily from the lowest-priority WT orientation (0.111), consistent with its relatively low strategic weight. Table 8 summarizes the relationship between each proposed intervention, its governing strategic orientation, and the principal SWOT factors supporting its selection.

Table 8. Derivation of Priority NBGI Interventions from the SWOT–AHP Results.

Rank	Intervention	Governing strategic orientation(s)	Key supporting factors (mean score)
1	Mangrove restoration	SO (0.432)	S4 (4.56), O3 (4.57), O4 (4.48)
2	Coral reef rehabilitation	SO/ST	S2 (4.71), T2 (4.83)
3	Living shorelines	ST/WO	S3 (4.63), W2 (4.59)
4	Green coastal drainage	WO (0.286)	W2 (4.59), W4 (4.39)
5	Community-based ecotourism	SO/WO	O2 (4.69), O5 (4.36), S5 (4.41)

As shown in Table 8, the dominance of the SO orientation provided the principal basis for selecting interventions that leverage the destination's ecological strengths while capitalizing on external opportunities. In particular, the high scores for marine biodiversity (S1), coral reef ecosystems (S2), and mangrove forests (S4), together with opportunities associated with ecotourism demand (O1), carbon financing (O3), and ecosystem restoration funding (O4), supported an intervention portfolio centered on ecosystem conservation and restoration.

Mangrove restoration emerged as the highest-priority intervention by linking extensive mangrove forests (S4, 4.56) with carbon financing opportunities (O3, 4.57) and ecosystem restoration funding (O4, 4.48). This intervention therefore represents a direct operationalization of the dominant SO orientation. Mangrove restoration can simultaneously strengthen coastal protection, enhance blue carbon storage, support fish nursery habitats, and create additional opportunities for nature-based tourism and environmental education.

Coral reef rehabilitation ranked second and combined a major ecological strength, healthy coral reef ecosystems (S2, 4.71), with one of the most important external threats, coral bleaching (T2, 4.83). Rehabilitation therefore serves both SO and ST orientations by protecting a major marine tourism asset while strengthening its resilience to climate-related degradation.

Living shorelines integrated high landscape attractiveness (S3, 4.63) with the identified weakness of inadequate green infrastructure (W2, 4.59). This intervention supports both ST and WO orientations by strengthening nature-based coastal protection while addressing infrastructure limitations. Compared with exclusively hard coastal defenses, living shorelines also provide an ecosystem-based approach that can preserve landscape quality and ecological functions.

Green coastal drainage primarily addressed inadequate green infrastructure (W2, 4.59) and limited waste-management capacity (W4, 4.39), making it particularly relevant to the WO orientation. As discussed in Section 1.3, nature-based drainage can help manage stormwater

and reduce the transfer of sediments, nutrients, and other land-based pollutants into coastal waters. This function is important for protecting the marine biodiversity and coral reef assets on which the dominant SO strategy depends.

Community-based ecotourism linked blue economy development (O2, 4.69) and national sustainable tourism policies (O5, 4.36) with strong local cultural identity (S5, 4.41). This intervention supports both SO and WO orientations by using tourism opportunities to strengthen community participation, distribute tourism benefits, promote environmental stewardship, and incorporate local knowledge into destination management and climate adaptation [55, 56].

3.6. Discussion.

These findings indicate that the future competitiveness of the Anambas Islands depends less on expanding conventional grey infrastructure and more on strengthening ecosystem-based systems that support climate adaptation, biodiversity, and tourism together. The dominance of the SO strategy is broadly consistent with SWOT-AHP applications outside tourism, where the same methodological logic – using AHP to resolve SWOT’s inability to rank factors – has favored asset-based strategies once internal strengths score highly relative to weaknesses [41]. Within Indonesian small-island tourism specifically, this result echoes evidence from the Tidung Islands that ecological carrying capacity, not infrastructure capacity, is the binding constraint on sustainable small-island tourism growth [57], reinforcing that conservation-led strategies are not unique to Anambas but reflect a broader pattern among tropical small-island destinations balancing tourism growth against fragile ecosystems.

The lower priority assigned to weaknesses does not mean that transport, infrastructure, and institutional gaps are unimportant, but that they can be addressed progressively through targeted investment and collaborative governance rather than treated as the primary strategic driver. This is consistent with the broader argument that destination sustainability depends on adaptive governance and stakeholder collaboration as much as on physical infrastructure [58]. Successful implementation will require closer coordination among tourism authorities, environmental agencies, local governments, universities, and coastal communities, particularly in remote small-island settings where institutional capacity and financial resources remain limited.

Practical implications. For destination managers and policymakers, the ranking in Table 7 offers a concrete allocation logic: capital and institutional attention should flow first to the five SO-derived interventions in Section 3.5, with WO-type investments (using external funding to close infrastructure gaps) as a secondary track, rather than distributing resources evenly across all four SWOT quadrants.

Limitations The study relied primarily on expert judgments obtained through the SWOT-AHP framework. Although the pairwise comparisons were systematically evaluated through consistency testing, the resulting priorities remain subject to the subjective assessments and perspectives of a relatively small expert panel ($n = 15$). The study also adopted a single-case design focused on the Anambas Islands, which may constrain the transferability of the findings to other coastal and small-island tourism destinations with different environmental, institutional, infrastructural, and socio-economic conditions. Future research could strengthen the robustness and external validity of the findings by incorporating larger and more diverse

expert panels, comparative case studies across small-island destinations, and longitudinal assessments of NBGI implementation outcomes.

Transferability. Because the Anambas Islands share structural characteristics – geographic isolation, high marine-ecosystem dependence, constrained institutional capacity – with many other tropical small-island destinations, the SWOT-AHP framework itself, as a decision-support method, is likely to transfer readily [59]. However, the specific factor weights and intervention ranking reported here are context-specific outcomes of local ecological conditions and stakeholder composition, and should not be assumed to hold elsewhere without re-running the assessment with local experts. Comparative, multi-site applications of the same framework across Southeast Asian and other tropical small-island destinations would be needed to establish how much of the ranking generalizes versus reflects Anambas-specific conditions.

4. Conclusions

Future research should extend the analytical framework by examining complementary multi-criteria decision-making techniques, such as the Analytic Network Process (ANP), DEMATEL, and fuzzy AHP, to better capture interdependencies, causal relationships, and uncertainty among strategic factors. Future studies could also integrate spatial analysis, ecosystem-service valuation, and climate-scenario modelling with SWOT-AHP results to assess the spatial feasibility, economic value, and climate robustness of prioritized NBGI interventions. Such integration would provide a stronger evidence base for evaluating the economic and implementation feasibility of alternative interventions and for supporting investment and policy decisions in small-island destinations. This study examined strategic priorities for implementing nature-based green infrastructure (NBGI) to support climate-resilient and sustainable coastal tourism in the Anambas Islands, Indonesia, by integrating SWOT analysis with the Analytic Hierarchy Process (AHP). Twenty-one strategic factors were identified across the four SWOT dimensions. The AHP results indicated that Strength received the highest priority weight (0.372), followed by Opportunity (0.304), Weakness (0.198), and Threat (0.196). Among the strategic alternatives, the Strength–Opportunity (SO) strategy achieved the highest priority weight (0.432), indicating a predominantly proactive orientation that emphasizes leveraging existing ecological assets and external opportunities. Based on this strategic orientation and cross-referencing the prioritized SWOT factors with the scientific evidence on NBGI, five priority interventions were identified: mangrove restoration, coral reef rehabilitation, living shorelines, green coastal drainage, and community-based ecotourism. Collectively, these interventions have the potential to generate environmental, economic, and social co-benefits by supporting coastal risk reduction, ecosystem conservation, sustainable tourism development, and community adaptive capacity. The findings position healthy coastal and marine ecosystems as strategic natural infrastructure that can complement conventional infrastructure and provide an important foundation for climate-resilient small-island tourism development. The findings provide policymakers and destination managers with a structured and transparent basis for prioritizing limited resources toward conservation-oriented and ecosystem-based tourism development. The SWOT-AHP framework enables decision-makers to compare strategic priorities systematically while making the underlying assumptions and relative weights explicit. As discussed in Section 3.6, the framework may be applicable to other tropical small-island destinations facing comparable climate, ecological, and tourism

pressures; however, the specific factor weights and intervention priorities identified in this study are context-dependent and should be reassessed with local evidence and stakeholder judgments rather than directly transferred to other destinations.

Competing Interests

The authors declare that they have no competing financial or non-financial interests that could have influenced the work reported in this manuscript.

Author Contributions

All authors contributed equally to the conceptualization, methodology, data collection, data analysis, interpretation of the results, manuscript preparation, review, and editing. All authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

- [1] Intergovernmental Panel on Climate Change (IPCC). (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability; Cambridge University Press: Cambridge, UK. <https://doi.org/10.1017/9781009325844>.
- [2] Scott, D.; Hall, C.M.; Gössling, S. (2019). Global tourism vulnerability to climate change. *Annals of Tourism Research*, 77, 49–61. <https://doi.org/10.1016/j.annals.2019.05.007>.
- [3] Travel & Tourism Economic Impact 2024: Global Trends; WTTC: London, UK. (accessed on 1 July 2026) Available online: <https://researchhub.wttc.org/category/economic-impact>.
- [4] Mycoo, M.; Wairiu, M.; Campbell, D.; Duvat, V.; Golbuu, Y.; et al. (2022). Small islands. In Climate Change 2022: Impacts, Adaptation and Vulnerability; Cambridge University Press: Cambridge, UK; pp. 2043–2121. <https://doi.org/10.1017/9781009325844.017>.
- [5] Narayan, S.; Beck, M.W.; Reguero, B.G.; Losada, I.J.; van Wesenbeeck, B.; et al. (2016). The effectiveness, costs and coastal protection benefits of natural and nature-based defences. *PLOS ONE*, 11, e0154735. <https://doi.org/10.1371/journal.pone.0154735>.
- [6] De Bruin, K.; Dellink, R.; Agrawala, S. (2009). Economic aspects of adaptation to climate change: Integrated assessment modelling of adaptation costs and benefits. *OECD Environment Working Papers*, 6. <https://doi.org/10.1787/225282538105>.
- [7] Seddon, N.; Chausson, A.; Berry, P.; Girardin, C.A.J.; Smith, A.; Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 375, 20190120. <https://doi.org/10.1098/rstb.2019.0120>.
- [8] Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change (CBD Technical Series No. 41); Secretariat of the Convention on Biological Diversity: Montreal, Canada. (accessed on 1 July 2026) Available online: <https://www.cbd.int/doc/publications/cbd-ts-41-en.pdf>.
- [9] IUCN Global Standard for Nature-based Solutions: A User-Friendly Framework for the Verification, Design and Scaling Up of NbS; IUCN: Gland, Switzerland. (accessed on 1 July 2026) Available online: <https://portals.iucn.org/library/node/49070>.

- [10] Green Infrastructure (GI) — Enhancing Europe's Natural Capital (COM(2013) 249 final); European Commission: Brussels, Belgium. (accessed on 1 July 2026) Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2013%3A0249%3AFIN>.
- [11] Benedict, M.A.; McMahon, E.T. (2006). *Green Infrastructure: Linking Landscapes and Communities*; Island Press: Washington, DC, USA.
- [12] Beck, M.W.; Losada, I.J.; Menéndez, P.; Reguero, B.G.; Díaz-Simal, P.; Fernández, F. (2018). The global flood protection benefits of mangroves. *Scientific Reports*, 8, 4717. <https://doi.org/10.1038/s41598-018-22699-3>.
- [13] Alongi, D.M. (2014). Carbon cycling and storage in mangrove forests. *Annual Review of Marine Science*, 6, 195–219. <https://doi.org/10.1146/annurev-marine-010213-135020>.
- [14] Donato, D.C.; Kauffman, J.B.; Murdiyarso, D.; Kurnianto, S.; Stidham, M.; et al. (2011). Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience*, 4, 293–297. <https://doi.org/10.1038/ngeo1123>.
- [15] Ferrario, F.; Beck, M.W.; Storlazzi, C.D.; Micheli, F.; Shepard, C.C.; Airolidi, L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. *Nature Communications*, 5, 3794. <https://doi.org/10.1038/ncomms4794>.
- [16] Fourqurean, J.W.; Duarte, C.M.; Kennedy, H.; et al. (2012). Seagrass ecosystems as a globally significant carbon stock. *Nature Geoscience*, 5, 505–509. <https://doi.org/10.1038/ngeo1477>.
- [17] Duarte, C.M.; Losada, I.J.; Hendriks, I.E.; Mazarrasa, I.; Marbà, N. (2013). The role of coastal plant communities for climate change mitigation and adaptation. *Nature Climate Change*, 3, 961–968. <https://doi.org/10.1038/nclimate1970>.
- [18] Macreadie, P.I.; Anton, A.; Raven, J.A.; et al. (2019). The future of blue carbon science. *Nature Communications*, 10, 3998. <https://doi.org/10.1038/s41467-019-11693-w>.
- [19] Tourism and the Sustainable Development Goals. (accessed on 1 July 2026) Available online: <https://www.unwto.org/tourism-and-sustainable-development-goals>.
- [20] Adger, W.N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography*, 24, 347–364. <https://doi.org/10.1191/030913200701540465>.
- [21] Folke, C.; Carpenter, S.R.; Walker, B.; Scheffer, M.; Chapin, T.; Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15, 20. <https://doi.org/10.5751/ES-03610-150420>.
- [22] Transforming Our World: The 2030 Agenda for Sustainable Development. (accessed on 1 July 2026) Available online: <https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>.
- [23] Oceans for Prosperity: Reforms for a Blue Economy in Indonesia. (accessed on 1 July 2026) Available online: <https://documents1.worldbank.org/curated/en/735521616773893016/pdf/Oceans-for-Prosperity-Reforms-for-a-Blue-Economy-in-Indonesia.pdf>.
- [24] Hinkel, J.; Aerts, J.C.J.H.; Brown, S.; et al. (2018). The ability of societies to adapt to twenty-first-century sea-level rise. *Nature Climate Change*, 8, 570–578. <https://doi.org/10.1038/s41558-018-0176-z>.
- [25] Kelman, I.; West, J. (2009). Climate change and small island developing states: A critical review. *Ecological and Environmental Anthropology*, 5, 1–16. Available online:
- [26] Kabupaten Kepulauan Anambas Dalam Angka 2024. (accessed on 1 July 2026) Available online: <https://anambaskab.bps.go.id/id/publication/2024/02/28/be3b83d5aaba81da8c5c8f8b/kabupaten-kepulauan-anambas-dalam-angka-2024.html>.
- [27] Rencana Strategis LKKPN Pekanbaru Tahun 2020–2024. (accessed on 1 July 2026) Available online: <https://kkp.go.id/storage/AkuntabilitasKinerja/1097/document-akuntabilitas-kinerja>

- [667a4f5ce5ddeRencana%20Strategis%20%28RENSTRA%29%20LKPN%20Pekanbaru%20Tahun%202020-2024.pdf](#).
- [28] Nature-Based Solutions for Supporting Sustainable Development; (accessed on 1 July 2026) Available online: <https://wedocs.unep.org/bitstream/handle/20.500.11822/39864/NATURE-BASED%20SOLUTIONS%20FOR%20SUPPORTING%20SUSTAINABLE%20DEVELOPMENT.%20English.pdf?sequence=1>.
- [29] Kurniawan, F.; Adrianto, L.; Bengen, D.G.; Prasetyo, L.B. (2019). The social-ecological status of small islands: An evaluation of island tourism destination management in Indonesia. *Tourism Management Perspectives*, 31, 136–144. <https://doi.org/10.1016/j.tmp.2019.04.004>.
- [30] Helms, M.M.; Nixon, J. (2010). Exploring SWOT analysis – Where are we now? A review of academic research from the last decade. *Journal of Strategy and Management*, 3, 215–251. <https://doi.org/10.1108/17554251011064837>.
- [31] Kurttila, M.; Pesonen, M.; Kangas, J.; Kajanus, M. (2000). Utilizing the analytic hierarchy process (AHP) in SWOT analysis: A hybrid method and its application to a forest-certification case. *Forest Policy and Economics*, 1, 41–52. [https://doi.org/10.1016/S1389-9341\(99\)00004-0](https://doi.org/10.1016/S1389-9341(99)00004-0).
- [32] Creswell, J.W.; Plano Clark, V.L. (2018). *Designing and Conducting Mixed Methods Research*, 3rd ed.; SAGE Publications: Thousand Oaks, CA, USA.
- [33] Cohen-Shacham, E.; Andrade, A.; Dalton, J.; Dudley, N.; Jones, M.; et al. (2019). Core principles for successfully implementing and upscaling nature-based solutions. *Environmental Science & Policy*, 98, 20–29. <https://doi.org/10.1016/j.envsci.2019.04.014>.
- [34] Building Resilience to Climate Change: Ecosystem-Based Adaptation and Lessons from the Field. (accessed on 1 July 2026) Available online: <https://iucn.org/resources/publication/building-resilience-climate-change-ecosystem-based-adaptation-and-lessons>.
- [35] Nunn, P.D.; Aalbersberg, W.; Lata, S.; Gwilliam, M. (2014). Beyond the core: Community governance for climate-change adaptation in peripheral parts of Pacific Island Countries. *Regional Environmental Change*, 14, 221–235. <https://doi.org/10.1007/s10113-013-0486-7>.
- [36] Morris, R.L.; Boxshall, A.; Swearer, S.E. (2020). Climate-resilient coasts require diverse defence solutions. *Nature Climate Change*, 10, 485–487. <https://doi.org/10.1038/s41558-020-0798-9>.
- [37] Spalding, M.; Burke, L.; Wood, S.A.; Ashpole, J.; Hutchison, J.; zu Ermgassen, P. (2017). Mapping the global value and distribution of coral reef tourism. *Marine Policy*, 82, 104–113. <https://doi.org/10.1016/j.marpol.2017.05.014>.
- [38] Su, Y.; Xu, J.; Sotiriadis, M.; Shen, S. (2021). Authenticity, perceived value and loyalty in marine tourism destinations: The case of Zhoushan, Zhejiang Province, China. *Sustainability*, 13, 3716. <https://doi.org/10.3390/su13073716>.
- [39] World Tourism Day: Sector Pledges to Promote Investment, Education and New Destinations. (accessed on 1 July 2026) Available online: <https://www.unwto.org/news/sector-pledges-to-promote-investment-education-and-new-destinations>.
- [40] Saaty, T.L. (1980). *The Analytic Hierarchy Process*; McGraw-Hill: New York, NY, USA.
- [41] Görener, A.; Toker, K.; Uluçay, K. (2012). Application of combined SWOT and AHP: A case study for a manufacturing firm. *Procedia – Social and Behavioral Sciences*, 58, 1525–1534. <https://doi.org/10.1016/j.sbspro.2012.09.1141>.
- [42] Kadlec, R.H.; Wallace, S.D. (2009). *Treatment Wetlands*, 2nd ed.; CRC Press: Boca Raton, FL, USA. <https://doi.org/10.1201/9781420012514>.
- [43] Vymazal, J. (2011). Constructed wetlands for wastewater treatment: Five decades of experience. *Environmental Science & Technology*, 45, 61–69. <https://doi.org/10.1021/es101403q>.
- [44] Temmerman, S.; Horstman, E.M.; Krauss, K.W.; Mullarney, J.C.; Pelckmans, I.; et al. (2023). Marshes and mangroves as nature-based coastal storm buffers. *Annual Review of Marine Science*, 15, 95–118. <https://doi.org/10.1146/annurev-marine-040422-092951>.

- [45] Gössling, S. (2002). Global environmental consequences of tourism. *Global Environmental Change*, 12, 283–302. [https://doi.org/10.1016/S0959-3780\(02\)00044-4](https://doi.org/10.1016/S0959-3780(02)00044-4).
- [46] UN-Habitat Partners with WWF to Tackle Global Challenge of Waste Management in Cities and Plastic Pollution. (accessed on 1 July 2026) Available online: <https://unhabitat.org/news/10-feb-2020/un-habitat-partners-with-wwf-to-tackle-global-challenge-of-waste-management-in>.
- [47] Global Waste Management Outlook; UNEP International Environmental Technology Centre. (accessed on 1 July 2026) Available online: <https://www.unep.org/ietc/resources/publication/global-waste-management-outlook-2015>.
- [48] Making Tourism More Sustainable: A Guide for Policy Makers; UNEP & UNWTO. (accessed on 1 July 2026) Available online: https://wedocs.unep.org/bitstream/handle/20.500.11822/8741/-Making%20Tourism%20More%20Sustainable_%20A%20Guide%20for%20Policy%20Makers-2005445.pdf.
- [49] Morgan, D.L. (2014). Pragmatism as a paradigm for social research. *Qualitative Inquiry*, 20, 1045–1053. <https://doi.org/10.1177/1077800413513733>.
- [50] Denzin, N.K. (1978). *The Research Act: A Theoretical Introduction to Sociological Methods*, 2nd ed.; McGraw-Hill: New York, NY, USA.
- [51] Etikan, I.; Musa, S.A.; Alkassim, R.S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5, 1–4. <https://doi.org/10.11648/j.ajtas.20160501.11>.
- [52] Reefs at Risk Revisited; World Resources Institute. (accessed on 1 July 2026) Available online: <https://www.wri.org/research/reefs-risk-revisited>.
- [53] World Bank. (2021). *The Changing Wealth of Nations 2021: Managing Assets for the Future*; World Bank: Washington, DC, USA. <https://doi.org/10.1596/978-1-4648-1590-4>.
- [54] OECD. (2020). *Sustainable Ocean for All: Harnessing the Benefits of Sustainable Ocean Economies for Developing Countries*; OECD Publishing: Paris, France. <https://doi.org/10.1787/b1a30f8e-en>.
- [55] Scheyvens, R.; Hughes, E. (2019). Can tourism help to "end poverty in all its forms everywhere"? The challenge of tourism addressing SDG1. *Journal of Sustainable Tourism*, 27, 1061–1079. <https://doi.org/10.1080/09669582.2018.1551404>.
- [56] Scheyvens, R. (1999). Ecotourism and the empowerment of local communities. *Tourism Management*, 20, 245–249. [https://doi.org/10.1016/S0261-5177\(98\)00069-7](https://doi.org/10.1016/S0261-5177(98)00069-7).
- [57] Adrianto, L.; Kurniawan, F.; Romadhon, A.; Bengen, D.G.; Sjafrie, N.D.M.; et al. (2021). Assessing social-ecological system carrying capacity for urban small island tourism: The case of Tidung Islands, Jakarta Capital Province, Indonesia. *Ocean & Coastal Management*, 212, 105844. <https://doi.org/10.1016/j.ocecoaman.2021.105844>.
- [58] Ruhanen, L. (2013). Local government: Facilitator or inhibitor of sustainable tourism development? *Journal of Sustainable Tourism*, 21, 80–98. <https://doi.org/10.1080/09669582.2012.680463>.
- [59] Hall, C.M. (2019). Constructing sustainable tourism development: The 2030 agenda and the managerial ecology of sustainable tourism. *Journal of Sustainable Tourism*, 27, 1044–1060. <https://doi.org/10.1080/09669582.2018.1560456>.



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