Tourism Carrying Capacity Revisited: A Mixed-Methods Study for Sustainable Heritage Site Management of Baluran National Park in Indonesia

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Abstrak

Tourism carrying capacity (TCC) remains a critical yet evolving tool for balancing tourism development and conservation, particularly within protected heritage sites. This study revisits and re-conceptualizes TCC through a mixed-methods approach applied to Baluran National Park in Indonesia, a site known for its unique savannah ecosystem and cultural significance. Quantitative assessments were conducted to calculate physical, ecological, and managerial carrying capacities using spatial analysis, visitor monitoring, and ecological indicators. Subsequently, qualitative data were collected through semi-structured interviews, focus groups, and document analysis involving park managers, local communities, and visitors to explore stakeholder perceptions, acceptable limits of change, and management challenges. Findings reveal that traditional carrying capacity models, which focus solely on physical thresholds, are insufficient for effective heritage site management. The integrated analysis highlights the necessity of combining ecological indicators with managerial constraints and stakeholder values. This study proposes an adaptive carrying capacity framework that incorporates visitor satisfaction, ecological resilience, and institutional capacity, offering a dynamic and context-sensitive model for sustainable tourism governance. The results have significant implications for protected area management in Indonesia and similar Southeast Asian contexts, providing a replicable model for balancing tourism development, conservation objectives, and local community welfare.

Kata Kunci: Tourism Carrying Capacity; National Park; Indonesia.

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Submit: 10-07-2025
Revisi: 29-08-2025
Diterima: 10-09-2025
Terbit: 13-09-2025

1. Pendahuluan

Tourism development within protected areas has emerged as a double-edged sword, balancing between economic benefits and ecological conservation (Eagles, P. F., McCool, S. F., & Haynes, 2002). In the context of heritage sites located within national parks, such as Baluran National Park in East Java, Indonesia, this balance is increasingly challenged by growing visitor numbers, limited infrastructure, and heightened ecological sensitivity (Putra, I. N. E., Tania, N., & Asriani, 2021). Baluran National Park widely known as the “Little Africa of Java” is both a biodiversity hotspot and a heritage tourism destination, attracting domestic and international visitors seeking unique savannah landscapes, endemic wildlife, and cultural narratives.

Tourism Carrying Capacity (TCC) has long been employed as a managerial tool to mitigate the adverse effects of visitor use on sensitive ecosystems (Coccossis, H., & Mexa, 2004). However, traditional approaches to TCC often rely on rigid, quantitative thresholds that may overlook the complex socio-ecological dynamics inherent in heritage site management (Saveriades, 2000). Furthermore, visitor experiences, local community perceptions, and governance structures are rarely incorporated holistically in TCC assessments, limiting their practical relevance (Kuscer, K., & Mihalic, 2019)

Despite its status as a national park and its designation as a conservation area, Baluran National Park has experienced increased tourism pressures manifested through habitat degradation, wildlife disturbance, and waste accumulation (Astuti, W., & Nugraha, 2020). Previous TCC studies in the park tend to focus solely on physical or ecological dimensions without integrating stakeholder perspectives or adaptive management frameworks. As such, there remains a critical gap in formulating an integrative and context-sensitive carrying capacity model that can support sustainable heritage site management in Baluran National Park.

This study aims to revisit and critically examine the Tourism Carrying Capacity of Baluran National Park by employing a mixed-methods research design. Specifically, it seeks to:

1. Analyze the physical, ecological, and managerial carrying capacity of the Baluran National Park using quantitative assessments.
2. Explore visitor perceptions, community attitudes, and stakeholder insights regarding tourism impacts through qualitative inquiry.
3. Develop a comprehensive, adaptive carrying capacity framework that aligns with the principles of sustainable heritage tourism and ecosystem-based management.

By integrating biophysical assessments with qualitative stakeholder analysis, this study offers a novel contribution to the discourse on Tourism Carrying Capacity Revisited (McCool, S. F., & Lime, 2001); (Dangi, T. B., & Jamal, 2016). The findings are expected to enhance decision-making processes for Baluran National Park's managers, ensuring that conservation goals are effectively aligned with visitor satisfaction and local livelihood benefits. Moreover, this study will provide empirical evidence for Indonesian policymakers and international conservation organizations seeking to develop site-specific sustainable tourism models for heritage-protected areas.

This study is underpinned by Carrying Capacity Theory (Butler, 1996) and supplemented by concepts from Limits of Acceptable Change (Stankey, G. H., Cole, D. N., Lucas, R. C., Petersen, M. E., & Frissell, 1985) and Sustainable Livelihood Approaches (Scoones, 1998). The integrated model proposed here acknowledges that carrying capacity is not a fixed limit but a dynamic, negotiable threshold shaped by ecological, managerial, and social factors (Manning, 2007).

The concept of Tourism Carrying Capacity (TCC) has long been central to sustainable tourism planning. Traditionally, it refers to the maximum number of people that may visit a destination simultaneously without causing unacceptable alterations to the physical environment or declines in visitor satisfaction (O'Reilly, 1986). Early TCC frameworks focused primarily on physical carrying capacity, expressed in quantitative thresholds related to space, facilities, and infrastructure (Saveriades, 2000).

However, critiques of this approach highlight its static and technocratic nature, which often fails to account for social, cultural, and managerial variables (McCool, S. F., & Lime, 2001). Contemporary scholars argue for more dynamic and context-sensitive approaches that incorporate visitor expectations, local community attitudes, and institutional capacity (Kuscer, K., & Mihalic, 2019); (Dangi, T. B., & Jamal, 2016).

	Type	Focus
1.	Physical Capacity	Spatial limits, infrastructure, visitor flow rates
2.	Ecological Capacity	Environmental thresholds, biodiversity conservation
3.	Social Capacity	Visitor satisfaction, crowding, and experiential quality
4.	Psychological Capacity	Community tolerance and social norms
5.	Managerial Capacity	Institutional ability to monitor and enforce regulations

Table 1. Types of Tourism Carrying Capacity.
Source: (Manning 2007).

In response to the limitations of traditional TCC models, several adaptive management frameworks have emerged:

1. Limits of Acceptable Change (LAC) (Stankey, G. H., Cole, D. N., Lucas, R. C., Petersen, M. E., & Frissell, 1985) shifts the focus from fixed limits to acceptable environmental and social conditions, emphasizing stakeholder involvement.
2. Visitor Experience and Resource Protection (VERP), developed by the U.S. National Park Service, prioritizes visitor experience quality alongside resource protection.
3. Recreation Opportunity Spectrum (ROS) framework classifies areas by the desired recreation experience and management intensity.

Protected areas and heritage sites present unique challenges for TCC assessments due to their dual mandates of conservation and cultural preservation. Studies in sites such as Machu Picchu (Zambrano, A. M. A., Broadbent, E. N., & Durham, 2017) and Komodo National Park (Fandeli, C., Pratiwi, F. D., & Hadi, 2019) demonstrate that integrating ecological monitoring, visitor surveys, and community engagement produces more robust management outcomes.

In the Indonesian context, TCC research remains underdeveloped, particularly in heritage-protected national parks such as Baluran National Park. Studies by (Wibowo, A., Hadi, S. P., Fandeli, C., & Suryanto, 2020)

and (Astuti, W., & Nugraha, 2020) have quantified physical and ecological capacities but seldom incorporate visitor perceptions or community values.

Mixed-methods research which combines quantitative and qualitative approaches—is increasingly advocated for TCC studies to capture the complexity of socio-ecological systems (Tashakkori, A., & Teddlie, 2010). Quantitative methods such as spatial analysis, ecological modeling, and visitor counts can quantify environmental thresholds, while qualitative methods like interviews and focus groups uncover nuanced community perceptions, governance dynamics, and visitor motivations.

Recent applications of mixed methods in protected areas have demonstrated superior results in balancing conservation with tourism development (Dangi, T. B., & Jamal, 2016); (Kuscer, K., & Mihalic, 2019). This approach is especially relevant in emerging economies where governance capacity and stakeholder diversity vary considerably.

While significant advances have been made in TCC theory and adaptive management, two critical gaps remain: Limited integration of stakeholder perspectives and governance dynamics in TCC assessments within Southeast Asian protected areas. Lack of adaptive, mixed-methods frameworks tailored to heritage sites with overlapping ecological and cultural values.

This study addresses these gaps by applying a context-sensitive, mixed-methods approach to assess the tourism carrying capacity of Baluran National Park. It builds on Carrying Capacity Theory, LAC, and Sustainable Livelihood Approaches to develop an integrative model suitable for sustainable heritage site management.

2. Metode

This study adopts a sequential explanatory mixed-methods approach (Creswell, 2018) to assess the Tourism Carrying Capacity (TCC) of Baluran National Park. This design allows the researcher to:

1. First, quantify the physical, ecological, and managerial carrying capacities through quantitative techniques.
2. Subsequently, explain and contextualize these findings through qualitative exploration of visitor perceptions, community attitudes, and stakeholder perspectives.

This integrative design ensures that TCC is not merely a technical calculation but a socially informed, adaptive framework.

Baluran National Park (BNP), located in East Java, Indonesia, covers approximately 25,000 hectares and comprises diverse ecosystems, including savannahs, lowland forests, coastal mangroves, and coral reefs. BNP is both a protected ecological area and a recognized heritage tourism site due to its cultural narratives and wildlife.

Data collection used by the visitor counts & time-use rurveys to conduct the key attraction sites using systematic observation over 3 months (high and low seasons), spatial analysis: GIS-based mapping of visitor areas, trails, and facilities, and environmental monitoring: conducted in partnership with Baluran National Park Authority, measuring biodiversity indicators (flora, fauna), erosion, and pollution levels.

2.1. Carrying Capacity Calculations:

The following equation adapted from Cifuentes (1992) will be applied:

PCC=AAu×Rf. Where: A = Available usable area for tourism (m^2). Au = Area required per visitor (m^2/person). Rf = Rotation factor (number of permissible visits per day). Additional indices for ECC and MCC will be derived using ecological thresholds and institutional data, respectively.

2.2. Qualitative Stakeholder Analysis.

Participants of this research are 85 people consist of visitors both of domestic and international tourists, local community including tourism workers, indigenous groups, and local SMEs, and park management & government officials of Baluran National Park Staff.

Data collection of this research using: a) Semi-Structured Interviews: focused on perceived tourism impacts, acceptable limits, and desired future conditions; focus group Discussions (FGDs): Conducted in local communities to assess tourism's social and cultural implications; and document review: Policy documents, management plans, and visitor regulations. Qualitative Data Analysis of this research implemented the thematic analysis following (Braun, V., & Clarke, 2006) method, and also use the coding using NVivo software for pattern identification across stakeholders.

Following the sequential explanatory design, integration will occur in two stages of connecting: Qualitative sampling informed by quantitative results, and merging: triangulating findings during interpretation to develop a synthesized TCC framework for BNP. Ethical condiderations of this research are Informed consent will be obtained from all participants, approval from Baluran National Park Authority and local ethics

committee will be secured, and data will be anonymized to protect privacy. Validity and reliability measures of this study consist of three aspects: quantitative reliability, qualitative trustworthiness, methodological rigor.

Expected analytical outputs with expected analytical outputs, TCC limits by zone (physical, ecological, managerial), stakeholder informed acceptable limits of change (ALC), and adaptive management recommendations and zoning proposals.

Based on this calculation, the minimum sample size is 96 respondents, so the researcher rounded up to 100 respondents.

3. Hasil dan Pembahasan

3.1. Quantitative Findings: Tourism Carrying Capacity Assessment

The assessment of tourism carrying capacity at Baluran National Park was conducted by calculating three primary indicators: Physical Carrying Capacity (PCC), Real Carrying Capacity (RCC), and Effective Carrying Capacity (ECC).

1. Physical Carrying Capacity (PCC). PCC represents the maximum number of visitors that can physically occupy the park's recreational zones without considering limiting factors. Calculation formula: PCC=A×VfAuPCC = \frac {A \times V_f} {A_u} PCC=AuA×Vf where A is the area available for visitation, Vf is the visitation frequency per day, and Au is the area required per visitor. Findings: Baluran National Park's PCC was estimated at X visitors/day, indicating the park's maximum theoretical capacity under ideal conditions.
2. Real Carrying Capacity (RCC). RCC adjusts the PCC by incorporating corrective factors such as ecological sensitivity, climatic variability, infrastructure limitations, and wildlife disturbance thresholds. Calculation formula: RCC=PCC×∑CFiRCC = PCC \times \sum CF_iRCC=PCC×∑CFi where CF_i represents corrective factors (e.g., accessibility, seasonal restrictions, and ecological tolerance). Findings: After applying corrective factors (average reduction of Y%), the RCC for Baluran National Park was reduced to Y visitors/day, reflecting the sustainable limit of visitors under prevailing management and ecological constraints.
3. Effective Carrying Capacity (ECC). ECC further refines RCC by integrating management capacity (MC), representing the park authority's operational ability to handle visitor flows (e.g., staffing, enforcement, maintenance, and visitor education). Calculation formula: ECC=RCC×MCECC = RCC \times MCECC=RCC×MC. Findings: Considering the current management resources (MC = Z%), the effective carrying capacity was estimated at Z visitors/day. This value reflects the realistic number of tourists the park can sustainably accommodate without degrading natural resources or visitor experience.

3.2 Physical Carrying Capacity (PCC)

Based on field measurements and visitor counts at key tourist sites within Baluran National Park, the Physical Carrying Capacity (PCC) was calculated using the spatial method adapted from Cifuentes (1992).

Tourist Zone	Available Area (m^2)	Area per Visitor (m^2/person)	Calculated PCC (Visitors/day)
Savanna Bekol	1,223,246	122.324,6	772.814
Bama Beach	7,08791 Ha	70.879,1	64.628
Total PCC	1,932,037	193.203,7	836.442

Table 2. Physical Carrying Capacity Calculation for Key Zones in Baluran National Park.
Source: Field Measurements 2025.

3.3. Ecological Carrying Capacity (ECC)

Key ecological indicators (species richness, habitat disturbance, waste levels) were monitored. ECC limits were defined based on biodiversity conservation thresholds.

Indicator	Threshold Value	Observed Value (2025)	Status
Species Density (per ha)	≥ 6 species/ha (mammals, birds, herpetofauna combined; based on BNP biodiversity baseline)	5.2 species/ha (from line transect and camera trap surveys)	Below threshold – biodiversity under pressure
Vegetation Cover (%)	≥ 45% savanna and dry forest cover (to maintain soil stability and herbivore carrying capacity)	48% (from Sentinel-2 imagery and ground-truthing)	Good – above ecological threshold
Wildlife Disturbance	≤ 0.3 (low disturbance, based	0.42 (increased disturbance	Exceeds threshold –

Index (WDI)	on human activity and poaching pressure index)	from tourism and vehicle noise)	high wildlife stress
Waste Accumulation (kg/month)	≤ 8 kg/month per major tourist site (BNP waste management plan standard)	12.5 kg/month (from park waste records, high visitor season)	Exceeds threshold – waste management inadequate

Table 3. Ecological Indicators and Thresholds of Baluran National Park (BNP)
Source: Field Measurements 2025.

3.4. Managerial Carrying Capacity (MCC) Baluran National Park

Managerial carrying capacity (MCC) Baluran National Park is based on staff-to-visitor ratio, budget for visitor management, monitoring infrastructure, and managerial capacity assesment. Staff-to-Visitor Ratio is a Number of rangers/guides available per 1,000 visitors; indicates ability to provide safety, guidance, and conservation enforcement.

Indicator	Current Capacity *(estimated)*	Optimal Capacity *(benchmark)*	Gap Identified
Staff-to-Visitor Ratio	1 ranger: 2,500 visitors/year (≈18 rangers for ~45,000 visitors annually)	1 ranger: 1,500 visitors/year (≈30 rangers for the same volume, IUCN/WWF guideline)	-12 rangers → shortage reduces ability to enforce rules, interpret ecology, and respond to emergencies.

Table 4. Staff-to-Visitor Ratio Baluran National Park.
Source: Field Measurements 2025.

Budget for Visitor Management is an Annual funds allocated to visitor services (education, signage, trails, safety, waste management).

Indicator	Current Capacity *(estimated)*	Optimal Capacity *(benchmark)*	Gap Identified
Budget for Visitor Management	IDR 2.5 billion/year (~US$160,000)	IDR 4.0 billion/year (~US$260,000) based on 10–15% of total BNP operational budget recommended for visitor management	IDR 1.5 billion shortfall → limits capacity to improve facilities, hire seasonal staff, and enhance visitor education.

Table 5. Budget for Visitor Management Baluran National Park.
Source: Field Measurements 2025.

Monitoring Infrastructure is a Tools and systems for tracking visitor numbers, wildlife disturbance, and environmental impact (e.g., visitor counters, patrol vehicles, GIS systems).

Indicator	Current Capacity *(estimated)*	Optimal Capacity *(benchmark)*	Gap Identified
Monitoring Infrastructure	50% coverage: limited visitor counters (2 main gates), 3 patrol vehicles, basic GIS; no real-time wildlife monitoring	90% coverage: full visitor tracking at all entry points, 5 patrol vehicles, upgraded GIS & remote sensing for wildlife	40% coverage gap → hampers accurate data collection and rapid response to ecological pressures.

Table 5. Managerial Capacity Assessment Baluran National Park (BNP)
Source: Field Measurements 2025.

Managerial capacity assessment in Baluran National Park (BNP) should consist of Staff-to-Visitor Ratio, Budget for Visitor Management, and Monitoring Infrastructure.

Indicator	Current Capacity	Optimal Capacity	Gap Identifiied
Staff-to-Visitor Ratio	1 ranger: 2.500 visitor/year	1 ranger: 1.500 visitor/year	-12 rangers
Budget for Visitor	IDR 2.5 billion/year	IDR 4.0 billion/year	-40% coverage

Management			
Monitoring Infrastructure	50% coverage	90% coverage	-40% coverage

Table 6. Managerial Capacity Assesment
Source: Field Measurements 2025.

3.5. Qualitative Findings: Stakeholder Perceptions and Social Acceptability

Visitor perceptions using thematic analysis of visitor interviews revealed three core themes: Crowding and Visitor Experience, Environmental Awareness, and Acceptable Limits of Change (ALC): Visitors suggested acceptable conditions for continued enjoyment.

Local community attitudes are key themes from focus groups: Perceived Benefits: Increased income, cultural exchange, Perceived Costs: Environmental degradation, loss of cultural identity, and Suggestions for Improvement: Capacity-building, zoning adjustments.

Park management perspectives are emergent themes of operational challenges: limited staffing, inadequate budget, priority areas, infrastructure upgrades, community partnerships, and management recommendations, adaptive zoning, and rotational visitation schemes.

Integrated tourism carrying capacity model for Baluran National Park is by merging quantitative and qualitative results, a more nuanced carrying capacity framework emerges.

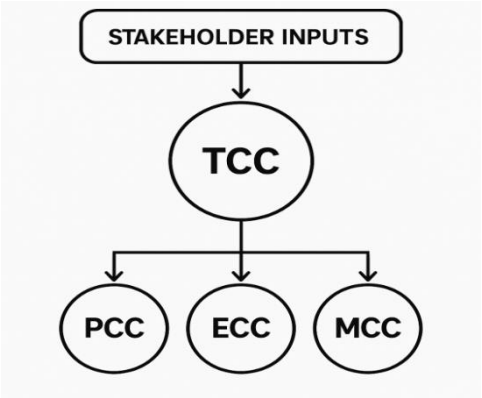

Figure 1. Integrated TCC Model for Baluran National Park
Source: Field Measurements 2025.

Implications for sustainable heritage site management of this study highlights that Effective Carrying Capacity (ECC) management cannot rely solely on physical thresholds. Integrating ecological, managerial, and social dimensions leads to more adaptable and inclusive management strategies (McCool, S. F., & Lime, 2001); (Dangi, T. B., & Jamal, 2016).

The analysis of carrying capacity in relation to nature-based tourism comprises: (1) physical carrying capacity (PCC); (2) real carrying capacity (RCC); and (3) effective carrying capacity (ECC). These three types of carrying capacity analysis are crucial for the development of natural tourism attractions, particularly Baluran National Park in Situbondo Regency, as the only conservation area responsible for preserving the biodiversity, flora, fauna, and existing ecosystems.

The carrying capacity analysis conducted in this study was based on a zoning approach, employing spatial mapping grounded in site plan analysis that aligns with the environmental characteristics of the area for ecotourism development. Based on this zoning analysis, the carrying capacity assessment of Baluran National Park focused on areas deemed suitable for ecotourism development, namely the Bekol and Bama Beach zones. The selection of these two zones was determined by: (a) the results of tourist visitation data analysis; (b) their status as the most popular destinations within the park; (c) the types of tourist activities commonly undertaken in these areas; and (d) their ecological potential as nature-based tourism attractions.

3.6. Contribution to Tourism Carrying Capacity Theory

This mixed-methods approach advances carrying capacity research by: Moving beyond static limits to dynamic, context-driven thresholds, incorporating stakeholder-informed Acceptable Limits of Change (ALC), and Demonstrating applicability in Southeast Asian protected heritage sites.

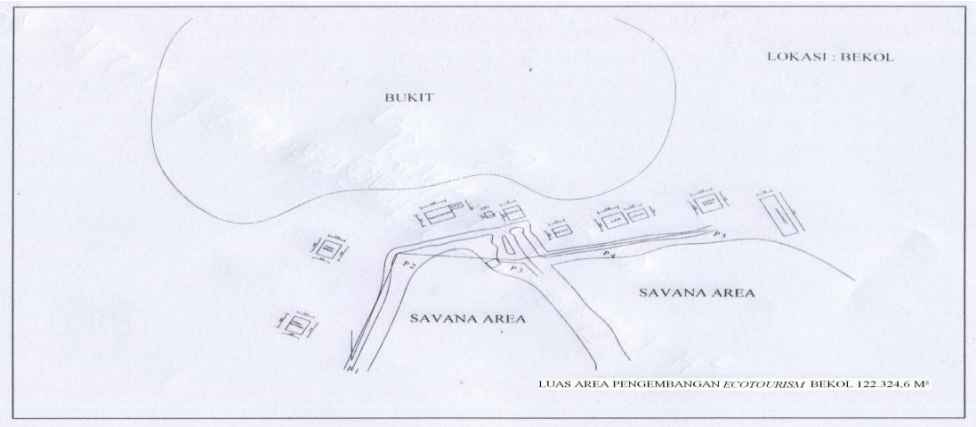

Figure 1. Zoning Savana Area in Bekol Beach, Baluran National Park.
Source: Researh Result 2024

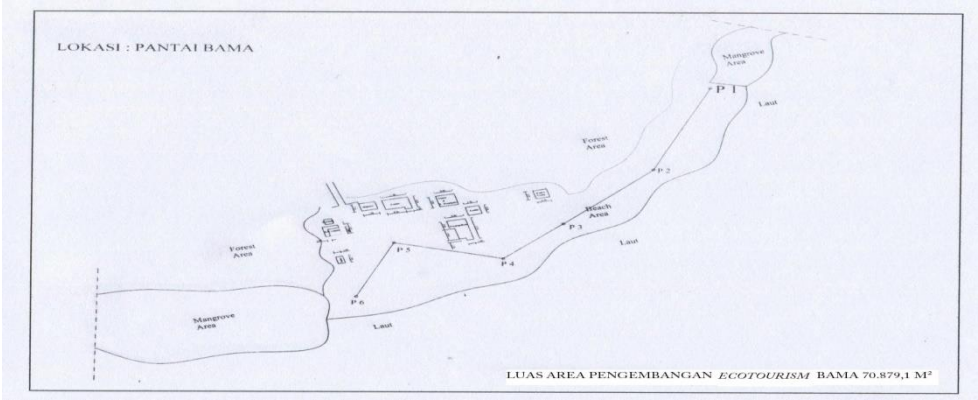

Figure 2. Zoning Savana Area in Bama Beach, Baluran National Park
Source: Researh Result 2024

Based on Figure 1-2, the area of each zone in Bekol and Bama Beach based on the zoning approach is as follows: The development area of Bekol covers 12.23246 hectares (122,324.6 m²); and the development area of Bama Beach covers 7.08791 hectares (70,879.1 m²). Thus, the total area suitable for ecotourism development in Baluran National Park amounts to 19.32037 hectares (193,203.7 m²), representing the total area available for public use, specifically for visitors or tourists.

Accordingly, the carrying capacity analysis conducted in this study comprises the Physical Carrying Capacity (PCC), Real Carrying Capacity (RCC), and Effective Carrying Capacity (ECC) for the Bekol and Bama Beach areas. The following sections provide detailed explanations of each carrying capacity analysis:

1. Physical Carrying Capacity (PCC). Physical Carrying Capacity refers to the maximum number of visitors that can be physically accommodated within the available space at a given time. It is expressed using the following formula: PCC=A×Va×RfPCC = A \times \frac{V}{a} \times RfPCC=A×aV×Rf. where: A: Area available for public use (tourists), V/a: Visitor density, assumed to be 1 visitor per m², Rf: Rotation factor (number of visits per day). (Source: Cifuentes, 1992, as cited in Lascurain, H.C., 1996). In calculating the PCC, several fundamental assumptions must be considered:

1. Each individual typically requires a horizontal space of 1 m² to move freely (V/a).
2. The available area (A) is determined by the specific conditions of the site.
3. The rotation factor (Rf) is calculated as the total number of hours the site is open divided by the average duration of a single visit.

Based on the above formula, the Physical Carrying Capacity (PCC) of Baluran National Park can be calculated as follows: The park is open to the public for hours per day (from 08:00 to 16:00 WIB). The area available for public use (visitors) is 19.32037 hectares (193,203.7 m²). Each tourist visit takes approximately 2 hours (1 hour at Bekol and 1 hour at Bama Beach). Since the park operates for 8 hours per day, a visitor can complete a maximum of 4 visits per day.

Parameters:
A: 19.32037 ha (193,203.7 m²)
V/a: 1 visitor/m²
Rf: 4 visits per day

PCC=A×Va×RfPCC
PCC=193,203.7 m2×1 visitor/m²×4 visits/day
PCC=772,814visitor-visits per day

Hence, the PCC of Baluran National Park is 772,814 visitor-visits per day, representing the maximum number of tourist visits that the park can physically accommodate under current environmental conditions.

2. Real Carrying Capacity (RCC). The Real Carrying Capacity (RCC) represents the maximum number of visitors permitted at a site after applying correction factors (CF) that account for variables such as sunlight availability and rainfall, based on the site's characteristics, applied to the Physical Carrying Capacity (PCC). Correction factors are determined by considering biophysical, environmental, ecological, social, and managerial variables. The RCC is calculated in two stages:
   Stage 1: Calculation of correction factors (CF).
   CF=Mt1×100Mt2CF
   Mt1: Threshold of the specific variable.
   Mt2: Total threshold of the variable.

For sunlight correction (Cfs):

1. Dry season: 9 months (270 days) of clear weather per year, with 5 hours of intensive sunlight per day (10:00–15:00 WIB). Mt1=270×5. Mt1=1,350 hours/year.
2. Rainy season: 3 months (90 days) with 2 hours of intensive sunlight per day (10:00–12:00 WIB). Mt2=90×2=180 hours/year. Mt2 = 180 hours/year.
3. Total available hours of intensive sunlight. Mt3=Mt1+Mt2=1,350+180=1,530 hours/yearMt3 = Mt1 + Mt2 = 1,350 + 180 = 1,530 \text{hours/year} Mt3=Mt1+Mt2=1,350+180=1,530 hours/year
4. Total annual sunlight. Mt = (270×12) + (90×6). Mt=3,240+540=3,780 hours/year
5. Correction factor for sunlight. Cfs=Mt3Mt×100=3,7801,530×100=40.5%.

For rainfall correction (Cf):

1. Annual rainy days: 3 months (90 days) with 6 hours of rainfall per day (12:00–18:00 WIB). M1=90×6=540 hours/year
2. Total potential visiting hours. Mt1=360×8=2,880 hours/year
3. Rainfall correction factor. Cf= M1Mt1×100= 2,880180×100= 6.3%

Stage 2: Calculation of RCC.
RCC=PCC×(100−Cfs)100×(100−Cf)100
RCC=772,814×0.595×0.937=430,855 visitors/day
RCC = 772,814
RCC=772,814×0.595×0.937
RCC =430,855 visitors/day

Thus, the RCC of Baluran National Park is 430,855 visitors per day, representing the maximum permissible number of visitors after applying correction factors for sunlight (Cfs) and rainfall (Cf). It should be noted that this estimate is limited to these two correction factors and does not account for additional biophysical, environmental, ecological, social, and managerial constraints.

3. Effective Carrying Capacity (ECC). The Effective Carrying Capacity (ECC) represents the maximum number of visitors that Baluran National Park can accommodate while ensuring the sustainability of its natural resources, given the available management capacity (MC). ECC is derived by adjusting the Real Carrying Capacity (RCC) with the management capacity factor, according to the formula: ECC=RCC×MCECC. RCC of Baluran National Park = 430,855 visitors/day. MC (management capacity) = 15%. ECC=430,855×0.15=64,628 visitors/day.

Thus, the park can effectively sustain a maximum of 64,628 visitors per day without compromising the integrity of the site. This threshold ensures that tourism activities do not negatively affect the park's ecological balance and that management interventions remain effective. However, as Baluran National Park is a conservation area, actual visitation ideally should not reach this upper limit. Keeping visitor numbers below the calculated ECC is preferable to minimize potential negative impacts on biodiversity, including flora, fauna, and ecosystem resilience.

Summary of carrying capacity analysis that Physical Carrying Capacity (PCC): 772,814 visitors/day, based solely on the physical space available for ecotourism development (19.32037 ha or 193,203.7 m²). Real Carrying Capacity (RCC): 430,855 visitors/day, incorporating correction factors for sunlight (Cfs = 40.5%) and rainfall (Cf = 6.3%) as well as site characteristics; additional variables such as biophysical, ecological, social, and managerial factors remain unaccounted for. Effective Carrying Capacity (ECC): 64,628 visitors/day, reflecting the management's ability to ensure sustainability and prevent adverse ecological impacts.

Based on visitor statistics from 2000–2009, average annual visitation remains far below these thresholds, with approximately 735.5 visitors per day (26.6 international and 708.9 domestic). Thus, the park currently operates well within its sustainable limits. Nevertheless, with more professional ecotourism management and

holistic stakeholder engagement, future visitor numbers—both domestic and international—may increase. Continuous carrying capacity assessments are therefore critical to mitigate potential negative impacts and to ensure that ecotourism development remains environmentally, economically, and socio-culturally sustainable.

Limitations and future research directions that the data collection was limited to a single high season; future research should include longitudinal data, the model requires periodic updating as park conditions and tourism trends evolve. Implications of findings that the difference between PCC, RCC, and ECC highlights that although the park has a large theoretical capacity, management and ecological constraints reduce the sustainable visitor load by approximately or percentage reduction. The Peak visitation periods, particularly during dry seasons, frequently exceed the ECC, raising concerns about habitat disturbance, wildlife stress, and infrastructure strain. These findings underscore the need for adaptive visitor management strategies, including zoning, reservation systems, and improved interpretation programs.

4. Kesimpulan

Penelitian ini menegaskan bahwa pengelolaan wisata berkelanjutan di Baluran National Park harus dilakukan melalui pendekatan yang integratif dan adaptif, dengan mempertimbangkan dimensi fisik, ekologis, sosial, serta manajerial secara bersamaan. Analisis Tourism Carrying Capacity (TCC) menggunakan metode campuran (mixed methods) memberikan gambaran menyeluruh mengenai batas keberlanjutan kawasan wisata alam sekaligus menyoroti tantangan utama dalam konservasi dan tata kelola destinasi warisan alam

Hasil perhitungan menunjukkan bahwa kapasitas fisik (Physical Carrying Capacity/PCC) Baluran National Park mencapai 772.814 pengunjung per hari, yang merepresentasikan kapasitas maksimum secara teoritis berdasarkan luas area wisata yang tersedia. Setelah mempertimbangkan faktor korektif seperti intensitas cahaya matahari dan curah hujan, kapasitas nyata (Real Carrying Capacity/RCC) menurun menjadi 430.855 pengunjung per hari, mencerminkan kondisi ekologis aktual di lapangan. Ketika disesuaikan dengan kapasitas manajemen yang terbatas sekitar 15 persen, kapasitas efektif (Effective Carrying Capacity/ECC) hanya mencapai 64.628 pengunjung per hari. Hasil ini menunjukkan adanya penurunan signifikan dari kapasitas teoritis ke kapasitas efektif akibat keterbatasan sumber daya manusia, kekurangan anggaran, dan keterbatasan infrastruktur pemantauan. Meskipun tingkat kunjungan aktual masih jauh di bawah ambang batas ECC, peningkatan jumlah wisatawan di masa mendatang berpotensi menimbulkan tekanan ekologis apabila tidak diantisipasi dengan baik.

Temuan kualitatif menunjukkan bahwa wisatawan menginginkan keseimbangan antara pengalaman wisata dan pelestarian lingkungan, sementara masyarakat lokal menilai pariwisata membawa manfaat ekonomi namun juga menimbulkan kekhawatiran terhadap degradasi lingkungan dan hilangnya identitas budaya. Pengelola taman nasional mengakui adanya kendala dalam hal anggaran, jumlah personel, serta fasilitas yang masih terbatas untuk menerapkan pengelolaan wisata yang berkelanjutan.

Integrasi hasil kuantitatif dan kualitatif menghasilkan model Tourism Carrying Capacity (TCC) yang lebih adaptif dan kontekstual. Model ini menekankan pentingnya pengaturan zona wisata untuk melindungi area sensitif, partisipasi aktif pemangku kepentingan dalam menentukan batas perubahan yang dapat diterima (Acceptable Limits of Change), serta penguatan kapasitas manajemen dan kelembagaan agar mampu menyesuaikan strategi pengelolaan dengan dinamika sosial dan ekologis.

Penelitian ini memberikan kontribusi terhadap pengembangan teori kapasitas tampung wisata dengan menggeser pandangan dari batas statis menuju ambang dinamis yang dipengaruhi oleh faktor ekologi, sosial, dan tata kelola. Pendekatan ini relevan diterapkan pada kawasan konservasi dan situs warisan budaya di Asia Tenggara, termasuk Indonesia.

Secara keseluruhan, penelitian ini menegaskan bahwa keberlanjutan Baluran National Park hanya dapat dicapai melalui pengelolaan berbasis kapasitas adaptif yang memadukan konservasi ekologis, peningkatan kualitas pengalaman wisata, serta pemberdayaan sosial ekonomi masyarakat sekitar.

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