SCIENTIFIC CULTURE

www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 2.1, (2026), pp. 2110-2122
Open Access. Online & Print

DOI: 10.5281/zenodo.122.126167

TOURISM DEVELOPMENT MODEL ANALYSIS ON SOME COASTAL TOURISM OBJECTS AFFECTED BY THE CYCLONE SEROJA DISASTER IN EAST FLORES DISTRICT AND KUPANG CITY

Apriana H. J. Fanggidae[1], Robin Chen[2], Amanda Jelita Eka Riani Johanis[3], Marisa Susanti Bette Seran[4]

[1]Universitas Nusa Cendana, Nusa Tenggara Timur, Indonesia, apriana.fanggidae@staf.undana.ac.id, https://orcid.org/0000-0001-5277-7629
[2]National Taipei University, New Taipei City, Taiwan, robinchen@gm.ntpu.edu.tw, https://orcid.org/0000-0002-0397-1844
[3]Universitas Nusa Cendana, Nusa Tenggara Timur, Indonesia, amanda.johanis@staf.undana.ac.id, https://orcid.org/0009-0009-6162-120X
4Universitas Timor, Nusa Tenggara Timur, Indonesia, cucanseran@unimor.ac.id, https://orcid.org/0009-0004-2618-0713

Received: 20/11/2025
Accepted: 29/12/2025

Corresponding Author: Apriana H. J. Fanggidae (apriana.fanggidae@staf.undana.ac.id)

ABSTRACT

This study examines the impacts of Tropical Cyclone Seroja on coastal tourism in East Flores Regency and Kupang City, East Nusa Tenggara, Indonesia, and develops a sustainable tourism recovery model. Using a qualitative descriptive approach, the research engaged 20 key informants through semi-structured interviews, field observations, and focus group discussions. The study integrates the CEAS (Community-based, Eco-sensitive, Adaptive, Socio-economic) framework with Impact Chains analysis to understand disaster-tourism relationships. Findings reveal multidimensional impacts including socio-cultural disruption through destruction of traditional infrastructure (lopo, Bale Lewho), economic vulnerabilities with income reductions exceeding 70% for micro-enterprises, and environmental degradation including coastal erosion, mangrove destruction, and coral reef damage. Despite severe disruptions, communities demonstrated remarkable resilience through sustained hospitality practices and adaptive strategies. The research proposes an integrated sustainable tourism development model that balances economic recovery with ecological restoration and community participation. The approach emphasizes community-based tourism ensuring local participation, eco-sensitive development respecting ecological carrying capacity limits, adaptive climate-responsive planning, and long-term socio-economic sustainability. This model provides a comprehensive framework for disaster-resilient tourism development that prioritizes environmental restoration, inclusive governance, and economic diversification while maintaining cultural authenticity and community agency.

KEYWORDS: Coastal Tourism, Disaster Recovery, Sustainable Tourism, Cyclone Seroja, Community Resilience, Impact Chains, Climate Adaptation.

1. INTRODUCTION

Tourism is one of the fastest-growing sectors in Indonesia, contributing significantly to economic growth, employment, and cultural exchange. In coastal regions, tourism provides unique opportunities through marine ecosystems, cultural heritage, and natural landscapes (Ounanian et al., 2021). However, the sustainability of coastal tourism is highly vulnerable to the impacts of climate change and hydrometeorological disasters, which often result in severe socio-economic and ecological consequences (Li & Gopalakrishnan, 2021). The Intergovernmental Panel on Climate Change (IPCC) has repeatedly emphasized that extreme events such as cyclones, storm surges, and floods will increasingly disrupt tourism systems, particularly in developing countries with limited adaptive capacity (Intergovernmental Panel On Climate Change (IPCC), 2023).

The case of Tropical Cyclone Seroja in April 2021 provides a stark example of such vulnerability. The cyclone, which struck East Flores Regency and Kupang City, **caused widespread destruction** over 2.000 buildings were damaged, nearly 8.000 people were affected, and economic losses reached 3.4 trillion rupiah (Badan Nasional Penanggulangan Bencana (BNPB), 2021). In East Flores, Adonara Island was the epicenter of the disaster, with fatalities, displacement, and severe damage to tourism infrastructure. Kupang City, as the provincial capital, also suffered significant losses, including damage to coastal facilities and transport networks. These impacts disrupted livelihoods, particularly in the coastal tourism sector which had been an important source of income for local communities.

The coastal tourism sector in East Flores and Kupang holds strategic value. East Flores is rich in natural attractions such as beaches, coral reefs, and diving sites, while Kupang City offers diverse tourism assets, from natural and cultural destinations to culinary and urban tourism facilities. Despite this potential, **the disaster highlighted two interrelated challenges** the physical vulnerability of tourism infrastructure to hydrometeorological hazards, and the socio-economic fragility of communities dependent on tourism-related activities (micro-businesses, seasonal employment, and supporting services).

Previous studies on post-disaster tourism recovery in Indonesia, such as those in Aceh (tsunami) (Liu-Lastres et al., 2020) and Lombok (earthquake) (Sasongko et al., 2025), show that recovery efforts often emphasize physical reconstruction, while socio-cultural resilience, environmental restoration, and sustainable planning receive less attention. In East Flores and Kupang, similar risks emerge: rapid rebuilding without ecological consideration may accelerate degradation (erosion, coral damage), while economic pressures may override cultural integrity and social equity. Thus, the tourism development model must shift from purely growth-oriented frameworks to approaches that integrate resilience, sustainability, and local wisdom (Khater & faik, 2024).

The concept of carrying capacity provides an important analytical lens for this shift. Ecological carrying capacity concerns the ability of ecosystems to withstand tourism pressures without degradation (Marquez et al., 2023), which is often reduced post-disaster due to vegetation loss and erosion. Social carrying capacity reflects the extent to which communities can host tourists without experiencing cultural strain or social conflict (Wiranta, 2023). Economic carrying capacity refers to the maximum tourism activity before reaching saturation points that undermine local benefits. Balancing these dimensions requires trade-offs between economic, ecological, and social objectives, as illustrated in the sustainable development triangle.

Against this background, the present study aims to develop a sustainable tourism development model for East Flores and Kupang. **The model integrates two complementary frameworks** (1) the CEAS approach (Community-based, Eco-sensitive, Adaptive, Socio-economic), and (2) the Impact Chains framework, which systematically maps the causal relationships between hazards, vulnerabilities, and socio-economic impacts. By combining these approaches, the study provides a holistic and adaptive framework that emphasizes community participation, ecosystem restoration, climate adaptation, and long-term socio-economic sustainability.

The significance of this study is twofold. Empirically, it documents the socio-cultural, economic, and environmental impacts of Cyclone Seroja on coastal tourism in East Flores and Kupang, providing field-based insights into post-disaster recovery dynamics. Theoretically, it contributes to the literature on sustainable tourism by operationalizing carrying capacity and resilience frameworks in a disaster-affected context. For policy and practice, the findings offer guidance for local governments, tourism actors, and disaster management agencies to formulate recovery strategies that not only rebuild infrastructure but also ensure inclusivity, sustainability, and resilience

against future climate risks.

2. METHODS

This study employed a qualitative descriptive design to explore the socio-cultural, economic, and environmental impacts of Cyclone Seroja on coastal tourism and to formulate a sustainable development model. The qualitative approach was selected to capture local perspectives, institutional responses, and contextual challenges that are often overlooked in quantitative surveys (Houghton et al., 2022; Skarbek, 2020). To analyze complex relationships, **this research integrated two analytical frameworks** the Impact Chains model (Zebisch et al., 2022), which enabled the mapping of hazard-vulnerability-impact linkages.

The research focused on East Flores Regency and Kupang City in East Nusa Tenggara (NTT), Indonesia. East Flores Regency is characterized by coastal and island-based tourism encompassing Adonara, Solor, and Larantuka, with tourism assets including beaches (Ina Burak, Watotena), diving sites, and Semana Santa cultural tourism. This region was severely affected by Cyclone Seroja, experiencing fatalities, population displacement, and destruction of community tourism facilities. Meanwhile, Kupang City, serving as the provincial capital and gateway to Eastern Indonesia, possesses more developed tourism infrastructure with attractions such as Lasiana Beach, Batu Nona, and Kelapa Lima, alongside urban cultural and culinary destinations. Cyclone Seroja caused substantial damage to housing, road networks, and beach facilities, exposing urban tourism to climate risks.

Primary data were obtained through semi-structured interviews with stakeholders, field observations at selected coastal tourism sites, and focus group discussions (FGDs) with local communities. Secondary data were sourced from official reports by BNPB (National Disaster Management Agency) and BPS (Central Statistics Agency), as well as academic literature and policy papers on tourism, disasters, and sustainability.

A purposive sampling technique was employed to ensure the inclusion of key stakeholders directly involved in tourism recovery and development. The study engaged 20 key informants comprising local governments (East Flores and Kupang City Tourism Offices), Regional Disaster Management Agency (BPBD/BNPB representatives), private sector actors in tourism and hospitality, community leaders and youth organizations, and academics and NGOs involved in tourism and disaster management. This composition enabled triangulation of perspectives across government, community, and private stakeholders.

In-depth interviews were conducted with 20 informants strategically selected through purposive sampling to ensure diverse stakeholder representation. **Selection criteria included** (1) institutional diversity across government (n=5), private sector (n=4), community leaders (n=6), and civil society/academics (n=5); (2) gender balance, with 8 female and 12 male participants to capture gender-differentiated disaster impacts and recovery experiences; (3) occupational representation spanning formal tourism operators (hotel managers, tour guides), informal economy workers (street vendors, homestay operators), traditional leaders, and youth organization representatives; (4) geographic distribution between East Flores (n=11) and Kupang City (n=9) to reflect urban-rural disparities; and (5) socio-economic stratification including micro-entrepreneurs directly dependent on tourism income, mid-level business owners, and salaried government officials to avoid elite capture bias. Special attention was given to including marginalized voices such as female micro-entrepreneurs and informal sector workers who are typically underrepresented in disaster recovery planning yet disproportionately affected by tourism disruptions.

Each interview session lasted 45-90 minutes and was audio-recorded with informed consent. Interviews were conducted in Bahasa Indonesia and local languages where necessary, with cultural mediators present to ensure comfortable communication and accurate interpretation of community perspectives. Observations were carried out through field visits to sites such as Ina Burak Beach, Lasiana Beach, and Batu Nona to document environmental conditions, infrastructure status, and post-disaster tourism activities. FGDs were organized in Nihaone Village (East Flores) and Kupang City, involving 15-20 community representatives per session with deliberate inclusion of women's groups, youth organizations, and elderly traditional knowledge holders for findings validation and to capture intergenerational perspectives on cultural resilience. Document review was conducted to cross-check primary data with secondary sources, including BPS tourism statistics and BNPB disaster reports.

Data analysis followed four systematic steps. First, thematic coding was performed on interview transcripts and field notes using NVivo to identify socio-cultural, economic, and environmental patterns. Second, Impact Chains mapping was

conducted to systematically link hazards, vulnerabilities, and impacts to reveal causal pathways from cyclone hazards to tourism disruptions. Third, triangulation was implemented through cross-validation among interviews, observations, and documents to enhance data credibility.

To ensure research validity, Lincoln and Guba's criteria were applied through credibility ensured via prolonged field engagement and member-checking with key informants (Enworo, 2023), transferability achieved by providing detailed contextual descriptions of East Flores and Kupang, and dependability and confirmability maintained through audit trails and peer debriefing during analysis. Ethical clearance was obtained from the research committee of Universitas Nusa Cendana, with participants providing informed consent and guaranteed anonymity.

3. RESULT

The findings of this study reveal multidimensional impacts of Cyclone Seroja on coastal tourism in East Flores Regency and Kupang City, encompassing socio-cultural disruptions, economic decline, environmental degradation, and infrastructure challenges. The analysis Impact Chains mapping demonstrates complex interconnections between disaster impacts and tourism sustainability.

3.1. Socio-Cultural Impacts and Community Resilience

Cyclone Seroja generated profound socio-cultural disruptions, particularly affecting traditional community structures in East Flores. Official reports documented 181 fatalities in East Nusa Tenggara and West Nusa Tenggara, accompanied by the displacement of over 11,000 people (BNPB, 2021). The destruction extended beyond residential areas to encompass culturally significant infrastructure, including traditional meeting houses (lopo), ceremonial gazebos, and Bale Lewho cultural houses, which serve as focal points for community gatherings and ritual practices.

Field interviews revealed the cultural significance of these losses, **as articulated by a village elder** "We lost not only our homes but also the places where we used to gather. The lopo was important for cultural meetings; now we have nowhere to perform our rituals" (Interview, Nihaone, April 2022). This finding underscores the interconnection between physical infrastructure and cultural continuity in tourism-dependent communities.

Despite these severe disruptions, the research identified substantial community resilience manifested through sustained hospitality practices and adaptive strategies. Local residents demonstrated commitment to maintaining welcoming attitudes toward visitors as part of recovery initiatives. **A female trader in Nihaone exemplified this resilience** "I must be kind to visitors so that they feel welcome here. If they are happy, they will come again and maybe buy our products" (Interview with Mrs. Juli, 2022). These testimonies indicate that social capital, expressed through hospitality traditions and cultural continuity, constitutes a fundamental asset for tourism recovery and sustainable development.

3.2. Economic Vulnerability and Livelihood Disruption

The cyclone precipitated severe economic contractions across coastal tourism sectors in both study locations. In East Flores, micro-enterprises operating near Ina Burak Beach experienced income reductions exceeding 70% compared to pre-disaster levels. Homestay operators reported complete cessation of bookings for extended periods, while food vendors and souvenir sellers described the elimination of their primary income sources.

Quantitative impacts were documented through stakeholder interviews, with one local youth entrepreneur **stating** "Before the cyclone, we could sell snacks and drinks to visitors, maybe earning 300–400 thousand rupiah on a good weekend. After Seroja, no one came. For weeks, we sold nothing" (FGD, Nihaone, 2022). This testimony illustrates the vulnerability of informal tourism economies to disaster-induced disruptions.

Kupang City demonstrated similar patterns despite its more developed tourism infrastructure. BPS (2021) data indicated a 60% decline in hotel occupancy rates, while vendors at Lasiana Beach estimated monthly income reductions of up to 70%. Although Kupang benefited from accelerated infrastructure rehabilitation due to its urban status, the delayed return of tourists resulted in prolonged livelihood recovery periods. This finding aligns with existing literature suggesting that post-disaster tourism recovery often prioritizes physical infrastructure over economic livelihood restoration (Carballo et al., 2019).

3.3. Environmental Degradation and Ecological Impacts

Cyclone Seroja generated substantial environmental degradation across multiple coastal

ecosystems, directly affecting tourism resource quality and long-term viability. Field observations and **stakeholder reports documented three primary categories of environmental impact** coastal erosion, mangrove destruction, and coral reef damage.

Coastal erosion manifested through significant shoreline retreat in both Adonara and Kupang Bay, characterized by sand loss and exposure of underlying rocky substrates. In Adonara, protective mangrove belts were extensively uprooted, eliminating natural barriers and exposing inland settlements to future storm events. Coral reef ecosystems in Kupang Bay sustained widespread damage, including structural breakage and increased sedimentation that reduced underwater visibility for diving activities.

The tourism implications of environmental degradation were articulated by a diving guide from Kupang "The coral used to be colorful and full of fish. After the cyclone, many parts were broken. Tourists complain the water is not as clear as before" (Interview, Kupang Bay, 2022). These findings corroborate arguments by Spalding et al. (2017) that ecological carrying capacity diminishes substantially following disaster events, fundamentally undermining long-term tourism viability and destination competitiveness.

3.4. Infrastructure Challenges and Tourism Accessibility

Post-disaster assessments revealed significant disparities in tourism infrastructure resilience and recovery capacity between the two study locations. In East Flores, 52% of access roads to primary tourism sites remain unpaved, with cyclone damage further compromising connectivity through bridge collapses and increased transportation costs. **Infrastructure limitations were emphasized by local stakeholders** "Sometimes tourists want to visit Ina Burak, but when it rains, the road is muddy and dangerous. Even locals don't dare to go" (Interview, Nihaone, 2022).

Kupang City demonstrated superior accessibility infrastructure, supported by El Tari Airport and established road networks. However, several critical routes to major attractions including Lasiana Beach and Batu Nona sustained damage or blockages following the cyclone, highlighting urban infrastructure vulnerability to extreme weather events.

Accommodation and service amenities reflected the development disparity between locations. East Flores provided only 37 lodging facilities, predominantly non-starred establishments, with limited restaurant options outside Larantuka town center. At Ina Burak Beach, visitors consistently reported inadequate basic amenities including restroom facilities, waste management systems, and freshwater access. Conversely, Kupang City maintained over 90 hotels and 200 restaurants, though notably lacked disaster-adaptive infrastructure such as evacuation shelters and barrier-free access for vulnerable populations.

Tourism resource inventory analysis revealed distinct destination profiles East Flores concentrated 85% of its 41 documented sites on natural tourism attractions including beaches, diving locations, and trekking routes. Kupang City demonstrated greater diversification with 16 natural sites, 21 cultural attractions, 17 artificial facilities, 2 religious destinations, and 13 culinary venues, indicating enhanced resilience through resource diversity.

3.5. Community Perspectives and Development Potential

Community stakeholders expressed measured optimism regarding tourism development potential despite post-disaster challenges. At Ina Burak Beach, residents consistently emphasized physical attributes including calm wave conditions, white sand quality, and panoramic coastal views. Tourist perspectives validated these assessments: "The scenery is beautiful, the sand is soft and clean, not like other beaches filled with garbage" (Interview, Kupang tourist, 2022).

Beyond physical attributes, communities identified hospitality traditions and cultural openness as core strengths. Residents demonstrated readiness to host visitors, manage promotional activities, and enhance service delivery. Initial marketing initiatives through social media platforms (@explor.inaburak) indicated community engagement in destination promotion, though efforts remain limited and heavily dependent on informal word-of-mouth networks.

3.6. Carrying Capacity Assessment and Sustainability Constraints

Post-disaster carrying capacity assessments revealed significant reductions across multiple dimensions. Ecological carrying capacity experienced substantial decline due to coastal erosion and coral reef degradation, limiting the environmental foundation for sustainable tourism development. Social carrying capacity faced potential constraints as community leaders expressed concerns about rapid tourism growth

disrupting traditional cultural practices and community cohesion.

Economic carrying capacity demonstrated vulnerability through overdependence on coastal tourism without sectoral diversification. An NGO representative articulated sustainability concerns: "If everyone rushes to rebuild hotels and cafes, the environment will be destroyed again. We need to balance income with ecosystem restoration" (Interview, Kupang, 2022). This perspective reflects the sustainable development paradigm emphasizing equilibrium between economic, social, and ecological objectives (Hall et al., 2016).

3.7. Integrated Development Framework

The research findings support the necessity for a comprehensive post-disaster tourism development framework integrating CEAS principles with Impact Chains analysis. **The proposed model emphasizes four interconnected dimensions** community-based approaches strengthening local participation in decision-making processes; eco-sensitive strategies prioritizing mangrove and coral reef restoration; adaptive measures integrating early warning systems and resilient infrastructure; and socio-economic sustainability ensuring equitable benefit distribution across stakeholder groups.

Therefore, the author defines a relevant framework for post-disaster tourism development approach called the CEAS approach, **which includes**

1. Community-based tourism to ensure local participation;
2. Eco-sensitive development that respects ecological carrying capacity limits;
3. Adaptive learning based on conditions (climate and disaster-responsive planning); and
4. Long-term socio-economic sustainability, not merely short-term recovery.

Figure 1: This Post-Disaster Tourism Development Model with a CEAS Approach.

In the picture, the vertices of the triangle represent the full and theoretical achievement of each sector's target (economic, ecological, and social), where the top point stands for the goal of economic growth, the left point represents environmental preservation, and the right point symbolizes social welfare. Any movement along the sides of the triangle from one vertex to another reflects a bilateral trade-off between two pure targets. For example, shifting from the ecological side to the economic side means relaxing strict environmental preservation in favor of economic growth benefits—such as building new highways to accelerate the transport of goods and people, or allowing tourism exploitation on pristine sea islands. Moving from the social side to the economic side indicates well-known conflicts between technological advancement and job protection, or emerging issues arising from the tension between short and long supply chains, which **also reflect a trade-off** short supply chains benefit specific social groups such as consumers and producers, while long supply chains allow for job creation and economic value-added.

Based on the above explanation, it can be internalized into a comprehensive model for sustainable tourism development in the Flores and Kupang regions (see Figure 10). The long-term sustainability of the tourism sector largely depends on the preservation and enhancement of environmental quality, particularly in coastal areas that are vulnerable to the impacts of climate change. One of the most tangible threats of climate change is the increasing intensity and frequency of extreme weather events, such as tropical storms and cyclones. Cyclone Seroja, which struck the Nusa Tenggara Timur region in April 2021, is a concrete example of the impact of climate change on coastal areas with high tourism potential, such as East Flores Regency and the City of Kupang.

Cyclone Seroja caused extensive damage to tourism infrastructure, coastal ecosystems, as well as cultural and natural sites that serve as tourist attractions. In East Flores, beaches and marine tourism areas experienced severe erosion, coral reef damage, and the loss of coastal vegetation such as mangroves. In Kupang City, various tourism facilities were severely damaged, and the recovery process was slow due to limited resources and the lack of well-prepared climate adaptation planning.

To analyze and design recovery strategies and climate-resilient tourism development, the Impact Chains approach is highly relevant. Impact Chains allow for the identification of cause-and-effect relationships from climate threats to the tourism

sector, ranging from physical hazards (such as strong winds, extreme rainfall, and sea-level rise), ecosystem and infrastructure vulnerabilities, to socio-economic impacts such as declining tourist arrivals, loss of livelihoods, and the destruction of cultural and natural assets.

In this context, tourism development in areas affected by Cyclone Seroja needs to be designed by incorporating Impact Chains as a strategic framework. For example, coastal erosion and coral reef damage not only affect the tourism landscape but also reduce the recreational experience value for visitors. The declining environmental quality then affects tourism demand, reduces local community income, and lowers the destination's competitiveness.

Furthermore, the Impact Chains approach can be used to map the types of tourists affected, their motivations for visiting, and their perceptions of risk and conservation efforts. For instance, cultural or ecotourism visitors to Larantuka or Kupang Bay may have a higher willingness to pay (WTP) for the restoration of damaged cultural sites or marine ecosystems compared to typical mass tourists.

Therefore, the application of the Impact Chains framework can assist local governments, businesses, **and communities to**

1. Identify critical points of climate risk to tourism,
2. Design community- and ecosystem-based adaptation and mitigation strategies, and
3. Build a destination recovery narrative integrated with sustainable tourism promotion.

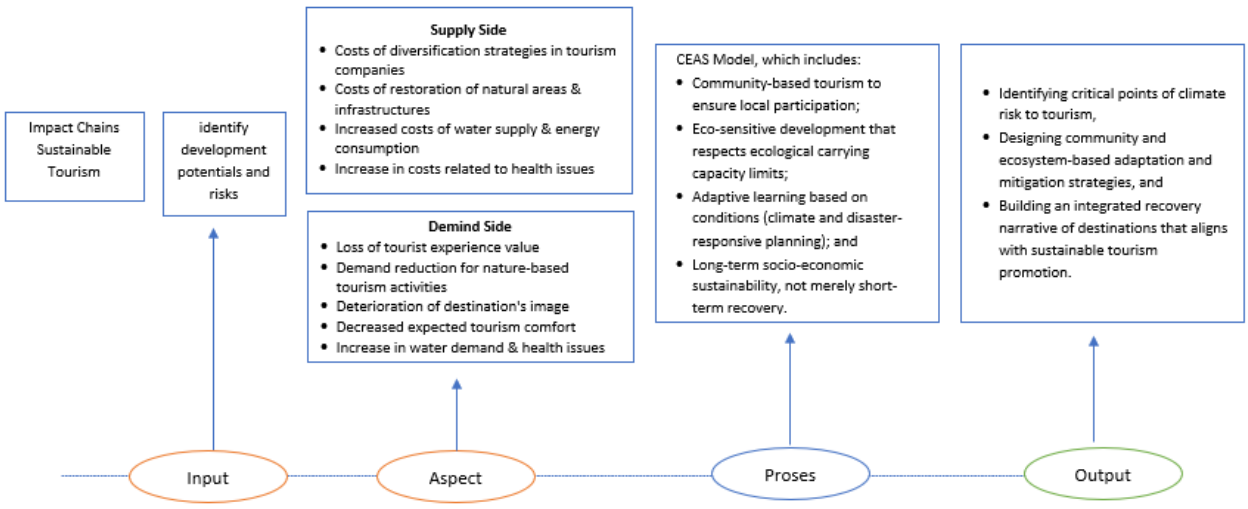

Figure 2: Model Sustainable Tourism Development in East Flores Regency and Kupang City.

The implementation of this model is also in line with the need for climate risk-based tourism recovery policy formulation, as recommended by the The Intergovernmental Panel on Climate Change (IPCC) and various international organizations such as UNDP and GIZ. Thus, in the aftermath of Cyclone Seroja, East Flores and the City of Kupang have a significant opportunity not only to rebuild the tourism sector, but also to make it more resilient, inclusive, and sustainable in facing future climate change challenges.

This approach and model aim to ensure that tourism not only provides short-term benefits but also guarantees long-term sustainability for local communities, ecosystems, and cultural heritage. By integrating economic, environmental, and socio-cultural aspects into tourism development, while upholding local wisdom, sustainable tourism can serve to enrich tourist experiences, improve community welfare, and preserve cultural and natural heritage. These efforts are crucial to ensure that tourism delivers not only short-term benefits but also remains sustainable in the long term.

The next stage is to formulate strategies for tourism development. Based on the SWOT analysis, the resulting strategies include strengthening partnerships, enhancing promotion, providing adequate facilities, improving human resource capacity, designating tourism as a leading sector, encouraging community participation, and utilizing

technology. With the optimal implementation of this designed model, it is expected to restore the attractiveness and increase the number of visitors to a tourist destination, thereby contributing to regional income growth. Furthermore, tourism development is expected to prioritize local wisdom as an effort to preserve and maintain cultural values or traditions that have developed within the community.

4. DISCUSSION

The findings of this study confirm that Cyclone Seroja exposed the multidimensional vulnerability of coastal tourism systems in East Flores and Kupang, where socio-cultural, economic, and environmental impacts converged to weaken community resilience and tourism sustainability. This aligns with recent climate assessments (Intergovernmental Panel On Climate Change (IPCC), 2023), which emphasize that extreme weather events driven by climate change disproportionately affect coastal and small-island communities with limited adaptive capacity. The integration of CEAS (Community-based, Eco-sensitive, Adaptive, Socio-economic) and Impact Chains frameworks provides a comprehensive analytical lens for understanding these complex interactions and developing sustainable recovery strategies.

4.1. Socio-Cultural Vulnerability and Community Resilience

The destruction of cultural infrastructure represents more than physical loss; it disrupts the social fabric that underpins community identity and tourism appeal. Cyclone Seroja not only destroyed physical infrastructure but also disrupted cultural practices, as demonstrated by the loss of traditional meeting houses (lopo) and ceremonial structures (Bale Lewho) in East Flores. These facilities serve as anchors for community cohesion and cultural transmission, making their destruction particularly significant for tourism-dependent communities that rely on cultural authenticity as a competitive advantage.

Despite these disruptions, cultural continuity emerged as central to recovery processes. Communities expressed sustained optimism and maintained hospitality traditions toward visitors, confirming the critical importance of social capital in disaster recovery. These results align with established research on post-disaster tourism recovery, which demonstrates that community resilience and collective memory constitute fundamental prerequisites for sustainable tourism restoration (Prayag et al., 2020). Similar patterns have been documented in post-tsunami Aceh (Daly & Yenny, 2012) and Japan's 'bosai culture' (Pastrana-Huguet et al., 2022), where cultural identity functioned as an anchor for tourism revival following catastrophic events.

4.2. Economic Fragility and Livelihood Disruption

The economic impacts of Cyclone Seroja revealed the extreme vulnerability of tourism-dependent livelihoods to environmental shocks. This phenomenon mirrors global evidence from other disaster-affected tourism destinations. Caribbean tourism recovery studies by (Sheller, 2020), have documented how reconstruction efforts typically prioritize physical infrastructure over livelihood restoration, inadvertently prolonging economic hardships for tourism-dependent communities. Post-disaster recovery frameworks consistently highlight that delaying livelihood restoration during the early recovery phase can result in uneven and incomplete recovery, potentially leading to long-term economic vulnerabilities, as seen in the aftermath of the 2015 Nepal earthquake (Karki et al., 2022).

Within the Indonesian context, similar outcomes have been documented in Lombok following the 2018 earthquake sequence (Maryanti et al., 2021), where tourism workers experienced the slowest recovery rates among all affected economic sectors. The concentration of tourism activities around beach-based attractions without economic diversification further amplifies vulnerability to environmental disruptions. Recent studies on climate-tourism feedback highlight that an over-dependence on specific types of attractions, such as beach tourism, amplifies economic vulnerability when environmental disruptions occur (Zeydan & Zeydan, 2025).

The informal nature of many tourism enterprises exacerbates their vulnerabilities. Street vendors, homestay operators, and small-scale service providers often lack access to formal insurance mechanisms or disaster recovery funding, leaving them especially vulnerable to prolonged recovery periods. This underscores the urgent need for inclusive recovery policies that specifically address the challenges faced by informal economy participants and provide targeted support for livelihood restoration (Suresh & Kumar, 2019)

Economic carrying capacity limitations became evident through the study findings, as communities lacked sufficient economic diversity to absorb tourism income losses (Raju et al., 2019). The development of alternative income streams, including cultural festivals, agro-tourism ventures,

and renewable energy projects, emerges as a critical strategy for building economic resilience against future environmental shocks.

4.3. Environmental Degradation and Ecological Carrying Capacity

Cyclone Seroja substantially reduced the ecological carrying capacity of tourism destinations through multiple environmental impact pathways, including accelerated coastal erosion, mangrove forest destruction, and coral reef ecosystem damage. These environmental changes directly affect tourism resource quality and destination competitiveness, creating cascading impacts throughout the tourism system.

Local stakeholder testimonies, particularly from diving operators reporting reef breakage and reduced underwater visibility due to sedimentation, provide tangible evidence of ecosystem service degradation. These observations corroborate established research on coral reef vulnerability (Spalding et al., 2017) and recent studies documenting coral Ecosystem collapse under combined tourism and climate pressures in destinations. The degradation of marine ecosystems threatens both biodiversity conservation goals and the economic foundation of marine-based tourism, affecting the sustainability of these destinations (Lam-González et al., 2022).

Mangrove destruction represents a particularly critical loss, as these ecosystems provide essential coastal protection services while supporting diverse marine life that attracts tourists. Case studies from Fiji illustrate how mangrove removal for tourism development increases coastal vulnerability to storms and flooding (Singh et al., 2021), creating a negative feedback loop that undermines the very environmental assets that attract visitors. Such evidence underscores that ecosystem-based adaptation strategies, including mangrove restoration and coral reef rehabilitation programs, constitute essential components of disaster-resilient tourism development (Temmerman et al., 2013).

The temporal dimension of ecological recovery presents additional challenges for tourism sustainability. Marine ecosystem restoration typically requires years to decades for full recovery, during which tourism quality and carrying capacity remain compromised. This temporal mismatch between ecological recovery timeframes and economic recovery pressures creates tensions between short-term livelihood needs and long-term environmental sustainability objectives.

Climate change projections indicate increasing frequency and intensity of extreme weather events in the region, suggesting that current environmental degradation represents not an anomalous event but rather an indication of future conditions (Rahman et al., 2024). This reality necessitates fundamental shifts in tourism development approaches, prioritizing resilience and adaptation over purely growth-oriented strategies.

4.4. Community Agency and Local Innovation in Tourism Recovery

Despite facing substantial challenges, local communities demonstrated remarkable agency and creativity in tourism recovery processes. Community stakeholders at Ina Burak Beach actively promoted their destination's natural attributes, including pristine beaches, calm waters, and panoramic coastal views, while emphasizing cultural hospitality as a competitive advantage. These grassroots marketing efforts, including social media promotion through platforms like Instagram (@explor.inaburak), represent autonomous community responses to economic disruption.

Such community-driven initiatives align with established principles of community-based tourism (Gopal, 2023), which emphasize local ownership, cultural authenticity, and equitable benefit distribution as foundations for sustainable tourism development. Community agency in tourism recovery demonstrates the potential for bottom-up development approaches that complement formal reconstruction programs while strengthening local ownership and cultural integrity.

Recent research on youth engagement in sustainable tourism [18] further illustrates how younger community members contribute innovative approaches to destination promotion and sustainable practices. The integration of traditional hospitality values with contemporary marketing techniques observed in this study reflects broader trends in community-led tourism development that merit continued support and capacity building.

Local innovation extends beyond marketing to include service delivery adaptations and product development initiatives. Communities demonstrated flexibility in adjusting tourism offerings to post-disaster conditions while maintaining quality standards and cultural authenticity. This adaptive capacity represents a significant asset for long-term tourism sustainability that should be recognized and supported through policy interventions.

The preservation of cultural practices and community values during recovery processes indicates strong social cohesion and collective

identity. These social capital assets constitute fundamental resources for sustainable tourism development that cannot be replaced through external investment or technical assistance alone.

4.5. Policy Implications and Governance Considerations

T The research findings generate critical implications for tourism disaster recovery policy and governance, with recommendations explicitly prioritized through a phased approach aligning with SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action). First priority during months 0-6 must address immediate livelihood stabilization with environmental safeguards, including emergency cash transfers and micro-credit programs targeting informal tourism workers who experienced income reductions exceeding 70%, temporary employment through community-based ecosystem restoration projects such as mangrove replanting that simultaneously create income while initiating recovery, and a moratorium on new tourism infrastructure in ecologically sensitive zones until carrying capacity assessments are completed, directly supporting SDG 11.5 and SDG 13.1. Second priority during months 6-18 involves parallel ecological restoration and climate-adaptive infrastructure rehabilitation, including systematic mangrove and coral reef restoration using science-based targets, climate-adaptive infrastructure incorporating elevated facilities and early warning systems, and establishment of participatory governance through community tourism committees with statutory authority and minimum 40% women's representation, operationalizing SDG 11.4 and SDG 13.2. Third priority during months 18-36 addresses economic diversification through cultural festivals, agro-tourism ventures, renewable energy cooperatives, legally-mandated benefit-sharing agreements requiring 30% of tourism revenues for local programs, and cultural authenticity preservation through traditional knowledge documentation, advancing SDG 11.a and SDG 13.3.

Implementation requires cross-cutting governance mechanisms including coordination across national, provincial, and district levels through integration with existing National Action Plans for Climate Change Adaptation and Disaster Risk Reduction, establishment of multi-stakeholder tourism recovery task forces with mandatory representation from government, disaster management agencies, private sector, community leaders, youth organizations, and academics, and sustained political commitment codified through regional regulations aligned with Indonesia's Tourism Law and Disaster Management Law. Innovative financing mechanisms should blend climate adaptation funds from Green Climate Fund for ecosystem-based adaptation projects, public-private partnerships where investors contribute to restoration in exchange for concessions with strict environmental criteria, payment for ecosystem services schemes channeling tourism fees to community conservation groups, and parametric insurance providing automatic payouts when cyclone thresholds are exceeded, aligning with SDG 13.a and SDG 11.b.

Comprehensive monitoring systems should track ecological indicators including mangrove coverage via remote sensing and coral health indices, socio-economic metrics such as income distribution disaggregated by gender and occupation (Yamazaki-Honda, 2022), governance effectiveness measures including percentage of community recommendations implemented, and SDG-aligned indicators including 11.5.1 (disaster-related economic losses) and 13.1.1 (disaster risk reduction strategies). Quarterly reviews by multi-stakeholder task forces enable adaptive management while documenting lessons for regional knowledge sharing through ASEAN networks, contributing to global discourse on climate-resilient tourism development in vulnerable coastal communities while ensuring recovery strategies prioritize environmental restoration, inclusive governance, and economic diversification over purely growth-oriented frameworks.

4.6. Limitations and Future Research Directions

Several limitations constrain the scope and generalizability of this research. The temporal constraints of post-disaster assessment limit longitudinal analysis of recovery trajectories and long-term sustainability outcomes. Geographic focus on two specific locations restricts transferability to other coastal tourism destinations with different environmental conditions, cultural contexts, or governance systems.

Methodological constraints include reliance on qualitative data collection methods that, while providing rich contextual insights, limit quantitative validation of proposed frameworks and causal relationships. The study's focus on community perspectives, while essential for understanding local impacts, could benefit from broader stakeholder engagement including regional and national policy makers, international tourism operators, and environmental organizations.

Future research priorities should include longitudinal studies tracking tourism recovery trajectories over extended periods to validate theoretical frameworks and identify critical success factors. Comparative analysis across different disaster types and geographic contexts would enhance understanding of framework applicability and boundary conditions. Quantitative validation studies employing survey methods and statistical analysis could complement qualitative findings while testing specific hypotheses about disaster-tourism relationships.

Methodological advancements should explore mixed-methods approaches that combine quantitative measurement with qualitative interpretation, participatory research methodologies that strengthen community engagement, and remote sensing technologies for environmental monitoring. Real-time monitoring systems could provide early warning capabilities while supporting adaptive management approaches.

Integration of youth perspectives, as highlighted by recent sustainability research [18], could strengthen adaptive strategies by incorporating intergenerational knowledge transfer and technological innovation. Gender-differentiated impact analysis would provide insights into how disaster effects and recovery processes affect different community groups.

The development of quantitative indicators for measuring tourism sustainability and resilience remains a priority for supporting policy evaluation and comparative analysis. These indicators should capture multiple dimensions of sustainability while remaining practical for implementation in resource-constrained contexts.

International comparative studies examining similar coastal tourism destinations affected by climate-related disasters would enhance understanding of universal patterns while identifying context-specific adaptation requirements. Such research could inform regional cooperation initiatives and knowledge sharing mechanisms for disaster-resilient tourism development.

5. CONCLUSION

The study demonstrates that Cyclone Seroja exposed the multidimensional vulnerability of coastal tourism systems in East Flores and Kupang, where socio-cultural, economic, and environmental impacts converged to challenge community resilience and tourism sustainability. The integration of CEAS (Community-based, Eco-sensitive, Adaptive, Socio-economic) and Impact Chains frameworks provides a comprehensive analytical approach for understanding complex disaster-tourism interactions and developing sustainable recovery strategies.

The research reveals that post-disaster tourism recovery requires more than physical infrastructure rebuilding; it demands holistic approaches that address ecological restoration, community participation, and long-term resilience building. The destruction of cultural infrastructure represents profound losses that extend beyond physical damage to disrupt social fabric and community identity. However, the demonstrated community resilience through sustained hospitality practices and local innovation capacity indicates significant potential for participatory recovery approaches.

The proposed sustainable tourism development model emphasizes four critical dimensions community-based approaches strengthening local participation in decision-making processes; eco-sensitive strategies prioritizing mangrove and coral reef restoration; adaptive measures integrating early warning systems and resilient infrastructure; and socio-economic sustainability ensuring equitable benefit distribution across stakeholder groups.

Key policy implications include the necessity for resilience-first recovery approaches that prioritize ecosystem rehabilitation alongside climate-adaptive infrastructure development, implementation of inclusive governance mechanisms that institutionalize community participation, and economic diversification strategies that supplement coastal tourism with complementary activities to reduce vulnerability to environmental shocks.

The study's limitations include temporal constraints limiting longitudinal analysis and geographic focus restricting transferability to other contexts. Future research should pursue longitudinal studies tracking recovery trajectories, comparative analysis across different disaster types and geographic contexts, and quantitative validation of proposed frameworks.

The findings contribute to sustainable tourism literature by operationalizing carrying capacity and resilience frameworks in disaster-affected contexts, while providing practical guidance for local governments, tourism stakeholders, and disaster management agencies to formulate recovery strategies that ensure inclusivity, sustainability, and resilience against future climate risks. The research underscores that sustainable tourism development in climate-vulnerable regions must fundamentally shift from growth-oriented frameworks to approaches that integrate ecological restoration, community

agency, and adaptive capacity building as prerequisites for long-term viability.

REFERENCES

Badan Nasional Penanggulangan Bencana (BNPB). (2021, April 6). Dampak Terkini Siklon Tropis Seroja Akibatkan 8.424 Warga NTT Mengungsi. https://bnpb.go.id/berita/-update-dampak-terkini-siklon-tropis-seroja-akibatkan-8-424-warga-ntt-mengungsi

BNPB. (2021, April 13). Tropical Cyclone 26S (Seroja) Nusa Tenggara Islands, Indonesia | Flash Update #3 — Indonesia | ReliefWeb. Relief Web. https://reliefweb.int/report/indonesia/tropical-cyclone-26s-seroja-nusa-tenggara-islands-indonesia-flash-update-3

Carballo, R., León, C., & Carballo, M. (2019). Fighting overtourism in Lanzarote (Spain). Worldwide Hospitality and Tourism Themes, 11, 506–515. https://doi.org/10.1108/WHATT-06-2019-0043

Daly, P., & Yenny, R. (2012). Cultural heritage and community recovery in Post-Tsunami Aceh. From the Ground Up: Perspectives on Post-Tsunami and Post-Conflict Aceh, 57–98.

Enworo, O. (2023). Application of Guba and Lincoln's parallel criteria to assess trustworthiness of qualitative research on indigenous social protection systems. Qualitative Research Journal. https://doi.org/10.1108/qrj-08-2022-0116

Gopal, B. (2023). THE ROLE OF COMMUNITY INVOLVEMENT IN PROMOTING SUSTAINABLE TOURISM PRACTICES. ShodhKosh: Journal of Visual and Performing Arts. https://doi.org/10.29121/shodhkosh.v4.i2.2023.3196

Houghton, T., Lavicza, Z., Diego-Mantecón, J.-M., Fenyvesi, K., Weinhandl, R., & Rahmadi, I. F. (2022). Hothousing: Utilising industry collaborative problem solving practices for STEAM in schools. Journal of Technology and Science Education, 12(1), 274. https://doi.org/10.3926/jotse.1324

Intergovernmental Panel On Climate Change (IPCC). (2023). Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781009157896

Karki, J., Matthewman, S., & Grayman, J. (2022). From goods to goats: Examining post-disaster livelihood recovery in the aftermath of the Nepal earthquake 2015. Natural Hazards (Dordrecht, Netherlands), 114, 3787–3809. https://doi.org/10.1007/s11069-022-05543-0

Khater, M., & faik, mohamed. (2024). Tourism as a catalyst for resilience: Strategies for building sustainable and adaptive communities. Community Development, 55, 1–17. https://doi.org/10.1080/15575330.2024.2382174

Lam-González, Y., León, C., León, J. de, & Suárez-Rojas, C. (2022). The Impact of Degradation of Islands' Land Ecosystems Due to Climate Change on Tourists' Travel Decisions. Land. https://doi.org/10.3390/land11101644

Li, X., & Gopalakrishnan, S. (2021). Climate Change and Coastal Vulnerability. Oxford Research Encyclopedia of Economics and Finance. https://doi.org/10.1093/acrefore/9780190625979.013.576

Liu-Lastres, B., Mariska, D., Tan, X., & Ying, T. (2020). Can post-disaster tourism development improve destination livelihoods? A case study of Aceh, Indonesia. Journal of Destination Marketing & Management, 18, 100510–100510. https://doi.org/10.1016/j.jdmm.2020.100510

Marquez, L., Miranda, R., & Nabout, J. (2023). Assessing Tourism Carrying Capacity in One Sustainable Protected Area of Cerrado: Balancing Ecological and Socio- Economic Dimensions. Fronteiras Journal of Social Technological and Environmental Science, 12, 194–212. https://doi.org/10.21664/2238-8869.2023v12i3.194-212

Maryanti, S., Netrawati, I. G. A. O., Suastina, I. G. P. B., Sukmana, F. H., & Martini, D. (2021). Post-Disaster Mitigation and Recovery in Tourism Destinations: Learning from The Lombok Earthquake. International Journal of Scientific Research in Science and Technology, 571–584. https://doi.org/10.32628/IJSRST218297

Ounanian, K., van Tatenhove, J. P. M., Hansen, C. J., Delaney, A. E., Bohnstedt, H., Azzopardi, E., Flannery, W., Toonen, H., Kenter, J. O., Ferguson, L., Kraan, M., Macias, J. V., Lamers, M., Pita, C., Ferreira da Silva, A. M., Albuquerque, H., Alves, F. L., Mylona, D., & Frangoudes, K. (2021). Conceptualizing coastal and maritime cultural heritage through communities of meaning and participation. Ocean & Coastal Management, 212, 105806. https://doi.org/10.1016/j.ocecoaman.2021.105806

Pastrana-Huguet, J., Casado-Claro, M.-F., & Gavari-Starkie, E. (2022). Japan's Culture of Prevention: How Bosai Culture Combines Cultural Heritage with State-of-the-Art Disaster Risk Management Systems.

Sustainability, 14(21), 13742. https://doi.org/10.3390/su142113742
Prayag, G., Spector, S., Orchiston, C., & Chowdhury, M. (2020). Psychological resilience, organizational resilience and life satisfaction in tourism firms: Insights from the Canterbury earthquakes. Current Issues in Tourism, 23(10), 1216–1233. https://doi.org/10.1080/13683500.2019.1607832
Rahman, T. U., Saud, D., & Nawaz, T. (2024). Sustainable tourism in a changing climate: Strategies for management, adaptation, and resilience. Penrose: International Journal of Interdisciplinary Studies. https://doi.org/10.62910/penrose24001
Raju, M. S., Udayashankar, N., & Seshadri, S. (2019). Measuring Tourism Carrying Capacity. Environmental Impacts of Tourism in Developing Nations. https://doi.org/10.4018/978-1-5225-5843-9.CH003
Sasongko, I., Gai, A. M., Wijayaningtyas, M., Susanti, D., Sukowiyono, G., & Putra, D. (2025). Sasak Cultural Resilience: A Case for Lombok (Indonesia) Earthquake in 2018. Heritage. https://doi.org/10.3390/heritage8050155
Sheller, M. (2020). Reconstructing tourism in the Caribbean: Connecting pandemic recovery, climate resilience and sustainable tourism through mobility justice. Journal of Sustainable Tourism, 29, 1436–1449. https://doi.org/10.1080/09669582.2020.1791141
Singh, S., Bhat, J., Shah, S., & Pala, N. (2021). Coastal resource management and tourism development in Fiji Islands: A conservation challenge. Environment Development and Sustainability. https://doi.org/10.1007/s10668-020-00764-4
Skarbek, D. (2020). Qualitative research methods for institutional analysis. Journal of Institutional Economics, 16(4), 409–422. https://doi.org/10.1017/S174413741900078X
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
Suresh, R., & Kumar, S. (2019). Fight for Sustainability: An Analytical Study on Problems Faced By Street Entrepreneurs in Tourism Destinations. 22, 4155–4165.
Temmerman, S., Meire, P., Bouma, T. J., Herman, P. M. J., Ysebaert, T., & De Vriend, H. J. (2013). Ecosystem-based coastal defence in the face of global change. Nature, 504(7478), 79–83. https://doi.org/10.1038/nature12859
Wiranta, M. (2023). Social Carrying Capacity of Tourism Development at Tanjung Benoa Beach, Badung Regency. LACULTOUR: Journal of Language and Cultural Tourism. https://doi.org/10.52352/lacultour.v2i2.1246
Yamazaki-Honda, R. (2022). Promoting Coherence Among Disaster Risk Reduction, Climate Change Adaptation, and Sustainable Development for Disaster Resilience. Journal of Disaster Research. https://doi.org/10.20965/jdr.2022.p1015
Zebisch, M., Terzi, S., Pittore, M., Renner, K., & Schneiderbauer, S. (2022). Climate Impact Chains—A Conceptual Modelling Approach for Climate Risk Assessment in the Context of Adaptation Planning. In C. Kondrup, P. Mercogliano, F. Bosello, J. Mysiak, E. Scoccimarro, A. Rizzo, R. Ebrey, M. D. Ruiter, A. Jeuken, & P. Watkiss (Eds.), Climate Adaptation Modelling (pp. 217–224). Springer International Publishing. https://doi.org/10.1007/978-3-030-86211-4_25
Zeydan, İ., & Zeydan, Ö. (2025). Sustainability of beach tourism in Türkiye in the era of climate change. Journal of Multidisciplinary Academic Tourism. https://doi.org/10.31822/jomat.2025-10-2-213