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Model Spasial Kesesuaian Pengembangan Wilayah untuk Ekowisata Bahari di Kabupaten Sumba Timur

Spatial Model of Suitability Area Development for Marine Ecotourism in East Sumba Regency

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Abstrak

Wilayah pesisir Kabupaten Sumba Timur memiliki sumber daya alam yang sangat potensial dengan tingkat produktivitas yang tinggi, baik sumber daya yang dapat diperbarui maupun yang tidak dapat diperbarui. Ekosistem pesisir yang dapat diperbarui seperti mangrove, terumbu karang, padang lamun, dan perikanan berperan penting dalam mendukung mata pencaharian masyarakat lokal sekaligus menawarkan potensi yang kuat untuk pengembangan ekowisata bahari. Beberapa kawasan pesisir, termasuk Pantai Londa Lima, Pantai Walakiri, Pantai Tapil, Pantai Puru Kambera, dan Pantai Wanga, memiliki karakteristik fisik dan sosial yang beragam yang dapat mendukung aktivitas ekowisata. Penelitian ini bertujuan untuk menilai keberlanjutan pemanfaatan sumber daya pesisir di Kabupaten Sumba Timur melalui evaluasi kesesuaian pengembangan ekowisata bahari dengan mengintegrasikan dimensi ekologi, ekonomi, sosial, budaya, dan kelembagaan. Pendekatan kuantitatif digunakan dengan metode skoring yang diperoleh dari survei lapangan, pengolahan data, dan analisis deskriptif. Analisis ini menggunakan beberapa parameter fisik, antara lain tipe pantai, panjang garis pantai, material dasar laut, kecepatan arus, biota berbahaya, tutupan lahan, dan ketersediaan air tawar. Aspek sosial dinilai menggunakan kerangka 4A pariwisata, yaitu attraction (atraksi), accessibility (aksesibilitas), amenities (amenitas), dan ancillary services (layanan pendukung). Hasil penelitian ini memberikan gambaran untuk mendukung pengembangan ekowisata bahari yang berkelanjutan di Kabupaten Sumba Timur. Hasil analisis menunjukkan bahwa Indeks Kesesuaian Wisata (IKW) Pantai Tapil adalah 1,15, Pantai Wanga sebesar 1,41, Pantai Walakiri sebesar 2,09, Pantai Puru Kambera sebesar 1,38, dan Pantai Londa Lima sebesar 2,0. Berdasarkan analisis IKW, Pantai Walakiri dan Pantai Londa Lima merupakan lokasi yang sesuai untuk pengembangan ekowisata berbasis pantai.

Kata kunci: model spasial, ekosistem pesisir, ekowisata bahari, kesesuaian, Sumba Timur

Abstract

The coastal region of East Sumba Regency possesses significant natural resources with high productivity, including both renewable and non-renewable resources. Renewable coastal ecosystems such as mangroves, coral reefs, seagrass beds, and fisheries play an important role in supporting local livelihoods while offering strong potential for marine ecotourism development. Several coastal areas, including Londa Lima Beach, Walakiri Beach, Tapil Beach, Puru Kambera Beach, and Wanga Beach, exhibit diverse physical and social characteristics that can support ecotourism activities. This study aims to assess the sustainability of coastal resource utilization in East Sumba Regency by evaluating the suitability of marine ecotourism development through the integration of ecological, economic, social, cultural, and institutional dimensions. A quantitative approach was employed using a scoring-based method derived from field surveys, data processing, and descriptive analysis. The analysis applies several physical parameters, including beach type, coastline length, seabed material, current velocity, hazardous biota, land cover, and freshwater availability. Social aspects are assessed using the 4A tourism framework: attraction, accessibility, amenities, and ancillary services. The results provide insights to support sustainable marine ecotourism development in East Sumba Regency. The result shows that The Tourism Suitability Index (TSI) for Tapil Beach is 1.15, Wanga Beach with a score of

1.41, Walakiri Beach is 2.09, Puru Kambera Beach with a score of 1.38, and Londa Lima Beach with a score of 2.0. Based on the TSI analysis, the Walakiri Beach and Londa Lima Beach are suitable locations for beach-based ecotourism development

Keywords: spatial model, coastal ecosystem, marine ecotourism, suitability, east sumba

Introduction

Coastal areas are dynamic areas and have unique ecosystems. Coastal environments are highly susceptible to change resulting from upstream activities as well as processes occurring within the coastal zone.

The types of ecosystems are coral reefs, mangrove forests, beaches and sand, estuaries, and seagrass (Kay R and Alder J, 1999). Sustainable development has become the main paradigm in the world of coastal area management in the late 20th century. Several key themes underpin the concept of sustainability, namely environmental integrity, economic efficiency, and social justice (Dahuri et al., 2001). Environmental integrity emphasizes the protection of ecosystems and biodiversity conservation as essential considerations in decision-making. Economic efficiency focuses on the optimal use of resources through approaches such as cost–benefit analysis to ensure sustainable development. Meanwhile, social justice highlights the importance of improving and maintaining the quality of human life for both present and future generations.

Efforts to fulfill sustainable coastal area management need to be carried out appropriately and effectively. In the development of technology with a spatial and environmental approach, GIS (Geographic Information System) has become one of the decision-making support systems that integrates spatial data to solve environmental problems (Cooper, 2000). This is because information system technology such as GIS has quickly been able to answer many problems in the field of regional planning, especially in terms of handling and calculating large amounts of data. Geographic Information System (GIS) is a spatial-based information system and is a tool that connects database attributes with digital maps (Cowen, D.J. 1988) .

Spatial analysis is used in determining spatial planning (Zoning). Zoning is spatial planning through functional boundaries according to the potential of resources and carrying capacity, as well as ecological processes in a single coastal ecosystem. The concept of zoning is a system for forming land or water areas that are allocated for specific use, where the division is planned for a particular use that has special characteristics (Mennecke, 2000). Zoning is based on the concept of spatially controlled separation, determined in various situations and modified to suit various ecological, social, economic and political environments (Rongxing Li, 2001). The existing zoning results will be analyzed for the

suitability of the use of marine ecotourism that supports the strengthening and development of existing tourism activities. Ecotourism is an environmentally oriented tourism activity for the integration of natural resource protection and tourism industry interests (Prahasta, 2002). As for the various forms of ecotourism activities, one of them is marine ecotourism, namely a tourism concept that utilizes the characteristics of coastal and marine resources, as well as human resources that are integrated into an integrated component in tourism utilization (Cardenas AF, 1984). The selection of potential locations for conservation areas requires certain criteria such as ecology, social and economy (Date CJ, 1986). The application of criteria is very helpful in identifying and protecting locations objectively. The criteria are as follows: (1) Ecological criteria are the overall value of the existence of biota species from a coastal ecosystem, measured by biodiversity, naturalness, dependency, representation, uniqueness, integrity, productivity, and vulnerability; (2) Social criteria are the overall value of coastal social and cultural benefits, such as social acceptance and support, public health, locations used for recreation, cultural values, aesthetics or beauty values, conflicts of interest, security, accessibility, public concern, conflict compatibility; (3) Economic criteria are the overall value of coastal economic benefits measured by important species that produce commercial value, fisheries interests, forms of threats, economic benefits, and tourism development values.

The analysis of carrying capacity which is part of the management concept was also carried out in this study. The concept of carrying capacity is based on the idea that the environment has a maximum capacity to support the growth of an organism and suitability (Prahasta, 2002). The important thing in the concept of carrying capacity is the existence of a continuous and sustainable level of utilization of natural resources or ecosystems, and is sustainable without causing damage to natural resources and the environment Shekar S and Chawla S, 2003).

This study examines several important issues using an integrated approach from the aspects of ecological, economic, social, cultural and institutional integration. The results of the study will greatly support the blue economy policy which means that the utilization of coastal and marine resources is accompanied by sustainability for the sake of sustainability, improving community welfare, economic growth, and creating jobs due to empowerment and capacity building. The blue economy transformation framework for economic development related to coastal and marine resources is in principle that coastal and marine potential must be developed and enrich the lives of coastal communities who carry out socio-

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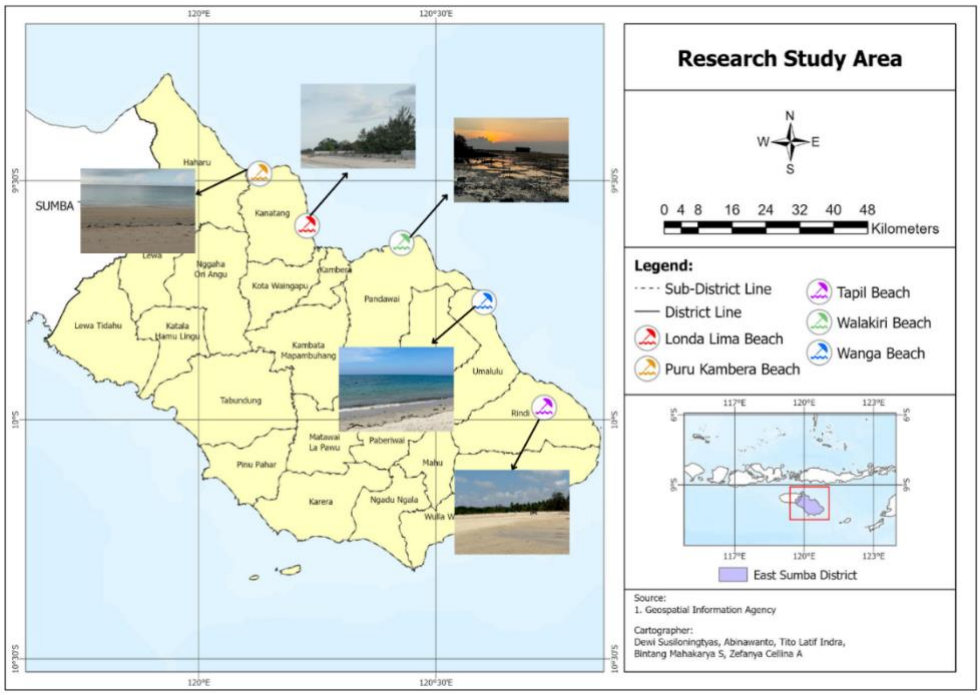
economic activities, so that the government needs to ensure the sustainability and abundance of coastal and marine resources to continue to ensure sustainable livelihoods.

Materials and Methods

The research was conducted in the coastal area of East Sumba Regency, particularly in Kota Waingapu District and Pandawai District located on the northern coast of East Sumba Regency. These locations were selected because they represent coastal and marine ecosystems that support marine ecotourism development.



Gambar 1. Research Study Area (Source: Data Processing, 2024)

The data used in this study consist of primary and secondary data. Primary data were collected through field surveys conducted in October 2024 at five observation locations, namely Walakiri Beach, Londa Lima Beach, Tapil Beach, Wanga Beach, and Puru Kambera Beach. At each location, observation points were determined using GPS to record geographic coordinates and environmental conditions. Data collection was carried out through direct observation of coastal physical conditions, measurements at observation points, and interviews with local communities and tourism managers using structured questionnaires.
Secondary data were obtained from government institutions and related agencies, including the East Sumba Regency Tourism Office, the Marine and Fisheries Office of East Sumba Regency, and statistical data from Badan Pusat Statistik (BPS), as well as previous studies relevant to coastal tourism and marine resource management.

Descriptive analysis was used to interpret the physical and social conditions related to the suitability of coastal tourism areas as recreational facilities. According to Simonds (1978), the physical elements of coastal tourism objects include beaches, sea levels, and the surrounding coastal land area.

Data Collection Method

The data collection method used in this study was a survey method. The types of data collected include primary and secondary data. Primary data were obtained using structured questionnaires, field observations, and geographic point recording using GPS devices at selected coastal locations. The questionnaire was designed to obtain accurate information regarding tourism conditions, community perceptions, and tourism facilities.

Secondary data were collected from related agencies and previous research. The scope of the collected data includes ecological, social, economic, and institutional data. Ecological data include physical, chemical, and biological components of coastal ecosystems, such as beach characteristics, coastal vegetation, and marine ecosystem conditions.

Social data include demographic characteristics of the population, mobility patterns, and community livelihoods. Economic data include information related to marine tourism activities and tourism development potential. Institutional data include formal and non-formal institutions involved in coastal area management. Formal institutions refer to organizations that have authority based on applicable regulations, while non-formal institutions refer to community-based rules or customary practices operating in the study area.

Results and Discussion

The results of the identification and inventory of potential resource utilization in East Sumba Regency produced are the existence of mangrove ecosystems, fishery resources, seagrass ecosystems, and coral reef ecosystems. The existence of this natural resource potential is then analyzed for the suitability of the Coastal Conservation Area based on ecology, economy, socio-culture, and institutions, where the resulting Conservation Area is then divided into a zoning system. After that, this zoning is continued with an analysis of the suitability of ecotourism utilization for diving ecotourism, snorkeling ecotourism, beach ecotourism, beach ecotourism, mangrove ecotourism, and seaweed cultivation. The results of the suitability of utilization are analyzed by calculating the carrying capacity based on assimilation capacity, regional carrying capacity and utilization.

The resource inventory in East Sumba Regency revealed the presence of mangrove, seagrass, and coral reef ecosystems, as well as various fishery resources. The existence of this natural resource potential is then analyzed for the suitability of the Coastal Conservation Area based on ecology, economy, socio-culture, and institutions, where the resulting Conservation Area is then divided into a zoning system. After that, this zoning is continued with an analysis of the suitability of ecotourism utilization for diving ecotourism, snorkeling ecotourism, beach ecotourism, beach ecotourism, mangrove ecotourism, and seaweed cultivation. The results of the suitability of utilization are analyzed by calculating the carrying capacity based on assimilation capacity, regional carrying capacity and utilization.

The existing zoning results will be analyzed for the suitability of the use of marine ecotourism that supports the strengthening and development of existin tourism activities. Ecotourism is an environmentally oriented tourism activity for the integration of natural resource protection and tourism industry interests. As for the various forms of ecotourism activities, one of them is marine ecotourism, namely a tourism concept that utilizes the characteristics of coastal and marine resources, as well as human resources that are integrated into an integrated component in tourism utilization . The selection of potential locations for conservation areas requires certain criteria such as ecology, social and economy. The application of criteria is very helpful in identifying and protecting locations objectively. The criteria are as follows:

1. Ecological criteria are the overall value of the existence of biota species from a coastal ecosystem, measured by biodiversity, naturalness, dependency, representation, uniqueness, integrity, productivity, and vulnerability.
2. Social criteria are the overall value of coastal social and cultural benefits, such as social acceptance and support, public health, locations used for recreation, cultural values, aesthetics or beauty values, conflicts of interest, security, accessibility, public concern, conflict compatibility.
3. Economic criteria are the overall value of coastal economic benefits measured by important species that produce commercial value, fisheries interests, forms of threats, economic benefits, and tourism development values.

Recreation as an integral part of tourism. Recreation is also related to the approach or connection between rest and leisure; recreation and tourism. The meaning of that Recreation are much closer and more intimate (Williams, 2009).. The suitability assessment parameter uses the suitability matrix in Yulianda's (2019) research, with the Tourism Suitability Index (TSI) with four conformity classes. TSI score ≥2.5 is a very appropriate class, TSI 2.0–<2.5

is appropriate, TSI 1–<2.0 is not appropriate, and TSI <1 is very unsuitable. The data used in the study are shown in the following table.

The physical and social characteristics of each beach location were identified through field observations and are presented in Table 1.

Tabel 1. The Results of the Physical and Social Components

Aspect	Tapil Beach	Wanga Beach	Walakiri Beach	Puru Kambera Beach	Londa Lima Beach
Beach type	White Sand Mixed Coral Fragments	Black Sand	White Sand	Mud Rocky Step	White Sand
Coastline Length (km)	4.592	5.11	1.31	5.34	4.8
Water Base Material	Muddy Sand	Sandy Coral	Sandy Coral	Sandy Coral	Sandy Coral
Current speed (cm/sec)	12.75	9.61	21.45	20.91	19.03
Beach land cover	High Scrub	Coconut Open Land	Mangroves and Coconut Open Land	Savana	Coconut Open Land
Dangerous biota	Sea Urchins, Stringrays	Sea Urchins	Nothing	Sea Urchins, Stringrays, Lionfish	Sea Urchins
Social Component	Poor in attraction and accessi bilities, and amenities	Poor in attraction and activities, and amenities	Complete with Attraction, amenities, and accessibility in good condition	Poor in attraction and amenities, accessibility in good condition	Complete with Attraction, amenities, and accessibility in good condition

Source : primary and secondary data processing, 2024

The identified parameters presented in Table 1 were subsequently used as the basis for the tourism suitability assessment. Each parameter was assigned a weight and score according to the suitability matrix applied in this study. The scoring process aimed to evaluate the level of suitability of each beach location based on its physical and social characteristics. The values obtained from each parameter were then summed to produce the Tourism Suitability Index (TSI) for each beach. The results of this analysis are presented in Table 2.

Tabel 2. The Results of the Physical and Social Components

No	Parameter	Weigh	Category	Score	Tapil Beach Score	Wanga Beach Score	Walakiri Beach Score	Puru Kambera Score	Londa Lima Beach Score
1	Beach Type	0,200	White sand	3	2	1	3	0	3
			White sand mixed with coral fragments	2					
			Black sand, a little steep	1					
			Mud, rocky, steep	0					
2	Coastline Length (km)	0,050	>2	3	3	3	2	3	3
			>1-2	2					
			>0,5-1	1					
			<0,5	0					
3	Water base material	0,200	Sand	3	1	2	3	2	2
			Sandy coral	2					
			Muddy sand	1					
			Mud, sandy mud	0					
			>10 m	0					
4	Current speed (cm/sec)	0,090	0-17	3	3	3	2	2	2
			17-34	2					
			34-51	1					
			>51	0					
5	Beach land cover	0,125	Coconut, open land	3	1	3	0	2	3
			Bush. Low grove, Savanna	2					
			High Scrub	1					
			Mangroves, settlements, harbors	0					
6	Dangerous biota	0,005	Nothing	3	1	2	3	0	2
			Sea urchins	2					
			Sea urchins and stingrays	1					
			Sea urchins, stingrays, lionfishs, sharks	0					
7	Social component 4A	0,200	Complete with Attraction, Accessibility, Amenities and Ancillary in good condition	3	0	0	3	2	3
			Has Attraction, Accessibility, and Amenities in good condition	2					
			Has easy-to-reach Attraction and Accessibility	1					
			Has Attraction and poor Accessibility	0					
Total Score					1.15	1.41	2.09	1.38	2.0
Level of Suitability of Physical and Social Parameters					NS	NS	S	NS	S

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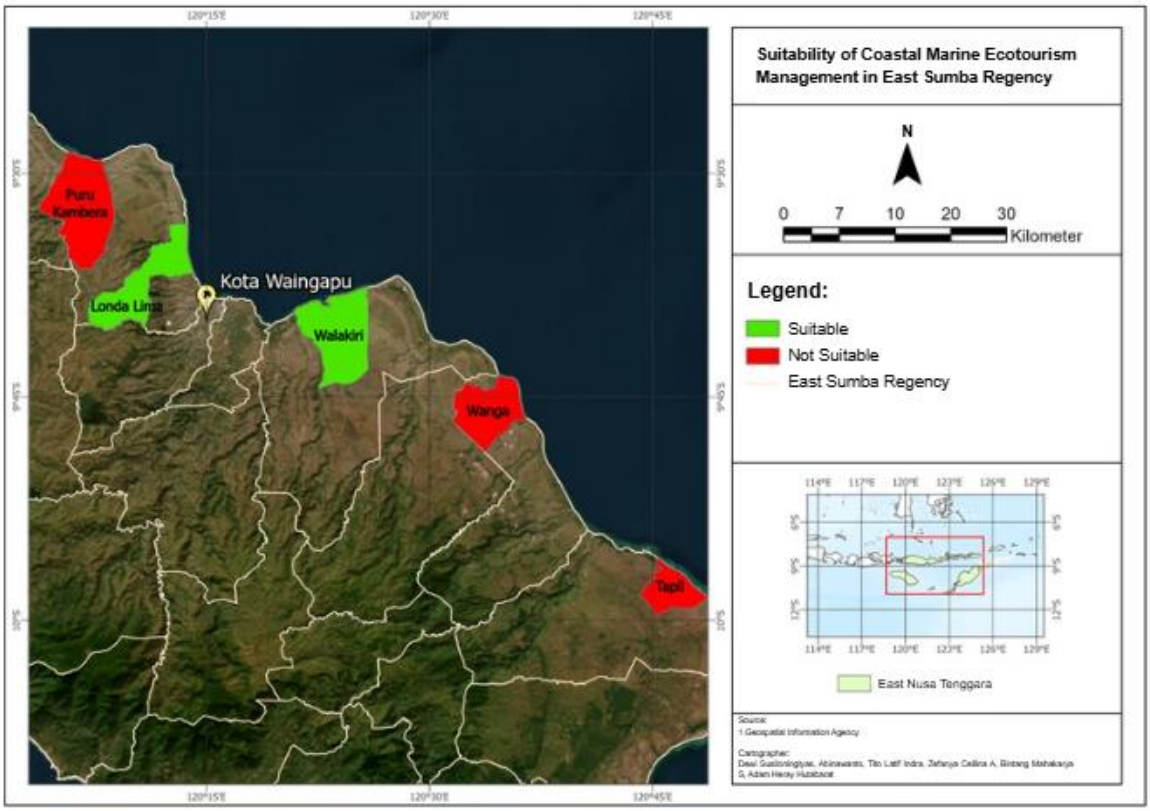
The results of the tourism suitability assessment based on physical and social parameters are presented in Table 2. The assessment was conducted by assigning weights and scores to each parameter, including beach type, coastline length, water base material, current speed, beach land cover, the presence of dangerous biota, and social components consisting of attraction, accessibility, amenities, and supporting institutions. The values obtained from each parameter were then summed to determine the total Tourism Suitability Index (TSI) for each beach location.

Based on the calculation results, Walakiri Beach obtained the highest total score of 2.09, followed by Londa Lima Beach with a score of 2.00. These values indicate that both beaches fall into the suitable category for beach tourism development. In contrast, Tapil Beach obtained a score of 1.15, Wanga Beach 1.41, and Puru Kambera Beach 1.38, which indicates that these three beaches are categorized as not suitable for the development of coastal ecotourism.



Gambar 2. Suitability of Coastal Marine Ecotourism Management in East Sumba Regency

The results of the analysis of determining the suitability for coastal tourism activities, it can be stated that of the five beaches that are the research locations, there are only two beach locations, namely Walakiri Beach and Londa Lima Beach which can be developed into ecotourism activities for coastal tourism purposes. As for the other three beaches,

namely Tapil Beach, Wanga Beach, and Puru Kambera Beach, they have a suitability index value of 1 to less than 2 which indicates that the three beaches are not suitable for the development of coastal ecotourism locations in East Sumba Regency. Some of the reasons are because there are still no adequate facilities, besides that, accessibility is also poor, such as unpaved road conditions and relatively far from Waingapu City. This is different from the two beaches that have a suitability index of more than 2. These two beaches have good potential to become coastal ecotourism locations, because several aspects such as road facilities and accessibility, as well as proximity to Waingapu City also play an important role. Other aspects are also management and cooperation with local communities which are very good support for the development of tourism potential, in addition to the site attraction which is already an attraction for these two beaches.The condition of suitability on the two beaches is undoubtedly a shared responsibility to develop the East Sumba Regency area by relying on the tourism sector, which can support regional development.

Conclusion

The novelty in this research is expected to provide benefits to the Coastal Community and also the Regional Government of East Sumba Regency in managing coastal areas, by offering novelty in the concept of sustainability integration in coastal area management. An important emphasis on the novelty aspect in this research is that the use of spatial aspect can sharpen the operational capabilities of government agencies responsible for decision making in coastal area management. This can strengthen the real novelty that coastal area management is carried out by developing integration between conservation areas and the suitability of space for marine ecotourism. This research will also be useful as a flagship of the Renstra strategy in the field of developing science and technology applications for maritime affairs, as well as supporting government policies for the blue economy concept. The novelty in this study is the use of technology in the analysis and decision-making that is carried out in an integrated manner, namely the determination and utilization of coastal conservation areas for zoning-based ecotourism activities. Through this gradual and integrated analysis approach, it can better overcome the problem of environmental damage and help coastal communities who have had limited information and participation in the utilization and management of resources in coastal areas, especially in East Sumba Regency with the integration of conservation area preservation and resource utilization, especially for marine ecotourism. The condition of suitability on the two beaches is undoubtedly a shared

responsibility to develop the East Sumba Regency area by relying on the tourism sector, which can support regional development.

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