



Integrating Indigenous Knowledge of Kaombo into Disaster Mitigation Education for Coastal Resilience and Sustainability in Buton

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Abstract. Coastal communities are among the most vulnerable to environmental hazards caused by climate change, resource exploitation, and declining ecological resilience. Strengthening disaster mitigation education at an early age is therefore crucial for building long-term community preparedness and sustainability. This study explores the Kaombo system, an indigenous environmental management practice of the Butonese people in Southeast Sulawesi as a model for integrating local ecological wisdom into disaster education, particularly for children in coastal areas. Employing a qualitative descriptive approach supported by ethnographic observation and participatory interviews with local leaders, teachers, and community members, the research investigates how Kaombo embodies principles of environmental ethics, collective responsibility, and adaptive governance. The findings reveal that Kaombo practices such as customary prohibitions, communal rituals, and ecological stewardship can be translated into child-friendly educational programs that cultivate disaster awareness, respect for nature, and community-based resilience. Embedding Kaombo values into formal and informal education empowers children as agents of cultural continuity and environmental guardianship. The study concludes that integrating indigenous knowledge into disaster mitigation education not only enhances coastal resilience but also nurtures sustainable environmental behavior across generations.

Keyword: Green Innovation Behavior, Green Technological Savviness, Perceived Green Organizational Support, Green Commitment, Green Human Capital.

1 Introduction

Global climate change has accelerated the vulnerability of coastal areas to environmental disasters such as coastal abrasion, sea level rise, and increasingly intense tropical storms. In this context, modern technology-based mitigation efforts have not adequately answered the social and ecological complexities faced by coastal [1]. Many studies have shown that the integration of indigenous knowledge plays an important role in increasing the resilience of coastal communities through a contextual approach rooted in cultural values. Thus, strengthening environmental resilience needs to be accompanied by disaster mitigation education from an early age that instills ecological awareness and social responsibility in the younger generation [2].

Although conceptually important, there is an empirical and implementable gap between local knowledge and disaster mitigation education in coastal areas of Indonesia

The disaster education curriculum in primary and secondary schools is still generic and has not accommodated local values [3]. On the other hand, local knowledge practices such as the Kaombo system in Buton, which regulates the balance between humans and nature through customary prohibitions and conservation systems, are still rarely studied in the context of disaster mitigation education [4]. Previous research has focused more on the ecological and social aspects of Kaombo, not yet reaching the pedagogical realm that integrates local values into disaster learning for children [5].

The relevance of this research is becoming stronger because coastal areas such as Buton face a combination of natural and social threats of coastal ecosystem damage, degradation of cultural values, and low disaster mitigation literacy. Adapting Kaombo values into disaster mitigation education can increase the ecological awareness of coastal children while strengthening community resilience through the preservation of local wisdom. This approach is in line with the principles of Education for Sustainable Development (ESD), which emphasizes education based on participation, values, and local contexts. Thus, Kaombo-based disaster mitigation education not only functions as an environmental learning instrument, but also as a socio-ecological adaptation strategy in coastal areas.

The novelty of this research lies in the integration of two domains that were previously rarely united: child-oriented disaster mitigation education and the revitalization of Kaombo local wisdom as a model of contextual pedagogy in the coastal area of Buton. This approach conceptualizes Kaombo not only as a social-customary system, but also as a source of ecological value that can be translated into learning modules that form resilient attitudes towards disasters. By involving indigenous leaders, teachers, and coastal communities in curriculum design, this research is expected to produce a participatory, inclusive, and sustainable disaster mitigation education model while contributing to strengthening disaster risk reduction policies in the Indonesian archipelago.

2 Method

This research employs a qualitative descriptive approach combined with an ethno-educational perspective to explore how the Kaombo system a traditional ecological system practiced by the Buton people can be integrated into disaster mitigation education to strengthen the resilience and sustainability of coastal communities [6]. The approach is grounded in an interpretive paradigm that emphasizes understanding cultural meanings and ecological practices within their local contexts. The study is designed as a case study focusing on South Buton Regency, where the Kaombo tradition continues to function as an integral component of forest and coastal conservation systems. The research was conducted in Wabula Village, Buton Regency, Southeast Sulawesi, an area that maintains active Kaombo practices and demonstrates strong community participation in environmental rituals.

Participants were selected through purposive sampling to represent key stakeholders involved in knowledge transmission and environmental stewardship, including customary apparatus (five individuals), teachers (six individuals), students aged 10–15 years, community environmental facilitators (four individuals), and local government officials (two individuals) [7]. This selection ensured representation of traditional knowledge holders, educators, and the younger generation as central actors in sustaining Kaombo-based educational practices. Data collection was conducted through triangulation of sources and methods to enhance validity and reliability. Ethnographic observation involved field visits to Rongi Village and Siompu Island to document Kaombo practices such as ritual activities, zoning of land use, and seasonal prohibitions (pamali) related to environmental protection. Semi-structured interviews were carried out with customary leaders, local educators, students, and environmental officials to capture processes of intergenerational knowledge transfer and perceptions of ecological ethics. Focus group discussions were also conducted with teachers and coastal youth communities to explore the potential integration of Kaombo values into school-based disaster education curricula. Additionally, document and artifact analysis included examination of customary texts, local regulations, and community documentation reflecting Kaombo ecological ethics.

The collected data were analyzed using thematic analysis following the framework of Braun and Clarke, with inductive coding applied to identify key themes such as ecological ethical values and disaster risk reduction practices embedded within Kaombo, local mechanisms of environmental education, and strategies for integrating indigenous knowledge into formal and non-formal disaster education systems [8]. To ensure credibility and trustworthiness, data validation procedures included triangulation, member checking with local informants and educators, and peer debriefing involving cultural experts and educational researchers. The study adhered to qualitative research ethics by securing participant consent, respecting cultural values, and safeguarding the intellectual property rights of indigenous communities.

3 Result and Discussion

3.1 Pamali Practice (Customary Prohibition)

Pamali practice represents a form of customary environmental regulation embedded in local wisdom that shapes community interaction with nature and functions as an informal disaster mitigation mechanism. These culturally constructed prohibitions reflect ecological awareness and collective responsibility toward environmental sustainability. Detailed data regarding this analysis can be found in Table 1.

TABLE 1. Pamali Practice (Customary Prohibition)

Field Findings	Examples of Behavior	Meaning & Relationship with Disaster Mitigation
1) Prohibition of cutting down certain trees in the Kaombo forest and near springs; [9]	1) Parabela reprimanded residents who cut down large trees near the cliff;	1) Maintain soil strength → prevent landslides; maintain water discharge & prevent drought;
2) Pamali takes weathered wood in the Kaombo forest [10]	2) Residents never cut trees that grow to protect the springs;	2) Roots resist erosion & landslides;
	3) Residents only pick wood outside the Kaombo area	3) Weathered wood maintains soil fertility and moisture → reduces risk of soil erosion and degradation
Prohibition of dumping garbage into the sea	Children are prohibited from throwing plastic waste while playing	Reduce pollution & protect coastal ecosystems → prevent abrasion
1) Pamali clears land in certain months; [11]	1) Residents do not open their fields during the “long hot month” period;	1) Maintain vegetation cover → reduce risk of fire & erosion;
2) Prohibition of cultivating sloping land without paradefense approval [12]	2) Farmers ask permission before clearing land on the slopes	2) Prevent damage to soil contours → reduce risk of landslides
Pamali takes sand or stones from the beach	Residents are prohibited from taking sand for building materials; Parabela gives a stern rebuke	Maintain shoreline structure → prevent erosion and damage to the coastline
1) The prohibition of fishing in the bay of salam (“masa istirahat laut”); [13]	1) Fishermen stop going to sea in the sacral area for 1–3 months;	1) Restoring marine ecosystems → preventing decline of fish stocks and ecological imbalance;
2) Prohibition of catching small marine life (baby fish, small sea cucumbers, small shellfish) [14]	2) Children reprimanded if they catch small fish on shallow shores	2) Maintaining regeneration of marine life → preventing imbalance in coastal ecosystems
Prohibition of cutting grass or shrubs near settlements	Residents deliberately maintain low vegetation as a deterrent	Reduce the spread of wildfires and maintain soil moisture
1) Prohibition of cutting grass or shrubs near settlements during dry wind season; [15]	Residents do not cultivate camps near prohibited forest areas	Avoid forest fires → protect vegetation that resists landslides and erosion
2) Pamali lighting a fire in the Kaombo forest [16]		
Prohibition of cutting down mangrove trees	1) Residents take care of mangrove areas;	Safeguarding the coastal green belt → increases resistance to waves, storms, and tsunamis
	2) Children are forbidden to break branches	

Pamali on making excessive noise during the westerly wind season [17]	1) Fishermen do not hit boats hard;	Cultural vigilance toward extreme weather → encourages awareness of high waves and coastal hazards
	2) Residents reduce night activities near the beach	

3.2 Breakdown of the Prohibited Zone

The spatial organization of customary territory reflects a structured environmental governance system that regulates human interaction through zoning arrangements. This division into prohibited, buffer, and allowed areas demonstrates how traditional ecological knowledge contributes to disaster risk reduction and ecosystem resilience. Detailed data regarding this analysis can be found in Table 2.

TABLE 2. Breakdown of the Prohibited Zone

Zone	Field Observations	Disaster Mitigation Function
Kaombo (Core/Confinement Zone)	1) There is no human activity; heavily guarded forests;	1) Resists strong winds, prevents abrasion and landslides;
	2) The forest vegetation is very dense dominated by large trees;	2) <i>Thick canopy keeps soil moisture</i> → prevents dryness & forest fires;
	3) Many indicator animals appear in this zone;	3) High biodiversity supports the balance of the ecosystem so that it is stable against natural shocks;
	4) This area is most often marked with customs;	4) It is a natural boundary that prevents residents from entering high-risk areas (cliffs, unstable soil)
	5) The soil looks soft and covered with thick leaf litter	5) <i>Litter inhibits surface flow</i> → prevents flash flooding and slope erosion
(Buffer Zone)	1) Used on a limited basis to take light forest products;	1) Maintaining ecosystem stability and preventing overexploitation;
	2) Residents only take small rattan, leaves, traditional medicines, not large wood;	2) <i>Preventing biomass decline</i> → maintaining microclimate stability;
	3) The vegetation is still quite dense but there are small paths made by residents;	3) The restricted path prevents large <i>land clearing</i> → reduces the risk of erosion expansion;
	4) There is a small river flow or water seepage towards the village;	4) This zone functions as a hydrological buffer, maintaining the availability of water during the dry season;
	5) This area becomes a buffer habitat for animals that migrate from kaombo.	5) <i>Keeping ecological connectivity</i> → the environment more resilient to climate change
(Zone Allowed)	1) Community activities are carried out openly;	1) Restricting humans from entering ecologically vulnerable zones;

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| <ul style="list-style-type: none"> 2) Used for small farms, and coconut groves; 3) Residents apply the rule of clearing small land without burning; 4) Many natural fences are made of stone; 5) In the rainy season, residents often work together to clean the environment | <ul style="list-style-type: none"> 2) Keeping intensive activities from penetrating into sensitive zones; 3) Reduce the risk of land fires that can seep into prohibited zones; 4) Restrict livestock from damaging erosion-resistant vegetation; 5) Reduce the potential for local flooding in settlements. |
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3.3 Traditional Rites as an Early Warning System

Traditional rites function as culturally embedded mechanisms that guide community responses to environmental conditions and seasonal changes. These ritual practices reflect accumulated ecological knowledge that strengthens environmental resilience and disaster preparedness. Detailed data regarding this analysis can be found in Table 3.

TABLE 3. Traditional Rites as an Early Warning System

Types of Rites	Observation	Impact on Environmental Resilience
Kaombo Opening Ritual	Conducted before certain planting or fishing periods	Serves as a marker of safe and unsafe seasons for community activities
Ritual of Fishing Prohibition (Sasi/Morompa)	Fishermen stop fishing for 1–3 months	Restores fish populations and reduces stress on marine ecosystems
Reading Signs of Nature by Parabela	Parabela observes wind patterns, waves, and animal movements	Functions as a tradition-based early warning system

3.4 Key Dimensions of Kaombo Integration in Mitigation Education

Integration of Kaombo values into mitigation education reflects a multidimensional learning process that shapes knowledge, attitudes, and behavioral responses toward environmental protection. These dimensions illustrate how indigenous ecological wisdom contributes to disaster awareness and sustainable community practices. Detailed data regarding this analysis can be found in Table 4.

TABLE 4. Breakdown of the Prohibited Zone

Dimension	Description
Cognitive	Kaombo knowledge helps children understand natural signs, environmental risks, and conservation functions. It enables recognition of seasonal patterns, ecosystem changes, and traditional “red flags” relevant to disaster mitigation. [18]
Affective	Traditional values such as respect for nature, obedience to pamali, and community solidarity strengthen environmental awareness and a sense of belonging to coastal areas. [19]

Behavioral

Children engaged in Kaombo practices demonstrate stronger conservation behavior, including avoiding littering at sea, maintaining coastal vegetation, and participating in ecological gotong-royong activities. [20]

The results of ethnographic observations in Wabula, Rongi, and Siompu Island show that Kaombo functions as a conservation and disaster mitigation system that has been formed for generations. The prohibition of cutting down large trees, clearing land in prohibited zones, and taking marine products in certain periods is a form of adaptive governance that maintains coastal ecological stability [21]. This mechanism is in line with ecosystem-based mitigation studies that emphasize that coastal forests and natural vegetation are the main anchors of abrasion, erosion, and extreme waves [22]. Thus, Kaombo is not only of cultural value, but also a vital ecological infrastructure.

Customary prohibitions governing the use of space and seasons work as an early warning system based on ecological experience [23]. Parabela and traditional elders read natural signs such as changes in wind, waves, and fauna behavior as risk indicators, which then translate into pamali or customary prohibitions. This practice is in line with scientific findings that local knowledge plays an important role in improving the accuracy of community decisions in disaster mitigation. Thus, Kaombo acts as a community early-warning knowledge system that has proven to be relevant throughout generations [24].

The Kaombo zoning system which divides space into Kaombo (core zone), Kaowa (buffer zone), and Pela (utilization zone) demonstrates the sophistication of locally-based spatial governance [25]. A core zone that is completely free of human activities keeps forest vegetation tight and supports slope stability; buffer zones are regulated by limited utilization; and the utilization zone becomes a safe space for people's daily activities. This structure is consistent with the literature that confirms that traditional zoning can reduce risk exposure and strengthen ecological connectivity [26].

When associated with field findings, it can be seen that people obey pamali not only for spiritual reasons, but because it is proven to maintain the quality of life of the community. For example, a ban on dumping garbage into the sea contributes to the cleanliness of coastal ecosystems, while a ban on clearing land in the hot months prevents the risk of fire and erosion. In the global literature, customary-based conservation practices such as seasonal closure have been shown to increase marine biomass and long-term ecological resilience. This shows that Kaombo has a strong ecological foundation even though it comes from cultural values. The research findings in the appendix show that Kaombo knowledge is more inherited through family, customary rites, and community practices than formal education. Schools have not systematically integrated Kaombo values even though students are already practicing them intuitively in daily life. This is in accordance with research that highlights the gap between cultural practices and students' scientific understanding in the context of disaster education. As a result, Kaombo's ecological value has not been translated into complete disaster literacy in schools.

The FGD with teachers and coastal youth as recorded in the attachment revealed that Kaombo has great potential to be a source of contextual learning. Students have an easier time understanding the concepts of risk, conservation, and ecosystems when they are associated with customary prohibition practices, cultural rites, or the reading of natural signs that they see on a daily basis. Research on local knowledge-based education in various regions also shows that cultural-ecological learning models are more effective in improving disaster preparedness than general theoretical approaches. This proves that Kaombo can be a pedagogical foundation for disaster mitigation.

However, this study also found implementation obstacles, especially the absence of official Kaombo-based modules, the limitations of teachers in processing traditional knowledge into subject matter, and the concern of some people about the reduction of cultural meaning if taught formally. These findings reflect a pattern of challenges also found in many indigenous communities around the world, where culture-based education requires strategic collaboration mechanisms between indigenous leaders, schools, governments, and communities. Without this synergy, the integration of Kaombo in the curriculum will run partially.

The integration model suggested by this study is participatory and community-based, involving paradedfenders as resource persons, integrating classroom learning, field practice, cultural rites, and forest and coastal conservation projects. This approach is aligned with the principles of Education for Sustainable Development (ESD) and the Sendai Framework, which emphasizes the importance of contextual, collaborative, and value-based learning. Studies related to community-based early warning systems also confirm that community involvement and strengthening cultural values increase the effectiveness of mitigation. Thus, Kaombo has the potential to become a model of disaster education that not only protects the current generation but also maintains the continuity of local culture.

4 Conclusion

This study concludes that Kaombo is an environmental governance system based on local wisdom that is effective in maintaining coastal ecosystems and mitigating disaster risks through pamali practices, customary rites, and structured spatial zoning. This local knowledge passed down through families and communities has been proven to function as a mechanism for conservation, spatial control, and culture-based early warning systems. Although not yet fully integrated in formal education, Kaombo has great potential as a contextual learning resource to improve disaster literacy and environmental sustainability in the younger generation. Participatory integration between indigenous peoples, schools, and policy makers is key for Kaombo to become a pedagogical model for disaster mitigation that is relevant and sustainable.

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