Between Policy and Practice: Discrepancies in the Implementation of Sustainable Governance Principles in the Dringo Nature Reserve

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Abstract. The Dringo Nature Reserve was chosen as a case study to analyze the implementation gap between sustainable governance principles and actual conservation area management practices at the local level. Principles analyzed include state responsibility, desirability, integration, the precautionary principle, equity, and the polluter pays principle. This study employed a qualitative methodology through field observations, comprehensive interviews with key informants such as managers and local community members, and an examination of policy documents. The results indicate that current management practices do not meet the tenets of sustainable governance. Low levels of oversight and ineffective law enforcement are contributing factors to the ongoing implementation. The study revealed that institutions share responsibilities and community engagement is largely limited to technical implementation rather than meaningful participation in decision-making

Keywords: Co-Management, Conservation Area, Implementation Gap, Indonesia, Sustainable Governance.

1 Introduction

When it comes to protecting ecological zone and preserve its critical function, conservation area plays pivotal role to preserve biodiversity [1]. When discussing anthropogenic climate change and declining environmental quality, ecological zone existence is crucial to maintain the sustainability of life-supporting systems. The systems include hydrological cycles, air quality, soil fertility, and many other supporting ecological systems [2]. We may conclude that conservation issue require continuous effort in terms of national political commitment to adopt sustainable development to achieve global conservation goals.

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To properly manage the conservation area require not only national arrangements, but also require global regulations as a clear guideline that being formulated by International Union for Conservation of Nature (IUCN). These guidelines could gave stakeholders a clear guideline in protecting biodiversity, restrictions in terms of resource exploitation, and regulation to establish efficient yet collaborative governance arrangements [3]. The whole legal framework in Indonesia usually further supported by legal structure to properly encompass conservation and environmental law [4].

In Indonesia, there are regulated limitation in public activity within conservation area. The limitations explicitly exclude academic activity such as education, research, carbon sequestration, and cultivation specifically to gain sample for breeding. This activity is designed ensure a strict collaborative effort to protect conservation areas. The technical regulation can be found in Government Regulation No. 28 of 2011 on the Management of Nature Reserves and Conservation Areas and hopefully able to spearhead government regulation to protect conservation area in Indonesia.

However, in practice, these rules are often very difficult to enforce. Unsynchronized and autonomous local government may have a different agenda, creating different local development interests have been a major cause of conservation rule violations. Tourism sector, for example, is often promoted nature-based tourism as a source of regional income; it often leads to the uncontrolled commercialization of protected areas without adequate consideration of their ecological carrying capacity. Komodo National Park, where tourism development has sparked controversy over habitat degradation and the marginalization of local communities is one of the unflattering example on how nature ecosystems disrupted by uncontrolled development [5], [6]

Recently, there are climbing case of uncontrolled land acquisitions , which has recently become increasingly common in Indonesia, stems not only from intentional violations but also from the need to meet daily needs[7], [8]. This is driven by the growth of settlements around conservation areas and the expansion of agricultural land. This suggests that local economic needs are putting pressure on these areas. Many communities invade conservation zones because they cannot easily access resources and lack other viable means of earning a living [8].

A broader pattern of policy fragmentation is reflected in the lack of alignment between conservation regulations and regional development policies, which then weakens the effectiveness of implementation [7], [9], [10]. Limited institutional resources and overlapping mandates between agencies also often lead to limited field oversight, further creating room for repeated violations. A lack of literacy and education regarding the goals and functions of conservation also contributes to exacerbating this condition. This represents a larger problem related to communication and community involvement in conservation area governance [9].

The Dringo Nature Reserve, officially a protected area located in Banjarnegara Regency, Central Java, holds a crucial position in its ecosystem. This area is a crucial part of the upstream ecosystem of the Dieng Plateau and functions as a water catchment area and carbon sink [11], [12]. The site is experiencing a significant increase in tourism, agriculture, and infrastructure development, which puts its ecological function at greater risk. As a result, the area now finds itself in a difficult position: on the one hand, its environmental sustainability must be maintained, while on the other, it continues to face pressure from the economic needs of the local community, which relies on nature-based tourism and agriculture.

According to the 2022 inventory conducted by the Balai Konservasi Sumber Daya Alam Jawa Tengah, Tlogo Dringo Nature Reserve is classified as an area with a high level of ecological vulnerability [13]The interview results also show that the aquatic ecosystem is still getting worse. This is shown by a drop in water discharge, which is thought to have dropped by more than 30% in recent years, and a drop in water quality, which is shown by more turbidity and organic pollution in the area around it. Changes in water quantity, physicochemical quality, and human activity pressures are all common ways to measure the degradation of aquatic ecosystems [14].

These conditions are further supported by studies indicating that pressures on the area largely stem from uncontrolled human activities. Research by Anggara [11] found that local communities illegally take water from the reserve using highcapacity pumps to help with farming outside the reserve. This has made it harder for people to get water in the conservation area. In addition, the growing number of visitors and poorly managed recreational activities, such as informal camping and unregulated fishing, have begun to generate tangible environmental impacts. Vegetation surrounding the lake has been damaged, soil quality has declined due to erosion in exposed areas, and the increasing human presence in close proximity to natural habitats poses a risk to wildlife that depend on relatively undisturbed ecological conditions [7], [8], [10].

These findings are consistent with the study by Putri [15], which illustrates that illegal fishing activities and the creation of camping sites within buffer zones have expedited habitat degradation and disturbed ecosystem equilibrium. These studies demonstrate that the ecological vulnerability of the Tlogo Dringo Nature Reserve involves multiple factors from various angles, resulting from the collective impact of various human activities occurring both within and around the conservation area. This situation will forever be a dynamic that illustrates the fundamental conflict between environmental conservation and development needs [7], [16]. Pressures to accelerate economic growth often lead to conflicts between protection goals and the use of natural resources, such as land requirements for agriculture, mining, and infrastructure [16] .

This discrepancies even more apparent at the stage of policy implementation. In this context, efforts to realize sustainable conservation governance frequently encounter various obstacles in practice, not only in the Dringo Nature Reserve but also across many protected areas in Indonesia. Although, at the normative level, policies have incorporated sustainability values, their implementation continues to reveal significant gaps. This study elucidates the discrepancy between policy and practice through the concept of the implementation gap, which denotes the divergence between policy objectives established at the normative level and their actual execution in practice [17] Nonetheless, this study does not regard policy implementation theory as its principal analytical framework. Instead, the concept of the implementation gap is used in a limited manner as a conceptual lens to identify the existence of such discrepancies.

The main analytical framework adopted in this study is the set of principles underpinning sustainable governance, which are used to assess how conservation governance is carried out in practice. This idea says that a gap happens when important ideas like state responsibility, sustainability, integration, precautionary, equity and the polluter pay principle are not fully realized in real-life governance. Although several studies have examined the governance of protected areas and the implementation of conservation policies, most of them tend to focus

either on the normative aspects of policy or on general program evaluations. Research that specifically investigates the gap between sustainable governance principles and empirical practices at the local level remains relatively limited.

Several studies have shown that conservation research in Indonesia emphasizes regulatory frameworks and policy design, neglecting issues related to implementation in the field [18], [19]. Some studies discuss conservation approaches, which are often top-down and fail to fully accommodate the socio-ecological complexities and actor relationships that are crucial components of the implementation process in local contexts [8]. Research on protected areas in developing countries shows that formal metrics play a significant role in conservation policy evaluations, despite concerns about implementation gaps and environmental equity [20], [21]. Of these studies, only a small number have attempted to systematically incorporate sustainable governance principles as a holistic analytical framework essential for understanding the dynamics of conservation policy implementation. Another research from Bennett [22] share a similar notions that research usually looks at institutional analysis, participation, and environmental sustainability as separate things instead of putting them all together in one idea.

Based on the issues outlined above, This study aims to tackle the following research questions, considering the aforementioned issues: (1) What is the gap between the principles of sustainable governance and how they are put into action in the governance of the Dringo Nature Reserve? And (2) How can we rethink the idea of sustainable governance to fill in the gaps in the management of the Dringo Nature Reserve? In accordance with these questions, the goals of this study are (1) to find out what the difference is between the principles of sustainable governance and how they are actually put into practice in the management of the Dringo Nature Reserve; and (2) to come up with a new way of thinking about the idea of sustainable governance in conservation areas. This study should not only give an empirical account of the gaps that already exist, but it should also help us understand them better so that we can come up with governance approaches that are more flexible, inclusive, and based on the situation.

2 Methods

Qualitative research methodology was utilized to examine the implementation gap of sustainable governance principles within the Dringo Nature Reserve. This method allows for a thorough examination of processes, institutional dynamics, and the functions of diverse stakeholders engaged in conservation governance in the region. The results were then examined through the lens of sustainable governance principles, encompassing state responsibility, sustainability and conservation, integration, precautionary measures, equity, and the polluter pay principle. This method aligns with Joseph A. Maxwell's viewpoint which asserts that qualitative research not only delineates phenomena but also contextualizes them within the framework of fundamental causal relationships [2].

The Dringo Nature Reserve was chosen as the site for the study because it shows how hard it is to fill in the gaps in protected area governance at the local level. Data was obtained from two principal sources: primary and secondary data. Primary data were acquired through comprehensive interviews with informants directly engaged in the management and utilization of the Dringo Nature Reserve.The informants were: (1) officials from the Balai Konservasi Sumber Daya Alam (BKSDA), such as the Head of Regional Conservation Section and forest

rangers; (2) staff from the Dinas Lingkungan Hidup of Banjarnegara Regency who work in pollution and environmental damage control; and (3) community leaders and representatives from forest-based community organizations like Lembaga Masyarakat Desa Hutan (LMDH) Cemeti Alam Lestari, Kelompok Tani Hutan (KTH), Masyarakat Mitra Polisi Hutan (MMP), and Masyarakat Peduli Api (MPA) who live near the area.

Secondary data were gathered through document analysis, that involve official policy documents (laws, government regulations, ministerial regulations, and local regulations), as well as scientific publications, including journal articles and books pertinent to conservation and protected area management, specifically those applicable to the Dringo Nature Reserve. Three steps were taken to check the reliability of these secondary data sources: (1) making sure that the documents came from official or verifiable sources; (2) checking the credibility of the institutions or authors that issued the documents, such as government agencies, research institutions, or reputable journals; and (3) choosing documents based on how relevant they were to the research focus, especially in terms of sustainable governance principles and how they were put into practice in protected areas .

After gathering data from different sources, the next step was to analyze it in a systematic way to find patterns, connections, and meanings that were important to the research focus.This study utilizes an interactive data analysis model, formulated by Matthew B. Miles and A. Michael Huberman [23] comprising three principal stages: (1) data reduction; (2) data display; and (3) conclusion drawing. During the data reduction phase, the researcher curated, streamlined, and enhanced raw data collected from interviews and documents.The data were then categorized into groups based on the rules of sustainable governance. The condensed data were arranged into structured formats like narratives or tables to make it easier to see patterns and connections between the results. In the final stage of drawing conclusions, the researcher made sense of the results by linking the patterns they found to the study's idea of sustainable governance. We looked at each finding to see if it was in line with, not in line with, or against the ideas of sustainable governance.

3 Results & Discussion

3.1 Implementation Gaps in the Principles of Sustainable Governance in the Management of the Dringo Nature Reserve

Poverty, justice, participation, accountability, and institutional effectiveness are the foundations of sustainable governance ([24]). These principles have been integrated into the national legal framework. The guiding principles for environmental management outlined in Article 2 of Law No. 32 of 2009 concerning Environmental Protection and Management address these issues extensively. These key principles include state accountability, desirability and conservation, integration, prudence, justice, and the polluter pays principle. These principles serve as the basis for creating basic rules that shape how environmental policies are formulated and implemented. The following discussion is conducted in accordance with the key principles of (1) state responsibility, (2) desirability and conservation, (3) integration, (4) prudence, (5) justice, and (6) the polluter pays principle.

3.1.1 Principle of State Responsibility

The government in protecting conservation areas from harmful exploitation. Three main indicators analyzed in the application of the principles are: (1) affirmation of state authority, (2) institutional capacity, and (3) effectiveness of supervision. Formally, the state is present through the determination of conservation status, clarity of institutional mandate, and the existence of a regulatory framework that protects conservation. This also serves as a form of affirmation of State Authority. Meanwhile, having sufficient personnel, infrastructure, and management coverage indicates the institutional capacity of the Government as a management agency to carry out their protection duties. The final indicator, namely the effectiveness of supervision, shows how capable the state is in controlling activities that can endanger the area, such as patrols, monitoring, and responding to violations that occur in Dringo [3], [20]

State authority claims in conservation governance must be consistently implemented in practice [25]. In the case discussed in this study, the Dringo Nature Reserve is a protected area under the responsibility of the Central Java Natural Resources Conservation Agency. One method used by the state to communicate and enforce conservation regulations is by installing warning signs stating activity restrictions. However, field findings indicate that implementation is still inconsistent with these regulations; the prohibitions remain merely administrative and regulatory. Observations indicate that illegal fishing continues to occur around the lake without consistent enforcement. Similarly, local communities continue to use water pumps to transfer water from the conservation area to agricultural land outside the reserve, despite this clearly being in violation of regulations.

It was also found that people frequently camp and engage in other tourism-related activities without official permits, even in restricted areas. This lack of oversight suggests that conservation regulations have not yet translated into behavioral compliance among local stakeholders. This could be due to inadequate oversight and ineffective law enforcement mechanisms [7], [10], [21]. It can be concluded that there is no clear alignment in the implementation of state authority, because the authority that is officially in place has not yet produced effective regulatory control.

Institutional capacity is another important factor influencing how well conservation efforts work. This relates to how well the management agency can carry out its duties. The number of staff must cover all monitoring activities and be equipped with the appropriate facilities to support them. Data collected in the field and from the Natural Resources Conservation Agency (BKSDA) indicates that only 3 to 5 officers are responsible for areas exceeding 30 hectares. This ratio means each officer should cover approximately 6–10 hectares. This ratio is illogical given the extremely steep terrain in the field. Another finding is the distance of the management office from the conservation area, which is 5–10 kilometers. This makes it more difficult to respond quickly to on-site activities, especially on busy days such as weekends or holidays.

Interviews and field observations indicate that routine patrols occur only once or twice a week. In some cases, patrols occur only a few times a month. This frequency does not align with the level of activity in the area, allowing violations to continue unnoticed. Consequently, illegal fishing, water extraction with pumps, and unauthorized tourism continue to occur repeatedly, both in buffer zones and in core conservation areas. Implementing these regulations without standards directly impacts the strictness of those responsible and how quickly institutions can react to violations.

The looming implementation of the principle of state responsibility stems from a mismatch between strong formal authority and limited institutional capacity [2], [4], [21]. The analysis reveals that despite state authority being formally established through legal provisions, regulatory frameworks, and the existence of management institutions, its implementation remains ineffective on the ground. Lack of personnel, extensive monitoring areas, institutional limitations, and geographical constraints indicate that current capacity is not commensurate with the breadth of the protection mandate. This situation directly contributes to poor oversight and allows illegal activities to continue without consistent law enforcement. In this case, the mismatch in implementation of the principle of state responsibility is caused by the mismatch between strong formal authority and limited institutional capacity.

3.1.2 Principle of Sustainability and Conservation

In environmental management, the principles of sustainability and conservation are fundamental principles that emphasize the urgency of maintaining a balance between the sustainable use and protection of natural resources ([3] The three main indicators examined in this study include ecological, social, and economic sustainability [26]. The following section outlines and identifies gaps between the normative framework and actual field practices for each indicator to assess the extent to which sustainability principles have been implemented in the management of the Dringo Nature Reserve.

In another study on ecological sustainability, ecological sustainability is defined as a condition that maintains the condition and function of an ecosystem to protect it from the intervention of human activity, including water quality, vegetation conditions, and the sustainability of wildlife habitat [26]. Based on this definition, various formal steps taken by management authorities can be identified, such as designating areas as nature reserves, installing warning signs, and restricting certain activities as part of ecosystem protection efforts.

On the other hand, field observations indicate that many external pressures remain, such as uncontrolled tourism, pumped water extraction, and the community's dependence on direct resource use in the area. Observations around Dringo Lake indicate that irregular tourist paths and trails damage visible vegetation, making the land surface vulnerable to erosion. Another problem arises when local communities use water pumps to transfer water from the conservation area to agricultural land outside the conservation area, causing the lake level to drop. This creates numerous secondary problems, particularly during the dry season. Illegal fishing activities also continue to occur without adequate oversight, further demonstrating that ecological integrity cannot be maintained in practice.

The continuity of social interactions demonstrates the importance of conservation policies and the livelihoods of local communities, particularly regarding access, understanding, and participation in area management [27], [28]. In practice, this involvement manifests itself in joint patrols, dissemination of conservation regulations, and community participation in monitoring tourism activities. In the case of Dringo, this participatory approach has been realized through collaboration between the Natural Resources Conservation Agency (BKSDA) and local community groups such as the Fire Awareness Community (MPA), Forest Farmer Group (KTH), Forest Guard Community Partners (MMP), and the Cemeti Alam Lestari Forest Village Community Institution (LMDH).

Most residents living in the area are aware that the area is protected, but they are not always aware of the permitted activities or the legal consequences for violating regulations. This is reinforced by interviews, which indicate that people in the area still lack easy access to information on conservation regulations. Some people in the community take water from the area without realizing that this violates conservation regulations for fishing. In terms of community participation, only a small percentage of people are able to participate in conservation management, and the entire community is not yet covered. Field findings indicate that community involvement in formal groups such as the LMDH (Land Management Unit) influences their active participation, directly proportional to the intensity of active participation in conservation management. It can be concluded that implementation is still less inclusive and has not succeeded in encouraging broad behavioral transformation, being limited to certain formal groups. As a result, community aspirations regarding the management of the Dringo Nature Reserve have not been fully realized, particularly regarding equitable access to information, increased public understanding, and increased community involvement.

Meanwhile, economic aspirations relate to how the utilization of ecological conservation areas can generate economic benefits without compromising their function [2], [7], [27]. Around the Dringo Nature Reserve, tourism-related activities have become a significant source of local economic opportunities. Community members benefit from the presence of visitors by providing services such as parking, food and beverage sales, and camping equipment rentals near the lake area. This demonstrates that economic activities can coexist with local livelihoods as long as they are managed proportionally.

Conservation governance can be challenging by the lack of organized tourism management and limited information for visitors. Field observations show that visitors often set up tents in areas where they aren't allowed, which causes pollution of the air, noise, and environment. This is made worse by the fact that there is no oversight in these areas, which means that environmentally harmful practices can happen without any effective control.

Even though there is a set of rules and different management strategies to find a balance between protection and use, there are still big differences in practice. This conclusion comes from looking at the principles of sustainable conservation governance, where ecological pressures are clear in the form of vegetation degradation, environmental degradation, and disturbance of wildlife habitats caused by uncontrolled human activities. Socially, although community engagement initiatives have been initiated, limited access to information, lack of understanding of regulations, and uneven participation indicate that social aspirations have not been fully realized. Economically, although tourism provides tangible benefits to local communities, its unstructured management risks increasing environmental pressures. This fragmentation between aspirations and implementation systems poses a risk to the achievement of long-term conservation goals[2], [4], [22]. Overall, these conditions indicate that aspirations have not been implemented as an integrated system.

3.1.3 Principle of Integration

In this study, this principle is analyzed through several key indicators: inter-agency coordination, synchronization of authority, and collaboration between actors [29]. Conservation efforts should be carried out synergistically, integrating various actors, sectors, and levels of government within an integrated coordination system [4], [7], [18], [29].

The management of the Dringo Nature Reserve involves many different groups, such as the Natural Resources Conservation Agency (BKSDA), which manages the main area, and Perhutani and the LMDH, which handle the buffer zone and tourism-related activities. However, interviews and field observations showed that the LMDH's tourism management in the upstream area is not fully connected to the BKSDA's monitoring system. This means that visitors often don't know where the tourism zone ends and the core conservation area begins. This is evident in the fact that tourists continue to enter restricted areas, and the lack of signage exacerbates this. This indicates that these institutions are still unable to fully synergize in the conservation process.

In terms of supervision process, there is no integrated patrol mechanism involving the Natural Resources Conservation Agency (BKSDA) and other stakeholders, making monitoring efforts fragmented and less effective in preventing violations. However, at the same time, forms of collaboration are beginning to emerge at the local level. Bottom-up initiatives from community groups such as MPA, KTH, and MMP are implemented by conducting patrols and educating the community on environmental protection. The LMDH, on the other hand, helps maintain environmental cleanliness and plant trees along illegal routes. However, these collaborative efforts remain limited and exclusive, and are not yet integrated into a comprehensive governance system.

For example, BKSDA patrols do not always involve community groups such as LMDH or MPA, which complicates coordination in sharing information about potential violations, decreasing effectiveness and slowing down the handling process. Conversely, LMDH, which operate tourism activities, interact directly with visitors but do not always follow the same rules as the BKSDA regarding controlling access to core conservation zones. As a result, visitors can still enter restricted areas due to the lack of clear and coordinated oversight. Furthermore, rehabilitation efforts such as tree planting carried out by local communities are often not aligned with the conservation programs designed by the BKSDA. This lack of coordination results in fragmented initiatives that fail to produce optimal ecological outcomes.

There needs to be regular and structured communication between institutions like the Natural Resources Conservation Agency (BKSDA), Perhutani, and the Forestry and Forestry Ministry (LMDH). This communication is often sporadic. Similarly, overlapping authority in tourism management and conservation monitoring shows that authority synchronization has not been fully achieved, which causes confusion at the implementation level. Meanwhile, collaboration between actors, which started with community engagement, is still only partial and has not yet been turned into a cohesive and comprehensive governance framework. In conclusion, the implementation gaps in the integration principle are due to limited coordination between institutions, a lack of synchronized authority, and the absence of fully integrated collaboration between actors within an integrated governance system.

3.1.4 Precautionary Principle

Any potential environmental damage must be anticipated and mitigated at an early stage, regardless of contact regarding its full [30]. This study analyzes this principle through several key indicators: risk identification, accessibility of information systems, thoroughness of preventive monitoring, and coordination between stakeholders.

Management authority is a crucial aspect of the first indicator, risk identification. Several areas around Dringo Lake have been identified as highly vulnerable, particularly zones frequently used for tourism. This was verified through interviews with BKSDA officials and field observations. Based on field observations, the popularity of certain areas has resulted in a 40–60% decrease in vegetation compared to other zones with minimal human intervention. From a water ecology perspective, during the dry season, informant monitoring results confirmed a drastic drop in the ecological water level, which could disrupt the lake's balance. Risks to the water ecosystem have also been identified, particularly related to water extraction using pumps for agricultural purposes outside the nature reserve. Furthermore, human activities also negatively impact wildlife such as birds and small animals, especially when there are increased visitor numbers during holidays and special events.

This awareness is not accompanied by the availability of a formally documented risk mapping system. Vulnerable zones should be prioritized based on their ecological sensitivity. Consequently, information regarding high-risk areas has not been systematically incorporated into management planning or activity control and is only partial due to a lack of understanding of their priorities.

Regarding the availability of information systems, field findings revealed a very limited number of information boards, which are not strategically placed at key access points such as entrances, parking areas, or road intersections. This leaves many visitors unaware of conservation boundaries due to the limited availability and quality of information signs. Signs are generally limited to basic labels such as "nature reserve," without accompanying zoning maps, detailed boundary explanations, or clear guidance on permitted and prohibited activities.

The lack of standardization in warning signs, both in terms of design, language, and clarity of messages, also complicates the situation. Some signs rely solely on text without easily understandable visual symbols, while others are damaged or illegible. The lack of clear physical legibility between the core conservation zone and the tourist area further increases the likelihood of violations [31] In practice, access routes to the lake are not clearly marked, resulting in poor wayfinding and visitors easily entering restricted areas. This situation indicates that the existing information system has not effectively fulfilled its educational and prevention functions, contributing to low levels of visitor compliance.

The intensity of preventive surveillance indicates that the frequency of patrols does not reflect the level of activity in the area, particularly on weekends and during holidays. Observations and interviews revealed that the increase in visitor numbers was not matched by an increase in the presence of supervisory personnel, resulting in longer gaps between monitoring periods. Consequently, environmentally damaging activities often occur without supervision. A lack of a system for monitoring high-risk areas (hotspot monitoring) also occurs. So many areas that should require great focus, such as places with lots of activity, are not properly monitored. Therefore, surveillance is generally risk-based, making it less effective in preventing violations early [7], [8].

Findings related to inter-agency coordination indicate the absence of an integrated prevention strategy involving the Natural Resources Conservation Agency (BKSDA), community groups such as MPAs, and LMDHs. Although communities speak directly with visitors and are aware of ongoing activities, there is no formal information system for them to promptly report these to the BKSDA. Collaborative opportunities with the community are also suboptimal, as BKSDA

patrols do not consistently involve local community groups. Currently, governance is fragmented, with each actor operating independently. This creates gaps in oversight at specific times and locations, which can be exploited for activities that violate conservation regulations. The lack of a regular coordination forum and clear role allocation contributes to this.

Although environmental risks have been identified, limitations in information systems, weak oversight, and inadequate coordination between actors result in a reactive rather than preventative approach. In practice, management prioritizes enforcement rather than preventative measures. This indicates that the precautionary principle has not been fully embedded as a guiding principle in conservation governance, posing long-term risks to ecosystems. Overall, the implementation gap in this precautionary principle lies in the absence of an integrated preventive management system.

3.1.5 Equity Principle

Within the framework of environmental law, environmental benefits and burdens must be distributed fairly across generations and among different social groups [32] The primary benchmarks of ecological justice and social justice serve to assess the extent to which environmental protection policies are inclusive and equitable. The equitable distribution of environmental responsibilities and protections is a key element of ecological justice. This emphasizes the importance of maintaining ecosystem sustainability for present and future generations. Social justice, on the other hand, emphasizes equality in participation, decision-making processes, and the distribution of benefits derived from natural resource management [33]

From an ecological justice perspective, environmental management must ensure that both the responsibility for protecting nature and the benefits derived from its use are shared fairly [33] . This perspective not only identifies who utilizes natural resources but also addresses the question of who is responsible for their conservation and who experiences the impacts of environmental degradation.

Interviews and field observations indicate that communities in the area still depend on the area for their livelihoods. They do this by farming around the reserve, extracting water from the lake, and directly using other natural resources. However, no policy mechanisms exist that clearly distribute responsibilities for conservation or provide adequate protection for communities dependent on these resources. Therefore, it can be concluded that this principle has not been fully realized in the Dringo Nature Reserve.

At the same time, poor tourism management has resulted in environmental degradation. Vegetation destruction in camping areas, the emergence of informal paths leading to the lake, and soil erosion in several locations are evidence of this poor management. However, to date, there has been no proportional distribution of responsibility among stakeholders. Some visitors do not share responsibility for maintaining environmental sustainability, even though the negative impacts are collectively borne by the local community and the surrounding ecosystem. Activities such as improper waste disposal and disturbance of wildlife habitats are still common in Dringo.

Water resources are used without clear rules or procedures. Some people in the community also use pumps to extract water for agriculture, indicating a lack of regulations to ensure that

everyone has fair boundaries or responsibilities for environmental restoration. This situation shows that the state, local communities, and other resource users do not all have the same level of responsibility in maintaining environmental health.

Efforts have been made to involve communities by forming groups such as MPA, KTH, MMP, and collaborating with LMDH, but this involvement is largely limited to technical implementation at the field level. Interviews indicate that communities are typically actively involved in activities such as patrols, tree planting, and environmental education. However, they do not all have equal access to strategic decision-making processes that influence how conservation areas are managed. Field case studies show that decision-making has been implemented with top-down approaches, with government officials and management agencies still making most decisions about tourism management, establishing access boundaries, and other conservation policies.

Local communities are largely responsible only for implementing these policies. Not all community groups have equal access to partnership programs, meaning that only certain organized groups can participate. These findings suggest that the principles of equality and inclusion in governance have not been fully implemented. However, from a sociological justice perspective, local communities should not only act as implementers but also have equal opportunities to participate in decision-making processes related to environmental governance [34]

This imbalance indicates that conservation governance remains relatively exclusive and fails to fully consider the needs of the communities most directly impacted. Therefore, we can conclude that the principle of equity is not being followed in the Dringo Nature Reserve, as there is an imbalance between environmental benefits and burdens, and there is a lack of equal participation in decision-making.

3.1.6 Polluter Pays Principle

The primary objective of this principle is to deter people from polluting and ensure that the costs of environmental damage are not borne by the community or government, but remain the responsibility of the polluter. This aligns with the Polluter Pays Principle, which states that anyone who damages or pollutes the environment must pay for the damage or repair it [28] Several key indicators to analyze include: identification of perpetrators, the existence and enforcement of sanctions, assessment of damage costs, environmental restoration initiatives, deterrent effects, and uniformity of law enforcement [28]. Findings from the Dringo Nature Reserve indicate that this principle has not been effectively implemented. There is no official mechanism or system to record or identify those who engage in environmentally damaging activities in the core zone. For example, visitors who enter restricted areas without permission are not registered or documented, making it difficult to prosecute violations.

Regulatory, Article 98 (1) of Law No. 32 of 2009 regulates criminal penalties for violations of environmental standards. In practice, violations in this area are usually only addressed through verbal warnings. What happens is that visitors who camp in prohibited zones or litter are simply given warnings by officers without being subject to administrative sanctions such as fines or future access restrictions. Similarly, regarding the imposition of damage costs, there is no mechanism that systematically obligates perpetrators to bear the costs of the damage they cause. Restitution obligations by responsible parties should be a reasonable sanction applied to cases

of vegetation damage resulting from camping or the creation of informal trails; instead, these impacts are left unaddressed or only addressed with limited efforts by authorities or local communities. As a result, the costs of environmental degradation are indirectly borne by the surrounding ecosystem and communities.

In terms of environmental restoration, activities such as tree planting and waste cleanup are carried out, but these activities do not constitute a mechanism for holding violators accountable. Waste management efforts, for example, are primarily carried out by community groups such as the Environmental Management Agency (LMDH) or volunteers who are not involved in the violations. However, if this principle were adhered to, visitors who generate waste would be responsible for cleanup. This indicates that the principle of direct accountability has not been implemented as a form of direct responsibility. Furthermore, the absence of strict sanctions increases the deterrent effect of environmental regulations.

Field observations indicate that activities such as illegal fishing and air pollution continue to occur repeatedly in the same locations over time, indicating that existing measures are insufficient to deter such behavior. Finally, in terms of consistency of law enforcement, there is a clear gap between legal norms and their practical implementation. Although the regulatory framework provides a strong legal basis for addressing environmental violations, enforcement on the ground remains inconsistent. In conclusion, the management of the Dringo Nature Reserve has not effectively implemented the polluter pays principle. The lack of means to identify perpetrators, weak law enforcement, lack of internalization of costs, and minimal deterrent effects indicate that those causing environmental damage are not paying for their losses [7], [9]; instead, the damage is inflicted on the surrounding environment and communities.

Based on the above analysis, it can be concluded that the management of the Dringo Nature Reserve continues to show a significant gap between the ideals of sustainable governance and the reality observed on the ground. These findings indicate that the current governance framework is not aligned with the principles of poverty, which emphasize justice, coordination, participation, and a strong commitment to environmental conservation. Therefore, a more comprehensive and systematic review of governance strategies is urgently needed to ensure that the management of this protected area is more equitable, robust, and sustainable in the long term.

3.2 Rethinking Sustainable Governance in the Dringo Nature Reserve

The evidence gathered from the previous section indicates that gaps in the principles of sustainable governance are consistently found across all of the aforementioned principles. This reflects weak state protection, inadequate institutional arrangements, limited use of the precautionary principle, and persistent inequities in the distribution of environmental benefits and burdens. Situations such as these suggest a need for a more fundamental re-evaluation of governance perspectives, methods, and frameworks that are detrimental to conservation. To more effectively address the complex dynamics in the Dringo Nature Reserve, these findings provide a strong argumentative basis for re-channeling the idea of sustainable governance.

Activities such as tourism, air travel, and agriculture around the conservation area continue with limited oversight and a lack of legal awareness among visitors and local communities. Current governance arrangements have failed to foster a strong conservation ethic or regulate stakeholder behavior in a meaningful and sustainable manner [4]. It can be concluded that while

Dringo management formally incorporates the core principles of sustainable governance, the reality on the ground still falls short of these normative expectations.

In the past, conservation was often implemented through a "fortress conservation" approach, isolating local communities from protected areas and, in some cases, sparing them in the name of environmental protection. However, more and more people are now recognizing that conservation efforts will only be successful if local communities are actively involved. This community engagement factor is key to reassessing sustainability governance within the Dringo Nature Reserve framework as a comprehensive transformation of the conservation paradigm [35]Local communities' knowledge, practices, and daily interactions regarding environmental ecology are crucial for maintaining a healthy system over time.

Co-management models, based on shared responsibility between the state and local communities, are gaining increasing attention. This new approach is known as community-based conservation, and views local communities as essential partners in protecting ecosystems. This community-based decision-making and implementation involves communities in policy development and implementation on the ground. Co-management, or community-based resource governance, is a model that emphasizes collaboration between government agencies and local groups at all stages of decision-making, implementation, and monitoring [36], [37]. This approach developed due to the inadequacy of top-down conservation models, which often do not fully reflect the complexity of socio-ecological dynamics at the local level [37]. This approach is particularly relevant for the Dringo Nature Reserve, given findings that demonstrate a disconnect between sustainability governance principles and their implementation.

From a state responsibility perspective, co-management signifies a transition from primarily administrative protection to a more cooperative governance model [38], [39]. The problem of the Natural Resources Conservation Agency (BKSDA) only being able to patrol once or twice a week due to staff shortages can be addressed through collaboration with local communities, such as members of the LMDH or MPA. The provision of a formal monitoring system as a link between the community and institutions is a must, considering that people who live near conservation areas are often the first to become aware of illegal activities such as fishing or air capture without permission.

This method allows for a more balanced integration of movement between ecological, social, and economic dimensions[39], [40]. Currently unregulated tourism activities can be controlled through a zoning system agreed upon by all parties. These activities include camping along lake shores, which damages vegetation. Local communities can contribute by helping to designate safe camping areas, limiting the number of visitors, and educating tourists about the environment. It is hoped that the share of economic activity will remain the same even with the new arrangement.

Fragmentation between institutions such as the Natural Resources Conservation Agency (BKSDA), Perhutani, and the Forestry and Environmental Management Agency (LMDH) can be addressed through collaborative management. Establishing a joint coordination forum will enable these actors to clearly define zoning boundaries, develop standard operating procedures for tourism management, and build an integrated information system [39], [40]. This requires publicly accessible zoning maps in strategic locations to facilitate implementation.

Collaborative management also supports the development of a community-based prevention system. This is also related to the precautionary principle. Local residents understand and understand how the environment is changing and can assist in mapping risks and temporarily closing vulnerable areas if erosion-prone areas due to tourism occur. Informal paths created by visitors can be diverted to official routes agreed upon by all stakeholders. This proactive approach allows preventative measures to be implemented before environmental damage becomes more severe.

Currently, only a small percentage of people gain an economic benefits of tourism, while a larger group bears the environmental costs. From an equity perspective, co-management provides a mechanism to address inequities in benefit distribution and participation. Revenue-sharing systems or collective management plans can help communities share benefits more equitably. Communities can also become key decision-makers and implementers through participatory forums, such as the establishment of meeting forums to discuss conservation management, both in policy and technical implementation.

Finally, formal and social law enforcement methods can be applied to align with the polluter-pays principle; co-management can make people more accountable. In local settings, social sanctions, such as community-based warnings, can also be an effective deterrent, especially if supported by agreed-upon rules. For example, visitors who litter or damage plants can be directly punished by being asked to clean up or pay a fine administered by the community group.

Table 1. Implementation of Co-Management in the Governance of the Dringo Nature Reserve

No.	Sustainable Governance	Implementation Gap	Co-Management	Implementation Co-Management
1	State Responsibility	Strong formal authority, but weak supervision	Collaborative monitoring (community-based monitoring)	Involving local communities as co-rangers for daily patrols and reporting illegal activities.
2	sustainability and conservation,	Ecological pressure due to uncontrolled tourism; unequal distribution of economic benefits	Zoning-based management and community-based ecotourism	Establishing designated camping zones and involving local communities as tourism managers.
3	Integration	Institutional fragmentation and overlapping authorities	Multi-actor coordination forums and integrated standard operating procedures (SOPs)	Developing shared zoning maps and establishing regular coordination forums.
4	Precautionary	Management remains reactive rather than preventive	Community-based prevention (participatory risk mapping)	Engaging communities in identifying vulnerable areas and closing informal or high-risk access routes

No.	Sustainable Governance	Implementation Gap	Co-Management	Implementation Co-Management
5	Equity	Inequality in benefit distribution and participation	Equitable benefit-sharing and inclusive decision-making	Implementing revenue-sharing mechanisms and community deliberation (village forums) in conservation management
6	Polluter Pays	Absence of sanctions and deterrent effects	Community-based enforcement	Applying local sanctions or fines for environmental violations

Sectoral or fragmented interventions cannot effectively close the implementation gap between various sustainable governance principles. Instead, collaborative governance systems play a role in bringing together diverse stakeholders. Key issues such as weak protection, inequitable distribution of responsibilities and benefits, limited coordination, and ineffective law enforcement are expected to be addressed through a co-management model as a dynamic process [7], [9], [38], [39], [41]. The goal of this integrated process is to create a governance system that is not only more effective in practice but also more equitable, cohesive, and sustainable [4]. Some of these mechanisms include meaningful community engagement, joint monitoring, integrated information systems, and a more equitable distribution of responsibilities among stakeholders.

4 Conclusion

This study reveals clear implementation gaps in the application of sustainable governance principles to the management of the Dringo Nature Reserve. Under the principle of state responsibility, weak oversight indicates that the state's protective function has not been effectively realized. In terms of environmental sustainability, various problems such as vegetation degradation, soil erosion, and disturbance to wildlife indicate that ecological integrity has not been adequately maintained, while economic benefits remain unequally distributed. Fragmented management, reflected in the lack of clear coordination between the Natural Resources Conservation Agency (BKSDA), Perhutani, and the LMDH, has resulted in asynchronous management practices. Furthermore, although environmental risks have been identified, the lack of systematic preventive measures has led to a predominantly reactive management approach, demonstrating a failure to implement the precautionary principle. In terms of equity, local communities tend to bear environmental burdens without receiving proportionate benefits or having equal participation in decision-making processes. Finally, under the polluter pays principle, the absence of firm sanctions indicates that accountability and prevention mechanisms have not been effectively enforced.

In response to these conditions, this study reviews sustainable governance through a more contextual and operational co-management approach that is crucial to implement through the following steps: (1) by introducing community-based collaborative patrols to address the limited capacity of BKSDA personnel and strengthen state responsibility; (2) to ensure ecological

sustainability while improving the distribution of economic benefits, it is necessary to establish a participatory zoning system and community-based tourism management; (3) create a multi-stakeholder coordination forum to align the roles of BKSDA, Perhutani, and local communities, thereby reducing overlapping authorities; (4) strengthen the precautionary principle through risk mapping and controlled access to sensitive zones, to strengthen prevention-based management; (5) increase equity and inclusiveness through benefit-sharing mechanisms and community deliberation forums; and (6) operationalize the polluter pays principle through stronger accountability mechanisms and enforcement of administrative and social sanctions to produce an effective deterrent effect. Overall, the co-management approach offers a practice-based pathway to transform the governance of the Dringo Nature Reserve into a sustainable governance model that is not only normative in principle but also realistic in its operational practice.

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