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Ecosystem Restoration in Tesso Nilo National Park: A SWOT Analysis of S-T Strategies to Overcome Threats

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ABSTRACT

Tesso Nilo National Park (TNNP) is a vital conservation area in Indonesia, known for its lowland tropical rainforest ecosystem with high biodiversity potential. Despite its ecological significance, TNNP faces severe challenges, including environmental degradation and land conversion, exacerbated by weak local government policies under Indonesia's Regional Government Law No. 23/2014. This study aims to analyze strategies for restoring and conserving TNNP's ecosystem through a comprehensive Strengths (S) and Threats (T) analysis. The research was conducted from May to September 2021 using a mixed-methods approach that combined quantitative and qualitative data collection techniques, including surveys, questionnaires, interviews, and literature studies. Data were analyzed using SWOT analysis, with 15 respondents selected through a disproportionate stratified random sampling technique. The findings reveal that TNNP's ecosystem restoration efforts are in quadrant IV of the SWOT matrix, emphasizing the need to leverage strengths while addressing significant threats. The S-T strategy, focusing on ecosystem restoration programs, is proposed as a viable approach. A practical example is the Lubuk Kembang Bunga Village restoration initiative, which successfully rehabilitated 10 hectares with a budget of IDR 1.611.008.000. This study highlights the importance of robust policy support and strategic interventions to balance ecological conservation with sustainable land use. The novelty of this research lies in its application of the SWOT framework to identify actionable strategies for ecosystem restoration in a complex socio-political and environmental context, providing a replicable model for other conservation areas.

1. INTRODUCTION

Indonesia is a country with extraordinary biodiversity, and its tropical forest areas play a vital role in maintaining the balance of the global ecosystem [1-3]. One of the most significant forest areas is Tesso Nilo National Park (TNNP) in Riau Province, Sumatra. This National Park is one of the areas with the highest levels of biodiversity worldwide, especially for plant and wildlife species, including the endangered Sumatran elephant. Additionally, TNNP is crucial in mitigating climate change and protecting other endemic species. This study aims to develop a comprehensive forest restoration policy strategy to address the threats to TNNP and maintain the sustainability of its biodiversity. The main research question in this study is that: How can a forest restoration policy that considers ecological, social, economic, and institutional aspects be formulated for TNNP?

TNNP is one of 54 National Parks throughout Indonesia. TNNP is a technical service unit under the Directorate General of Natural Resources and Ecosystem Conservation, Ministry of Environment and Forestry. The TNNP Office was established in 2007 in Pangkalan Kerinci, Pelalawan, Riau Province. The main task of TNNP is to manage the ecosystem of the National Park area in the context of conserving biological natural resources and their ecosystems based on applicable laws and regulations. TNNP refers to a nature conservation area that has an original ecosystem, managed with a zoning system that is utilized for science, education, cultural support, tourism, and recreation [4-7].

The community living around TNNP mainly works in the agricultural sector, followed by the trade and service sectors. There is a shift in livelihoods around TNNP. The number of people who use forest products as a livelihood has decreased significantly. The invasion of oil palm plantations and the entry of immigrants have changed traditional livelihoods dependent on forest products [8]. It has caused the community's view of the forest to no longer be a source of life as taught by their ancestors. The community around TNNP currently considers oil palm plantations a source of life, so they replace forests with oil palm plantations. The dynamics over time show that TNNP is increasingly threatened. More than half, with a total of 81,793 hectares of TNNP area, is no longer covered by natural forest, and conservation concessions need to be carried out in the form of ecosystem restoration and genetic restoration [9-11].

However, the forest area in TNNP is under tremendous

pressure due to various human activities. Illegal logging, land encroachment, and conversion of forests into oil palm plantations have caused significant degradation of the area [12, 13]. This condition threatens the sustainability of biodiversity and disrupts the forest's essential ecological functions, such as climate regulation, clean water provision, and soil protection from erosion [14-16]. This research aims to develop a forest restoration policy using an anticipatory approach, which considers factors that may affect the TNNP forest condition in the future and how to prevent or address potential threats before they occur. Although various conservation efforts have been made, their effectiveness is still not optimal. One of the main challenges is the lack of a comprehensive strategic concept in forest restoration policies in this area. To balance conservation and sustainable development, forest restoration in TNNP requires an approach that considers ecological, social, economic, and institutional aspects.

The approach through community empowerment programs continues to be carried out; one of the initial steps taken is to take a communal approach to provide an understanding that the TNNP forest is essential and can be beneficial to the community, and that there needs to be a policy by the government in maintaining its sustainability. This study's unique contribution lies in applying an anticipatory policy approach focused on forest restoration in TNNP, integrating SWOT analysis in formulating a strategic policy that considers the area's environmental and social dynamics. The policy must be based on research results to be used sustainably. The research in question uses policy research methods. Policy research is related to policy formulation, policy implementation, policy performance, and policy environment [17, 18]. The policy can be defined as an area of a decision-making, therefore, the policy does not provide a decision. The policy provides general direction and areas to be followed.

Policies in oral or written form provide general direction and limitations for managers to act. Based on this, the policy is a written or oral statement of individuals, groups, or governments that is a general guide to solving problems and achieving goals [19, 20]. Specifically, the policy used in this research is an anticipatory, proactive policy that addresses future changes with a more comprehensive strategy, distinguishing it from the reactive policy approaches often used in previous studies. A policy provides limitations on what can and cannot be made, and also only provides limits (scope) for action. Because policy is an action guide, policy is broader than decisions, and those who make policies are in a higher position than decision-makers. There are several types of policies, namely substantive and procedural, distributive, regulatory, redistributive, material, symbolic, public, and private goods policies. Based on the type, three policies are: responsive, futuristic, and anticipatory [21, 22].

In this study, the policy is anticipatory. An anticipatory policy is a proactive measure designed to foresee and address potential issues that may arise in the future. For instance, in this study, the ongoing conversion of TNNP property has resulted in uncontrollable deforestation. Based on this, the policy will be to save the damaged forest so that it does not cause more widespread danger and damage. The research in question uses the policy research method. Policy research is closely linked to policy creation, implementation, performance evaluation, and policy environment analysis. The policy can be interpreted as an area of decision-making; therefore, the policy does not provide a decision. The policy provides general direction and areas to be followed. This study used a SWOT analysis approach, which ultimately resulted in the concept of a forest restoration policy strategy in the Tesso Nilo National Park area, Indonesia. The approach used in this research is SWOT analysis, which aims to generate a forest restoration policy concept that can be applied in TNNP as part of efforts to save and restore the forest that has been degraded due to land conversion and other human activities. Using SWOT analysis, this study aims to provide meaningful contributions to formulating more effective and sustainable forest restoration policies in TNNP.

2. METHODS

2.1 Study areas

The TNNP forest is classified as a lowland tropical rainforest (*Dipterocarpa*) with a significant capacity for biodiversity, serving as the natural habitat for the Sumatran Elephant (*Elephas Maximus Sumatranus*). As a relatively suitable elephant habitat, TNNP is designated as an elephant conservation area. It is to support the designation of Riau province as an Elephant Conservation Center under Minister of Forestry of the Republic of Indonesia Regulation Number P.73/Menhut-II/2006 concerning Amendments to Minister of Forestry of the Republic of Indonesia Regulation Number P.54/Menhut-II/2006. Administratively: Pelalawan Regency (80193 Ha, 98.04%) and Indragiri Hulu Regency (1600 Ha or 1.96%), Riau Province. Covers Ukui District, Pangkalan Kuras, Lenggam (Pelawan Regency) and Kelayang District (Pelawan Regency) and Kelayang District (Indragiri Hulu Regency) (Figure 1).

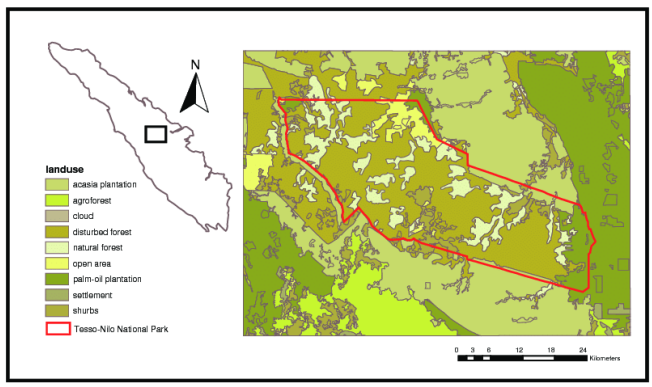

Figure 1. Tesso Nilo National Park (TNNP) area
Source: TNNP Center, 2020

2.2 Socioeconomic and historical data

Most people around TNNP work in the agriculture, trade, and service sectors. There has been a shift in livelihoods from dependence on forest products to oil palm plantations, triggered by migrant invasion and land conversion. This shift has changed people's perception of the forest—from a traditional source of life to commercial land. Historical data shows a significant decline in the use of forest products since the 2000s, along with the expansion of oil palm plantations. Threats to the sustainability of TNNP are increasing, marked by the loss of 50% of natural forest cover (source: TNNP Center, 2020), so ecosystem and genetic restoration policies are needed.

2.3 Area distribution TNNP

The ecosystem restoration policy is a breakthrough in the history of Indonesian forestry, allowing production forests not to be cut down for a certain period. Through ecosystem restoration, it is hoped that production forests in natural forests will function again as a balancer for ecosystems, both biotic and abiotic, but ecosystem restoration is an innovation in preserving natural resources. It will also contribute to efforts to save biodiversity and mitigate climate change. Ecosystem restoration activities are implemented through mechanisms and procedures for granting Business Permits to Utilize Timber Forest Products-Ecosystem Restoration (IUPHHK-RE). Currently, forest encroachment activities are continuing, so strategically analyzing the forest area restoration policy in TNNP is necessary. The strategy developed in this study is based on the indicators of the TNNP restoration policy, which consists of three leading indicators: the central government, local government, and the researcher's indicator (field facts of the research area). Several and alternative strategies for maintaining and developing the TNNP so that the expected results are obtained can provide solutions for the sustainability of the Tesso Nilo National Park, which is vital in the ecological, economic, and social sectors. The TNNP Center has successfully implemented ecosystem restoration starting in 2019 and 2021. In 2019, the ecosystem restoration carried out covered an area of 1.592 Ha, then in 2020, it covered an area of 10 Ha, and in 2021, it covered an area of 4.41 Ha.

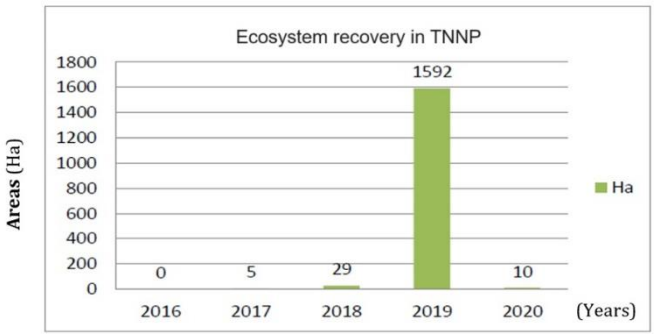

Figure 2. Ecosystem recovery in TNNP in the last five years
(Source: TNNP Center, 2020)

Figure 2 reveals that the ecosystem restoration activities in TNNP carried out by the TNNP Center in the last five years in 2016 was the initial plan for mapping areas prone to encroachment, so this year, it was used as the initial benchmark for ecosystem restoration activities in the TNNP area of the management zone and the traditional zone with an area of 674.3 ha. However, recovery has not yet been carried out. In 2017.5 ha of ecosystem restoration was realized in the TNNP area. In 2018, restoration was carried out, covering an area of 29 ha. In 2019, restoration was carried out, covering an area of 1,592 ha. In 2020, the restoration was carried out in an area of 10 ha with a budget of Rp. 1,683,245,000 and 95.71% have been realized for Rp. 1, 611,088,000 in the traditional zone, precisely in Lubuk Kembang Bunga Village, as the research was conducted.

2.4 Data collection and analysis

Data analysis at this stage is arrived at as follows: (1) observing the facts that occur in the field regarding regional rights in making policies based on laws on regional government and regulations from the minister of forestry; (2) conducting a field survey to find actors involved in the difficulty of restoring the forest area of the TNNP; (3) making recommendations from field survey results on ongoing ecosystem restoration policies; and (4) carrying out a social analysis (social conflict) in the TNNP area in the form of social analysis is more valuable, it is necessary to use the following principles: (a) participation/involvement of various parties to seek the truth using the concept of structural change and power relations which are considered problematic by society; (b) historical research. Historical arguments are essential in providing an overview of a society's past; (c) social problems should not be considered as something that is given. Social problems are the result of specific processes formed by certain forces and for particular interests; (d) the framework method used in social analysis must be sensitive to the instruments of power, which can take many forms, for example, scientific justification as an engineering tool; and (e) it must be carried out in a structured and sustainable manner.

Social conflict analysis is conducted by (a) participatory analysis, involving communities in conflict mapping using the Participatory Rural Appraisal (PRA) method to identify the root causes of land conversion; (b) historical analysis: a review of policy documents and land use reports from 2000–2020 to see trends in forest cover changes; (c) conflict indicators: (1) frequency of land disputes, (2) community participation in restoration, and (3) level of dependence on oil palm (measured through the proportion of income); and (e) data triangulation: the combination of primary data (interviews) and secondary data (satellite imagery, TNNP documents) to validate the results.

This research was conducted in May-September 2021, TNNP Pelalawan District, Riau Province. Surveys and interviews were conducted in Giri Sako Village, Lubuk Kembang Bunga Village, Air Hitam Village, Bagan Limau Village, and Pontian Mekar Village. The sampling technique used the stratified random sampling with the following criteria: (1) communities involved in land conflicts, (2) palm oil business actors, (3) local government representatives, and (4) conservation activists (total respondents: 10 people). The survey used a structured questionnaire (Likert scale) to measure community perceptions, supplemented by in-depth interviews and FGDs with five key informants. Most individuals residing near the TNNP are employed in the agriculture industry, with the trade and service sectors being the subsequent areas of occupation. There has been a shift in livelihoods around the TNNP. The number of people who use forest products as a livelihood is decreasing. The invasion of oil palm plantations and the influx of migrants changed traditional livelihoods previously heavily dependent on forest products. It causes the people's view of the forest to no longer be a source of life as taught by their ancestors. The people around TNNP currently regard oil palm plantations as a source of life, so the forest is replaced with oil palm plantations. The dynamics over time show that the existence of the TNNP is increasingly threatened. More than half of the total 81.793 hectares of TNNP is no longer covered by natural forest, and conservation concessions need to be made in the form of ecosystem restoration and genetic restoration.

2.5 Research framework

The approach through community empowerment programs

remains a cornerstone in promoting the sustainable management of Tesso Nilo National Park forests. A key initial step in this approach is to foster a collective understanding of the critical value of these forests, emphasizing their ecological importance and the potential benefits to the local communities. To ensure the long-term sustainability of the TNNP, it is essential to develop and implement government policies grounded in rigorous research findings, which can be continuously applied to guide management and conservation efforts [23, 24].

The policies must be underpinned by empirical research, specifically policy research methods that address policy formulation, implementation, performance, and the broader policy environment. In this context, a policy is interpreted as a set of decisions to address specific issues rather than merely the result of the decision-making process itself.

Quantitative and qualitative research methods are employed in the policy research undertaken in this study. The research design integrates statistical techniques and combined models to analyze data effectively. The key research methods applied include surveys, experimental designs, qualitative approaches, mixed-methods research, research and development (R&D), and distributing SWOT questionnaires to a targeted group of respondents. These respondents include stakeholders directly involved in the management of the TNNP, such as community leaders, members of the forest management group, and representatives from local enterprises or businesses.

The data and information collected from these respondents are systematically processed and analyzed to align with the research objectives. Descriptive analysis identifies external and internal challenges in implementing policy strategies concerning forest encroachment, while SWOT analysis determines the most effective strategy for developing Forest Management Units (FMUs). The ultimate goal of the SWOT analysis is to derive the most appropriate strategy for FMU implementation based on prevailing conditions.

SWOT analysis has long been recognized as a valuable tool across various industries, and its application extends to formulating strategic decisions in forestry management programs. The analysis assesses both internal factors—such as strengths (e.g., regulatory support) and weaknesses (e.g., limited budget)—and external factors, including opportunities (e.g., global conservation initiatives) and threats (e.g., pressures from the palm oil industry) [25-27].

This study's framework is designed to guide policy research, specifically focusing on implementing restoration policies. The framework integrates SWOT analysis to evaluate internal and external factors and incorporates the Analytic Hierarchy Process (AHP) scale to determine the weight of each factor, ensuring that strategic priorities are clear and actionable. In total, 15 key stakeholders, including government officials, non-governmental organizations (NGOs), and corporate representatives, were surveyed using a SWOT questionnaire. Furthermore, the study adopts the Social-Ecological Systems (SES) framework to assess community-ecosystem interactions, utilizing three indicators: (1) ecological resilience, (2) economic adaptation, and (3) social cohesion. These indicators form the basis for understanding the synergies between community empowerment and forest management efforts [28, 29].

This refined framework offers a comprehensive and structured approach to integrating community empowerment programs with policy research. By clearly delineating the research methods, policy formulation, and the stakeholders' roles, the study aims to provide a robust model for the management of TNNP forests while ensuring the inclusion of community perspectives in the policymaking process.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 TNNP area history

A 2016 land cover analysis by the World Wildlife Fund (WWF) Indonesia indicated that almost 90% of the former HPH SRT LLC was occupied by encroachers and planted with oil palm. HPH is a forestry concession focusing on felling wood as a primary material for industry or export purposes. Likewise, what happened in the TNNP area, from a total of 83.069 ha to only around 20.000 ha in the form of natural forest, the rest were indicated to be controlled, encroached on, and planted with oil palm. From the perspective of neo-classical economics, it is defined as the failure of the private sector and government [30, 31]. Meanwhile, from a sustainability perspective, it is defined as an inability to sustain resources [32-34]. Clearing land is not uncommon to burn, which will undoubtedly destroy flora and fauna [35, 36]. The dynamics from time to time show that the existence of the TNNP is increasingly threatened, and more than half of the total 81.793 hectares of national park area is no longer covered by natural forest. The community empowerment program approach continues to be carried out. The initial step taken is to carry out communal approaches to provide an understanding of the TNNP forest. TNNP is also essential and can be helpful for society. The most important thing in the management of a national park is the improvement of the standard of living of the people around the national park. Three things are of concern in involving the community in the management of the TNNP: the lack of understanding of the community and parties to the function of the TNNP—communities around TNNP do not fully understand the function and role of the TNNP. It is caused by the ineffectiveness of the communication strategy implemented by the TNNP Office and the lack of socialization of the legal framework regarding the function of TNNP forest areas.

Based on laws and regulations of the Regulation of the Minister of Forestry of the Republic of Indonesia Number P.73/Menhut-II/2006 concerning Amendments to the Regulation of the Minister of Forestry of the Republic of Indonesia Number P.54/Menhut-II/2006 in forest management based on ecosystem restoration, research that has not yet been developed in the TNNP location in this study is genetic restoration in the TNNP area in Indonesia. Genetic composition influences the form and function of ecologically important organisms, including body size, shape, physiological processes, behavioural traits, reproductive characteristics, tolerance to environmental extremes, dispersal and colonization capabilities, timing of seasonal and annual cycles, disease resistance, and many other properties.

3.1.2 TNNP area demographics

This research was conducted in May-September 2021 at TNNP Palalawan District, Riau Province. Surveys and interviews were conducted in Giri Sako Village, Lubuk Kembang Bunga Village, Air Hitam Village, Bagan Limau Village, and Pontian Mekar Village, as shown in Figure 1. SWOT questionnaires were given to respondents, and the

designated respondents were parties involved in fostering the TNNP management group, community leaders, business people, or company representatives, as shown in Table 1. SWOT analysis is simply an examination of an organization's internal strengths and weaknesses and its external environmental opportunities and threats. SWOT is a way that is designed and used as an initial step in the decision-making process and as strategic planning in various applications [37-39]. The steps taken were to create a SWOT questionnaire based on research indicators and develop it into a statement on a SWOT questionnaire sheet that can be used as a research instrument in determining restoration policy strategies with valid and reliable instruments, distributing questionnaires to predetermined respondents, carrying out weighting, ranking, determination of internal and external strategic cartesian coordinate positions, ranking and priority scales.

3.1.3 Strategic concept of forest area restoration policy in TNNP

Based on Table 1, the x and y coordinates in each quadrant of the SWOT strategy Cartesian coordinate system show the results of the respondents' answers. The external strategy has a value of 0.05 on the positive x-axis, while the internal strategy has a value of -0.07 on the negative y-axis. The results obtained in the SWOT matrix diagram in Table 1 are in quadrant IV. This value indicates strategic priority in the Strengths (S) and Threats (T) positions. The components of these two strategies must receive emphasis and attention to ensure TNNP and be managed sustainably. Based on this value, the threat factor is more significant than the strength factor (0.05; -0.07), so they can no longer propose or recommend forest areas in their territory to be reserved for ecosystem restoration activities.

The results of the SWOT matrix calculation show that the strategic position is in the fourth quadrant (ST) with a score of 10.97, which is close to the absolute value of 16 from the multiplication of the dot positions in the SWOT matrix. Meanwhile, the intersection of the lines at Cartesian coordinates (x;y) is (0.05; -0.07). Based on the results obtained, a strategic priority scale can be made using the data in Table 1.

Based on Table 2, the highest priority strategy is in quadrant IV, namely ST. In analyzing this strategy, it is possible to detail the ST components that need to be considered in carrying out the TNNP Area Restoration Policy strategy. The Strength (S) factor, namely:

1) Law of the Republic of Indonesia Number 23 of 2014 concerning Regional Government [40] is the basis for state power in taking over conditions in the regions based on supreme authority, including land management.
2) Granting of logging permits to IUPHHK-RE through granting IUPHHK when the ecosystem is in a balanced state needs to be revoked.
3) Local people who feel they are the owners of the area inherited by custom have long been the rulers of the land.
4) The government, through the Decree of the Minister of Forestry No. 255/Menhut-II/2004 dated Jul 19, 2004, gradually changed the function of part of the TNNP HPT area with a relatively flat topography to TNNP covering an area of 38.576 ha located in Pelalawan and Indragiri Hulu districts considering the potential for biodiversity and as an effort to protect, preserve and use sustainable living natural resources and their ecosystems.
5) Areas reserved for ecosystem restoration activities must be free from territorial conflicts, especially in the use of logging concession rights.
6) Ecosystem restoration can be a solution for forest entrepreneurs, and it can be implemented amid a moratorium on natural forest and peat utilization permits issued by the government until now.

Table 1. Internal strategy (X) and external strategy (Y) on cartesian coordinate position scores

External Strategies		**Heavy**	**Rating**	**Score**	**X**
Strength (S)	S1	0.186	3.7	0.687	
	S2	0.153	3.8	0.581	
	S3	0.153	3.9	0.597	
	S4	0.153	3.4	0.520	
	S5	0.164	3.3	0.541	
	S6	0.191	3.2	0.612	
				3,539	
					0.05
Weakness (W)	W1	0.169	3.3	0.558	
	W2	0.174	3.9	0.677	
	W3	0.155	3.9	0.604	
	W4	0.174	3.4	0.591	
	W5	0.164	3	0.493	
	W6	0.164	3.1	0.509	
				3,432	
Internal Strategies					**Y**
Opportunity (O)	O1	0.192	3.4	0.653	
	O2	0.167	2.6	0.435	
	O3	0.167	2.8	0.469	
	O4	0.128	2.8	0.359	
	O5	0.177	2.7	0.479	
	O6	0.167	3.4	0.569	
				2,965	
					-0.07
Threat (T)	T1	0.144	3.7	0.531	
	T2	0.181	2.8	0.506	
	T3	0.170	3.1	0.528	
	T4	0.138	3	0.415	
	T5	0.186	2.9	0.540	
	T6	0.181	3.2	0.579	
				3,099	

Table 2. Strategic ranking and priority

Quadrant	**Position**		**Matrix Area**	**Rating**	**Strategy Priority**
I	3.54	2.96	10.49	3	SO
II	3.43	2.96	10.18	4	WO
III	3.43	3.10	10.64	2	WT
IV	3.54	3.10	10.97	1	ST

The Threat factor (T), that is:

1) Weak local government rights with their existence of Law of the Republic of Indonesia Number 23 of 2014 concerning Regional Government [40], so that they can no longer propose or recommend forest areas in their territory to be reserved for ecosystem restoration

activities.

2) It is necessary to reconsider determining the fees that must be given to ecosystem restoration concession holders.
3) There is often involvement of traditional leaders and indigenous peoples under the pretext of land ownership for third parties.
4) The flat topographic structure causes land grabbing by migrants as settlements and companies.
5) Concessionary logging is when the concessionaire pays the government for the right to extract wood from the forest.
6) Do not abuse rights in conservation concessions (ecosystem restoration); concessionaires pay the government for their rights to protect forests.

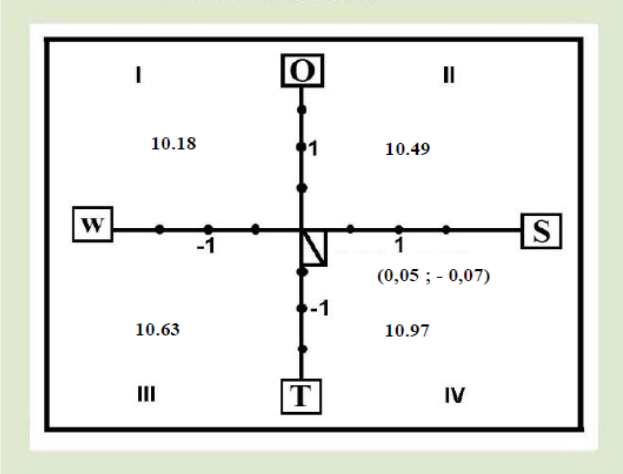

Figure 3. SWOT matrix diagram TNNP forest area restoration policy concept (0.05; -0.07)

In the results of Figure 3 above, there are weaknesses (W) and opportunities (O) in the area of TNNP at this time, so every year, the area decreases. Forest of the former TNNP of a total of 81.793 hectares and currently around 14.000 hectares from this research on the factors that cause reduced forest area so that researchers get the strategic concept of policy prioritizing strength factor (*Strength*) and threat factor (*Threat*), as in the SWOT calculations that the researchers did, and further research this can proposes a strategic concept of forest area restoration policy in Tesso Nilo National Park. It can be born or a reference for policy in making the power of government in restoring the forest in TNNP.

3.2 Discussion

3.2.1 TNNP area improvement

SWOT questionnaires were administered to selected respondents, including stakeholders involved in the management of TNNP, community leaders, business entities, and corporate representatives, as outlined in Table 1. SWOT analysis is a fundamental evaluative tool for assessing an organization's internal strengths and weaknesses and its external opportunities and threats. It provides a structured strategic decision-making and planning approach across various domains [37, 38]. The methodological steps included developing a SWOT questionnaire based on research indicators, refining it into structured statements for validity and reliability assessment, distributing it to selected respondents, conducting weight assessments, ranking, and determining internal and external strategic positions via Cartesian coordinates, followed by ranking and priority scaling, as detailed in Table 1.

3.2.2 Typology of TNNP areas and indigenous land rights

The discourse surrounding land ownership within the TNNP region primarily centres on the rights of Indigenous communities, often resulting in an anthropocentric viewpoint that prioritizes human interests in environmental governance. This perspective assumes that Indigenous populations possess inherent ownership rights due to their historical occupation of these lands. However, if economic stakeholders, such as investors, assert similar claims based on their financial contributions, how should equitable land tenure be adjudicated? [41-43]. A balanced approach must be adopted to reconcile conservation imperatives with economic activities [44, 45]. A viable strategy involves the integration of Indigenous land tenure rights within a conservation-oriented framework, ensuring participatory decision-making while enforcing stringent environmental regulations [46].

According to Mr Marion, a Forestry Police officer at the TNNP Office, ongoing forest encroachments critically endanger biodiversity. With only 14,000 hectares of natural forest remaining, immediate interventions are required to preserve sustainable land use. The degradation of TNNP is not solely a consequence of encroachment but also stems from ineffective law enforcement and conflicting policy frameworks [47-49]. A structured resolution mechanism requires multiple stakeholders, including indigenous representatives, conservation organizations, and governmental authorities, to formulate a legal framework that concurrently upholds indigenous land rights and conserves biodiversity.

The prevailing anthropocentric paradigm conceptualizes nature as a resource for human exploitation, disregarding its intrinsic ecological value [50]. Conversely, an eco-centric perspective contends that nature should be preserved for human benefit and as an autonomous entity [51, 52]. The application of ecofeminist ethics underscores a relational and interdependent dynamic between humans and nature, advocating for conservation policies emphasizing ecological integrity and socioeconomic development.

Conservation policies must incorporate ethical considerations into actionable frameworks to operationalize these theoretical constructs. Community-based conservation programs, which integrate indigenous ecological knowledge with scientific methodologies, offer a viable solution. Such programs empower indigenous communities as custodians of the environment while aligning conservation objectives with their socioeconomic interests.

3.2.3 Land disputes and oil palm plantations

Land tenure disputes in forested regions present a formidable challenge to sustainable environmental governance, particularly regarding land acquisitions by local communities and corporate entities. Of the 16.6 million hectares of oil palm plantations in Indonesia, approximately 3.4 million hectares encroach upon forested areas. This phenomenon is exacerbated by regulatory inconsistencies and discrepancies in land-use permit allocations [53].

A multifaceted resolution strategy is necessary, comprising are: (a) regulatory harmonization, ensuring coherence between national and regional land-use policies; (b) sustainable land-use planning, implementing strict zoning regulations to

prevent further encroachment while recognizing community land claims; (c) community-based agroforestry: promoting agroforestry systems that harmonize economic productivity with ecological sustainability; (d) Corporate Social Responsibility (CSR) measures: mandating palm oil companies to invest in conservation initiatives; and (e) Enhanced law enforcement: strengthening penalties against unauthorized land conversion and providing incentives for legal compliance [54, 55].

A Lubuk Kembang Bunga Village case study exemplifies a successful approach to sustainable agroforestry. The village received an ecosystem restoration budget of IDR 1.611.008.000 to implement integrated agroforestry. Farmers successfully combined oil palm cultivation with forest tree species such as jelutung and rubber, demonstrating the compatibility of economic and environmental objectives. However, a key challenge remains in securing regulatory backing for such initiatives. Current legal mandates dictate that communities must transition from oil palm to agroforestry within a 12-year timeframe, which may not align with their financial realities. A more adaptive policy framework, such as the Benah Term Strategy (BTS), allows for a phased transition towards sustainable farming while maintaining economic viability.

3.2.4 Policy recommendations

A comprehensive and evidence-based policy framework is essential to balance environmental sustainability and economic viability in the agricultural sector. Such policies must accommodate the interests of multiple stakeholders, including local communities, governmental agencies, and conservation organizations. Therefore, the following policy recommendations are proposed to facilitate the transition towards more sustainable agricultural systems while ensuring economic resilience and social well-being: (a) institutionalizing indigenous co-management: establishing formal mechanisms for indigenous participation in conservation governance; (b) scaling up community-based conservation: expanding successful agroforestry models such as the Lubuk Kembang Bunga initiative; (c) adaptive policy frameworks for agroforestry transition: revising regulations to permit a gradual shift from oil palm to ecologically sustainable agricultural practices; (d) enhanced stakeholder collaboration: facilitating partnerships among governmental agencies, conservation organizations, and indigenous communities to foster integrated policy solutions; and (e) long-term monitoring and evaluation mechanisms: Establishing accountability frameworks to measure conservation policy impacts on biodiversity preservation and community welfare.

4. CONCLUSIONS

This study analyzes ecosystem restoration strategies in Tesso Nilo National Park using a SWOT analysis, focusing on S-T strategies to mitigate significant threats. The findings indicate that TNNP's strategic position falls within quadrant IV of the SWOT matrix, suggesting that its strengths must be leveraged to counteract existing threats effectively.

The primary recommendation is strengthening ecosystem restoration policies through a community-based approach, enforcing stricter regulations against land encroachment, and enhancing collaboration between central and local governments and other key stakeholders. The successful restoration initiative in Lubuk Kembang Bunga Village demonstrates that a policy-driven and community-empowered approach can yield positive outcomes for ecosystem recovery.

Despite the success of certain restoration efforts, major challenges persist, particularly concerning the limited authority of local governments under Indonesia's Regional Government Law No. 23/2014 and ongoing land conflicts due to palm oil plantation expansion. Therefore, adaptive and long-term policies are required to balance conservation efforts with the economic sustainability of local communities.

This study presents a strategic, SWOT-based approach that can be replicated in other conservation contexts. By holistically considering ecological, social, economic, and institutional aspects, the sustainable and effective restoration of TNNP's ecosystem can be achieved in the long term.

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