

INTEGRATING TRADITIONAL ECOLOGICAL KNOWLEDGE IN TELUK BINTUNI DISTRICT: OPPORTUNITIES AND CHALLENGES FOR SUSTAINABLE RESOURCE MANAGEMENT

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HIGHLIGHTS

- Traditional knowledge plays a crucial role biodiversity conservation.
- In Teluk Bintuni District, local regulations support the integration of traditional knowledge, promoting collaboration for sustainable resource management.
- The study highlights the need for community engagement, capacity building, and education to effectively utilize traditional ecological.
- Successful conservation initiatives require collaboration to balance economic growth with environmental stewardship and social inclusivity, ultimately fostering sustainable development.

ABSTRACT

Traditional knowledge is vital for wildlife management and forest conservation in tropical regions and is passed down through generations. Thus, this research was designed to identify the challenges and opportunities encountered in implementing Traditional Ecological Knowledge (TEK) during regional development, particularly in relation to natural resource management in Teluk Bintuni District. The data were collected through interviews with local people and a Focus Group Discussion (FGD) involving government officials, Non-Governmental Organizations (NGOs), and local figures. The results revealed that the government had enacted Regional Regulation Number 1 of 2019 to recognize the customary rights of seven tribes, i.e., the Kuri, Wamesa, Irorutu, Sebyar, Simuri, Sougb, and Moskona tribes, thereby protecting traditional communities. The regulations emphasize the prioritization of people's rights in development, supported by the establishment of LMA *Tujuh Suku* (a Traditional Community Institution of Seven Tribes). The tribes have been utilizing TEK to deal with social and environmental issues, integrating the issues into development procedures to foster conservation and economic growth. The challenges, such as poor infrastructure, political instability, and low community engagement, hinder effective implementation. The strengths include accessible natural resources and international funding for conservation. The study highlighted the importance of education, stakeholder collaboration, and technology in documenting and incorporating TEK into conservation planning through participatory research, capacity building, and adaptive management.

Article Information

Received : 10 March 2025

Revised : 16 April 2025

Accepted : 21 April 2025

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Keywords: conservation, indigenous people, natural resources, traditional knowledge, tropical rainforest

INTRODUCTION

Traditional knowledge has been part of local people for generations and is crucial for effective wildlife management and biodiversity preservation in tropical countries, as the tropical forests have the richest species of trees (Cámara-Leret *et al.* 2020; Liang *et al.* 2022) and fauna (de Souza Amorim *et al.* 2022; Holt *et al.* 2013; Oliver *et al.* 2022). The knowledge encompasses the holistic understanding, practices, and beliefs of indigenous communities concerning their environment, passed down over generations. This knowledge system is particularly relevant in tropical countries where biodiversity is rich, but threatened by anthropogenic pressures like deforestation, climate change, and urbanization (Popradit *et al.* 2015; Reyes-García *et al.* 2016).

Indigenous people often possess detailed ecological knowledge about local species, ecosystems, and sustainable practices, which can enhance conservation strategies by integrating local ecological dynamics into broader management frameworks. Cultural relevance is another advantage of incorporating traditional knowledge in conservation programs. Indigenous people are more likely to support efforts when actively designing and implementing conservation initiatives (Asamoah *et al.* 2024; Ford & Martinez 2000).

Traditional practices, such as shifting cultivation used by indigenous farmers, promote sustainability and biodiversity conservation. By recognizing these practices within conservation programs, tropical countries can leverage existing local expertise to promote sustainable development (Van Der Sande *et al.* 2016; Whitfeld *et al.* 2014). The inclusion of traditional knowledge in policy-making processes ensures that the voices of indigenous people are heard in discussions about natural resource management and environmental protection, leading to more comprehensive and effective policies.

Natural resources, such as forests, are vital for providing ecological, economic, and social benefits. In developing countries, forests serve as a critical source of livelihood, food security, energy needs, and cultural identity for millions of people (Berkes *et al.* 2000; Carson *et al.* 2018; Sierra-Huelsz & Kainer 2018). However, sustainable utilization of forest resources remains a pressing challenge due to deforestation, land degradation, and competing economic pressures (Popradit *et al.* 2015; Tsujino *et al.* 2016).

Local knowledge, often referred to as Traditional Ecological Knowledge (TEK), is pivotal in fostering sustainable forest management and utilization practices. Local communities possess intricate knowledge of forest ecosystems, enabling them to employ sustainable harvesting techniques, such as selective logging, rotational grazing, and controlled burning, thereby promoting the conservation of these ecosystems. They also have an awareness of the medicinal, nutritional, and ecological value of various plant and animal species, such as sacred groves or areas within forests holding cultural or spiritual significance (Reyes-García *et al.* 2016; Zhao *et al.* 2016). Local knowledge also equips communities with strategies to cope with environmental changes, such as climate variability and resource scarcity.

In addition, local communities have developed expertise in identifying, harvesting, and processing Non-Timber Forest Products (NTFPs), which offer an alternative income source that reduces dependence on timber extraction and large-scale deforestation (Nunes *et al.* 2020; Thomaz Sandroni 2023). However, integrating local knowledge into formal forest management strategies faces several challenges, including marginalization of local communities, erosion of traditional practices, conflicts between modern and traditional approaches, and lack of documentation (Joa *et al.* 2018; Lawer & Ishaq 2024). To harness the full potential of local knowledge for sustainable forest utilization in developing countries, strategies can be employed, such as participatory forest management, strengthening land tenure rights, documenting and disseminating traditional practices, integrating local knowledge into national policies, and providing economic incentives for sustainable practices.

Teluk Bintuni District, one of the developing districts, has been part of forest utilization for decades, particularly for logging concessions and local use (Rumayomi *et al.* 2024). Recently, the primary development targets have been the infrastructure and empowerment of local people by enhancing their capability. Despite its progress, Teluk Bintuni faces challenges that require careful attention. Issues, such as the unequal distribution of development benefits, limited access to technology, and the need for greater investment in human capital, remain pressing concerns. Maintaining social harmony in a culturally diverse region also demands inclusive policies that respect local traditions and values. Looking ahead, the

future development of Teluk Bintuni will depend on sustainable practices that integrate economic growth with environmental stewardship and social inclusivity.

Collaborative efforts between government agencies, private companies, local communities, and international organizations will be essential to achieving long-term success. Furthermore, traditional knowledge, which balances the economic and ecological perspectives, is the primary driver of regional management, such as natural resource and forest utilization. Hence, their collaboration can be a “win-win solution” by understanding the traditional knowledge and regional development goals. However, the undesirable conditions of the collaboration can be reduced by regular monitoring. Thus, the challenges and opportunities presented by traditional knowledge during regional development, particularly in natural resources management, in Teluk Bintuni District, must be investigated. This study aimed to describe the potential use of traditional knowledge from the tribes in the Teluk Bintuni District and to integrate this knowledge into development initiatives. By identifying the stakeholders in the district, the possibility of implementing traditional knowledge can be proposed. Moreover, the results of this study could contribute to the development program in the district, particularly about sustainable forest management.

MATERIALS AND METHODS

Study Site

Teluk Bintuni District, located in the West Papua Province of Indonesia, was selected as the study area for this study. The administrative districts that make up this region are located on three sides of Teluk Bintuni, which is a gulf that divides the Bird's Head Peninsula and the Bomberai Peninsula, with a total area of 18,637 km² (Fig. 1). This study was conducted in the administration area of Teluk Bintuni District (1°57'50" - 3°11'26" LS and 134°44'59" - 134°14'49" E) covering the living area of seven tribes as stated in the Regional Regulations Number 1 Year 2019 on the Recognition and Protection of Traditional Legal Communities in Teluk Bintuni District, in which the seven tribes are Kuri, Wamesa, Irorutu, Sebyar, Simuri, Sougb, and Moskona.

The main study area is dominated by lowland forests, except mangroves. The lowland forest is dominated by primary forests, some of which are utilized for shifting cultivation, resulting in secondary forests. The forest consisted of lifeforms like ferns, herbs, lianas, shrubs, trees, palms/screw palms in the primary and secondary forests in the study area where the primary forest had a higher diversity, with 246 species found in the primary forest. In comparison, 162 species were found in the secondary forest. In their study, Rumayoni

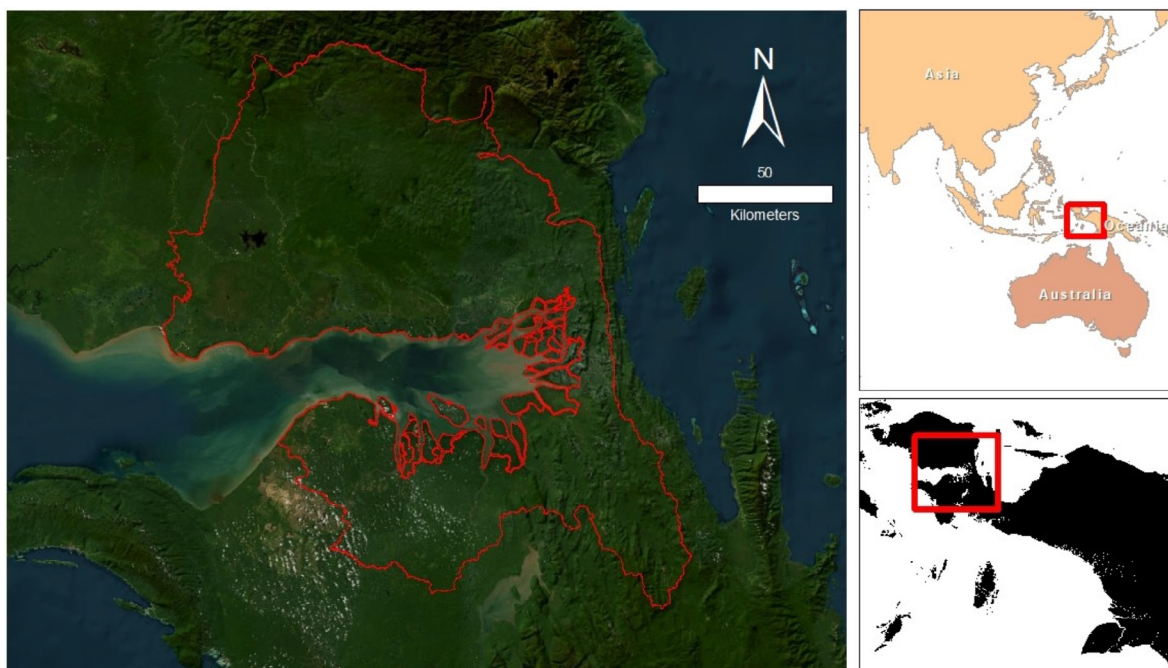


Figure 1 Teluk Bintuni District is shown as the area marked with a red box on the main map.

et al. (2024) found that 98 out of 310 species were shared between the two forests, with 36.3% exclusive to the primary forest and 15.7% exclusive to the secondary forest.

Data and Interview

Data concerning regional regulations in Teluk Bintuni District, in the context of socio-cultural and natural resource management, were the focus of this study. The implementation of traditional knowledge, primarily Traditional Ecological Knowledge (TEK), was incorporated into the natural resources management conducted by local people.

Data collection was conducted through interviews with respondents using a non-random process, which considered the perspective of the research goal (Cox 2015). The interview method was carried out using the guidance to collect social data, particularly with tribal leaders (7 respondents), heads of villages, and local people (30 respondents), while a Focus Group Discussion (FGD) was performed by the stakeholders like the central government (2 respondents), local government (27 respondents based on the list on Chapter III in the Regional Regulation of Teluk Bintuni District Number 7 Year 2016 on the Formation and Composition of Regional Organization in Teluk Bintuni District), Non-Governmental Organizations/NGOs (2 respondents), religion leaders (5 respondents), and representation of women (1 respondent). The interview process was conducted in informal situations to allow flexibility for the respondent in addressing the questions (Maryudi & Fisher 2020). Another interview with the government was conducted using the list of institutions obtained from initial talks with the government's representatives. The heads of villages and local people were selected using the purposive method, which required an understanding of socio-cultural conditions through preliminary observation.

To enrich the data, the local traders of wildlife meat and crops were also interviewed to learn about the process of hunting, traditional cultivation, and their perspective regarding the role of the ecosystem in their livelihoods. In order to collect data from local people, this study employed purposive sampling to select respondents, followed by the snowball method to gather additional information. Before conducting the interview, we observed the social conditions of the local people by gathering information from some tribal leaders and village

heads. The observation was used to determine the starting point of a purposive sample, where the researcher's judgment was employed to select the initial respondent as the expert respondent based on their ability to identify other potential respondents. Once the expert respondent was identified, other respondents were selected based on the guidance provided by the expert respondent (Drané *et al.* 2018; Goodman 1961).

Data Analysis

As this study collected qualitative data, we conducted a narrative analysis by presenting data on socio-cultural and natural resources management regulations in Teluk Bintuni District. Furthermore, the data of TEK was expressed by describing various interactions between local people and the natural resources. We hypothesized that the more local people interact with natural resources, the more dependent they are on these resources. For example, the use of vegetated areas as a traditional cultivation and hunting system implemented by the local people. The data were presented with illustrations using authentic documentation as strong evidence obtained during the study.

To set the strategies for integrating TEK into regional development, we performed the strengths, weaknesses, opportunities, and threats (SWOT) analysis by describing the condition of Teluk Bintuni District. The four factors were derived based on information collected from the Focus Group Discussion (FGD) and interviews, which were presented using the Eureka matrix (Ansoff, 1980; Wehrich, 1982), followed by a narrative presentation of the strategic issues. The SWOT analysis may be used to guide potential approaches by using the strengths and opportunities as positive factors, while minimizing the undesirable conditions of weaknesses and threats (Bull *et al.* 2016; Navarro-Martínez *et al.* 2020).

RESULTS AND DISCUSSION

Regulation Consisting of the Local People's Contents

Teluk Bintuni District has accommodated the customary rights of the seven tribes by gazetting the Regional Regulations Number 1 of 2019 concerning the Recognition and Protection of Traditional Legal Communities in Teluk Bintuni District. This regulation supported the position of local people, as mentioned in the seven tribes:



Figure 2 Institutions to support conservation and acknowledgement of customary right

Notes: (a) The office of LMA Tujuh Suku of Teluk Bintuni District; (b) The organizational structure of LMA Tujuh Suku is displayed in the office of LMA Tujuh Suku; (c) The office of Natural Resources Conservation Centre (Balai Konservasi Sumber Daya Alam/BKSDA Seksi Konservasi Wilayah III Bintuni) in charge of conservation program; (d) The monument of Tujuh Suku (seven tribes) as the recognition of customary rights. (Photo credit: Nimrod Agustinus Andytratnah Rumayomi)

Kuri, Wamesa, Irorutu, Sebyar, Simuri, Sougb, and Moskona. Moreover, to legally support the regulation, the regent issued Regulation Number 22 of 2020 concerning Guidelines for Identification, Verification, and Determination of Traditional Legal Communities in Teluk Bintuni District. According to the guidelines, the Teluk Bintuni District has legally prioritized the rights of local people during development. Furthermore, the establishment of the indigenous people's institution (in Bahasa Indonesia, Lembaga Masyarakat Adat *Tujuh Suku* [hereafter referred to as LMA *Tujuh Suku*]) as the office (Fig. 2a; 2b) and the monument has been built to show the seven tribes (Fig. 2d).

Other regulations have also been made to strengthen the position of local people in Teluk Bintuni, i.e., 1) Decision of the Regent of Bintuni Bay Number 188.4.5/064/2023 concerning Recognition of the Yen Clan's Traditional Legal

Community in the Moskona Tribe in Bintuni Bay District and 2) Regent's Decree Number: 188.4.5/C-8 Year 2021 concerning the Formation of a Committee for Indigenous People in Teluk Bintuni District, indicating that the district considers the local people during the development, so this condition can be seen as a strong opportunity to include traditional knowledge of tribes in this district. Recently, the government of Teluk Bintuni District implemented these regulations by issuing several guidelines to the committee to identify the customary rights of the tribes. The process is related to the activities of the private sector, such as the oil and gas sector and logging concessions, which require large areas to impact forest conversion or secondary succession.

Interactions with Natural Resources

In the administrative area of Teluk Bintuni District, there are seven tribes legally acknowledged. The tribes have been living in this



Figure 3 The dependency of local people in Teluk Bintuni on the natural resources

Notes: (a) the traditional cultivation; (b) the post-burning process during the shifting cultivation where they collect the plant debris and make a pile, then burn far away from the border to avoid forest fire; (c) the souvenir made of molluscs as a result of barter process and can be used as dowry; (d) the traditional selling of wild boar meat in the traditional kiosk; (e) products of traditional crops, like sweet potato; (f) papaya flowers and leaves as vegetables; (g) sweet potato and bananas; (h) durian. (Photo credit: Nimrod Agustinus Andyratnah Rumayomi)

area for generations and have been implementing traditional knowledge. Many studies indicated that the tribes still perform the cultural processes in their livelihood, which vary due to their living areas, ranging from coastal to terrestrial, as the tribes of Kuri, Wamesa, Irorutu, Sebyar, and Simuri live and have customary rights near the shoreline, while Sougb and Moskona tend to inhabit inland areas.

The tribes actually understand and agree with the customary rights belonging to each tribe, where each tribe consists of a clan, as stated legally in the Appendix of Regional Regulation Number 1 of 2019. In the Appendix of the regulation, the names of clans are written as the result of several stages during the process, based on discussions and consolidation between the local government and the tribal leaders in which the traditional knowledge is developed based on the agreement and understanding of local people transferred among

generations verbally and by practice. Hence, to implement and manage traditional knowledge, the tribes rely on tribal leaders, village heads, or older people. The tribes have been practicing traditional knowledge by conducting traditional cultivation, as well as implementing hunting systems and fishing (Fig. 3).

In certain conditions, some tribal members are allowed to rent out areas to be used by others, such as outsiders (not from the seven tribes). During a legal trade, such as in areas where local people are involved, they must agree with the owner of customary rights before obtaining the certificate. The LMA usually issues the agreement as a recommendation from the tribal representation during the trade. Figure 3 illustrates various types of interactions and dependencies between local people and natural resources.

<div style="text-align: center;"> External factors Internal factors </div>	Opportunities (O)	Threats (T)
		1. International and national policy of conservation 2. International fund and organization 3. Top priority of development infrastructure 4. IT availability 5. NGO
Strengths (S)	SO: Maxi-Maxi	ST: Maxi-Mini
1. Sustainable development program 2. Natural resources 3. Traditional knowledge 4. Conservation of biodiversity 5. Companies 6. Regional funds	1. Setting sustainable programs 2. Designing the regulations 3. Involving the local people 4. Collecting the TEK 5. Conducting the research	1. Landcover monitoring 2. Empowering human source 3. Collecting the biodiversity data
Weaknesses (W)	WO: Mini-Maxi	WT: Mini-Mini
1. Unbalanced development 2. Unstable position of stakeholders in government 3. Low accessibility 4. Political system as democracy	1. Stick to the priority of development 2. Collaboration with NGOs 3. Advocating the local people	1. Enhancing the economic sector 2. Law enforcement

Figure 4 Eureka matrix showing the SWOT description of the potential integration of Traditional Ecological Knowledge (TEK) during the development programs in Teluk Bintuni District and the potential strategies

Strengths, Weaknesses, Opportunities, and Threats

We have asked and proposed the conditions that determine the aspects of Traditional Ecological Knowledge (TEK) implementation in the Teluk Bintuni District area during a Focus Group Discussion (FGD). Hence, in this study, we described the factors impacting TEK implementation during the development program of Teluk Bintuni District, whether they were inhibiting or supporting elements. The factors were grouped into strengths, weaknesses, opportunities, and threats (SWOT) to describe the extent to which traditional knowledge was integrated into the development programs of Teluk Bintuni District. The use of TEK is related to the sustainable management of natural resources, like forests. Thus, the harmonization between conservation and exploitation can be addressed during exploitation.

The implementation of ecological and economic perspectives during forest utilization is conducted by local people and the private sectors, which is considered as the primary goal. As a result, conservation programs in developing districts often face unique challenges and opportunities, particularly when integrating conservation programs with TEK, encompassing the cumulative knowledge, practices, and beliefs of indigenous and local communities passed down through

generations and are deeply rooted in the sustainable management of natural resources. While leveraging TEK in conservation programs offers immense potential, it also requires a careful assessment of strengths, weaknesses, opportunities, and threats (SWOT) to ensure effective implementation and long-term success (Fig. 4).

Strengths

As stated in the Regional Development Plan of Teluk Bintuni for 2021–2026 and Regional Regulation Number 1 of 2019, this district has committed to implementing sustainable development programs. Moreover, this area is part of the West Papua Province, which has declared a conservation area of approximately 70% and aims to protect the indigenous people, as stated in the Manokwari Declaration (Cámara-Leret *et al.* 2019). Moreover, many regulations have been issued regarding the recognition and protection of local rights, indicating that the government prioritizes the local people during development.

The local people's structure has been described as comprising seven tribes within this district administration, each with traditional knowledge that has been passed down for generations, particularly concerning sustainable management. Many studies showed that Teluk Bintuni District's natural resources consist of vegetation with high biodiversity value (Kasihiw *et al.* 2023, 2024;

Rumayomi *et al.* 2024; Sillanpää *et al.* 2017). Moreover, the natural resources in this district have been exploited, which could provide financial support in addition to the regular funds.

Weaknesses

The infrastructure aspect of Teluk Bintuni District is being developed to balance accessibility. However, some areas in the district have not yet been well developed due to many developing districts in Papua now prioritize road development (Engert *et al.* 2024; Gaveau *et al.* 2021). Furthermore, the political system, like the election, would impact the position of stakeholders in the government. The atmosphere that focuses on the development mission mainly relies on personal leaders, impacting the integration of the conservation program and TEK.

Opportunities

We described global financing and policies as opportunities to implement TEK in the development program of Teluk Bintuni District. The global perspective prioritizes the local communities, like conservation programs and natural resources management, particularly in the tropics (Bong *et al.* 2024; Erbaugh *et al.* 2020; Kumar *et al.* 2021). Teluk Bintuni District is the location of several Non-Governmental Organizations (NGOs) that work as government partners. Additionally, information technology, supported by an internet connection, has been accessible to the resident areas, facilitating the distribution of information and data storage related to the development program, including TEK implementation. As the government has stated, infrastructure development is now a priority, including road expansion, which leads to improved accessibility.

Threats

Being a developing area, accessibility to remote areas in Teluk Bintuni District is low, resulting in some people living in marginal conditions. The marginal area primarily covers lowland tropical rainforests with some coastal areas dominated by mangrove ecosystems (Kasihw *et al.* 2024; Rumayomi *et al.* 2024; Sillanpää *et al.* 2017). Potential threats of deforestation and forest degradation are likely to take place as this area is a part of the location of some companies. The deforestation and forest degradation lead to biodiversity loss, which has already happened in

many tropical rainforests (Spracklen *et al.* 2015; Laurance 1999; Li *et al.* 2022). Moreover, incoming people inhabiting the Teluk Bintuni District will affect socio-culture, resulting in acculturation that may impact social and psychological factors.

Proposing the Potential Strategies to Integrate TEK into the Development Program

In Teluk Bintuni District, the integration between Traditional Ecological Knowledge (TEK) and regional planning and development is hindered by limitations and threats, as the district is prioritizing infrastructure construction to improve accessibility in the areas. Despite political instability, supporting variables are identified as strengths and possibilities that would achieve an optimistic aim. Companies that have invested over the years have exploited natural resources in this district. Conservation programs, like the carbon fund, are supported by international funds. Due to their high biodiversity and wide distribution areas, conservation areas are associated with varied traditional knowledge, making biodiversity and cultural conditions fascinating topics to study. International rules may support sustainable management, as this district has also incorporated NGOs into biodiversity and social conservation projects as part of its sustainable program for regional development. The implementation requires information technology, supported by an internet connection, to distribute and communicate data across different locations.

Our study proposes strategies formulated from the Eureka matrix that can be used to integrate traditional knowledge and regional programs.

Collecting Information on TEK using Education and Research

Education and awareness programs are essential for increasing biodiversity conservation awareness among local communities. Cultural education should be incorporated into local education systems. Workshops and training sessions should be organized to educate community members about conservation techniques (Carson *et al.* 2018; Gouwakinnou *et al.* 2019). Collaboration with stakeholders, including NGOs and government agencies, is essential. Monitoring and evaluation mechanisms should be established, such as community-based monitoring and feedback systems (Guibrinet *et al.* 2021; Lawer & Ishaq 2024).

Integrating traditional ecological knowledge (TEK) into conservation programs in developing districts presents a promising pathway toward sustainable resource management and biodiversity preservation. However, its success depends on addressing inherent weaknesses and mitigating potential threats through strategic planning and collaboration.

Research must be conducted by enhancing collaboration with universities and research boards to obtain data on Traditional Ecological Knowledge (TEK) in Teluk Bintuni District. Hence, the local government must set up systematic research planning and promote partnerships with the researchers. The study must have scientific content and be published by a scientific publisher. Hence, these studies can serve as a fundamental basis for setting policies in this district. Furthermore, the monitoring and evaluating of the implementation of the regulations must be regularly carried out to enhance the process of achieving the development goals. So, both infrastructure and social development can be balanced in this development. As a result, this condition could mitigate the social conflict between the government and local people.

To maximize the strengths of TEK, conservation programs must prioritize community engagement, capacity building, and documentation efforts while fostering partnerships between traditional knowledge holders and scientific experts. Policymakers must also play a crucial role by creating supportive legal frameworks that protect intellectual property rights and ensure equitable benefit-sharing.

Increasing the Collaboration between Multisectors and Stakeholders

Information Technology (IT) can support administrative processes, including TEK implementation, which can be used to connect and store databases on TEK implementation for each tribe. Moreover, the technology enhances communication among stakeholders and the circulation of information, such as using digital maps that can be integrated with the traditional boundaries of customary rights.

Information technology supports the transparency of many activities (Toivonen *et al.* 2019). With information technology, monitoring the implementation would be technically easy, as some studies have used such technology to monitor wildlife (Moßbrucker *et al.* 2016; Scotson

et al. 2017). For instance, anyone can access the regulations, and most people can understand the updated regulations.

Collaboration can be performed to strengthen the implementation among stakeholders. For example, a study was conducted to identify the TEK and local wisdom among tribes, and the results can be provided online, where the local agreement of tribes can be written using the proper methods. Conservation programs in developing districts should involve local communities during the planning and implementation of the programs (Börner *et al.* 2016; Chen *et al.* 2020; Donaldson *et al.* 2017) by building trust, incorporating local knowledge, as well as providing training and resources to empower the human resources related to the programs.

Integrating TEK into conservation planning involves conducting participatory research, mapping resources, and developing adaptive management plans. Sustainable practices like agroecology, wildlife management, and restoration projects should align with scientific research and TEK. For instance, the Teluk Bintuni District is part of an area managed by the Natural Resources Conservation Centre (*Balai Konservasi Sumber Daya Alam/BKSDA Seksi Konservasi Wilayah III Bintuni*) in terms of vegetation and wildlife management. Therefore, coordination and identification are necessary to involve local people in the conservation program.

As part of West Papua Province, the Manokwari Declaration has stated that forests should be conserved and sustainable development should be run (Cámara-Leret *et al.* 2019). Hence, this district is getting support for planning and implementation, such as policies and financial assistance. Teluk Bintuni District also acknowledges the tribes as part of the government, as stated in local regulations. Thus, this potency can be put into the planning and development of this district so that the government (regent and legislative board) can run the program following the roadmap.

Improving Strategies of A Sustainable Program

Traditional Ecological Knowledge (TEK) refers to the understanding and insights indigenous and local communities have developed over generations regarding their environment, ecosystems, and sustainable resource management. TEK also encompasses a holistic view of the relationship

between people and nature, integrating cultural beliefs, practices, and ecological knowledge. Leveraging TEK in Teluk Bintuni District can significantly enhance conservation efforts by aligning them with local customs and practices. The conservation program supports the goals of sustainable development programs, which can be used to balance economic and ecological goals. Many studies have shown that the role of local people significantly influences the development process (Alamgir *et al.* 2020; Ellis *et al.* 2017; Mayhew *et al.* 2019). Therefore, several practices can be recommended.

Community engagement and participation are considered as the primary strategies for conservation programs in developing districts to engage local communities actively in the planning and implementation processes by establishing relationships based on mutual respects between conservation organizations and local communities, incorporating local knowledge, and utilizing TEK to inform decisions about land use, species management, and habitat restoration.

Capacity building is implemented by providing training and human resources to empower local communities to participate actively in conservation efforts. TEK can be integrated with conservation planning by conducting participatory research and engaging community members in data collection about local biodiversity, ecosystem services, and traditional practices. Mapping resources can be carried out using community knowledge to create maps identifying important ecological areas, culturally significant sites, and resource distribution. Developing adaptive management plans can be built to create flexible management strategies that can be adjusted based on ongoing feedback from the community.

Achieving Economic and Social Visions

It is interesting to note that promoting sustainable practices conservation programs should promote sustainable practices that align with both scientific research and TEK, like agroecology, encouraging agricultural methods that are informed by traditional practices while also incorporating modern sustainable techniques; wildlife management by respecting traditional hunting

practices while ensuring species conservation; and restoration projects by utilizing native plant species identified through TEK for habitat restoration projects to ensure ecological compatibility.

Another crucial factor is the implementation of education and awareness programs on the importance of biodiversity conservation among local populations. It can be conducted through cultural education by incorporating teachings about the significance of biodiversity into local education systems, using culturally relevant materials and workshops, and organizing training sessions and events where community members can learn about conservation techniques alongside traditional practices.

During the planning and implementation of regional development, collaboration with stakeholders, such as partnerships with NGOs specializing in conservation, can provide additional resources, expertise, and government involvement, engaging government agencies to support policies that recognize and incorporate TEK into formal conservation frameworks. For example, successful conservation programs require collaboration among various stakeholders, such as NGOs and government agencies.

Community-based monitoring systems empower local communities to monitor biodiversity changes and provide continuous feedback on the success or challenges in implementing conservation strategies (Dirhamsyah 2013; Gouda *et al.* 2021; Rocca & Zielinski 2022). Overall, conservation programs should prioritize building trust, incorporating local knowledge, and promoting community engagement in planning and implementation.

To track the progress of the integration in planning and implementation, it is essential to conduct regular monitoring and evaluation. Monitoring and evaluation can be carried out through community-based monitoring systems, empowering local communities to track biodiversity changes using their traditional knowledge systems. The feedback can be built by creating channels for continuous feedback from community members regarding the successes or challenges faced in implementing conservation strategies.

CONCLUSION

Teluk Bintuni District has acknowledged the customary rights of seven tribes by issuing Regional Regulations Number 1 of 2019 to protect traditional communities. The acknowledgement is recognized by prioritizing people's rights during development, supported by additional regulations, and by establishing the LMA *Tujuh Suku* involving Kuri, Wamesa, Irorutu, Sebyar, Simuri, Sougb, and Moskona tribes who have lived in the area for generations, by practising Traditional Ecological Knowledge (TEK), having the primary goals of socio-economic and ecological factors. The TEK is incorporated into development programs as a method to achieve conservation and economic growth goals. Several challenges, such as limited infrastructure, political instability, and the need for community engagement, hinder effective implementation. Strengths include the availability of natural resources and international funding for conservation efforts.

Our study emphasized the importance of education, stakeholder collaboration, and the use of technology to document and share TEK. Strategies for incorporating TEK into conservation planning, such as participatory research, capacity building, and adaptive management, are vital. Ultimately, effective conservation programs must prioritize community-based involvement, trust-building, and the incorporation of local knowledge to achieve sustainable development goals in this district.

ACKNOWLEDGMENTS

The authors would like to thank the government, leader of the LMA *Tujuh Suku* Teluk Bintuni, local people, Siprianus Manibuy (*Kepala UPTD Kesatuan Pengelolaan Hutan Produksi Unit XV Bintuni, Dinas Kehutanan Provinsi Papua Barat*), *BKSDA Wilayah III Bintuni*, and *Dinas Pertanahan dan Lingkungan Hidup (DPLH) Kabupaten Teluk Bintuni* for supporting this study by providing the permit and information. We are also grateful to the anonymous reviewer(s) for sharing useful inputs.

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