



Biosfer: Jurnal Pendidikan Biologi

Journal homepage: <http://journal.unj.ac.id/unj/index.php/biosfer>



Besemah indigenous knowledge for forest conservation in biology education

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ARTICLE INFO

Article history

Received: 25 November 2025

Revised: 05 January 2026

Accepted: 3 February 2026

Keywords:

Besemah People

Sustainability

Traditional Forest Management

ABSTRACT

Indigenous knowledge plays an important role in forest conservation; however, modernization has caused indigenous knowledge almost to disappear. This study aims to determine the Besemah Indigenous Knowledge for forest conservation in Biology Education at Benawa hamlet, Penjalang Village, South Dempo District, Pagar Alam City, Indonesia. This research used a descriptive qualitative method with observation through interviews and documentation with 22 affluent information respondents. The collected data were analyzed using thematic analysis to identify patterns and meaning related to indigenous knowledge in natural resource management. Based on the results of the research, it was found that some indigenous knowledge played a role in forest conservation including the prohibition of cutting down certain trees, the prohibition of clearing land and fire sources, the prohibition of killing protected animals, the prohibition of polluting water sources, and the prohibition of entering the forest without the permission of the customary leader. The findings of this study can serve as a model of good practice in forest management, in which indigenous knowledge, customary rules, and the active role of traditional leaders guide sustainable resource use and community participation in the Ayek Mude Tebat Benawa customary forest.

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INTRODUCTION

Forests are collections of trees that grow densely and are places for animals and plants to associate and form ecological conditions that are unique and different from outside areas (Barton et al., 2021; De Frenne et al., 2021). Forests provide critical ecosystem services, such as water provision and regulation, oxygen production, biodiversity habitat, climate regulation, and carbon sequestration (Baciu et al., 2021; Pechanec et al., 2021; Casagrande et al., 2021). Because of its critical and numerous roles, it is important to maintain the forest ecosystem to balance the environment and sustain the lives of living things in it.

Indonesia has many types of forests, including customary forests. Customary forests are forest areas whose management rights are exercised by indigenous communities by involving the role of traditional law (Harada et al., 2022; Lewis et al., 2023). Law No. 41/1999, article 1, paragraph (6) stipulates that customary forests are state forests located within indigenous peoples' territory, giving them the right to material wealth within the customary forest. Recognition of indigenous peoples' rights to their customary territories has been guaranteed through Article 18B of the 1945 Constitution (Sihotiang et al., 2024). The knowledge possessed by traditional communities for generations in protecting the environment, including their customary forests, is called indigenous knowledge (IK).

Indigenous Knowledge (IK) is systematic knowledge that comes from the uniqueness of indigenous peoples through accumulated experience, informal experiments, and a deep understanding of the environment in a particular culture (Jessen et al., 2022). Indigenous knowledge is a form of knowledge that is inherent and developed in indigenous communities (Madonsela & Machete, 2025). Practices in indigenous knowledge are traditional efforts in solution management that are appropriate to a particular context and are adaptive, practical, and holistic (Bwambale et al., 2023; Melash et al., 2023). Applications of IK can be done in various fields such as health, land management, and conservation (Foley et al., 2023).

In Indonesia, many traditional communities have customary forests, research on IK owned by communities living around customary forests has been carried out, including the IK of the Dayak Tribe related to forest conservation and overcoming deforestation (Usop et al., 2021, 2021), IK of the Ammato community, IK of the Ammatoa community in South Sulawesi which contributes to the social-ecological system (Daniel et al., 2022), IK of the Cerekang community which is related to sustainable forest conservation efforts (Akhmar et al., 2022), IK of the Baduy Tribe which has a culture called *pikukuh* which is related to sustainable forest management and can be used by future generations (Asteria et al., 2024). However, among these studies, no one has discussed the IK of the Besemah tribe in the Ayek Mude Customary Forest, even though the role of forests in the Besemah community is vital because it is related to maintaining their water and food resources (Effendi et al., 2021; Meilinda et al., 2021). Therefore, this study is urgently needed because, without in-depth understanding and proper documentation of this indigenous knowledge, the sustainability of the Ayek Mude forest ecosystem—which serves as a critical buffer for water availability and food security—will be increasingly threatened by modernization, land-use change, and climate change.

Mude Ayek Customary Forest is in Tebat Benawa Hamlet, Penjalang Village, South Dempo District, Pagaralam Municipality, South Sumatra Province. This location is a forbidden forest maintained by the ancestors as a source of livelihood for the local community, especially water resources and biodiversity (Bonye et al., 2023; Vijayan et al., 2021). This forest is the first customary forest in South Sumatra based on the decree of the Minister of KLR, inherited by the descendants of Puyang (ancestors) Kedung Samad or Siak Alibid in Therefore, this study aims to examine the indigenous knowledge of the Besemah people related to their role in and the sustainability of preserving the Mude Ayek customary forest.

Although the Besemah community has long managed the Mude Ayek customary forest through their indigenous knowledge, systematic research on this knowledge remains very limited. The absence of comprehensive and documented data poses a serious threat to the long-term sustainability of the forest. Therefore, this study is formulated to address the following research question: What forms of indigenous knowledge (IK) of the Besemah Tribe are applied in the management of the Mude Ayek customary forest, and how does this indigenous knowledge practically contribute to efforts toward forest preservation and conservation?

METHODS

Research Design

This research used a qualitative descriptive method to identify and describe the IK of the Besemah Tribe in Tebat Benawa based on the understanding of the research subjects. Descriptive qualitative research is research through narrative analysis derived from contextual behavior that occurs and is observed by researchers (Sevilla-Liu, 2023). This research provides a clear picture of the characteristics and relationships between the phenomena being studied in a natural environment and provides rich and comprehensive insights (Busetto et al., 2020; Lucas et al., 2022). The phenomenon discussed in this research was the indigenous knowledge of the Tebat Benawa Village community in maintaining and managing natural resources.

Population and Samples

The object of this research was the community living around the Ayek Mude Tebat Benawa customary forest, and 22 respondents in total who met the criteria as information-rich respondents with the following conditions: local natives known to the community, traditional leaders, descendants of *Puyang* (elders), village officials, youth leaders, and migrants who have lived in Tebat Benawa Village for 10 years. Information-rich respondents are respondents whose information capture value is richer than traditional points (Ellerby et al., 2021). The sample size was considered adequate once no new information emerged, indicating that data saturation had been reached in accordance with qualitative research standards (Gill, 2020).

Table 1

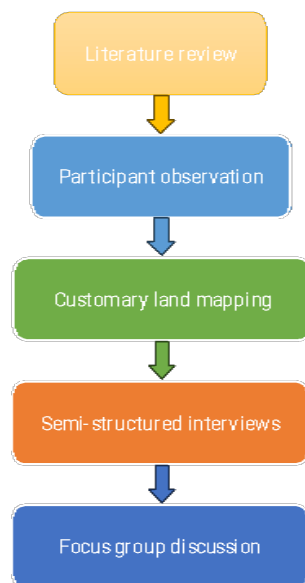
List of Respondents

No.	Respondent Code	Age	Gender	Occupation
1.	BD	68	Male	Customary Leader
2.	SH	38	Female	Housewife
3.	FU	44	Male	Head of RW 3
4.	HH	60	Male	Farmer
5.	HR	60	Male	Farmer
6.	HA	46	Male	Head of RT 7
7.	HL	45	Male	Farmer
8.	ZB	55	Male	Head of RT 9
9.	HH	40	Male	Head of RT 8
10.	YN	43	Female	Housewife
11.	MD	70	Male	Farmer
12.	DW	59	Male	Farmer
13.	HT	47	Male	Farmer
14.	HN	50	Male	Farmer
15.	RL	40	Female	Teacher
16.	IS	55	Male	Farmer
17.	BF	50	Male	Farmer
18.	LL	48	Male	Farmer
19.	DC	47	Male	Farmer
20.	SN	40	Female	Housewife
21.	GN	60	Male	Farmer
22.	JN	45	Male	Farmer

Data Collection

This research used primary and secondary data. Primary data was obtained directly from the village community who became respondents in the form of an overview of the *Mude Ayek* Customary Forest. Secondary data was obtained from other parties regarding the physical environment, social, and economic conditions of the community, and other data related to the object of research through villages, agencies, and sub-districts. Collection was through deep interviews or qualitative data collection methods with in-depth interviews through trusted respondents (Knott et al., 2022). For flexible and adaptive questions used in in-depth interviews, the appropriate approach is not the “validation of questions” as applied in quantitative instruments, but rather the interviewer’s competence and the strength of the interview question structure (Turner, 2014).

Deep interview was through 5 ways and stages in the form of:



(Albuquerque et al., 2014)

Figure 1. Five stages of in-depth interview

The questions asked in the interview are available in [Table 2](#)

Table 2

Interview Questions

No.	Question	No.	Question
1	Do you know about the customary forest in this village?	11	Do you know of any special traditions in preserving the environment of the Ayek Mude Tebat Benawa Customary Forest? If yes, what is the form of the tradition?
2	Do you know the name of the customary forest?	12	Does the community believe that there are special traditions in the forest?
3	Do you know the origin of the customary forest?	13	Do you know the sanctions for violating the rules in protecting the Ayek Mude Tebat Benawa Customary Forest?
4	Do you participate in preserving the forest? If yes, in what form?	14	If there are sanctions and rules in the Ayek Mude Tebat Benawa Customary Forest, how do people implement the sanctions and rules that apply?
5	In preserving the Ayek Mude Tebat Benawa Customary Forest, is there an important figure such as a customary leader? If yes, who is this figure?	15	Do you know what prohibitions are found in the forest?
6	Other than the customary leader, are there any important figures who participate in preserving the forest?	16	Do you know the areas of the forest that can be crossed?
7	Does the South Dempo government participate in preserving the customary forest?	17	Do you know which areas of the forest are off-limits?
8	What is the role of the government in preserving the customary forest?	18	Do you know what types of trees are in the Ayek Mude Tebat Benawa Customary Forest?
9	Do you know of any customary laws that apply in the customary forest environment?	19	Do you know what types of trees may not be cut down in the Ayek Mude Tebat Benawa Customary Forest?
10	If a community violates customary law what consequences will the community receive?		

Data Analysis Techniques

Qualitative data analysis is the process of simplifying data into a simple formula that is easy to read and easy to interpret. Data analysis in this study was carried out by theme analysis. Theme analysis is a qualitative research method that is useful for identifying patterns or meanings from the overall data (Baucham et al., 2024; Lindgren et al., 2020).

RESULTS AND DISCUSSION

Overview of the *Mude Ayek* customary forest

The *Mude Ayek* Tebat Benawa Customary Forest is a customary forest owned by the Tebat Benawa Hamlet Indigenous Community. It is an obligation for the community to preserve the customary forest. The *Mude Ayek* Customary Forest area has an average altitude above 1200 meters above sea level, with an area of 336 ha. The average height of trees that dominate the customary forest reaches 12 meters, and the trunk's diameter is 2-3 meters. The trees are not allowed to be cut down because they are believed to be a water catchment area and a source of springs in Tebat Benawa Village. Within the customary forest were three springs: *ayek puding*, which flows into the village, *ayek seluang*, which flows into the gardens and rice fields of the village community, and *ayek ringkih* for community use.

Indigenous knowledge of the Tebat Benawa Village community on the role of the *Mude Ayek* Customary Forest in protecting water sources

The Tebat Benawa community holds traditional knowledge (indigenous knowledge) to maintain the Adar forest, which has been maintained for generations. The Besemah tribe still strictly enforces social values that regulate community behavior in utilizing the forest. This practice teaches indigenous people to love nature more and have knowledge and habits that develop in the community (Su et al., 2020). This knowledge, which has been passed down from generation to generation, is crucial for the state of the climate, sustainable environment, and natural resources (Jessen et al., 2022; Negi et al., 2023; Nyadzi et al., 2021).

Table 3

Forms of indigenous knowledge of the Besemah Tribe of Tebat Benawa Village

No.	Recommended	Prohibition	Number of Informants who Know
1	In order to preserve the forest, it is recommended not to cut down trees in the <i>Mude Ayek</i> Customary Forest area.	There is a prohibition on taking certain wood in the <i>Mude Ayek</i> Customary Forest which is protected by the community.	22
2	To prevent the extinction of animals in the <i>Mude Ayek</i> Customary Forest, it is recommended not to take or kill protected animals in the <i>Mude Ayek</i> Customary Forest area.	Prohibition of clearing land for cultivation in the <i>Mude Ayek</i> Customary Forest area.	22
3	Should maintain attitude and speech in the <i>Mude Ayek</i> Customary Forest area.	Prohibition of making fire sources in the <i>Mude Ayek</i> Customary Forest area.	22
4	In order to maintain water sources, it is recommended not to pollute water sources in the <i>Mude Ayek</i> Customary Forest area.	Prohibition of excessive timber harvesting beyond the needs of the community in the <i>Mude Ayek</i> Customary Forest.	22
5	The Pagar Alam City Government recommends that the customary leader apply Sanctions for people who violate the rules in the <i>Mude Ayek</i> Customary Forest.	Prohibition of entering the customary forest area without the permission of the customary leader.	22

Forms of indigenous knowledge of the Besemah Tribe of Tebat Benawa Village

a. The suggestion is not to cut down trees in the *Mude Ayek* Customary Forest area to preserve the forest.

Trees are believed to absorb water and maintain springs, which the Tebat Benawa Village community utilizes for gardens and daily needs. This rule has been maintained by the ancestors of the Besemah Tribe of Tebat Benawa Village for a long time. The community's knowledge of managing and utilizing the forest around their area was called indigenous knowledge. From interviews conducted with the customary leader, the prohibition of cutting down trees was called *ghimbe* because the water source is there, a source for rice fields, gardens, and drinking water. The community claimed that anyone who violated it with the intention of commercializing or selling the felled wood would be subject to customary law sanctions in the form of a buffalo growing *kelase* (adult buffalo), and the wood and tools used to cut down were confiscated and became the property of the Tebat Benawa Village community. The Pagar Alam City Government has approved this no-cutting regulation to preserve the *Mude Ayek* Customary Forest. Indigenous knowledge of the Tebat Benawa Village community believed that cutting down trees or damaging the customary forest would cause the water sources in the customary forest to dry up, and the community would no longer get water. Customary regulations played an important role in tree conservation in various cultures (Lestawi et al., 2020; Wren-Lewis et al., 2020). The development of such regulations leads to local communities having valuable indigenous knowledge on the wise use of plants (Bayen et al., 2024; Gardner et al., 2022). Integrating regulations and community indigenous knowledge improves conservation efforts and maintains forest succession (Schmidt et al., 2021). In addition, a well-maintained forest can maintain the existence of water sources and maintain water quality (Wang et al., 2021).

b. Prohibition of excessive timber harvesting beyond the needs of the community in the *Mude Ayek* Customary Forest

Through the agreement of the customary leader and Tebat Benawa Village community members, timber collection was allowed but not for personal use. Wood collection can only be specialized for development purposes or the common interests of the community in Tebat Benawa Village. Wood must be taken wisely by taking productive-sized wood (worth taking) that is limited according to village needs. These utilization restrictions were still related to preserving forests and water resources in the *Mude Ayek* Customary Forest. These restrictions have been shown to reduce logging and increase the potential for environmental services (Kärkkäinen et al., 2020). The community protected some tree/wood species based on collective agreements and may not be taken or cut down. These species include Rasamala, Meranti, Medang, and Kayu Lanang. Plants prohibited from being cut down were plants with high economic potential. Biological resources with high economic potential can be overexploited (Gaisberger et al., 2022; Sawitri et al., 2020). Therefore, it is necessary to apply regulations and an inclusive ecological approach (Sheppard et al., 2020). Some species are allowed to be taken, but only for the benefit of the village community. Bamboo and Rattan, which have several species, are called *Serimit* Rattan, *Wi soft* Rattan, *Wi fat* Rattan, and *Wi sebut* Rattan. Bamboo and Rattan are abundant biological resources with crucial ecological and economic potential (Zhao et al., 2022).

c. Prohibition of clearing land for cultivation in the *Mude Ayek* Customary Forest area

The Tebat Benawa Village community agreed not to clear land for cultivation in the *Mude Ayek* Customary Forest area. Clearing land for cultivation means cutting down trees in the customary forest. This violation leads to sanctions previously written in the Tebat Benawa customary law. Sanctions for violators of the rules are a buffalo and an administrative fine of Rp—300,000,000 (three hundred million rupiah). Farming is the primary source of income for the people of Tebat Benawa Village. Therefore, the issue of land clearing needs attention. Massive land clearing for cultivation is one of the causes of forest loss in Indonesia (Juniyanti et al., 2023). Indigenous knowledge of the Tebat Benawa Village community that prohibits land clearing is a form of forest conservation that will protect water resources in their area. The prohibition or customary law applied by the Tebat Benawa community is the same as the *pikukuh* set by the Baduy tribe, aiming to conserve and maintain forest sustainability in their area (Asteria et al., 2024).

d. Prohibition of making fire sources in the *Mude Ayek* Customary Forest area

Indigenous knowledge of the Tebat Benawa Village community in protecting the *Mude Ayek* Customary Forest area includes implementing rules that prohibit the creation of fire sources. The *Mude Ayek* Customary Forest was prone to fires because of the dense vegetation of the customary forest. In addition, there were many dry and flammable leaves and twigs. This can lead to forest fires that are difficult to handle. Research (Pereira et al., 2023; Silvério et al., 2022) showed that fire is one of the strongest threats to indigenous forests in various regions globally. The occurrence of fires was strongly correlated with human activities that create fire sources in the forest, such as land clearing (Balch et al., 2015; dos Reis et al., 2021). Therefore, applying the prohibition of making fire sources in the *Mude Ayek* Customary Forest was one way and effort to preserve the forest's biodiversity and water resources. The application of customary rules regarding the prohibition of making fire sources in the forest is a form of reminder of the importance of three inseparable elements, namely humans, the environment, and God, which created a beautiful forest environment (Lestawi et al., 2020).

e. The suggestion is not to take or kill protected animals in the *Mude Ayek* Customary Forest area so that animals in customary forests do not become extinct.

The *Mude Ayek* Customary Forest area is where many animals live and breed. According to informants in the customary forest, there are several types of animals: tigers, siamangs, deer, and forest goats. An interview with the RT head revealed that the most common animal seen by the community was the siamang, and many tiger footprints were found. This prohibition applies to local communities and migrants to maintain the potential of animals and preserve the customary forest area. The role of customary law in preventing animal loss is vital. The *Idu Mishmi* tribe in Northeast India is a clear example of implementing this customary law, effectively protecting animal diversity (Nijhawan et al., 2020). The Bromo Tengger tribe in Semeru is another example of the implementation of customary laws prohibiting the hunting of protected animals; they involve magical elements that are still strongly developed in the community and involve tribal leaders and village governments in sanctioning violators who first pass through deliberations (Achmadi et al., 2019). Through community indigenous knowledge, customary law, and cultural values, protection of endangered species can be achieved through community empowerment and individual welfare (Delisle et al., 2018).

f. Maintaining attitude and speech in the *Mude Ayek* Customary Forest area

Based on interviews with the customary leader in Tebat Benawa Village, the village community has rules to protect the forest area in the religious field by prohibiting polluting water resources in the customary forest. Villagers are also prohibited from behaving in a dirty manner, such as littering, saying dirty words, and salivating carelessly. This prohibition is enforced because, according to local beliefs, the customary forest area has mystical value, so that if violated, it will bring a disaster because it is considered disrespectful to the "guardians/inhabitants of the customary forest" who also protect the *Mude Ayek* Customary Forest area. The prohibition of impolite speech in the customary forest is a form of concern for preserving customary forests (Yasir et al., 2022). Regulations on speech and behavior in the customary forest are a form of respect for human, natural, and spiritual relationships (Akhmar et al., 2022). Indigenous forests are sacred places with spiritual and cultural values that develop in indigenous communities, so they are considered sacred in their traditional knowledge (Lowman et al., 2017).

g. The suggestion not to pollute water sources in the *Mude Ayek* Customary Forest area so that water sources are maintained.

This suggestion arose due to awareness and mutual agreement among the Tebat Benawa Village community. An interview with a villager revealed four water sources in the forest, which serve as a water source for their hamlet. The community realizes the importance of protecting three water sources: *Ayek Ringkih*, *Ayek Seluang*, and *Ayek Puding*. They believed it would be difficult to get water if the forest were damaged. Environmental conservation efforts made by the community showed an attitude of ecological intelligence, with a prohibition to pollute water sources and not cut down trees believed to absorb water. The community realized that they are the ones who have control over the surrounding environment. Meilinda et al.'s 2021 research proved that the indigenous knowledge of the Besemah community about protecting water sources from pollution can benefit the community in maintaining food production, especially rice, by preserving water resources. Implementing good forest management and regulations can maintain water sources for indigenous peoples to benefit their daily

lives (Abas et al., 2022). Enforcing customary regulations and monitoring policies indirectly involved indigenous peoples in conservation efforts and preventing pollution of natural resources (Fernández-Llamazares et al., 2020).

h. Prohibition of entering customary areas without permission from the customary leader

The Tebat Benawa Village community of the Besemah Tribe applied the rule of not entering the customary forest without permission from the customary leader. The prohibition was imposed to protect the customary forest. The incident that made this rule even more sticky was a group of people who entered without permission and got lost in the forest. One of the *indigenous knowledges* of the Tebat Benawa Village community of the Besemah Tribe is the prohibition of entering the forest without permission to maintain the beauty of the customary forest area. The existence of myths and traditional beliefs cannot be separated from customary forests (Sinthumule, 2024). Applying this permit is intended to maintain the sacredness of the customary forest for indigenous peoples (Kujirakwinja et al., 2019). This rule facilitates monitoring of the state of the forest and protection for people who enter the forest so that they are easily found when lost (Mistry et al., 2016). Ifrani et al.'s 2019 research on the Dayak Kotabaru community proved that enforcing this prohibition is beneficial for the community and the environment.

i. Pagar Alam City Government's suggestion to the customary leader to apply sanctions for people who violate the rules in the *Mude Ayek* Customary Forest

The Pagar Alam City Government advised the customary leader to apply sanctions for people who violate the rules. The sanctions were written in the application book for the inauguration of the Tebat Benawa customary law community institution. This regulation was agreed upon according to customary law in consultation with the customary leader and the village community. The following are sanctions for violating the provisions of the *Mude Ayek* Customary Forest:

1. Anyone who commits illegal logging in the *Mude Ayek* Customary Forest area with the intention of commercializing or selling the logs will be subject to customary law sanctions in the form of 1 (one) buffalo growing *kelase* (adult buffalo), as well as wood and logging equipment confiscated and become the property of the Tebat Benawa Village community.
2. Anyone who cuts down timber or damages customary forests to open a garden or *kawe* will be subject to customary law sanctions in the form of 1 (one) buffalo and an administrative fine of Rp. 300,000,000 (three hundred million rupiah).
3. Anyone who takes customary forest products by cutting down trees and damaging customary forests will be subject to customary law sanctions in the form of 1 one adult goat. Suppose the provisions of these sanctions are not implemented. In that case, the perpetrators of violations will be submitted to the laws of the Republic of Indonesia (the authorities or authorized apparatuses) by the Tebat Benawa Village Customary Institution and the Government (RT/ RW) after consensus deliberation.

Collaboration between customary leaders and the government is needed to enforce regulations and establish various conservation efforts (Jayadi et al., 2024). Low participation from the government can cause damage to the forest ecosystem (Basu et al., 2023). Government involvement is expected to increase community participation in obeying regulations (Roengtam et al., 2023). In addition, government involvement is also expected to strengthen community rights in a legal framework integrated with applicable customary law (Aggarwal et al., 2021). The participation of various parties and enforcing regulations will bring positive results and sustainable forest management (Alam et al., 2019).

CONCLUSION

This study reveals that the traditional knowledge of the Besemah community in Tebat Benawa Village, which has been passed down through generations, functions as a conservation system in maintaining the sustainability of the *Mude Ayek* Customary Forest and its water resources. This knowledge is manifested through a series of advice and prohibitions in customary law, such as banning the random cutting of trees, opening agricultural land, hunting wildlife, burning forests, or polluting water sources, which is consistently implemented and reinforced with strict customary sanctions for violators. The full support from the Pagar Alam City Government for the enforcement of this customary

law strengthens the position of traditional knowledge as a sustainable conservation tool. More than just cultural heritage, the research findings emphasize that *Besemah* customary practices represent a tangible natural resource management mechanism, including controlling access to the forest, protecting water sources, and preserving biodiversity, which results from indigenous community knowledge, emphasizing that preserving indigenous knowledge is very important for managing natural resources and serves as a foundation to further safeguard that knowledge

ACKNOWLEDGMENTS

The author would like to thank the *Besemah* Indigenous Community for their cooperation and for sharing their indigenous knowledge. Special appreciation is also extended to the informants and local participants for their essential contribution during the fieldwork.

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