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Occupational Risk in Traditional Wild Honey Harvesting: A Case from Buloh Seuma, Indonesia

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Abstract

Traditional honey harvesting represents a hereditary practice in the utilization of non-timber forest products; however, its safety aspects have not yet become a primary concern, and research on this topic remains very limited. This research has the objective to identify hazard sources and evaluate the risk level associated with traditional wild honey harvesting in Buloh Seuma, South Aceh District, Indonesia. A qualitative methodology was employed, involving in-depth interviews with seven key informants, including pawang (honey harvesting leaders) and village heads, alongside field observations. The risk analysis utilized a semi-quantitative matrix that integrates frequency and severity scores, following a statistical-descriptive methodology. Findings reveal three significant activity stages associated with hazard potentials: forest expedition (8 sources), forest camping (4 sources), and tree climbing (6 sources). In Buloh Seuma, eight hazards have been identified, with two—falling from trees and bee stings—designated as high-risk. The local community exhibits adaptive capacity in mitigating these hazards; however, existing practices are predominantly intuitive and informal. The findings of this study highlight the need for context-specific safety strategies that integrate local community practices as part of sustainable area management. This can be achieved through the documentation of sustainability-oriented traditions and a reassessment of existing governance arrangements by management authorities to enable participatory monitoring, ensuring safe and sustainable honey harvesting practices.

Keywords: *local knowledge, non-timber forest product, risk levels, hazard, wildlife reserve*

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Introduction

The utilization of forest resources constitutes one of the occupations with the highest accident risks due to dynamic and unpredictable environmental conditions, particularly in industrial timber harvesting activities (Häring, 2015; Garland, 2018; Yovi, 2019; Harrington, 2021). Nevertheless, occupational safety is often perceived as an additional operational burden rather than an integral component of forest work (Yovi et al., 2019; Yovi & Yamada, 2019). The risks are even greater in traditional forestry practices involving non-timber forest products (NTFPs), where accident rates are estimated to be up to nine times higher (Klun & Medved, 2007), yet remain underrepresented in academic literature (Özbakır, 2023). These conditions underscore the urgent need to identify hazard sources and assess risk levels in traditional NTFP utilization practices.

Wild honey harvesting in Buloh Seuma, South Aceh, represents one of Indonesia's traditional NTFP practices. This activity takes place within the Singkil Swamp Wildlife Reserve (SSWR), a habitat for Sumatran tigers and saltwater crocodiles (Rahmi, 2018), thereby exposing harvesters to substantial ecological risks. Furthermore, regulatory provisions classify this area as a protection block where extractive activities are strictly prohibited (Ministry of Environment and Forestry Regulation P.76/Menlhk-Setjen/2015). According to Yovi et al. (2019), such ecological and regulatory constraints heighten the urgency for occupational safety assessments, as they can significantly influence the sustainability of harvesting activities—an issue that aligns closely with the sustainable development goals (van Vliet et al., 2024).

Within the framework of the Cultural Theory of Risk, this urgency becomes more evident because safety perceptions and behaviours in traditional practices are strongly shaped by the community's social values and cultural constructs (Douglas & Wildavsky, 1982). Yovi et al. (2016) highlight that risk assessment is essential for enhancing workers' welfare in terms of safety. Consequently, as outlined by the Chartered Quality Institute, occupational safety assessments should extend beyond identifying hazard sources and risk

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levels to include evaluations of existing mitigation strategies (Chartered Quality Institute, 2018). Such an approach is expected to enhance harvester welfare while strengthening the economic value of wild honey, which increasingly depends on ethical production practices (Nurrochmat et al., 2014; 2015; Nainggolan et al., 2025) and growing public awareness of its immunological benefits (Winahyu et al., 2021).

Methods

Study site Buloh Seuma is situated within a distinctive socio-ecological landscape that comprises a mosaic of peat-swamp forests—known as the Rawa Singkil—and coastal ecosystems that directly face the Indian Ocean (Figure 1). It is a traditional Kemukiman, consisting of three villages (Kuta Padang, Raket, and Gampong Tengah), located in a remote area (N2°33'46.95"; E97°39'40.91"). Until 2022, the area was accessible only by a three-hour boat journey; current overland access extends up to 14 hours from Banda Aceh, the capital city of Aceh Province.

The remoteness of the region severely limits emergency response capabilities, and during fieldwork, several connecting infrastructures—such as bridges—were observed to be in deteriorated condition. These constraints reinforce the community's reliance on local knowledge to navigate and manage the risks encountered during daily activities. The interplay between socio-cultural dynamics and geographic isolation creates a distinctive context for examining occupational hazards and indigenous safety practices in Buloh Seuma, particularly within the long-standing cultural tradition of wild honey harvesting. This research was conducted through a preliminary study in July 2024, followed by main data collection from December 2024 to January 2025.

Data collection This study utilized a purposive sampling method alongside a snowball technique to select informants, focusing on individuals identified as honey harvesting leaders (*pawang*) in Buloh Seuma, based on the assumption that they have extensive knowledge of traditional honey harvesting practices. This approach was selected as it facilitated direct access to *pawang* through trust-based social relations, enhancing both the responsiveness and depth of the data collected (Ting et al., 2025). Data were collected using purposive and snowball sampling with triangulation through interviews, observations, and literature validation (Newing et al., 2011; Lenaini, 2021; Fiantika et al., 2022; Nurfajriani et al., 2024). Six *pawang* were identified as key informants through this process. The number was deemed adequate, as data consistency was evident following the initial three interviews, with no significant differences noted. The data included hazard sources, risk frequency and severity, and the mitigation strategies utilized by the Buloh Seuma community. The data collection process adhered to occupational health and safety (OHS) management systems typically utilized in professional forestry sectors, as established by the International Organization for Standardization (ISO) (Chartered Quality Institute, 2018).

Data analysis The collected data were analyzed using descriptive statistical methods via a scoring system presented in tabular form (Table 1 and Table 2), based on the Standards Australia/Standards New Zealand (AS/NZS) 4360:2004 framework (2004).

The scores obtained were then analyzed using the formula established by Standards Australia/Standards New Zealand (2004) as shown in Equation *[1]*.

$$\text{Risk level} = \text{frequency of hazard occurrence} \times \text{severity of hazard} \quad [1]$$

The calculation results were compared with the risk level matrix (Table 3) to classify the risk associated with each hazard identified in the traditional wild honey harvesting practices of Buloh Seuma.

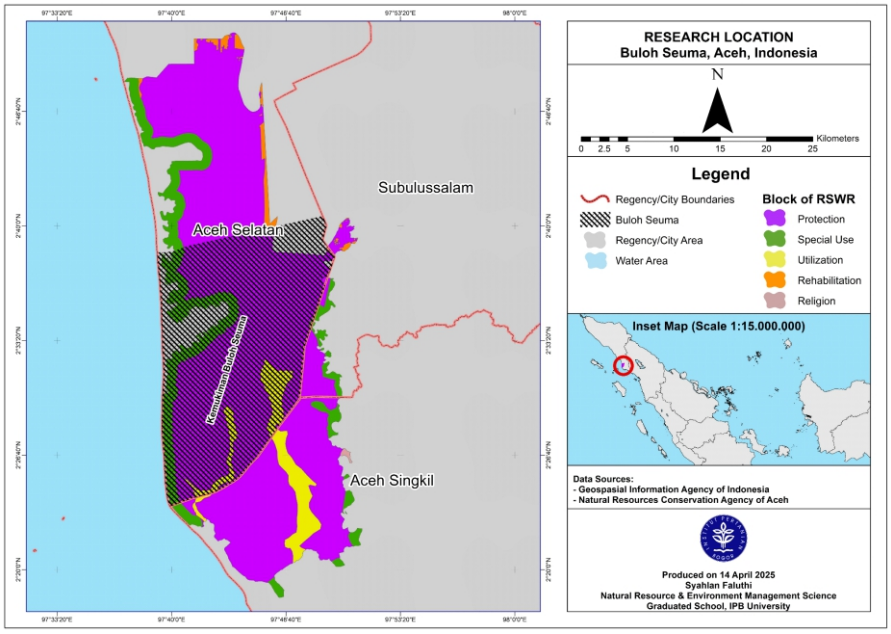

Figure 1 Map of Buloh Seuma as the research location.

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Results

Traditional wild honey harvesting in Buloh Seuma, as revealed through in-depth interviews and direct field observations, presents multiple hazard sources arising from extreme environmental conditions, manual techniques and tools, and a lack of adequate protective systems. According to the Regulation of the Minister of Manpower (MoM) of the Republic of Indonesia Number 5 of 2018 regarding Occupational Safety and Health in the Work Environment, hazards are categorized into two primary types: 1) Physical and technical environmental factors, and 2) Biological and ecological factors. The hazards are associated with particular harvesting stages, offering insight into the concentration of risks at each phase of the activity (Table 4).

Interviews and field observations have documented eight hazardous incidents, in addition to five potential hazards that have not yet occurred during traditional wild honey harvesting in Buloh Seuma (Table 5 and Table 6). The frequency and severity of these hazardous incidents were analyzed and presented in a risk level matrix in accordance with the AS/NZS 4360 standard (Table 7).

Discussion

Sources of hazards in traditional wild honey harvesting in Buloh Seuma Traditional wild honey harvesting in Buloh Seuma plays a central role in supporting the community's micro-economy. During the harvest season, honey production can reach 400–600 liters, with a selling price ranging from IDR300,000 to IDR500,000 liter^{-1}. These price fluctuations are influenced by demand levels and honey availability, consistent with the law of supply and demand (Fauzi et al., 2023). When projected, a single major harvest can generate an economic turnover of approximately IDR120 million to IDR200 million. Nevertheless, the substantial economic potential of such traditional practices remains insufficiently documented (Sheppard et al., 2020). Typically, harvesters sell their yields to collectors who serve as regular buyers and distribute the product to broader markets.

Given this economic value, occupational safety becomes essential, as it is directly related to the productivity of forest product harvesting (Yovi et al., 2019). This study identified 15 hazard sources (Table 4), most of which originate from physical and technical environmental factors (78.6%). These

Table 1 Frequency scoring criteria (Standards Australia/Standards New Zealand, 2004)

Frequency level	Score	Description
Very frequent	5	Always occurs in every harvesting activity
Frequent	4	Occurs in most harvesting activities (approximately every 6 months)
Occasionally frequent	3	Tends to occur at certain times (approximately once a year)
Rarely occurring	2	Occasionally occurs under specific conditions (approximately every 5 years)
Rare	1	Occurs only under extreme conditions (approximately once every 10 years)

Table 2 Severity scoring criteria (Standards Australia/Standards New Zealand, 2004)

Severity level	Score	Description
Very severe	5	Incidents resulting in permanent disability or immediate death
Severe	4	Incidents with significant impact that, if left untreated, may lead to disability or death
Moderately severe	3	Incidents such as bone fractures or conditions requiring intensive care for more than 24 hours
Mildly severe	2	Incidents causing pain, soreness, hallucinations, physical disturbances, or minor open wounds, but not requiring intensive care
Not severe	1	Minor incidents such as scratches, slips, stumbles, or falls on the forest floor without significant impact

Table 3 Risk level matrix (Standards Australia/Standards New Zealand, 2004)

		Hazard severity				
		1 (Not severe)	2 (Mildly severe)	3 (Moderately severe)	4 (Severe)	5 (Very severe)
Hazard frequency	5 (Very frequent)	5 (Medium)	10 (High)	15 (High)	20 (Very high)	25 (Very high)
	4 (Frequent)	4 (Medium)	8 (Medium)	12 (High)	16 (High)	20 (Very high)
	3 (Occasionally frequent)	3 (Low)	6 (Medium)	9 (High)	12 (High)	15 (High)
	2 (Rarely occurring)	2 (Low)	4 (Low)	6 (Medium)	8 (Medium)	10 (High)
	1 (Rare)	1 (Low)	2 (Low)	3 (Medium)	4 (Medium)	5 (High)

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Table 4 Sources of hazards in Buloh Seuma wild honey harvesting

Harvesting stage	Sources of hazard	Hazard category based on MoM Regulation Number 5/2018 (Indonesia)
Expedition to and from the harvest site	Boat size and stability River depth Extreme weather conditions Slippery terrain Lack of personal protective equipment (life jacket)	Environment (physical and technical)
	Thorny vegetation Wildlife Encroachers or poachers	Biological and ecological
Forest encampment during harvesting	Extreme weather conditions Limited access to healthcare facilities Limited communication access	Environment (physical and technical)
	Wildlife	Biological and ecological
Harvesting process	Tree height and climbing Low visibility Biomechanical load Harvester's technical skill Lack of personal protective equipment	Environment (physical and technical)
	Bee stings (wildlife)	Biological and ecological

Table 5 Frequency scores of hazards occurrence (Standards Australia/Standards New Zealand, 2004)

Hazard	Findings from interviews with informants	Frequency score
Falling from tree	Very rare; occurred only once	1
Hallucinations	Occurs approximately once a year	3
Seizures	Occurs each harvest season among climbers	3
Bee stings	Very frequent occurrence	5
Slipping	Very frequent, especially during travel to the harvest site	5
Scratches from thorns	Very frequent occurrence	5
Boat capsizing	Occurs fairly often when the boat is unbalanced	3
Musculoskeletal disorders	Frequently occurs post-harvest as muscle pain due to biomechanical strain	4
Wildlife attacks	-	0
Struck by falling trees	-	0
Drowning	-	0
Hypothermia	-	0
Conflict with encroachers or poachers	-	0

Table 6 Severity scores of hazards identified (Standards Australia/Standards New Zealand, 2004)

Hazard	Description	Severity score
Falling from trees	Resulted in fatality.	5
Hallucinations	Harvester became unresponsive.	2
Seizures	Occurred during or after tree climbing.	2
Bee stings	Caused pain and mild fever.	2
Slipping	No significant impact.	1
Scratches from thorns	Minor injuries.	1
Boat capsizing	No significant impact.	1
Musculoskeletal disorders	Required brief rest, did not disrupt harvesting.	2
Wildlife attacks	Causes significant disruption (potential).	4
Struck by falling trees	Causes permanent injury or even fatality (potential).	5
Drowning	Causes significant disruption (potential).	4
Hypothermia	Potentially fatal (potential)	5
Conflict with encroachers or poachers	Potentially fatal (potential)	5

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Table 7 Risk level matrix for hazards in traditional wild honey harvesting (Standards Australia/Standards New Zealand, 2004)

		Hazard Severity				
		1 (Not severe)	2 (Mildly severe)	3 (Moderately severe)	4 (Severe)	5 (Very severe)
Hazard frequency	5 (Very frequent)	5 - Slipping - Scratches from thorns	10 Bee stings	15	20	25
	4 (Frequent)	4	8 Musculoskeletal disorders	12	16	20
	3 (Occasionally frequent)	3 Boat capsizing	6 - Hallucinations - Seizures	9	12	15
	2 (Rarely occurring)	2	4	6	8	10
	1 (Rare)	1	2	3	4	5 Falling from trees

findings align with Putra et al. (2024), who reported that physical and technical factors are the primary determinants of occupational risk in the professional forestry sector. The key difference lies in the relatively stable conditions of professional forestry operations, which are supported by more advanced technical equipment, whereas in the traditional wild honey harvesting of Buloh Seuma, the tools used are highly traditional and manually operated (Table 8). In addition, research on the cognitive dimensions of forestry workers shows that individuals working in professional settings possess a more mature understanding of occupational safety (Yovi et al., 2023). Similar traditional practices are also observed among wild honey–harvesting communities in Sumbawa, Indonesia (Schouten et al., 2019), and in Anuradhapura, Sri Lanka (Madhubhashini, 2022), where harvesting activities are likewise conducted manually without adequate protective equipment.

The hazard sources identified in Buloh Seuma are similarly found in industrial-scale harvesting and Most of the hazard sources identified in Buloh Seuma are also found in industrial-scale forest harvesting as well as in other NTFP utilization practices (Heinrich, 2011; Garland et al., 2020; Sunkar et al., 2022). The patterns of occupational safety challenges are notably similar between professional and traditional harvesting practices. Traditional contexts are linked to increased risk levels owing to extended working hours, remote locations, and inadequate facilities or accessibility. In the peak honey harvesting season, harvesters may remain in the forest for as long as 15 days, utilizing only basic facilities. During certain instances, such as the Eid al-Fitr celebration, harvesters have noted the festivities occurring deep within the forest (MA, *pawang*, December 28, 2024, personal communication). Hamza et al. (2021) highlight that limitations in facilities and accessibility, especially the absence of medical services and communication networks, significantly elevate risk exposure during harvesting activities. Moreover, unpredictable weather conditions, such as heavy rainfall, storms, and lightning, intensify occupational hazards. In Poland, weather-related conditions are recognized as the primary hazard impacting forest harvesting processes (Pecyna et al., 2019).

Furthermore, the use of the boat introduces additional risk factors due to insufficient safety equipment. Sunkar et al. (2022) and Sofi (2015) emphasize that water transport in forest regions presents a considerable risk that necessitates the implementation of mitigation strategies. A comparable scenario occurs in honeycomb extraction, where harvesters forgo protective equipment due to the belief that it impairs work flexibility. Gardinia et al. (2024) highlight that a lack of familiarity with personal protective equipment (PPE) can impair concentration and flexibility, ultimately reducing overall work effectiveness.

Moreover, the harvesting of wild honey in protected areas presents risks influenced by biological and ecological factors, especially as this activity takes place within the protection block, which serves as the biodiversity epicenter of RSWR. Harvesters encounter direct risks from wildlife interactions and dangerous vegetation, given that harvesting locations coincide with the territories of the Sumatran tiger (*Panthera tigris sumatrae*) and the habitats of the saltwater crocodile (*Crocodylus porosus*) (Rahmi, 2018). Classical threats, including stings from wild bees during nest collection, continue to pose a significant risk (Purnaya et al., 2025).

Risk level based on matrix of AS/NZS 4360 Two hazards were classified as high-risk, five as medium-risk, one as low-risk, and five as potential hazards that had not yet occurred, based on the combination of hazard frequency and severity. The assessment was informed not only by the quantitative score derived from the multiplication of frequency and severity but also by the actual impact of each incident. For example, thorn scratches and falling from a tree both received a total score of five; nonetheless, their risk classifications varied. Thorn scratches were classified as medium-risk due to their association with minor injuries, while falling from a

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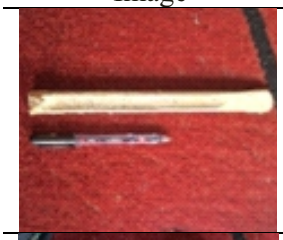
Table 8 Manual and traditional tools

Image	Tool name	Function
	*Pateng*	Made of bamboo, used as foot pegs inserted into the tree trunk to assist climbing.
	*Gulugo* (wooden mallet)	Used to hammer the *pateng* into the tree trunk.
	*Beunang* (rope)	Used to tie the basin and lower the honeycomb from the tree; traditionally made from rattan.
	Bucket or basin	Used as a container to collect and lower the honeycomb.
	*Tunam*	Burned to produce smoke, which is used to drive bees away from the hive.
	*Menung*	Used to pry the honeycomb off the tree surface.

tree was designated as high-risk because of its potential to result in fatalities. Based on inventory data from the Aceh Natural Resources Conservation Agency (BKSDA Aceh), this tree belongs to the species *Alstonia pneumatophora*, which can reach a height of up to 40 m.

In Buloh Seuma, 69% of hazard incidents during traditional wild honey harvesting are attributed to physical environmental factors and the technical skills of the harvesters. This finding aligns with the research conducted by Yovi et al. (2019), which indicated that human physical capacity accounts for 72% of work in the forestry sector. The Buloh Seuma community has historically addressed these risks through a precautionary principle based on collective experience, passed down through generations (MA, *pawang*, December 28, 2024, personal communication). This experience-based approach is consistent with the findings of Santriyana et al. (2023), which highlight that high-risk tasks should be undertaken by individuals possessing sufficient experience and competence in the respective field.

Two hazards were identified as high-risk: bee stings (*Apis dorsata*) and falls from trees. The International Labour Organization (2025) emphasizes that both hazards must be prioritized to ensure occupational safety in traditional wild honey harvesting in Buloh Seuma. Bee stings frequently occur among harvesters and are typically regarded as a standard aspect of the occupation. From a medical perspective, bee stings can induce significant clinical reactions and may result in fatality (Topal et al., 2019; Matindas et al., 2022). Conversely, falls from trees are infrequent; however, their outcomes can be lethal, as demonstrated by a singular event in Buloh Seuma that led to a death. To mitigate these risks, harvesters in Buloh Seuma utilize spiritual practices, including the recitation of specific prayers that have been transmitted through generations. These practices can enhance confidence, promote calmness and caution, and stimulate the release of oxytocin, contributing to physical resilience (Haris et al., 2025).

Alongside high-risk hazards, additional risks, including limb disorders, slips, scratches from thorns, hallucinations, seizures, and capsized boats were classified as moderate to low risks. The accumulation of these incidents, while not fatal, may lead to significant accidents if they occur

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simultaneously or repeatedly. This corresponds with Reason's (2000) Swiss Cheese Model, which illustrates how multiple vulnerabilities within a safety system can culminate in significant failures. When a harvester experiences hallucinations while on a tree, diminished concentration may elevate the risk of falling. Consequently, moderate to low risks necessitate systemic management via educational and adaptive strategies.

Risk mitigation in traditional wild honey harvesting in Buloh Seuma The low occurrence of accidents during wild honey harvesting in Buloh Seuma suggests the existence of local knowledge and informal regulations that serve to mitigate risks. This knowledge has been transmitted across generations, establishing an internal collective system within the Buloh Seuma community. Table 9 presents locality-specific interventions that govern occupational safety within the wild honey harvesting tradition of Buloh Seuma. The interventions have been influenced by the experiences of harvesters, focusing on spiritual and cultural values that lack formal codification.

The presence of these mitigation practices demonstrates that the Buloh Seuma community recognizes the risks associated with wild honey harvesting and has formulated localized strategies to mitigate them. Forest product harvesters, in both professional and traditional settings, acknowledge the implications of their activities, yet frequently overlook them (Yovi et al., 2019). Local interventions in Buloh Seuma exhibit alignment with contemporary mitigation strategies when contrasted with theoretical approaches. The *peusijuek* ritual, designed to mentally prepare harvesters, corresponds with the notion of mental preparedness, which improves focus (Dhuhri et al., 2024). The recitation of prayers or mantras for protection exemplifies a form of transcendental communication that may enhance calmness and optimism among harvesters (Gufran & Amrillah, 2022). The practices indicate that wild honey harvesting in Buloh Seuma transcends economic motivations, embodying a tradition that links the community to nature and their environment (MA, *pawang*, December 24, 2024, personal communication). Comparable practices exist within the Muna ethnic community in Southeast Sulawesi, where transcendental communication occurs during an agricultural ritual referred to as *Kapontasu* (Hardin, 2016).

The strict selection of *pawang* members exemplifies an administrative control mechanism that corresponds with the National Institute for Occupational Safety and Health (NIOSH) risk management hierarchy (2024) (Figure 2). This tradition is believed to have existed prior to 1945 (Hermaliza et al., 2022), well before the establishment of NIOSH in 1970. This indicates that conventional assessment frameworks are pertinent to contemporary risk management principles (Yovi et al., 2021; Hinze et al., 2022). The selection process guarantees that only individuals considered competent and physically and mentally fit are permitted to participate in high-risk activities. Comparable practices have been documented in traditional wild honey harvesting communities in India and Kenya (Deori et al., 2016; van der Wal et al., 2022).

Local honey harvesters indicate that each individual typically endures a minimum of ten bee stings, which are generally regarded as non-threatening to health. Thus, performing harvesting activities during nighttime is regarded as an effective approach to reduce the risk of bee stings, which are a significant hazard. This is consistent with the biological traits of bees as diurnal species, whose aggressiveness diminishes at night (Young et al., 2021; Pattikawa et al., 2023). Harvesting typically commences when moonlight diminishes, a phenomenon locally known as *loeb buleun*. This condition limits the visibility of harvesters, thereby increasing their exposure to hazards, in line with the findings of Kustianto et al. (2023) concerning occupations performed under restricted visibility. Engaging in physically demanding activities at night disrupts the human circadian rhythm, increasing the risk of disturbances such as hallucinations and seizures (Sefrina, 2021). The phenomena are closely associated with various documented incidents in the traditional wild honey harvesting practices of Buloh Seuma.

Table 9 Local intervention as a risk mitigation

Local intervention	Description	Implication
Peusijuek and prayer recitation	Prior to the commencement of harvesting activities, the *pawang* conducts the *peusijuek* ritual and recites prayers to ensure safety and facilitate the smooth execution of the process. This ritual functions as a means of spiritual communication that enhances the mental readiness of the harvesters.	It serves as a non-physical safeguard, purportedly shielding against misfortune while promoting inner tranquility and increased awareness during the harvesting process.
Selection of *pawang* members	Participation in the team is restricted to men who have successfully undergone traditional selection, evaluated on the basis of courage, experience, and composure under pressure.	This functions as a mechanism of social control that evaluates individuals according to qualities considered culturally suitable for managing high -risk situations.
Nighttime harvesting	Harvesting occurs at night under low moonlight conditions to mitigate the activity of diurnal bees.	The modification of harvesting schedules in response to bee behavior exemplifies a traditional ecological adaptation designed to minimize the risk of stings.

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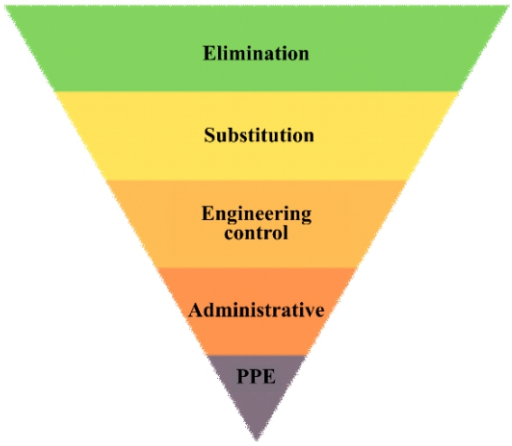

Figure 2 Risk management hierarchy (National Institute for Occupational Safety and Health, 2024).

Conclusion

This study illustrates that the practice of wild honey harvesting in Buloh Seuma is structured by a system of work that relies on local knowledge, spiritual values, and collective experience, yet it remains unincorporated into contemporary occupational safety measures. Sixteen hazards were identified across the three primary stages of harvesting, with 78.6% primarily influenced by physical and technical environmental factors. Eight incidents have been reported, with two—bee stings and falls from trees—classified as high-risk. The findings highlight that the community recognizes the high-risk nature of wild honey harvesting and has implemented locality-specific mitigation strategies, such as rituals, prayers, selective recruitment of harvest team members, and the scheduling of harvesting times. These strategies, while simple, demonstrate scientific relevance, reduce occupational accidents, and show that traditional knowledge can be effectively analyzed through a multi-disciplinary approach.

Recommendation

To ensure the practicality of these recommendations, the actions proposed here follow a phased implementation pathway. Immediate actions (0–3 years) focus on documenting existing practices, developing culturally compatible safety prototypes, and piloting community-based training. Mid-term strategies (3–5 years) involve operationalizing participatory monitoring teams and formalizing traditional-use blocks through agreements between honey harvesters, village authorities, BKSDA Aceh, and the district government. Long-term institutional support (>5 years) should center on integrating these community-based safety standards into district-level livelihood programs and national sustainable forest management policies. Establishing a simple monitoring and evaluation scheme—such as annual participatory safety assessments—would help track progress and refine these interventions. Collectively, these steps provide a practical and multi-level pathway for reducing occupational risks while sustaining traditional honey harvesting practices.

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