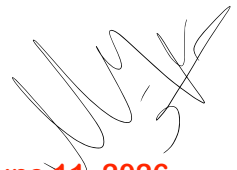


QUALITATIVE STUDY ON STRONG WIND HAZARDS AND SAFETY MANAGEMENT AT TANJUNG PIAI NATIONAL PARK USING THEMATIC ANALYSIS

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Abstrak

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Penelitian ini bertujuan untuk mengeksplorasi praktik pemantauan kondisi angin serta tantangan keselamatan yang dihadapi di Taman Nasional Tanjung Piai, Malaysia, sekaligus merekomendasikan perbaikan untuk memperkuat manajemen risiko angin. Pendekatan kualitatif digunakan dalam studi ini melalui metode analisis tematik terhadap data yang diperoleh dari wawancara mendalam dengan staf taman nasional. Hasil analisis mengungkap lima tema utama, yaitu ketidakpastian lingkungan dan pola cuaca, keterbatasan sistem pemantauan angin saat ini, kebutuhan akan solusi teknologi, variabilitas kondisi angin berdasarkan lokasi, serta faktor eksternal seperti kerusakan akibat cuaca ekstrem dan gangguan dari satwa liar. Praktik yang ada saat ini bergantung pada observasi manual, aplikasi cuaca, serta tanda-tanda alami seperti gerakan awan dan pepohonan. Meski menunjukkan kepekaan dan pengalaman staf, pendekatan ini tidak mampu memberikan peringatan secara real-time. Berdasarkan temuan tersebut, penelitian merekomendasikan penerapan sistem pemantauan dan peringatan angin berbasis lokasi dan waktu nyata, menggunakan sensor tahan cuaca yang ditempatkan secara strategis di area berisiko tinggi seperti dermaga dan wilayah pesisir. Sistem ini dilengkapi dengan mekanisme peringatan visual dan audio untuk pengunjung serta akses jarak jauh bagi pengelola taman, dengan desain tahan terhadap kondisi lingkungan ekstrem dan gangguan dari satwa liar. Temuan ini mendukung urgensi peningkatan infrastruktur keselamatan untuk menciptakan ekowisata yang lebih aman dan tangguh terhadap perubahan cuaca ekstrem.

Kata kunci: angin kencang, manajemen risiko, taman nasional, pemantauan cuaca, analisis tematik, keselamatan pengunjung.

Abstract

This research aims to explore wind condition monitoring practices and safety challenges faced in Tanjung Piai National Park, Malaysia, and recommend improvements to strengthen wind risk management. A qualitative approach was used in this study through thematic analysis of data obtained from in-depth interviews with park staff. The analysis revealed five main themes: the uncertainty of the environment and weather patterns, the limitations of the current wind monitoring system, the need for technological solutions, the variability of wind conditions by location, and external factors such as damage from extreme weather and disturbance from wildlife. Current practices rely on manual observation, weather apps, and natural cues such as cloud and tree movements. While this demonstrates staff sensitivity and experience, it is not capable of providing real-time alerts. Based on the findings, the research recommends implementing a real-time, location-based wind monitoring and warning system, using weatherproof sensors strategically placed in high-risk areas such as docks and coastal areas. The system is equipped with visual and audio warning mechanisms for visitors and remote access for park managers, and is designed to withstand extreme environmental conditions and wildlife disturbances. The findings support the urgency of improving safety infrastructure to create safer and more resilient ecotourism against extreme weather changes.

Keywords: strong winds, risk management, national parks, weather monitoring, thematic analysis, visitor safety.

1. Introduction

Weather plays a crucial role in the planning and management of ecotourism areas, especially those located along coastlines. Sudden changes in weather conditions such as heavy rain, storms, or strong winds can significantly impact not only the safety of visitors but also the sustainability of the habitats. These coastal regions are

often sensitive to climate changes, where short term weather fluctuations can lead to long term environmental consequences. The dynamic nature of coastal weather patterns, influenced by ocean currents, tides, and atmospheric pressure changes, requires constant observation and understanding to anticipate potential hazards

As ecotourism continues to grow in popularity, especially in biodiverse regions, there is an increasing need to integrate environmental monitoring systems that support both visitor safety and conservation efforts. These systems can include tools such as weather sensors, wind speed detectors, and real-time data platforms that help anticipate hazardous conditions and inform timely decision-making. In areas rich with delicate ecosystems, even minor disturbances can have lasting ecological impacts, making proactive monitoring all the more essential. One such area where this concern is becoming more evident is in Malaysia's Tanjung Piai National Park.

Tanjung Piai National Park, located in Johor, Malaysia, is a significant ecological and tourist site known for its unique mangrove forests and rich biodiversity. However, the park faces challenges related to unpredictable and strong wind conditions, which pose safety risks to visitors and can disrupt park operations. Currently, the park management relies primarily on manual weather observations and the experience of staff to monitor wind conditions, as there is no installed wind speed detection system.

Strong winds can cause falling trees, damage to facilities, and interruptions to visitor activities, thereby affecting the overall safety and visitor experience. These conditions not only present physical dangers, but they can also impact the smooth operation of the park and reduce the overall enjoyment of those visiting the area. Despite these risks, there is limited formal infrastructure or technology in place to provide real time alerts or warnings that could help prevent accidents or allow for quick responses. The absence of reliable warning systems leaves both visitors and park staff more vulnerable during sudden changes in weather.

Understanding the current challenges and safety measures in place is essential to developing effective solutions that are practical, efficient, and capable of improving safety standards. This understanding can also guide future improvements in park management, ensuring that both environmental preservation and visitor well-being are prioritized.

Cases that are similar to the one in Tanjung Piai National Park are areas such as the following. Louisiana, USA (Mississippi Delta), and Coastal Vietnam (Mekong Delta). Louisiana, USA (Mississippi Delta) fought of wind related problems by Coastal Wetland Restoration in which projects like the coastal wetlands planning, protection and restoration act focus on restoring marshes and wetlands to absorb wind energy (Thomas, 2024). Doppler Radar and Hurricane Forecast Centers in which the national hurricane center uses doppler radar and satellite for precise wind monitoring and early warnings, and Community Evacuation Plans in which the local government conducts regular hurricane drills, and evacuation route planning. Coastal Vietnam (Mekong Delta) also has its own methods in handling strong wind

such as the following Mangrove Rehabilitation in which areas like Ca Mau province has extensive mangrove restorations project to strengthen natural coastal defenses against wind and waves (Nguyen, 2021). and Typhoon Early Warning in which Vietnams national center for hydro meteorological forecasting provides real time updates and warnings. As can be seen in the comparison above Tanjung Piai National Park has mangroves but needs replanting and protection, it also has a lack of engineered solutions such as a wind warning system.

This research is aimed to provide a qualitative analysis of the wind-related challenges and existing safety practices at Tanjung Piai National Park by drawing insights from a park staff member's experience, which serves as a valuable source of first-hand information. Through this approach, the study seeks to gain a clearer understanding of the current conditions and the measures already in place to handle wind-related risks. By closely examining the experiences shared by the staff, the research intends to highlight specific areas where the park's safety strategies may fall short or require improvement, as well as to identify opportunities where enhancements can be made to strengthen overall preparedness and response to strong wind events.

In this study the method that will be used is thematic analysis. Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data. It minimally organizes and describes your data set in rich detail (Braun, 2006). Another definition of it can be worded as the following Thematic analysis is a qualitative research method that is used for systematically identifying, organizing, and offering insight into patterns of meaning (themes) across a dataset (Nowell, 2017). Based on these two definitions it can be concluded that thematic analysis is a flexible and systematic method used to identify, analyze, and interpret patterns of meaning (themes) within qualitative data. Because of the type of data that will be taken for this research the method that will be used is thematic analysis. This approach is especially suitable for the current study, which focuses on understanding wind-related challenges and safety practices at Tanjung Piai National Park based on insights from a park staff member. By using thematic analysis, the study can effectively capture and interpret key themes related to the park's current response to strong winds, gaps in safety procedures, and opportunities for improvement, all grounded in the lived experience of those directly involved in managing the site.

The objective of this qualitative analysis is to explore potential practices and solutions for monitoring wind conditions at Tanjung Piai National Park, while also recommending possible improvements, including technological interventions to enhance wind-related risk management and safety measures within the park.

2. Research Methods

This report begins by examining the issues found in Tanjung Piai National Park, particularly the potential hazards caused by strong winds and the concerns surrounding safety management. The purpose of this examination is to identify the specific challenges that may affect both the environment and the well-being of visitors to the park. This initial stage of observation and data gathering was conducted thoroughly by the students on 14 January 2025, during a field visit to Tanjung Piai National Park. The Park is located at Taman Negara Johor Tanjung Piai Mukim, 82030 Kukup, Johor Darul Ta'zim, Malaysia, and is known for its coastal geography, which makes it more susceptible to strong wind conditions and related safety risks.

The next step was to formulate the research problem. In this case, the key issues addressed include how wind conditions are currently monitored at Tanjung Piai National Park and the limitations of these practices. It also involves identifying the specific challenges posed by strong winds to visitor safety and park operations, which can include disruptions to scheduled activities, damage to infrastructure, or heightened risks during extreme weather events. Furthermore, the research examines the safety measures and response strategies that are currently in place to manage such risks, evaluating their effectiveness in real-world conditions. Finally, the study aims to explore what improvements can be recommended to strengthen wind risk management and preparedness in the park, ensuring a safer and more resilient environment for both visitors and park staff.

The problem formulations then became the basis for the research objectives of this report. These objectives include exploring the potential practices for monitoring wind conditions at Tanjung Piai National Park and recommending potential improvements, including technological solutions, to enhance wind risk management in the park. It can be concluded that the main focus of this research is to identify and analyze the hazardous wind conditions and the existing safety management methods implemented within Tanjung Piai National Park. Which is followed by finding potential solutions and recommendations. These elements serve as the core research objects and are systematically analyzed using the thematic analysis method.

To support these objectives with relevant and practical data. The primary method of data collection in this research involves an in-depth interview with a staff member of Tanjung Piai National Park to obtain firsthand insights into the local environmental conditions and challenges. Additionally, a comprehensive on-site survey of the research area was conducted to gather observational data and assess the current situation in greater detail.

Once sufficient data in the form of interview answers are collected, the next step of this report is to process and analyze the data to extract meaningful insights. The chosen method for this stage is thematic analysis, a qualitative research approach that allows for the identification, analysis, and interpretation of patterns or themes within the data. This method begins with familiarizing oneself with the responses, followed by generating initial codes that highlight significant features relevant to the research objectives. These codes are then grouped into overarching themes that reflect the key issues, concerns, and suggestions shared by the interviewee. By using thematic analysis, the research is able to provide a structured and in-depth understanding of the challenges and opportunities related to wind condition monitoring and safety management at Tanjung Piai National Park.

3. Results and Discussion

Codes

The following are the results that were gotten for the research based on the utilization of the thematic analysis qualitative method

Explanation of the Codes from Each Theme

Codes were developed through a systematic breakdown of the interview transcript, identifying recurring concepts, observations, and concerns shared by the park staff. Each code reflects a distinct data point or insight, categorized under broader thematic concerns the following is an explanation of each coded answer in this report:

Table 1. Environmental and Weather Conditions Codes

No.	Codes	Explanation
1	Recognition of Recurring Weather Pattern	Staff recognize certain dates or times when strong winds are likely, based on prior occurrences. This shows pattern recognition from experience, even without instruments.
2	Experience-Based Wind Forecastin	Weather predictions are made intuitively by experienced staff rather than through formal tools.

Table 2. (Cont) Environmental and Weather Conditions Codes

No.	Codes	Explanation
3	Unpredictability of Wind Strength	Weather conditions have become less consistent, possibly due to climate change, making manual observation unreliable.

4	Dependence on Broader Weather Conditions	Wind behavior is linked to broader environmental factors like monsoon seasons or rain, rather than local-only indicators.
5	Climate Change Impact on Weather Patterns	Historical seasonal trends have shifted, making strong winds more irregular and difficult to predict.
6	Wind Flow Changes Due to Landscape	Trees and natural structures reduce or redirect wind flow, altering wind behavior in various park zones.
7	Localized Wind Variability	Wind speed differs even within short distances; one area may be calm while another is dangerous.
8	Prolonged Duration	Strong winds typically last 2 hours but can continue all day during certain conditions
9	Common Times	Early morning and evening are reported as times when strong winds are more frequent.

Tabel 3. Wind Monitoring and Safety Measures Codes

No.	Codes	Explanation
1	Lack of Real-Time Wind Indicators	No wind speed detectors are installed; staff rely on mobile weather apps or direct observation.
2	Need for Transparent Wind Monitoring System	Staff need tangible, visible evidence to support safety decisions, especially for skeptical visitors.

Tabel 4. (Cont) Wind Monitoring and Safety Measures Codes

No.	Codes	Explanation
3	Visitor Skepticism About Weather Warnings	Visitors sometimes do not believe warnings due to the absence of physical proof, which delays compliance.

4	Geographical Discrepancy in Wind Conditions	Certain areas are more wind-prone, making uniform safety protocols less effective.
5	Management's Role in Weather Safety Decisions	Decisions to halt activities or evacuate areas are made by park management based on manual judgment.
6	Operational Halts Due to Strong Winds	Park activities are paused during hazardous conditions for visitor safety, but these pauses are based on subjective assessments.
7	Safety Warnings for Visitors	Staff warn visitors directly during dangerous conditions, often patrolling by bicycle.
8	Ensuring Visitor Compliance with Safety Protocols	Staff need to enforce rules, which can be difficult when visitors doubt the danger or ignore instructions.

Tabel 5. Technological Solutions Codes

No.	Codes	Explanation
1	Reliance on Digital Weather Forecasting	Staff use phone apps, though they recognize these are not always accurate for local wind conditions.
2	Preference for Technological Solutions Over Observation	Staff prefer to use technology because it offers clearer evidence and easier communication with visitors.
3	Access to Real-Time Wind Speed Data	Real-time feedback is viewed as critical to quick response and public communication.

Tabel 6. (Cont) Technological Solutions Codes

No.	Codes	Explanation
4	Need for a Localized Monitoring System	The Park would benefit from sensors that measure conditions specifically in Tanjung Piai.

5	Proposed Solution: Displaying Real-Time Wind Data	Displaying live wind speed near entrances and main paths could improve compliance and trust.
6	Limitations of Existing Weather Apps	Generic apps may not reflect the true conditions inside the park due to localized environmental differences.
7	Weather Durability	Equipment must survive extreme conditions, including heavy rain and environmental corrosion.
8	Immediate Alerts	Fast, automatic alerts are needed for safety—delays could result in injury or confusion.
9	Alert Mechanisms	Suggestions include warning lights, loudspeakers, and SMS alerts to inform staff and visitors.

Tabel 7. Location-Based Wind Variability Codes

No.	Codes	Explanation
1	Wind Strength Variability Across Locations	Wind is not uniform some spots have stronger gusts, while others remain relatively calm.
2	Impact of Physical Barriers on Wind Flow	Trees and buildings affect wind strength acting as shields or wind tunnels depending on layout.
3	Need for Multi-Site Wind Data Collection	A single sensor may not reflect all conditions multiple sensors are required for accuracy.

Tabel 8. (Cont) Location-Based Wind Variability Codes

No.	Codes	Explanation
4	Microclimatic Differences in Small Areas	Even short distances within the park experience different weather due to

		vegetation or elevation.
5	Jeti Tiga Negara	Identified as a high-risk location due to tall trees and openness to sea winds.
6	Coastal Areas	Exposed zones near the sea are more affected by strong gusts than forested areas.

Tabel 9. Wildlife and Environmental Factors Codes

No.	Codes	Quote
1	Potential Disruptions from Wildlife	Animals such as monkeys may tamper with or damage equipment, affecting reliability.
2	Need for Protective Measures Against Animal Interference	Equipment must be encased or protected to avoid tampering.
3	Weather-Related Damage to Infrastructure	Past examples show the vulnerability of structures.
4	Human Interaction with the Natural Environment	Tourists' presence affects the environment, and risks impact visitor safety.
5	Vulnerability of Infrastructure to Natural Events	Facilities are not designed to withstand constant strong winds or floods.
6	Effects of Wind on Local Ecosystem	Strong winds displace animals and damage plant life, changing the natural balance.
7	No Recent Injuries	Despite damage and risk, there have been no major recent injuries possibly due to staff vigilance.

Themes

The following are the themes that were based for the research based on the utilization of thematic analysis method that is used from the data gathered by interviewing park rangers that work in Tanjung Piai National Park

Environmental and Weather Conditions

This theme focuses on how the natural patterns, unpredictability, and changing climate impact Tanjung Piai. Based on the thematic analysis the staff expressed a clear need for technological support, particularly wind

speed detectors that are capable of providing real time alerts and able to withstand environmental hazards such as rain and corrosion. Staff members rely heavily on experience and visible natural indicators such as sudden gusts, accelerated cloud movement, or intense tree swaying to anticipate strong winds. The weather has also become more erratic in recent years, which the respondent attributed to climate change. Strong winds typically occur during early mornings or evenings and may last several hours, sometimes continuing throughout the day if accompanied by rain. These findings align with the first research objective, which is to explore current practices for wind monitoring. It is evident that although staff have developed intuitive methods for weather prediction, these approaches lack formal structure and real-time accuracy.

Wind Monitoring and Safety Measures

This theme addresses the current safety procedures and their limitations. The Park lacks technical tools. The Tanjung Piai National Park currently has no wind speed detection instruments in place. Monitoring is conducted manually, using weather applications and staff judgment. In hazardous situations, management temporarily halts park operations and notifies visitors. However, staff have reported skepticism from some visitors due to the absence of tangible proof of danger. This theme directly addresses the second and third research questions: the limitations in current monitoring practices and the safety challenges posed by strong winds. The lack of reliable indicators increases the risk to both visitors and infrastructure, especially in high-risk areas like the jetty and open coastal zones.

Technological Solutions

This theme highlights the park's need for technological upgrades, such as real-time sensors, warning systems, and localized apps. The staff expressed a clear need for technological support, particularly wind speed detectors capable of providing real-time alerts and withstanding environmental hazards such as rain and corrosion. Preferred alert mechanisms include visible warning lights and audio announcements. Real-time data visibility is emphasized to enhance credibility with visitors and streamline safety responses. This theme supports the fourth research objective, which is to recommend improvements for wind risk management. The adoption of robust and localized monitoring technology is crucial for improving operational efficiency and visitor safety.

Location-Based Windy Variability

This theme explains how different zones in the park face different wind risks. Wind conditions vary significantly across the park. For example, Jeti Tiga Negara has tall trees and open paths, while inland forested zones are more protected. Open coastal areas are more exposed, while tree-covered zones near the jetty offer partial shielding. These differences highlight the need for

a multi-sensor system that can capture wind behavior at various locations within the park. Understanding these variances is vital for implementing targeted safety measures and choosing optimal sites for future detector installation.

Wildlife and Environmental Factors

This theme brings attention to external threats like wildlife tampering and natural wear. Additional risks that derived from environmental and ecological elements, such as fallen trees caused by strong winds and potential equipment interference from wildlife such as monkeys. The infrastructure is also vulnerable to natural elements like corrosion and heavy rain, showing a need for durable solutions.

Summary of Research

Based on the information above there are a couple of points that can be summarized such as the following:

1. Wind monitoring at Tanjung Piai. Wind behavior at the park is unpredictable and varies across locations. Staff rely on natural signs such as cloud movement and tree sway to anticipate strong winds.
2. Wind Monitoring and Safety Measures. Monitoring is conducted manually, and safety responses involve halting operations and warning visitors. However, the absence of a real-time monitoring system creates challenges in ensuring timely, evidence-based decisions. There is no existing wind detection system, leading to credibility issues and limited preparedness.
3. Technological Solutions. There is a strong need for tools such as real-time wind speed detectors that are durable, remote-accessible, and capable of sending alerts to both staff and visitors.
4. Location-Based Wind Variability. Different areas within the park experience different wind intensities. This justifies the need for a multi-sensor setup that can capture localized wind conditions.

Wildlife and Environmental Factors. The infrastructure is vulnerable to damage from strong winds, rain, and wildlife. Any monitoring solution must consider these environmental stressors.

4. Conclusion

This study aimed to explore potential practices for monitoring wind conditions at Tanjung Piai National Park and to recommend improvements to strengthen wind risk management. Through a qualitative approach using thematic analysis, five key themes were identified, highlighting environmental unpredictability, limitations in current monitoring methods, the need for technological solutions, location-specific wind variability, and environmental threats such as wildlife and weather

damage. The research identified both existing and potential practices. Currently, wind condition monitoring at the park depends on a combination of weather applications, staff observation, and natural indicators such as cloud movement and tree sway. While these methods show the staff's experience and environmental awareness, they lack consistency, and the ability to provide real-time alerts. Through thematic analysis, several potential solutions were revealed, including real-time sensor usage, localized monitoring, and visitor-facing alert systems, all of which align with the park's ecological setting and operational needs. The research recommends a clear solution which is the implementation of a real-time, location-based wind monitoring and alert system. This system would involve strategically placed, weather-resistant sensors in high-risk zones such as the jetty and coastal areas. The solution includes visual and audio alert mechanisms to inform both staff and visitors, remote access for park management, and design features that withstand harsh environmental conditions and potential interference from wildlife.

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