Wanagama Healing Forest Hazard Risk Assessment: Balancing Traditional Healing Practices and Public Health Safety

Ratih Madya Septiana [1*], *Nunuk* Supriyatno[1], *Dwiko Budi* Permadi[1], *Intan* Pratiwi[1], *Khoirunisa* Rahmatika[1]

[1]Faculty of Forestry, Universitas Gadjah Mada, Indonesia

Abstract. One of the benefits of forests for humans is forest therapy (healing forest). Wanagama Healing Forest (WHF) has a tracking path accessible for forest-healing activities. Tracking path safety must be addressed to ensure visitors feel safe and comfortable. Objectives are to (1) identify hazards along the WHF tracking path, (2) assess exposure pathways and risk levels for users and practitioners, and (3) recommend culturally sensitive risk-management strategies that preserve traditional practices while reducing health risks. Methods combine qualitative and quantitative approaches: participatory ethnobotanical surveys and semi-structured interviews with healers and users; observational assessments of hazards; and a structured risk assessment using Hazard Identification, Risk Assessment, and Risk Control (HIRARC) along the tracking path. The research was conducted on a tracking path in WHF. The tracking of path safety and physical condition was evaluated in accordance with SNI 9006:2021 on Forest Tourism for Health Therapy. The results of the study show that the criteria affecting visitor safety are wind speed and storage, while the dominant factors affecting visitor insecurity are temperature. If, based on the physical site, the tracking path is suitable for the development of a promotive orientation with an increase in the unsafe segment, then, for the spiritual site criteria, it is suitable for the development of curative, preventive, rehabilitative, and palliative orientations with an increase in the unsafe segment. Furthermore, risk assessment and control using HIRARC revealed that the dominant high-risk category was tripping over a stone. The dominant moderate risk was the fall of dead trees. The dominant low risk was being punctured/scratched by plant thorns. Control efforts include eliminating potential sources of hazard, replacing unsafe segments, building and repairing infrastructure, installing warning signs, and using personal protective equipment (PPE).

1 Introduction

Social restrictions during the pandemic can affect mental health, so people need facilities or spaces for mental health therapy that are equipped with guaranteed safety and health

* Corresponding author: ratihmadya.s@ugm.ac.id

protocols. An ideal environment for mental health therapy is a key factor in preventing stress. The criteria for this ideal environment include providing inner peace, comfort, safety, and happiness for an individual, thereby allowing the body to suppress the release of stress-inducing hormones such as adrenaline and cortisol.

One alternative location for stress management therapy is the forest. Forests in Indonesia hold significant potential in the form of biodiversity of flora and fauna, which constitute a valuable asset of forest resources for this nation. The vast potential of forests enables them to provide a range of ecosystem services, including cultural services—that is, benefits such as comfort, inspiration, recreation, psychosocial well-being, beauty, aesthetics, and health [4] [6][11]. The type of cultural service provided by forests is the forest as a healing and therapeutic tool, or healing service. Forest therapy has healing effects that are directly linked to the five human senses: sight, hearing, taste, smell, and touch. Forest therapy has been shown to reduce stress and depression, improve metabolic function, and boost the immune system, all of which positively impact the body [2][3] [10] [13].

Wanagama University Forest is an educational forest located in the sub-districts of Playen and Patuk, Gunungkidul Regency, Special Region of Yogyakarta. The Wanagama educational forest was originally associated with the term "rocky soil," which described how critically degraded the land was due to forest exploitation during the Dutch colonial era. In its early stages of development, the Faculty of Forestry at UGM was granted management rights over a 10-hectare forest area in Plot 5, which became the foundation for the development of Wanagama forest management. Subsequently, thanks to the efforts of the academic community of the UGM Faculty of Forestry, local stakeholders, and the community in reforesting the Wanagama forest by planting various pioneer plant species, Wanagama Forest was able to recover from its critical phase and provide benefits to the surrounding community—ecologically, economically, and socially [14][15]. Wanagama then underwent development and expansion, covering a total area of 622 hectares divided into 8 plots with high natural potential. Wanagama Forest is an integrated ecosystem with unique characteristics in topography, rock layers, soil types, hydrological systems, microclimate, flora and fauna, experimental planting plots, and socio-economic interactions with the surrounding community. The potential embedded in Wanagama Forest serves as the foundation for forest management activities with diverse functions, including Wanagama's role as an eco-tourism destination rooted in environmental conservation. The development of Wanagama Forest into an eco-edu forest is a strategic approach to managing the forest to preserve the uniqueness and authenticity of its ecosystem.

Additionally, the eco-edu forest can serve as both a tourist destination and an educational facility. Wanagama Eco-Edu Forest currently offers various tourist attractions, including outdoor activities, water-based tourism, forest healing, aromatic plant gardens, camping grounds, Wanagama Bird Park, Wanagama Honey, Pawon Alas resto, and a wood museum. This nature tourism destination is supported by scenic natural landscapes and attractive water sources, complemented by camping facilities, walking trails, hiking, jogging, and cycling, as well as lodging, meeting rooms, joglo (traditional Javanese pavilions), an auditorium, a multipurpose hall, a cafeteria, and a parking area. Facilities and infrastructure for the forest healing hiking trail that do not meet standards can increase the risk of accidents for visitors. Accidents can result in both material and immaterial losses. Therefore, it is important to design the hiking trail at Wanagama Forest Healing. Moreover, the forest healing hiking trail under study is a newly opened trail, officially inaugurated on February 26, 2022, and measuring 1.11 km.

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identify hazards along the WHF tracking path, (2) assess exposure pathways and risk levels for users and practitioners, and (3) recommend culturally sensitive risk-management strategies that preserve traditional practices while reducing health risks.

2 Methods

Primary data were collected directly in the field through observation (direct observation of the research subjects), measurements, and interviews with Wanagama managers, conducted using an interview guide. Meanwhile, secondary data includes Wanagama profile data and the 2021 Wanagama ArcGIS Map. Additionally, the study used a literature review to inform data collection and analysis. The literature review is based on the SNI Standard 9006:2021 on Forest Tourism for Health Therapy. The data to be collected includes: Primary data includes the condition of the hiking trails, pavement type, slope, trail length, trail width, vegetation density, light levels, noise levels, wind speed, humidity, ion levels, and hazard risks. Secondary data is obtained from documents related to the Wanagama profile and the Healing Forest. Figure 1 shows the map of compartment 5.

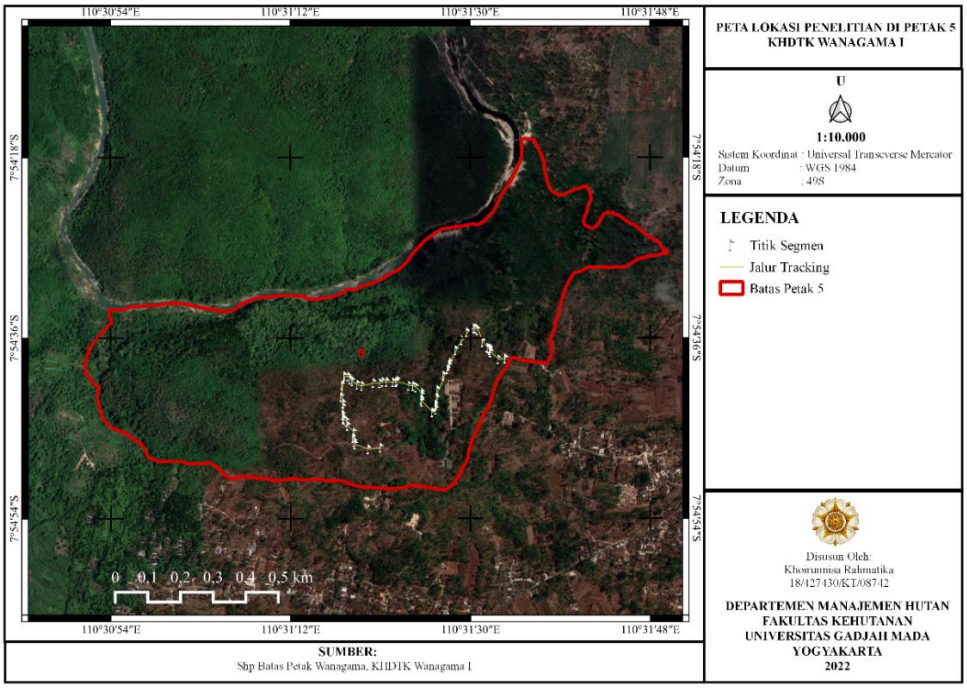

Fig. 1. Compartment 5 of Wanagama University Forest

Methods combine qualitative and quantitative approaches: participatory ethnobotanical surveys and semi-structured interviews with healers and users; observational assessments of hazards; and a structured risk assessment using Hazard Identification, Risk Assessment, and Risk Control (HIRARC) along the tracking path. The research was conducted on a tracking path in WHF. The tracking of path safety and physical condition was evaluated in accordance with SNI 9006:2021 on Forest Tourism for Health Therapy.

3 Result and Discussion

The forest healing trail is the primary access route for visitors to enjoy Wanagama's forest healing experience. The trail's topography ranges from flat to relatively steep and undulating, with one side sloping along parts of the route. The minimum annual air temperature in the Wanagama University Forest is 23.1°C, the maximum is 32.4°C, and the average is 27.7°C. Average humidity ranges from 80–90%. Humidity is highest from January to March and lowest from August to September. The average wind speed is 11.75 knots (5.99 m/s), with a minimum of 6.17 knots (3.17 m/s) and a maximum of 19 knots (9.69 m/s). Annual rainfall in the Wanagama area is 1,900 mm. Rainfall during the dry months is <60 mm/month and occurs for 2–6 months per year. The average number of rainy days from October to April is 80 days/year. The highest rainfall occurs from December to February, averaging 200 mm/month. The number of rainy days during these months ranges from 10 to 24. Based on the climate classification by Schmidt and Ferguson, Wanagama falls under climate type C. The soil types found in Wanagama are latosol, rendzina, Mediterranean grumusol, and alluvial soil.

The vegetation along this trail is dominated by tree species such as mahogany (*Schleichera oleosa, Gliricidia sepium, Podocarpus neriifolius, Hibiscus* tiliaceus, and Morus alba, as [9] said that optimum density and understory vegetation management in healing forest are important for visitors. The shrubs include rattan (*Calamus rotang*), *Caesalpinia sappan*, and snake plant (Sansevieria). Additionally, the ground cover consists of grasses in the family Poaceae. The trail surface varies, with sections of concrete, stone, soil, and uneven limestone. Along the hiking trail, there are 8 tourist spots: the name wall/landmark at compartment 5 of the Wanagama Eco Edu Forest, the soil profile spot, 3 natural streams at 3 locations, the Joglo House spot, the cave wall for keris washing, and the silk house spot. This forest healing tourism initiative uses the existing natural conditions without altering their function as a tourist site.

3.1 Identify Hazards Along The WHF Tracking Path

Wanagama Healing Forest has two types of trails: the induction trail and the therapy trail. The assessment of physical safety criteria along the healing forest trail, as shown in Table 5.2, indicates that some were rated safe, while others were rated unsafe or very unsafe. Sound intensity measurements along the trail using a Sound Level Meter yielded the following values: in the morning, 30.29-41.73 dB; in the afternoon, 30.83-40.37 dB; and in the evening, 33.58-44.52 [5][7] . When assessed for safety using the SNI 9006:2021 standard, the average noise intensity along the trail is deemed safe for visitors participating in forest healing activities. According to [6], the safe sound intensity for human hearing falls within the normal range of 30–50 dB. Sound intensities above 50–60 dB are considered the initial noise level[1]. [8] and [12] state that continuous exposure to noise levels above 50 dB can cause adverse health effects, including physiological disturbances, communication issues, balance problems, hearing impairment, and stress. Noise acts as a stressor that causes physical, psychological, and behavioral changes in humans. Noise sources along the trail are predominantly natural sounds, such as birdsong and the rustling of trees in the wind. Every sound or rhythm perceived by the human ear influences bodily functions. Natural sounds can serve as a soothing medium, creating a sense of peace, such as water, wind, or birdsong. Noise levels at WHF are considered safe for visitors in the morning, afternoon, and evening because they remain within normal ranges throughout the day.

Wind speed measurements along the Healing Forest trail, taken with a Digital Anemometer Wind Speed Tester, show that wind speeds range from 0 to 0.15 m/s in the morning, 0 to 0.35 m/s in the afternoon, and 0 to 0.23 m/s in the evening. When assessed for safety using the SNI 9006:2021 standard, the wind speeds along the trail are deemed safe for visitors participating in healing forest activities. These threshold values (< 1 m/s) provide a safe, comfortable, peaceful, and healthy environment. Visitors can engage in forest healing activities in the morning, afternoon, and evening, as wind speeds at the forest healing site are considered safe under clear conditions at all times. The wind speeds measured along the trail range from no wind to calm conditions; therefore, this location is safe for visitors, as potential wind-related hazards—such as exposure to dust, micro- and macro-particles, falling branches and trees, or destructive tornado-like winds—do not occur. Dust and particles entering the body can cause various health issues, such as eye irritation, coughing, and respiratory infections. Furthermore, high wind speeds can be destructive. Wind speeds exceeding 17.2 m/s can snap tree branches, topple trees, and cause other severe environmental damage, potentially threatening visitors' safety and security. The soil types found in Wanagama are latosol, rendzina, Mediterranean grumusol, and alluvial soil.

Mechanical hazards along the trail include the risk of being struck by a falling tree, falling mahogany fruit, or a branch; falling, slipping, or tripping; being pierced or scratched; and tripping over a tree. The biological hazards identified along the trail include snake bites. The trail features dense undergrowth, which creates ideal conditions for snakes to nest.

3.2 Asses Exposure Pathways and Risk Levels for Users and Practitioners

The risk of being struck by a falling tree is high. Hazard: Dead Trees in the Segment. The probability of being struck is rated at 2, and the impact/consequence is rated at 3. Trees may fall due to the thin topsoil in the Wanagama area. Additionally, living trees may be leaning, while dead trees have weaker root systems than when they were alive. Visitors struck by a tree are at risk of serious injury and may require hospitalization. This risk is deemed intolerable and requires immediate mitigation.

There are areas with steep slopes along the trail that lack guardrails, and while some guardrails are present, they are not yet secure enough to protect visitors. Additionally, the trail is narrow, so visitors who are not careful risk falling down the steep slope, which could result in injury.

There is a real risk of falling down a steep slope. Visitors who fall are at risk of serious injury and may require hospitalization. This risk is considered intolerable and must be addressed immediately. The risk of falling is heightened by friction with small- to medium-sized limestone rocks, which, when dry, have a loose structure. Additionally, the risk of falling may arise from the trail's slope. These rocks are evenly distributed along the covered trail. The risk of slipping is also increased by moss-covered rocks. These moss-covered, slippery rocks are unevenly distributed across each segment. These moss-covered, slippery rocks closely resemble the surrounding soil in color and are positioned nearly level with it; thus, if visitors are not careful, they risk slipping and falling.

There is a risk of slipping because the concrete path is slick with moss. The path runs along the entire segment, and nearly its entire surface is covered with moss. The stone and cement steps are also covered in moss, making them slippery to walk on. The steep, slippery path, especially during the rainy season, poses a risk of slips for visitors who are not careful. Additionally, there are currently no safety railings for visitors.

4 Conclusion

Risk assessment and control using HIRARC revealed that the dominant high-risk category was tripping over a stone. The dominant moderate risk was the fall of dead trees. The dominant low risk was being punctured/scratched by plant thorns. Control efforts include eliminating potential hazard sources, replacing unsafe segments, building and repairing infrastructure, installing warning boards, and using personal protective equipment (PPE)

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