

Malay Community Wisdom for Conserving Catchment Areas of Hydroelectric Power Plant Reservoirs

Sabiduría de la comunidad malaya para la conservación de las cuencas de captura de los embalses de las centrales eléctricas

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How to Cite: Effendi, I., Pahri, S. D. R., Ramya, R., Saikim, F. H., Wiyati, R., Jamaan, A., ... Nasution, M. S. (2026). Malay Community Wisdom for Conserving Catchment Areas of Hydroelectric Power Plant Reservoirs. *Revista Kawsaypacha: Sociedad Y Medio Ambiente*, (18), A-008. <https://doi.org/10.18800/kawsaypacha.202602.A008>



Abstract: A catchment area is a piece of land that receives, stores, and channels water to its surrounding places. This research was conducted from December 2023 to March 2024 and aims to determine the cultural potential and local wisdom of the Malay community in the catchment area of Koto Panjang Hydroelectric Reservoir (KPHR) in Kampar Regency, Indonesia. Data was collected through interviews and observation. Information was provided by KPHR employees, regional government organizations, community leaders, traditional leaders, farmers, laborers, and other members of society. The questions referred to local community wisdom and policies for protecting the catchment area, as well as ecological, socio-economic, and cultural aspects. Some aspects of the mindset and livelihood patterns of the residents of KPHR catchment area seem to be in synergy with the presence and functioning of this reservoir catchment area. These include small-scale agricultural patterns, simple lifestyles, fire-free agriculture, perennial crop cultivation, river and reservoir fishermen, the Islamic and the Malay cultural perspective, and the existence of tourism awareness groups. Thus, local wisdom needs to be empowered through integrated agriculture, increasing the efficiency of resource use, and introducing field-friendly technology.

Keywords: Forest conservation. Community empowerment. Agroforestry. Silvofishery. Silvopasture. Conservation culture.

Resumen: Una cuenca hidrográfica es un área que recibe, almacena y canaliza agua hacia los lugares circundantes. Esta investigación tiene como objetivo determinar el potencial cultural y la sabiduría local de la comunidad malaya en la cuenca del embalse hidroeléctrico de Koto Panjang (KPHR) en la regencia de Kampar, Indonesia. Esta investigación se llevó a cabo de diciembre de 2023 a marzo de 2024. Los datos se recopilaron mediante entrevistas y observación. Los informantes fueron empleados del KPHR, organizaciones gubernamentales regionales, líderes comunitarios, líderes tradicionales, agricultores, trabajadores y otros elementos de la sociedad. Las preguntas abarcaron la sabiduría local de la comunidad y las políticas para la protección de la cuenca, así como aspectos ecológicos, socioeconómicos y culturales. Algunos aspectos de los patrones de subsistencia y la mentalidad de las personas que viven en la cuenca del KPHR se consideran en sinergia con la existencia de esta cuenca. Esto incluye patrones agrícolas a pequeña escala, estilos de vida sencillos, procesamiento de tierras sin quema, cultivo de plantas perennes, pescadores de río y lago, la perspectiva cultural islámica y malaya, y la existencia de grupos de concientización turística. Es necesario potenciar el conocimiento local mediante la agricultura integrada, aumentando la eficiencia en el uso de los recursos e introduciendo tecnología respetuosa con el medio ambiente.

Palabras clave: Conservación forestal. Empoderamiento comunitario. Agroforestería. Silvopescas. Silvopastorado. Cultura de la conservación.

1. Introduction

Koto Panjang Hydroelectric Reservoir (KPHR) was built between 1992 and 1997, it is 96 m high and has a pool area of 12,400 ha with water depth ranging from 73 to 85 m. This hydroelectric reservoir was built and managed by PT State Electricity Company (PT PLN) to supply electric power to Riau and West Sumatra Provinces. The catchment area covers the Kampar Regency (Riau), Pasaman Regency, and Limapuluh Kota Regency (West Sumatra). Its main water supply comes from the Kampar River and Batang Mahat River, which originate in West Sumatra province (PT PLN 2024). Currently, the quality of the KPHR catchment area has declined as a result of various activities undertaken by the surrounding communities. These include forestry, agriculture and plantation activities, fisheries, and mining. Furthermore, KPHR's sustainability has faced very serious challenges in recent years, such as unstable water availability, droughts during the dry season, and flooding during the rainy season, which have prevented the power plant from operating optimally (Rahmat et al., 2020).

Local ethnic Malay communities live around and within this catchment area. The Malay people is distributed across various regions, including the Malay Peninsula, Sumatra, Borneo, Riau Islands, southern Thailand, Brunei, Singapore, and the southern Philippines. Malay culture is one of the supporting pillars of Indonesia's national culture and it also contributes to the world cultural heritage. The active involvement of these local communities is essential for achieving sustainable catchment area conservation, as they understand the intricate relationships between land use, water quality, and ecosystem services. This knowledge is essential for effective conservation efforts. For example, local communities can identify key water sources, predict seasonal changes in water availability, and recognize the impact of land management practices on water resources (Liviak et al., 2024; Lubis et al., 2022).

The catchment area plays a crucial role in the overall performance of water reservoirs, influencing water quality, quantity, and resilience to environmental changes. Effective management of catchment areas is crucial for ensuring long-term sustainability and optimal performance of water reservoirs. Strategies include: 1) promoting sustainable land-use practices in the catchment area to minimize pollution and enhance water quality; 2) implementing conservation measures to reduce water consumption and increase water availability for the reservoir; 3) managing stormwater runoff to prevent flooding and erosion, protecting water quality and infrastructure; 4) restoring degraded areas within the catchment to enhance water infiltration and reduce runoff (Nurdin et al., 2019; Liviak et al., 2024).

Effective catchment management produces numerous benefits for reservoirs and surrounding communities, such as: improved water quality, protection of aquatic ecosystems, and ensuring safe drinking water for local communities. Furthermore, it increases water availability for various uses, including domestic, agricultural, and industrial purposes, while reducing flood risks and associated damages to infrastructure

and property. In addition, it helps enhancing resilience to climate change impacts and ensuring sustainable water supplies for the future. Thus, implementing comprehensive catchment management strategies that involve all relevant stakeholders is essential for ensuring the long-term sustainability of water resources and promoting a healthy environment for future generations (Grzybowski et al., 2023; Forero et al., 2025).

The size, shape, and characteristics of a catchment area significantly influence the amount of water that flows into a reservoir. For instance, forested catchments tend to have higher infiltration rates, allowing more water to percolate into the ground and replenish groundwater reserves. In contrast, urbanized catchments with impervious surfaces, such as roads and parking lots, produce greater surface runoff and reduce infiltration, which can ultimately decrease water availability in the reservoir (Mustofa, 2019). To maintain the proper functioning of the KPHR catchment area, efforts should be made to identify and strengthen community-based cultural practices that contribute to its protection. These community practices are collectively referred to as the local wisdom of the Malay community. This research aimed to identify and analyze the potential of local wisdom of those living in and around the PHKR catchment area and its contribution to the functioning of the catchment area.

2. Methodology

2.1 Time and place

This study was conducted from December 2023 to March 2025. Research and data collection were carried out in several villages located within the KPHR catchment area (Table 1).

Table 1. Location of KPHR Catchment Area

No.	Province	Regency	District
1	Riau	Kampar	XIII Koto Kampar
2	Riau	Kampar	Koto Kampar Hulu
3	West Sumatra	Pasaman	Mapat Tunggul Selatan
4	West Sumatra	Pasaman	Bonjol
5	West Sumatra	Lima Puluh Kota	Bukit Barisan
6	West Sumatra	Lima Puluh Kota	Gunuang Omeh
7	West Sumatra	Lima Puluh Kota	Harau
8	West Sumatra	Lima Puluh Kota	Kapur IX
9	West Sumatra	Lima Puluh Kota	Mungka
10	West Sumatra	Lima Puluh Kota	Suliki

Source: PT PLN (2024).

2.2 Research Methods and Procedures

A descriptive survey method with a qualitative approach was used in this study. Primary data were collected through interviews, observation, and documentation. Information was obtained from KPHR employees, regional government organizations, community leaders, traditional leaders, farmers, laborers, dam management staff, and other members of society. The questions addressed local community wisdom and policies for protecting the catchment area, as well as ecological, socio-economic, and cultural aspects. Secondary data were obtained from reports issued by government agencies and professional organizations, previous research findings, as well as other relevant sources.

A GPS device was used for recording the coordinates of land-cover sampling points, and a geographic information system (GIS) software for processing imagery and classifying land use in 2014 (Nurdin et al., 2017) and 2024. To define administrative boundaries, the results of this image interpretation were overlaid with administrative maps of Kampar, Pasaman, and Limapuluh Kota regencies. The 2014 and 2024 Landsat image interpretation results were then analyzed to determine the land-use patterns within the KPHR catchment area. The Land Cover Index (LCI) was calculated based on the area of permanently vegetated land within the KPHR catchment area, using the following formula;

Information:

LCI = Land Cover Index,

PVL = Permanently Vegetated Land area,

Watershed area = target catchment or watershed area

2.3 Data Analysis

The data obtained was grouped as required, tabulated into tables, and analyzed qualitatively and descriptively.

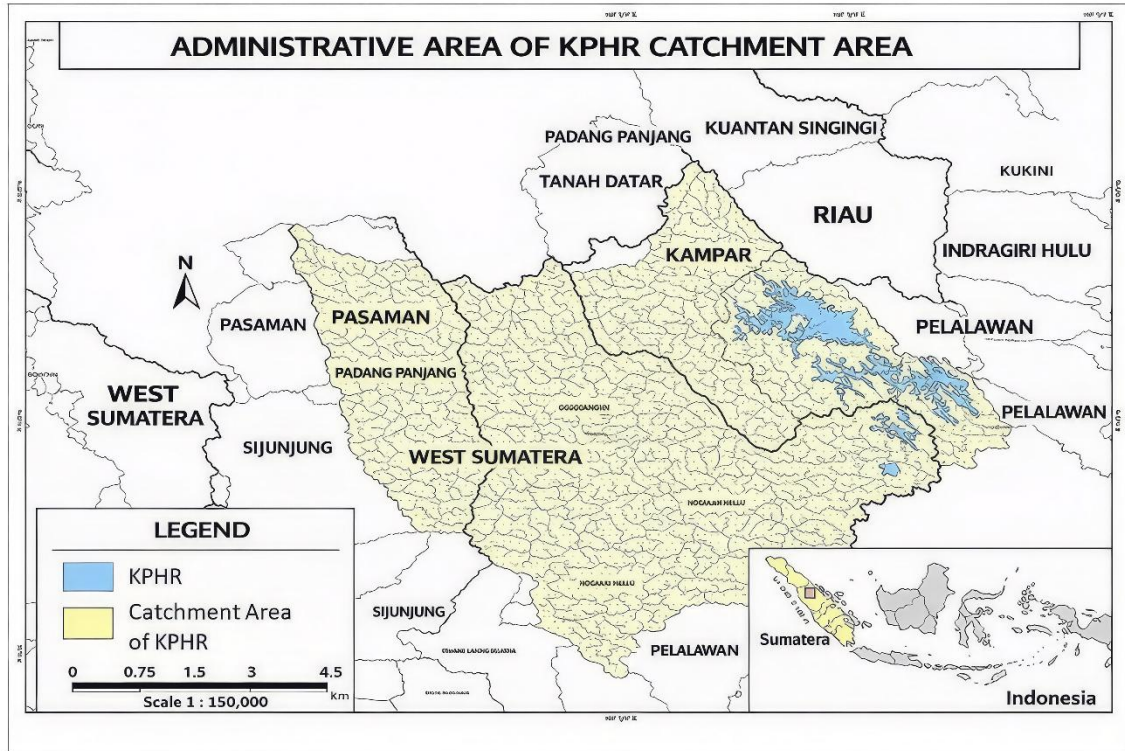
3. Results and Discussion

3.1 Geographical Location and Administration

The KPHR is located approximately 20 km from Bangkinang and 87 km from Pekanbaru. It was built between 1992 and 1997 with its main water supply coming from Batang Kampar Kanan and Batang Mahat rivers, both of which originate in Pangkalan Koto Baru District, Limapuluh Kota Regency, West Sumatra. Based on data reported by PT PLN (2024), the catchment area (Figure 1) covers 3337 km². The reservoir has a surface area of 124 km² (12 400 ha) and a storage capacity of 1545 km³, with a maximum water level of 85 m above sea level under full water supply conditions. Total inflow to the reservoir is 180.4 m³/s, while the outflow is 178 m³/s. The reservoir has an active capacity of 1040 million m³, can produce 114 MW (3×38 MW) or 542 GWh/year of electricity. The

KPHR catchment area extends geographically from 0° 30' 44" North Latitude to 0° 04' 41" South Latitude and from 100° 08' 31" to 100° 54' 25" East Longitude (PT PLN, 2024). A spatial representation of the administrative boundaries within the KPHR catchment area, including the area and ratio of each administrative unit, is presented in Table 2.

Figure 1. Administrative Area of the KPHR Catchment Area



Source: PT PLN (2024).

Table 2. Administrative Surface Area of the KPHR Catchment in 2014

Province	Regency	District	Area (Ha)	(%)
Riau	Kampar	XIII Koto Kampar	51 893.12	15.76
Riau	Kampar	Koto Kampar Hulu	20 195.84	6.13
West Sumatra	Pasaman	Mapat Tunggul Selatan	54 736.96	16.62
West Sumatra	Pasaman	Bonjol	20.08	0.01
West Sumatra	Lima Puluh Kota	Bukit Barisan	30 236.63	9.18
West Sumatra	Lima Puluh Kota	Gunuang Omeh	91.36	0.03
West Sumatra	Lima Puluh Kota	Harau	1863.50	0.57
West Sumatra	Lima Puluh Kota	Kapur IX	90 102.95	27.36
West Sumatra	Lima Puluh Kota	Mungka	1 106.59	0.34
West Sumatra	Lima Puluh Kota	Suliki	619.14	0.19
Total Area (Ha)			329 345.77	100.00

Source: Nurdin et al. (2017).

3.2 Land Cover Index Analysis

The Land Cover Index (LCI) is calculated by comparing the area designated as catchment land with the area covered by permanent vegetation. The results of this study indicate that the KPHR catchment area falls within the good-condition category based on its LCI. For this reason, vegetation enrichments outside forest areas is recommended, particularly through the revegetation of abandoned land and empty land. According to technical and socio-economic considerations, annual plants should be used for this purpose. The primary and secondary dryland forest areas within the KPHR catchment area already exceed the minimum forest area required in a watershed (Table 3). According to the Regulation of the Director-General of Land Rehabilitation and Social Forestry No. P.04/V-SET/2009, catchment areas are land covered with permanent vegetation. This includes annual plants, i.e. forest and/or garden vegetation, which can serve protective or conservation purposes. Based on land-use data from 2014 and 2024, permanent vegetation categories identified in the area include those of primary dryland forest, secondary dryland forest, dryland agriculture, and dryland agriculture mixed with shrubs (Figure 2). The Land Use Index (LUI) for the KPHR catchment areas in 2014 and 2024 was 95.14% in the Kampar Regency, 99.91% in Pasaman, and 97.03% in Limapuluh Kota, with an average LUI value of 97.16% (Table 4). The exiting vegetation cover index is > 75%, which indicates good quality conditions. This value is considerably higher than the LUI reported for the Kelayan River in 2009 by Widodo et al. (2012), which ranged from 8.11 - 32.18% (Nurdin et al., 2017).

Table 3. Land Cover Index (LCI) Values for the KPHR Catchment Area in 2014.

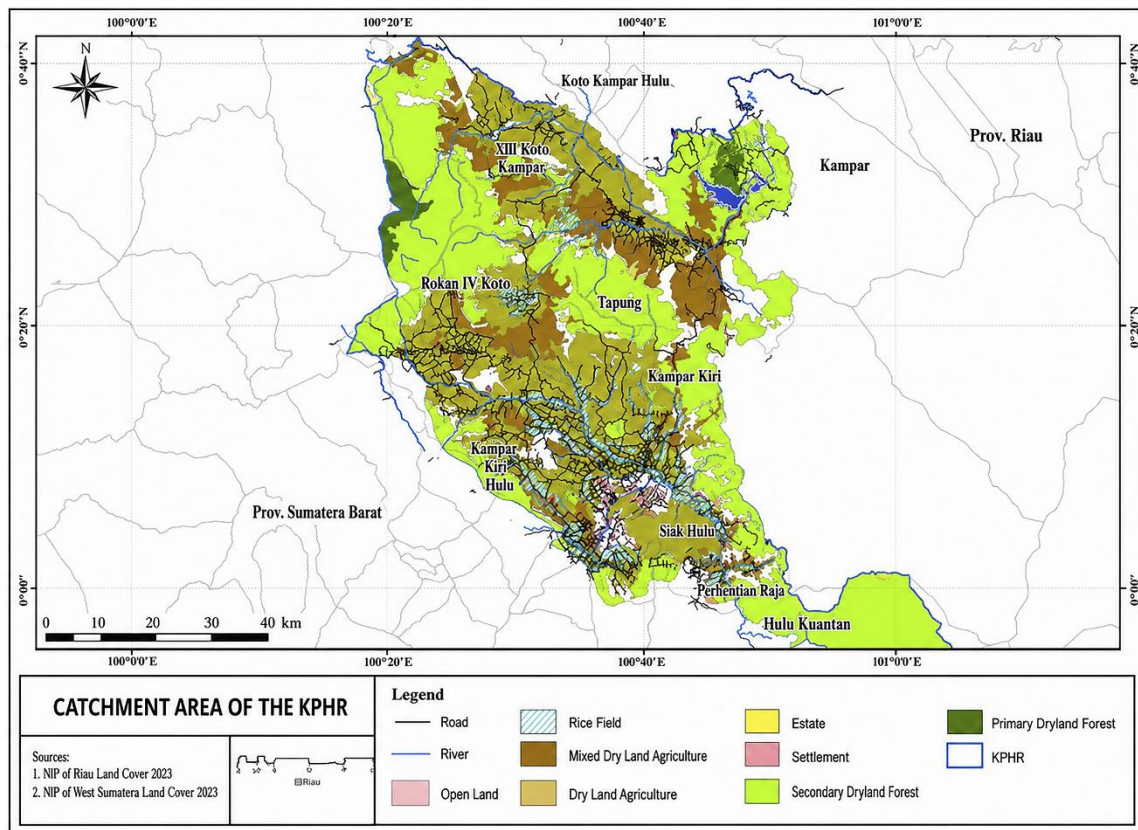
Province	Regency	Area (Ha)	??	P> t
		Land	Permanent vegetation	
Riau	Kampar	61 563.14	58 568.88	95.14
West Sumatra	Pasaman	54 624.61	54 573.52	99.91
West Sumatra	Lima Puluhan Kota	200 850.60	194 891.60	97.03
Total		317 038 34	308 034.00	97.16

Source: Nurdin et al. (2017).

Table 4. Land-Use Type in the KPHR Catchment Area in 2014 and 2024

No.	Land-Use Type	Area 2014*	Area 2024	Change 2014-2024			
		(ha)	(%)	(Ha)	(%)	(ha)	(%)
1	Primary dryland forest	81 633.71	25.56	79 976.05	24.29	-1657.66	-1.27
2	Secondary dryland forest	70 192.53	21.98	100 512.11	30.53	30 319.58	8.55
3	Plantation	10 756.74	3.37	10 804.21	3.28	47.47	-0.09
4	Residential area	948.13	0.3	958.65	0.29	10.52	-0.01
5	Dryland agriculture	78 149.88	24.47	70.525	21.42	-7 624.88	-3.05
6	Mixed dryland agriculture	72 877.65	22.82	61.391	18.65	-11 486.44	-4.17
7	Rice fields	3 502.80	1.1	3 810.04	1.16	307.24	0.06
8	Shrubs	360.79	0.11	203.21	0.06	-157.58	-0.05
9	Open land	916.89	0.29	1 042.01	0.317	125.12	0.03
10	Water body	10 984.33		10 882.45			
11	Land area	319 339.12	100.00	329 222.49	100.00		
12	Catchment area	330 323.45		340 104.94			

Source: Nurdin et al. (2019).

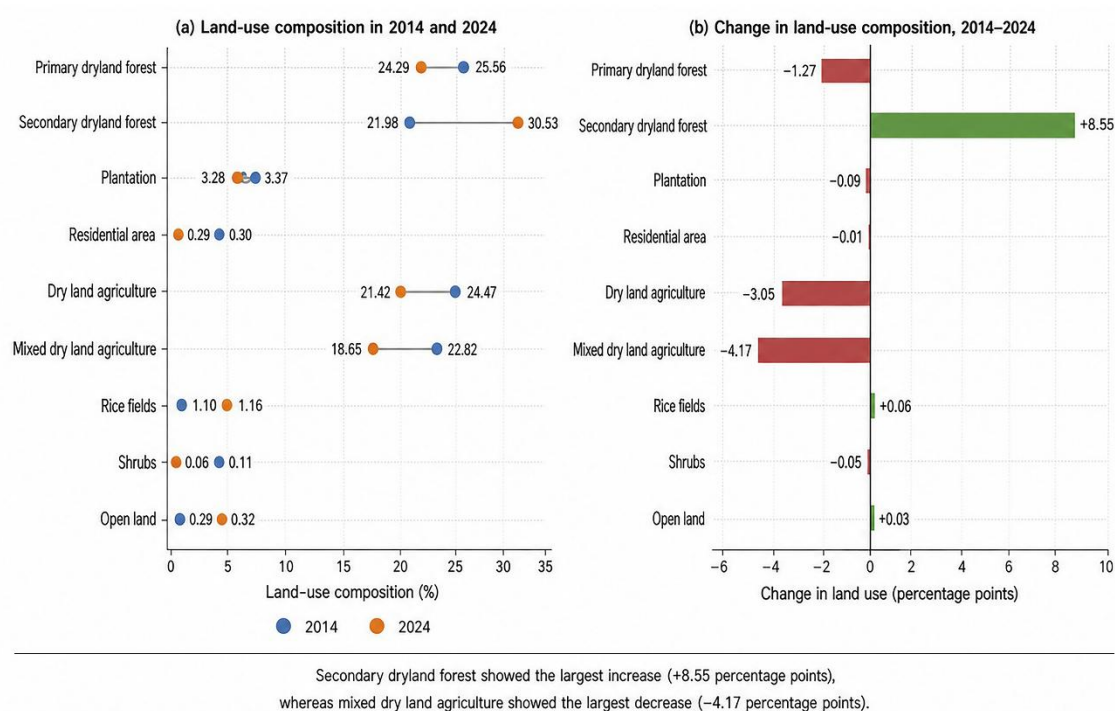
Figure 2. Land use in the KPHR Catchment Area in 2024

Land-cover conditions and land-use patterns greatly determine the sustainability of the KPHR catchment area. In 1985, the KPHR catchment area contained 3331 km² of forest, comprising 2142 km² of protected forest and 1189 km² of conversion forest. Landsat imagery show that the forest area had reduced to only 1167 km² in 2002. This means that over 17-year period the forest area declined by 975 km², i.e. an annual average loss of approximately 57 km². At that time, land converted to other land-use type, such as shrubs and reeds, mixed gardens, cultivated fields, and open land amounted to more than half of the water catchment area, namely 64% of it. Reports from 2002 indicated a very high sedimentation rate, estimated at 20.48 - 26.23 tonnes/ha/year, and a deforestation rate of 1290-650 m³/km²/year. Thus, the expected operational lifespan of the Koto Panjang hydropower project is estimated to decrease from 300 to 100 years (Rahmat et al., 2020; Nurdin et al., 2019).

From 2014 to 2024, land-use patterns in the KPHR area show a shift toward greater natural conditions, mainly driven by a substantial increase in secondary forest and a decrease in agricultural land. Primary dryland forest slightly declined from 25.56% to 24.29%, indicating minor degradation or conversion to other land-cover types, possibly secondary forest. In contrast, secondary dryland forest increased significantly from 21.98% to 30.53%, suggesting natural regeneration of vegetation on previously degraded or agricultural land. Furthermore, plantation areas decreased slightly from 3.37% to 3.28% and dryland agriculture declined from 24.47% to 21.42%, while mixed dryland agriculture dropped even more sharply, from 22.82% to 18.65%. In contrast, rice fields increased slightly from 1.10% to 1.16%.

Overall, these changes indicate ecological recovery in some areas. However, the decline in primary forest remains a concern because its high biodiversity and ecological functions cannot be fully replaced by secondary forest. Therefore, careful monitoring and sustainable land-use management are required (Figure 3).

The tendency for forest to be cleared for plantations and agricultural purposes to meet increasing food demands suggests that changes in land-cover patterns are likely to continue in the KPHR catchment area. Changes in forest land may affect the functions and reduce the water catchment capacity for the KPHR. Indeed, forest loss can reduce the capacity of vegetation in the catchment area to intercept and infiltrate rainwater. In addition, the reduction in forest cover is likely to increase the water evaporation rate. Consequently, fluctuations in water discharge between the rainy and dry seasons may occur in the KPHR catchment area. This is because rainwater enters and is stored in the soil (infiltration) during the rainy season, while the evaporation rate (evaporation) increases during the dry season (Rahmat et al., 2020; Nurdin et al., 2019; Nurdin et al., 2017).

Figure 3. Land-Use Percentage in the KPHR Catchment Area in 2014 and 2024

3.3 Small-Scale Agricultural Business Patterns

Small-scale farmers are those who own relatively small areas of agricultural land, often less than 2 hectares. They typically manage their land themselves or with the help of their families, with limited reliance on hired workers (Abegunde et al., 2020). Most residents of the KPHR catchment area and its surroundings are small-scale farmers. They cultivate relatively small plots of land, often less than 2 hectares, using simple and traditional agricultural technologies. With their family as their main workforce, they usually follow a diversified business pattern, combining different crops and livestock. They also rely on local resources and traditional skills in managing land and crops (Zárate Lozada et al., 2025).

The predominance of small-scale farming in the KPHR catchment area, actually has a positive impact, limiting its degradation rate. Farmers generally control and manage relatively small landholdings and have done this for generations. They aim at optimizing land use and improving the efficiency of their farming practices. In this context, government efforts focus on improving management efficiency, e.g. providing farmers with training and education on more efficient and sustainable agricultural practices. In addition, efforts are made to facilitate farmers' access to more sophisticated and effective agricultural technologies, such as irrigation systems, improved crop varieties, and good soil-management practices, while helping them to develop wider marketing networks and gain access to fair and profitable markets (Abdurrahman et al., 2023; Sujarwo et al., 2023; Gárate-Ríos et al., 2025).

3.4 Simple Lifestyle

The small-scale agricultural system adopted by the community in and around the KPHR catchment area is also associated with a relatively simple lifestyle, generally characterized by a higher awareness on the importance of environmental protection. They strive to reduce their ecological footprint, support sustainable practices, and be part of the environmental protection movement. Simple living culture is not just a lifestyle, but can also be understood as a philosophy that values a better, more meaningful, and better-balanced quality of life (McCarthy et al., 2023). Such values can have a positive impact not only on individuals and families, but also on society as a whole, particularly in fostering awareness of the environmental significance of the KPHR catchment area (Andrianus et al., 2018).

Simple living refers to a lifestyle that emphasizes simplicity, sustainability, and environmental awareness. It is an approach that aims to reduce excessive consumption, minimize negative impacts on the environment, and seek happiness in simple and meaningful things. People with simple lifestyles tend to be more conscious of what they consume. They consider actual needs rather than excessive desires, reduce waste, and tend to choose environmentally friendly products. The concept of minimalism is an important part of the simple living culture. It involves reducing unnecessary material objects, focusing on items that have real value and function, and avoiding excessive consumption (Adebisi et al., 2021; Oktariani & Yanti, 2023).

People with a simple living philosophy tend to support local agriculture and consume locally produced food. This helps support the local economy, reduces the carbon footprint of food transportation, and celebrates seasonal foods. They also tend to use energy and resources efficiently, such as saving electricity, using environmentally friendly transportation and renewable energy. Rather than seeking happiness in the possession of material goods, simple living encourages happiness that comes from experiences, strong social relationships, physical and mental health, and a balanced life (Ajekwe & Ibiamke, 2020; Mburu, 2023).

3.5 Fire-Free Agriculture

Burn-free land cultivation is an agricultural practice that aims to reduce or avoid the use of fire when land clearing and soil preparation before planting. This practice is critical for maintaining soil quality, reducing greenhouse gas emissions, and minimizing the risks of forest fires. Land can be prepared without burning using mechanical tools, such as tractors, chainsaws, and other cutting tools to clear vegetation and prepare the soil. Alternatively, manual tools such as sickles, hoes, or machetes can also be used to clear land without using fire (Mujayana et al., 2020).

Fire-free soil preparation has gained traction as a sustainable alternative to traditional methods that often involve burning. This shift is particularly evident in regions like

Indonesia and Malaysia, where government policies have been implemented to mitigate the environmental impacts of such practices. This policy is actually rooted in the culture of the Malay community in several parts of the two countries, and the community is aware of its significance to improve environmental conditions. And, although it may sometimes be seen as an additional cost, over time this practice has become more widely recognized and has become a social transformation in agricultural practices (Ekawati et al., 2024). In Malaysia, zero-burning techniques for oil palm cultivation have been shown to yield higher financial returns compared to traditional burning methods. These techniques promote soil preservation and reduce the need for fertilizers, enhancing sustainability and economic viability (Noor, 2003).

Fire-free agriculture has become an established cultural practice among local communities in and around the KPHR catchment area. This practice not only contributes to environmental protection but it also improves soil quality and produces long-term agricultural yields. Furthermore, it is in line with the principles of sustainable agriculture, which aim to maintain ecosystem balance and support sustainable food production (Irma, 2019). Fire-free agriculture also reflects the positive role of the culture of local farmers who contribute to maintaining the KPHR catchment area.

3.6 Forestry Perennial Crops

Communities living in and around the KPHR catchment area cultivate various perennial crops in the plantation sector to support their economy. These are locally referred as the plants of life and include coconut, rubber, cocoa, gambier, areca nut, coffee, among others. They also plant a variety of horticultural crops, such as avocado, star fruit, duku, durian, water apple, guava, jengkol, pomelo, tangerine, mango, mangosteen, passion fruit, melinjo, jackfruit, pineapple, papaya, twisted cluster bean, banana, rambutan, sapodilla, soursop, breadfruit, and others. These plants can be categorized as forestry plants, and thus they can still be planted in and around the KPHR catchment area, provided that they don't disturb the forest function of this area.

Perennial plants for life generally refer to plants that provide substantial ecological, social, and economic benefits to humans and the environment. These plants often play an important role in maintaining ecosystem balance, providing food resources, medicines, building materials, and other raw materials, as well as supporting the continuity of human and forest life. Trees such as teak (*Tectona grandis*), mahogany or mahoni (*Swietenia mahagoni*), meranti (*Shorea* sp), and lime (*Citrus aurantifolia*) are examples of plants for life that provide high-quality wood for construction, furniture, and other industries. They also play an important role in maintaining tropical forest biodiversity (Darmadi et al., 2023; Susanto et al., 2023).

Perennial fruit trees play a significant role in enhancing livelihoods, particularly in rural areas where communities rely heavily on natural resources. These trees contribute to both food security and economic stability through the commercialization of their fruits.

The fruits provide essential nutrients and can help alleviating hunger, especially during lean seasons. In addition, many indigenous fruits are valued for their medicinal properties, with 63% of households using them for traditional medicine (Kalaba et al., 2009a). Trees like the Indian jujube are drought-resistant and can thrive in adverse conditions, contributing to environmental sustainability (Sishu et al., 2023). Cultivation of these plants supports biodiversity and helps maintaining ecosystem balance, which is crucial for long-term agricultural sustainability (Kalaba et al., 2009b).

3.7 River and Reservoir Fishermen

The development of the KPHR has created a new livelihood opportunity for surrounding communities, particularly through fishing. It is not surprising, because before the reservoir was built, some of the locals were already used to fishing in the rivers in the area. With a surface area of 12 400 ha, the reservoir provides habitat for a variety of freshwater fish species. River and reservoir fishermen depend on fishing and other activities associated with inland waters as sources of income. They usually have special fishing skills and understand well local aquatic conditions, and carry out their activities using fishing gear such as nets, fishing rods, and traps. Furthermore, fishermen play an important role in the local economy and possess specialized knowledge of fish species, migration patterns, fishing seasons, and changing water conditions. This knowledge is often passed down from generation to generation and forms the foundation of their fishing skills (de Sousa et al., 2022; Primayanti & Puspita, 2022). River and reservoir fishing activities are also closely related to fisheries resource management. Conservation and good management efforts are essential for maintaining fish resources and ensuring long-term sustainability. Fishermen can also play an important role in preserving the aquatic ecosystem where they conduct their activities (Pita et al., 2016; Braga & Rebêlo, 2017).

In addition, they also play an important cultural and social role in local communities. They often contribute to the preservation of traditions and cultural values associated to life around water. Thus, their importance extend beyond their economic contribution, as they also contribute to ensuring the sustainability of aquatic resources and the diversity of river and lake ecosystems. Efforts to protect and properly manage the aquatic environment are essential to supporting fishermen's livelihoods and maintaining the sustainability of fish resources (Annisa et al., 2021).

3.8 Islamic Perspective on Environmental Issues

Nearly 100% of the population living in and around the KPHR catchment area is Muslim. According to the Islamic perspective, the natural environment is considered a gift from God and a sign of His power, and humans must responsibly protect and preserve it. Some important Islamic concepts and principles are relevant to environmental conservation. Humans are seen as caliphs (managers or representatives) of Allah on Earth, and therefore have the responsibility to care for, protect, and manage natural resources wisely

and fairly. The concepts of *tawakal* (complete trust in Allah) and *tawhid* (belief in the oneness of Allah) emphasize that humans are expected to make the best efforts to care for the environment, while recognizing that ultimately, the final result depends on Allah's will. According to the author these values may positively contribute to the conservation of this catchment area (Effendi et al., 2022a; Kula, 2021).

According to Islamic teachings, nature and other living creatures on Earth also have rights that must be respected and protected. Humans are prohibited from causing unjustified destruction or harm to other creatures. The principles of *hikmah* (wisdom) and justice are particularly relevant in protecting the environment. Wise and fair actions must be conducted for managing natural resources and dealing with environmental impacts. Islam also encourages the responsible use of natural resources, discourage excessive consumption, and refers to the need to consider the interests of future generations. The prohibition of waste (*israf*) and damage (*fasad*) represents an important principle in the Islamic tradition, which forbids wasteful practices and actions that intend to destroy the environment. Islam also encourages education and awareness on the importance of protecting the environment. Thus, through a correct understanding of religion, humans are expected to be good managers of the universe. Based on these principles, Muslims are encouraged to become agents of positive change, contributing to the protection of the natural environment, through practical actions such as the efficient use of natural resources, reducing waste, protecting forests and biodiversity, and participating in environmental conservation initiatives. Moreover, sincere attitudes and concern for the environment are also an important part of everyday Muslim practices (Munawaroh, 2023; Bathara et al., 2023).

3.9 Malay Cultural Perspective on the Environment

From a Malay cultural perspective, the natural environment is regarded as an integral part of community life and sustainability. Malay values concerning the relationship between humans and nature are reflected in their customs, traditions, and philosophy of life. Residents living in and around the KPHR catchment area generally adhere to Malay traditions, which emphasize the importance of harmonious coexistence with nature. This perspective considers humans as a part of the universe, responsible for maintaining balance and harmony with their surrounding environment. Nature is regarded as their teacher who provides lessons and guidance, encouraging them to observe, understand, and learn from natural processes to acquire life wisdom (Effendi et al., 2022b; Effendi et al., 2021).

Malay cultural values promote great respect for natural resources such as water, land, forests, and seas, which are regarded as gifts that must be protected, conserved, and used wisely. Within this framework, many practices and rules are related to environmental management, such as the prohibition of littering, the obligation of keeping rivers and beaches clean, and maintaining soil fertility for agriculture. Biodiversity is considered wealth that must be protected. Malay culture preserves biodiversity through traditional

ceremonies, the use of traditional medicinal plants, and nature conservation activities (Suwondo et al., 2017).

The principles of sustainability and balance are strongly emphasized in Malay culture. People are encouraged to use natural resources wisely to ensure sustainability and balance. These cultural values also emphasize the importance of maintaining harmony between human society and nature. In practice, these values and concepts inspire the community to keep the environment clean, respect nature, use natural resources sustainably, and engage in environmental conservation activities. Efforts such as planting trees, river or beach clean-ups, and participation in nature conservation initiatives are often undertaken as ways of upholding Malay environmental principles and reflecting the local wisdom embedded in Malay values (Zárate Lozada et al., 2025; Susanto et al., 2022).

3.10 Tourism Awareness Groups

The development of KPHR has also created opportunities for tourism in the surrounding areas, including water-based tourism, culinary tourism, and lake and mountain-based scenic tourism. Tourism Awareness Groups (Pokdarwis) have been formed and are actively operating in the area, with environmental protection as one of their missions. Researchers (Suprianto, 2023; Diab et al., 2022) have mentioned that these groups are community-based organizations in Indonesia aimed at promoting and developing tourism in their corresponding local areas.

Pokdarwis play a pivotal role in the sustainable development and management of tourism in various regions. They foster community participation, strengthen local knowledge, and promote local tourism initiatives. Their main goals include receiving both local and international tourists, for which purpose they promote unique local attractions, culture, and tourism-related activities. Thus, they create economic opportunities for local communities and promote cultural preservation, while ensuring sustainable tourism development that does not harm the local environment. Their activities range from planning and organizing tourism projects to implementing and monitoring these initiatives effectively. *Pokdarwis* aims at engaging local communities in tourism activities, ensuring that development aligns with community needs and resources (Febryano et al., 2023; Febriyanti & Wispandono, 2022). Training programs can further strengthen the skills of the group members, enabling them to manage ecotourism effectively and promote local attractions (Awalina & Hasbullah, 2024; Kristanto et al., 2024). However, a limited understanding of the potential benefits of tourism among community members can constrain the development of tourism initiatives (Maadi et al., 2024).

4. Conclusions

Some aspects of the livelihood patterns, mindsets, and life perspectives of the communities living in the KPHR catchment area seem to be compatible with the functioning of this reservoir catchment area. These represent forms of local wisdom, that must be nurtured and developed to reach its full potential. The main aspects identified include: i) small-scale agricultural business patterns, ii) a relatively simple lifestyle, iii) fire-free agriculture, iv) cultivation of perennial crops, v) river and reservoir fishing, vi) Islamic perspectives on the environment, vii) Malay cultural perspectives on the environment, and viii) the presence of tourism awareness groups.

The application of insightful agriculture practices, understood as the local wisdom of the communities in and around the KPHR watershed, represents a significant asset for sustainable development. These practices have proven effective and efficient in utilizing available resources while contributing to the conservation of the KPHR. Sustainable efforts are needed to introduce environmentally friendly technologies through community empowerment programs.

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Role of each author in the research according to the classification (CRediT)

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Revista Kawsaypacha: Sociedad y Medio Ambiente.

N° 18 julio – diciembre 2026. E-ISSN: 2709 – 3689

How to Cite: Effendi, I., Pahri, S. D. R., Ramya, R., Saikim, F. H., Wiyati, R., Jamaan, A., ... Nasution, M. S. (2026). Malay Community Wisdom for Conserving Catchment Areas of Hydroelectric Power Plant Reservoirs. *Revista Kawsaypacha: Sociedad Y Medio Ambiente*, (18), A-008. <https://doi.org/10.18800/kawsaypacha.202602.A008>

