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Socio-Ecological Dynamics and Inheritance of Local Knowledge in the Management of Repong Damar: A Case Study from Pekon Tanjung Setia, Lampung, Indonesia

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Abstract: Local knowledge plays an important role in maintaining a balance between humans and nature, especially in traditional agroforestry systems such as Repong Damar in Pekon Tanjung Setia. This study aims to analyze the system of inheriting local knowledge in the management of Repong Damar to preserve the ecology, economy, and culture of the community. A case study was adopted with a qualitative approach in the current research. The collection of data was conducted by participatory observation, in-depth interviews, and documentation. The data were then analyzed to obtain results related to the local knowledge inheritance system for managing the Repong Damar land. The sample was determined by purposive sampling with the following key criteria for informants, i.e., indigenous Tanjung Setia Village residents with profound experience and knowledge regarding Repong Damar land management. Key informants consisted of one village head, three traditional leaders, and five Damar farmers. Results of the study, based on observations from August to November 2025, showed that the inheritance of local knowledge was carried out from generation to generation through direct practice in the family and community environment. Inherited knowledge includes tapping techniques, nurseries, land management as well as social, spiritual, and ecological values. This inheritance process strengthens the attachment of the community to Repong Damar as a source of economic and cultural identity. Despite the challenges from the declining interest of the young generation in the agricultural sector, conservation is still being carried out through daily practices and informal education. The local knowledge inheritance system in Pekon Tanjung Setia is the foundation for the sustainability of Repong Damar, which maintains a balance between ecological and socio-cultural functions. These findings confirmed the importance of preserving local knowledge as an adaptive strategy in maintaining the sustainability of traditional agroforestry in Indonesia.

Keywords: Local knowledge; Inheritance; Repong Damar; Local wisdom; Traditional agroforestry; Sustainability

1 Introduction

The relationship between humans and the environment is undergoing dynamic changes influenced by various social and ecological factors [1]. Socio-ecological dynamics describe the interconnectedness between the human social system and the ecological system that sustains life [2]. These interactions can be adaptive or transformational, depending on the capacity of the community to respond to environmental changes and social pressures [3]. Socio-ecological dynamics are key in understanding how communities shape, maintain, and adjust practices of natural resource management in a sustainable manner [4]. Social systems such as local norms, values, and knowledge cannot be separated from ecological systems, such as structures of vegetation, biodiversity, and functions of the ecosystem because they influence and depend on each other [5]. In many countries, socio-ecological dynamics are particularly noticeable in communities that coexist with natural resources, especially indigenous people and local communities in forest areas [6]. Social changes such as modernization and migration often affect local knowledge systems that are the basis for environmental management [7]. Ecological changes such as forest degradation, land conversion, and climate change also suppress existing social systems [8]. Maintaining a balance between social and ecological

dynamics is an important challenge to sustain natural resource management [9]. Local knowledge is crucial for linking social values with ecological functions [10].

Local knowledge is a collection of knowledge, skills, and practices that develop through community experiences and interactions with the surrounding environment for generations [11]. Local knowledge covers social and ecological aspects that are highly contextual and specific to a particular region so that it is considered effective in natural resource management [12, 13]. Each community has a different form of local knowledge, depending on their history, geographical conditions, and experience in adapting to environmental changes [14]. Local knowledge contains not only practical value but also moral and spiritual value that strengthens men's relationship with nature [15]. In the context of socio-ecological dynamics, local knowledge acts as an adaptive mechanism that maintains a balance between human needs and environmental sustainability [16]. It is a source of cultural identity that strengthens social attachment in the community [17]. The uniqueness of local knowledge lies in its ability to adapt to local environmental conditions and socio-ecological changes, thus making an important contribution to maintaining the sustainability of ecosystems [18]. Local knowledge serves as a basis for local decision making, especially in forest management and agriculture [19]. Through oral inheritance and direct practice, local knowledge continues to evolve and becomes an important element in decision making that reflects local wisdom [20]. In addition, local knowledge contains conservation principles that have been proven to be effective in maintaining the balance of ecosystem [16, 21].

One form of the application of local knowledge in the socio-ecological system of Indonesian society can be found in the practice of agroforestry [22]. Agroforestry is a land use system that integrates forestry crops with agricultural or livestock crops simultaneously; it aims to improve the productivity, sustainability, and well-being of farmers [23]. Agroforestry systems have been internationally recognized as an important approach in mitigating climate change, conserving biodiversity, and enhancing food security [24]. Agroforestry functions not only as a production system but also as an ecological approach that connects humans with nature in harmony [25]. Through the combination of different types of forestry and agricultural crops, agroforestry systems help create a more balanced nutrient cycle and maintain soil fertility [26]. In addition, agroforestry can strengthen the economy of a community by diversifying high value production products [27] and serves as an effective form of forest conservation to keep the ecosystem sustainable [28].

The integration of socio-ecological dynamics in agroforestry allows the creation of mutually beneficial relationships between humans and the environment [29]. Adaptations of agroforestry in different regions show its flexibility in accommodating different environmental conditions, thus providing broad ecological and social benefits [30]. Each region develops a form of agroforestry that is in accordance with the potential of local resources and the culture of the local community [31]. This system can be applied in highlands, drylands, and coastal areas with different combinations of plants [32]. By making optimal use of local resources, agroforestry can be a solution to overcome land degradation and increase marginal land productivity without sacrificing important ecological functions such as carbon sequestration and soil conservation [33]. The adaptation also reflects the creativity of the community in maintaining economic resilience as well as preservation of nature [34]. Through the integration of ecological and social elements, agroforestry reflects a dynamic socio-ecological system, in which land management practices are based on the cultural values and ecological experiences of communities [35].

Repong Damar in Pesisir Barat, Lampung, Indonesia is one of the authentic examples of a social-ecological dynamic system based on local knowledge that still survives today. Repong Damar is a form of traditional agroforestry that combines resin trees (*Shorea javanica*) with various types of agricultural crops in a sustainable manner [36]. This system not only produces resin sap as a major economic commodity but also serves to maintain ecological balance, such as soil protection, water systems, and biodiversity [37]. The layered stand structure from the lower plants to the tall resin trees creates an ecological balance that resembles a natural forest [38]. Repong Damar is a natural fortress against erosion that threatens the Krui area. Repong Damar is also a source of identity and pride of the Krui people as a symbol of harmony between humans and nature [39]. The socio-ecological dynamics of resins can be seen in the way the community balances the ecological function of the land with the social and economic needs of the family [40]. The social structure of the community, the inheritance system, and customary norms play a major role in regulating access, utilization, and responsibility for land [41]. The system of inheriting local knowledge is an important part of the socio-ecological dynamics of Repong Damar. Through oral inheritance, hands-on practice, and informal education, local knowledge of resin, cultivation, and management techniques is passed down from generation to generation [42]. This inheritance of local knowledge not only maintains the economic sustainability of the community but also ensures the preservation of the Repong Damar ecosystem [43]. Without local heritage and preservation of knowledge, there is an increasing risk of practices that affect sustainability and cause environmental damage [44]. Therefore, understanding the mechanism of inheriting local knowledge in the management of Repong Damar is a strategic step in maintaining socio-ecological dynamics that support community welfare and environmental sustainability. This study aims to analyze the local knowledge inheritance system in the management of Repong Damar land in Pekon Tanjung Setia, Pesisir Barat, Lampung Province, Indonesia.

2 Methodology

2.1 Research Location and Time

Research was carried out from August to November 2025, in Pekon Tanjung Setia, Pesisir Selatan District, Pesisir Barat Regency, Lampung Province, Indonesia (Figure 1).

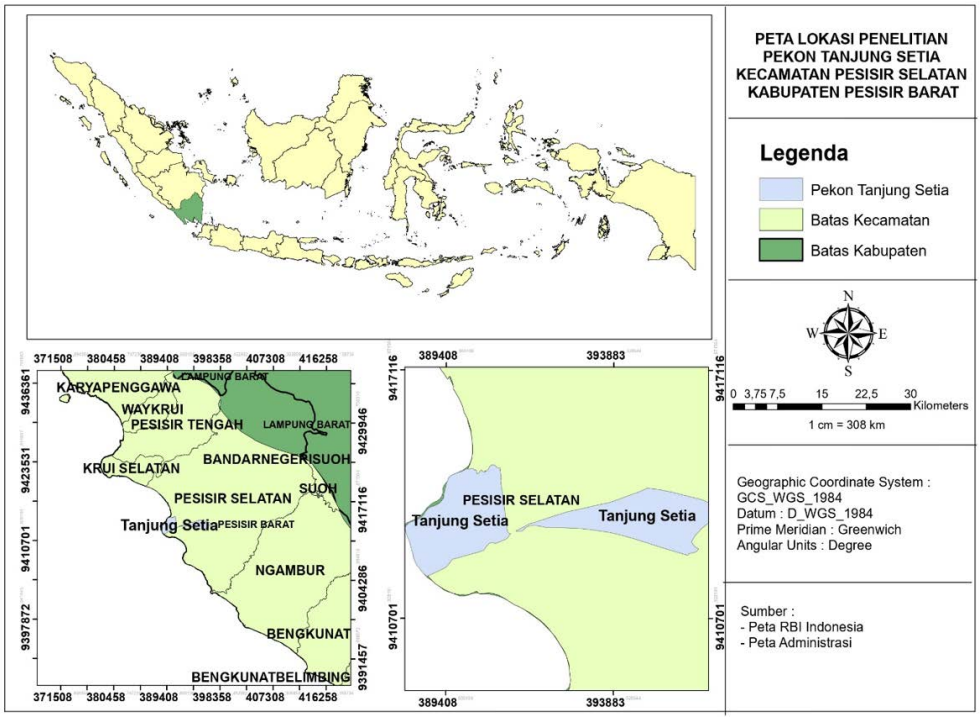

Figure 1. Map of the research location

2.2 Research Approach

This case study method adopted a qualitative approach. Case studies are a suitable strategy to answer research questions related to "how" and "why" [45].

2.3 Data Collection

The collected data consists of both primary and secondary data. Data was obtained through participatory observation, in-depth interviews, and documentation. Participatory observation was conducted from August to November 2025, and the method of recording participatory observation was done in writing (field notes) and audio recording. Primary data was collected through in-depth interviews with a semi-structured interview guide but remained flexible to develop follow-up questions, based on responses from the informants to ensure consistency and depth of the data obtained. The interview guide was designed to explore information through several core questions that include: Patterns and mechanisms of local knowledge inheritance with core questions such as "Is the knowledge inheritance of Repong Damar land management more through direct practice, or is there also a written or oral form?"; Management techniques with core questions related to "specific stages in nursery, planting, maintenance, to Damar resin harvesting techniques"; Damar resin harvesting tools with core questions such as "What are the tools used in Damar resin harvesting?"; Challenges in the inheritance of local knowledge and the meaning of local knowledge inheritance with core questions such as "What are the challenges in maintaining the sustainability of Damar resin land management today?"; and Damar resin sorting with core questions such as "What are the types of Damar resin?" Data collected directly through in-depth interviews and participatory observation is called primary data, while data obtained through documentation studies is secondary data. The key informants selected for the in-depth interview were conducted by purposive sampling, namely one Pekon heads, three traditional leaders, and five resin farmers. The selection of key informants was based on the study [46], the principle of data saturation, which focuses on the depth of phenomena exploration rather than statistical generalization. This aligns with the view of the study [47] that in qualitative research, data collection is stopped when information obtained from the latest key informants begins to show recurring patterns and no longer yields significantly new categories or insights related to the mechanisms of local knowledge inheritance. Although the sample size of key informants was only nine, the data had reached saturation and the depth of information obtained was sufficient to meet the research objectives.

2.4 Data Analysis

The collected data was analyzed qualitatively to examine the land inheritance system and the local knowledge inheritance system in the management of Repong Damar land, which is part of the culture of the local community. The stages are as follows: (a) raw data collection; (b) data transcript; (c) coding; (d) categorization of data; (e) provisional conclusion; (f) triangulation of data; and (g) final conclusion [48].

3 Results and Discussion

3.1 Inheritance of Local Knowledge as Part of Local Wisdom

The people of Pekon Tanjung Setia have had a local knowledge system that has been a guideline in the management of Repong Damar land for generations. This knowledge not only focuses on farming techniques, but also contains social, spiritual, and ecological values that maintain a balance between humans and nature [49]. Repong Damar is seen as an ancestral heritage that must be maintained for the sustainability of future generations. This local wisdom is integrated into the social, customary, and cultural systems of the community which strengthens the commitment to maintain Repong Damar [36]. Spiritual values are manifested in rituals such as *ngababali* which serves to ask for the safety and fertility of the land. This local knowledge is a socio-ecological mechanism that underpins the sustainability of land and communities [50]. Research [51] emphasized that local wisdom was important to maintain the preservation of ecosystems as well as culture. The inheritance of local knowledge creates a collective consciousness to maintain a harmonious relationship between humans and nature. These values reject the overexploitation of resin, as well as prioritizing sustainability and balance [52]. Knowledge does not only occur verbally but is rooted in daily habits in the garden, rituals, and consistent management. Local wisdom is the basis of ethics in resin farming so as not to damage nature and remain productive. The existence of local science systems is an important social capital in mitigating ecological and social risks. Local knowledge as part of this wisdom should always be maintained and enriched [53].

Figure 2. Repong Damar in Pekon Tanjung Setia

The people of Pekon Tanjung Setia believe that resin trees are not just ordinary garden plants, but part of the ecosystem that should be preserved. The existence of Repong Damar could also prevent landslides and floods due to the strong roots of the trees [54]. The sustainability of Repong Damar is an effort to maintain a source of income as well as a healthy environment. This management pattern that includes economic, social, and spiritual aspects is called local wisdom. This management practice has been going on for a long time since the Dutch era and continues to be maintained. The integration of noble values and techniques in a sustainable manner strengthens conservation and community empowerment. Repong Damar can be an example of sustainable agroforestry of indigenous people. The physical condition of Repong Damar in Pekon Tanjung Setia shows a layered vegetation structure that resembles a natural forest, with a combination of damar trees as the upper strata and various supporting plants in the lower strata, as seen in Figure 2. As an ancestral heritage, local knowledge about Repong Damar is passed down from generation to generation as part of socio-cultural identity [55]. Farmers educate children from an early age by taking them directly to the field; this experience forms an authentic knowledge regeneration. The study of traditional inheritance

systems emphasizes the importance of participatory practice and hands-on experience in local knowledge transfer so that knowledge is not interrupted, despite the challenges of modernization. Spiritual and social values are the glue for cultural and ecological preservation in Pekon Tanjung Setia. The success of this inheritance of local knowledge proves that local wisdom is not just a tradition, but an adaptive and transformative system [56].

3.1.1 Patterns and mechanisms of local knowledge inheritance

The inheritance of local knowledge in the management of Repong Damar in Pekon Tanjung Setia runs through a very natural pattern and is based on direct experience. The mechanism of learning by doing is at the heart of this process of inheriting local knowledge, through which children not only receive verbal explanations, but directly perceive with their parents and other family members. In this context, local knowledge is not provided through formal instructions, but through daily activities in Repong Damar, such as following the process of tapping resin, observing the characteristics of trees that are ready to be tapped, or recognizing weather changes that affect resin production. This learning pattern allows children to gradually understand skills, starting from the introductory stage to being able to carry out activities independently [57]. The learning by doing learning pattern is more effective because it provides space for children to understand the cause-and-effect relationship in the practice of Repong Damar management, so the inherited knowledge becomes more inherent [58]. Apart from technical skills, the learning by doing mechanism also involves learning ecological and ethical values related to Repong Damar. Children are not only taught how to tap or care for trees but also given an opportunity to understand the importance of keeping resin trees healthy as they can produce in the long term. Spiritual values such as belief in the balance of nature are conveyed through the context of hands-on experience in the garden. This process strengthens a child's emotional bond with nature, so the inheritance of local knowledge is not only technical but also ethical and ecological [59].

The involvement of families in the inheritance of local knowledge plays an important role in ensuring the continuity of local knowledge. Parents and older family members are consistently companions and role models for children in every activity in the garden. This mentoring pattern allows knowledge transfer to occur gradually, flexibly, and adaptively [60]. The absence of an age limit in the learning process of Repong Damar management allows children to start interacting with Repong from an early age, even before they fully understand the technical concepts. Local knowledge is inherited from spontaneous conversation, light direction during work, and repetition of the same activity over a long period. This renders local knowledge dynamic and able to adapt to social and technological changes [61]. The mechanism of inheriting local knowledge based on direct experience plays an important role in maintaining the authenticity of Repong Damar management practices. Because knowledge is passed down through real practice, this pattern tends to retain local wisdom that has been formed over generations. The pattern and mechanism of local knowledge inheritance in Pekon Tanjung Setia not only maintain the sustainability of the socio-ecological system of Repong Damar but also ensure its long lasting relevance and resilience [7].

3.1.2 Process of nurturing, planting, and caring for resin trees

The nursery process of resin in Pekon Tanjung Setia still relies on traditional methods and its seeding process is carried out in special locations close to the Repong land and in the yard of the farmer's house to facilitate supervision and initial maintenance. The community in Pekon Tanjung Setia applies three seeding methods that have been inherited from generations, namely direct seeding from resin seeds, the method of extracting resin seedlings that have grown naturally from old and fallen flowers, and through shoot cuttings by cutting shoots from resin branches, soaking the base of the stem first, then planting them in polybags until it is ready to be moved to the land. However, one of the obstacles in the natural breeding of this cat's eye resin is that the flowers/trees only bear fruit (produce seeds) irregularly, sometimes only once every 4 to 5 years, and the seeds are recalcitrant (easily damaged and not durable if stored) [62]. Therefore, vegetative propagation methods such as shoot cuttings are often used to propagate cat's eye resin plants. The selection of resin seedlings from superior trees is a very important local knowledge in the Repong Damar management system in Pekon Tanjung Setia. Superior trees are defined by the local community as resin trees that have superior characteristics, including consistent sap productivity, good resin quality with a bright yellow color, straight and tall trunk growth, and resistance to pest attacks. Seeds or sprouts taken from superior trees are believed to inherit these superior traits. Knowledge about the selection of mother trees is a form of traditional breeding that has been practised by the people of Pekon Tanjung Setia and has proven to be effective in maintaining the productivity of Repong Damar from generation to generation. This local knowledge-based selection system is in line with the principles of in situ genetic conservation that maintain the diversity of resin germplasm while improving the quality of production [63]. The practice of nurturing superior trees is not only an economic strategy but also a mechanism for the preservation of genetic resources that are valuable for the sustainability of the Repong Damar ecosystem [64].

The process of planting damar seedlings is carried out manually and follows local knowledge that has been passed down from generation to generation, starting from determining the planting time to selecting a shady planting location, as seen in Figure 3. The process of planting resin seedlings in Pekon Tanjung Setia begins with the creation of planting holes that are adjusted to the size of the seedlings' roots and soil conditions. Drilling is done manually

using a hoe. Resin planting in Repong is carried out randomly so that it resembles a natural forest structure with a heterogeneous composition of vegetation. This planting pattern has an important ecological function, namely creating vegetation diversity that supports the habitat of various species of flora and fauna, hence reducing the risk of massive spread of pests and diseases, and randomly optimizing the use of sunlight and soil nutrients by various types of plants in agroforestry systems [65]. Planting is conducted at the beginning of the rainy season, usually between October and December, when rainfall begins to increase and soil moisture is optimal for the growth of seedling roots. The timing of this planting is very important because resin seedlings require an adequate supply of water in the early stages of growth [66]. Resin seedlings are planted in shaded land conditions, not in open land exposed to direct sunlight. This characteristic indicates that young resin is classified as a plant that requires shade in the early stages of growth, so planting is often done under existing tree stands or in between other vegetation in the Repong system. These shade conditions protect the seedlings from exposure to extremely intense sunlight, reduce excessive evapotranspiration, and maintain soil moisture around the roots [67]. The lifespan of resin seedlings planted in Repong land varies, depending on the seedling method used. Seedlings that come from natural sprouts uprooted directly under the mother tree are generally planted in the garden if the seedlings already have a height of about 20 to 40 cm. Seeds from polybags propagated through shoot cuttings will be transferred to the garden after 3 to 4 months after the shoot cuttings. Meanwhile, seedlings from polybags sown from superior tree seeds are usually cared for 6 months until they reach a height of at least 40 to 60 cm and have a strong root system before being transplanted to a Repong land.

Figure 3. Process of seadling resin seedlings in Tanjung Setia (August 2025)

Care of resin seedlings in the early phase of growth in Pekon Tanjung Setia is not particularly intensive and relies on the natural processes of the Repong ecosystem. Farmers do not use additional chemical or organic fertilizers because the content of the organic matter from leaf litter in the garden is sufficient for the nutritional needs of seedlings. The main maintenance activity carried out is grassing, which is to clean the weeds and weeds that grow around the seedlings. Therefore, there is no excessive competition of nutrients, water, and light in the critical phase of early growth [68]. One of the advantages of the Repong Damar is the minimum interference from wild livestock so that young resin seeds can grow well. From the eco-physiological aspect, resin seedlings are classified as tolerant plants in the juvenile phase, which means that resin seedlings are able to grow and develop well under limited light conditions on the forest floor. This shade tolerant nature is an important ecological adaptation that allows the natural regeneration of resin under the forest canopy without the need for extensive land clearance. As it grows, the resin tree gradually becomes more light demanding (becoming intolerant) and will grow to obtain optimal sunlight for sap production [69]. The care of mature resin trees that have entered the productive phase has different characteristics from seedling treatment, with a focus on optimizing sap production. One important care practice is pruning branches of resin trees, which is done with the aim of forming a straight, tall, and branch-free main trunk. This pruning is very important to facilitate access for farmers when tapping sap and reducing the risk of accidents related to work. In addition, pruning improves the quality of resin wood if the resin tree falls and is cut down one day [70]. Resin trees that have a straight trunk and free wood have a higher economic value. Weeding activities are still organized periodically around the resin trees, especially in the rainy season when weed growth is very fast. A serious threat to the productivity of resin trees is the attack of stem borer termite pests in resin holes (*pepat*). To overcome this problem, some resin farmers in Pekon Tanjung Setia use chemical pesticides and plant-based pesticides made from the roots of the male tuba (a type of vine). The roots of the breed tuba are cleaned first, then pounded to release a

white liquid, which is the poison. After the roots of the breed tuba have been mashed, they are soaked in water for about 30 minutes; after which they are filtered and then sprayed into the hole (*pepat*) of the resin stem. This method of applying vegetable pesticides shows local wisdom in pest control that is environmentally friendly, effective, and sustainable without causing chemical residues that are harmful to the ecosystem and the quality of the resin sap produced [71].

3.1.3 Resin harvesting

People in Pekon Tanjung Setia have very strict rules in the process of tapping resin. In practice, there are several ping resin. Before the tapping is carried out, the part of the resin tree trunk to be tapped is cleaned of moss or dirt to ensure that the sap that comes out remains clean and healthy. New resin trees can be tapped after reaching the age of 20 to 25 years or having a trunk with a diameter of at least 30 cm. A sign of readiness for tapping can also be seen from the size and condition of the resin leaves. Resin trees that are not ready to be tapped are still wide in size; when the leaves have shrunk, it is a sign that the resin tree can be tapped. The people of Pekon Tanjung Setia have a belief that tapping of resin sap can be done when the moon is dead (the end of the month) to avoid termite attacks that can result in the fall of resin trees. Trees that are tapped at a young age will affect their growth and are quickly attacked by pests. The resin tapping technique or one known as making a tapping hole is the most important technical skill inherited in the management of Repong Damar. The tapping hole is made using a small axe with a technique that has been inherited traditionally. Holes are made in the bark of the trunk without injuring the wood of the terrace, so as not to damage the inside of the tree (Figure 4). For the first tapping, it is enough to have three to four holes (*pepat*) first with the aim of stimulating the resin tree to release resin without causing the death of the tree. The precision of the tapping technique greatly determines the productive age of the tree and the volume of resin produced in each harvest period [72]. The shape of the tapping hole is made in the shape of a triangle. The triangular shape allows the resin to flow more smoothly and makes it easier for the resin to collect at the bottom so that it is easier to hold and not spread to the surface of the rod. A triangular-shaped wound has a wound area narrower than a square or elongated shape. Research [73] explained that lesions with small fields accelerated the process of the closure of cambium tissue. The resin that comes out through the tapping wound is taken using a sling or bucket. The pick-up process is conducted when the resin has hardened for the best quality [74]. In the Repong Damar management system in Pekon Tanjung Setia, children are introduced to resin tapping techniques from the age of about ten years and are allowed to tap independently starting from the age of 15. The reason for this restriction is that tapping techniques require high precision so as not to damage the bark of the tree and interfere with the productivity of the resin. Incorrect tapping can cause wounds that are too deep, make the trunk susceptible to termites, and even reduce the ability of resin trees to release resin. Children are given initial experience as part of the process of inheriting knowledge, while more complex technical skills are learned when they start their adolescence.

Figure 4. Process of resin harvesting in Tanjung Setia (August 2025)

Resin harvesting in Pekon Tanjung Setia is basically not related to a specific month in the calendar but is greatly influenced by the reading of natural signs or the phases of the moon. Resin farmers in Pekon Tanjung Setia believe

that appropriate resin harvesting is done once a month so that the quality of the resin produced could guarantee a high price. The harvesting period greatly affects the quality of resin, the highest quality, i.e., class A export is often achieved in longer harvesting period of about four weeks, because the resin has a longer time to harden. In addition, the microclimatic conditions around the Repong Damar, such as air humidity and rainfall affect the quality of resin. Resin farmers realize that the best resin quality is obtained in the dry season. During this period, the resin hardened in the slab is not contaminated by rainwater, so it is brighter, cleaner, and more expensive in the market. In contrast, in the rainy season, resin is more often wet when contaminated by water, so it becomes darker or brownish in color. This condition often downgrades resin to DE or CKKK quality (Defective and Dirty Small Pieces), which is lower in price. Although the dry season produces the best resin quality, resin farmers understand that resin quantities tend to decrease during this period. The long dry season lasting five to six months reduces the release of resin, although it is of excellent quality and hardens perfectly. This is in contrast to the rainy season, where the quantity of resin often becomes more because moisture aids resin flow [75]. However, the high humidity actually decreases the quality. Resin farmers must balance the quality and quantity when determining the best time to unload, although the dry season remains the top choice for those pursuing export quality [76].

Resin harvesting (*ngunduh*) should only be done independently by adolescent boys aged 15 years and above. This age restriction is strongly related to the tall physical character of resin trees, which often reach more than 20–30 meters [77]. The activity of downloading resin requires courage, physical strength, and the ability to climb trees safely. In Pekon Tanjung Setia, resin harvesting is carried out for generations, mainly by adolescent boys and fathers. This is related to the considerable physical needs in resin downloading activities, such as climbing tall resin trees, carrying harvesting equipment, and lowering a considerable amount of hardened resin. Adolescent boys usually begin to be involved as a form of practice and habituation, while men take on the leading role as experienced workers could understand climbing techniques, take resin without damaging the *pepat*, and implement safety strategies during the harvest process. The involvement of adolescent boys in resin harvesting also reflects the gender-based division of labor [78] in the Pekon Tanjung Setia community, where high-risk work is more often performed by men. This social structure not only regulates work patterns but also affects the process of inheriting local knowledge related to the technical management of Repong Damar. Parents are responsible for ensuring teenage boys understand the correct climbing technique, determine which straps are ready to download, and how to avoid damage to tree trunks. Meanwhile, adolescent boys gradually put this local knowledge into practice until they become proficient. The process of inheriting local knowledge related to resin harvesting with hands-on practice becomes a practical and informal learning space that can guarantee the continuation of knowledge regeneration in a sustainable manner [79].

3.1.4 Resin harvesting tools

The resin harvesting tools used by resin farmers in Pekon Tanjung Setia when downloading resin still use traditional tools such as small axes, buckets or bebalans, ambon, and tembilung. Small axes or patil axes are the main tool in the process of tapping and harvesting resin because of their lightweight shape and easiness to control (Figure 5). The small size of the axe allows farmers to make triangular-shaped scissors (notches) and scrape the surface of the bark of the stem so that sap could come out. The precision of the incision is essential to maintain the productive age of the resin tree [80]. In addition to axes, the next important tool is ambon, which is a safety belt woven from rattan with a length of about one to two metres and used as an aid when climbing resin trees (Figure 6). Ambon functions as body support when the harvester is at so that it can work more stably. Ambon will be wrapped around the body of resin farmers; with the help of ambon, farmers then climb resin trees one by one to start harvesting the sap. Ambon is used by tying it in accordance with the size of the farmer's body. The tie can circle the tree and function to hold the farmer's body when climbing. The way to climb is by moving the ambon upwards while their feet are on the notches on the tree trunk. The flexible and strong structure of ambon renders it ideal for helping the resin harvesting process carried out on tall trees. The resin farming community in Pekon Tanjung Setia continues to maintain the use of ambon because it is more comfortable and suitable for the large diameter of resin trees. Ambon is believed to be safer as resin farmers in Pekon Tanjung Setia understand its usage, deriving from extensive experience from generations. One of the traditional containers still being used in resin harvesting is tembilung, which is a container made from areca nut fronds. Tembilung has a lightweight character and is easy to carry when farmers climb trees. Tembilung is usually installed near the ready-to-harvest *pepat* when the farmer moves from one tree to another. In addition to tembilung, the people of Pekon Tanjung Setia also use bebalang, namely a rattan basket that is used as a container to transport resin from inside the Repong to the settlement. The Bearings, with a large capacity, are strong and designed to withstand hard and dense resin loads. Tightly woven rattan provides air circulation so that the resin does not get wet. However, some resin farmers in Pekon Tanjung Setia have begun to replace tembilung and bebalang with plastic buckets and sacks that are easier to find and more practical to use (Figure 7 and Figure 8). The availability of cheap and easy-to-buy plastic buckets in the market has made some resin farmers switch for efficiency. However, the basic function of the tool has not changed, namely as a container and transport resin.

Figure 5. Hatchet

Figure 6. Ambon

Figure 7. Bucket

Figure 8. Sack

3.1.5 Challenges in inheriting local knowledge and the meaning of knowledge inheritance lokal

One of the most significant challenges in maintaining the sustainability of Repong Damar in Pekon Tanjung Setia is the existence of generational disruption in the inheritance of local knowledge. This phenomenon arises because most young people now prefer looking for jobs in the non-agricultural sector, which is considered to offer better economic prospects and lighter jobs. As a result, there has been a decrease in the interest and involvement of the younger generation in daily activities at Repong Damar. Despite facing disruption, most of the resin farming families in Pekon Tanjung Setia are still trying hard to maintain the traditional inheritance system. This effort is executed through a daily routine, in which parents consistently invite their children to the garden to introduce Repong Damar from an early age with a hands-on mechanism [81]. The family seeks to instill noble values and management ethics, thus emphasizing that Repong Damar is a heritage that must be maintained for the future of the economy. The consistency of parents in maintaining this daily habit is the main fortress in fighting the flow of migration and modernization. One of the strong motivations that still prevents some young generations from remaining involved in the management of Repong Damar is a guarantee of the family's economy in the future [40]. Although regular income may come from other sectors, Repong Damar is considered a stable and high-value asset, especially since resin is an export commodity. Repong Damar is the main livelihood for the majority of farmers and the income generated is quite significant [37].

The local knowledge inheritance system functions as a socio-ecological mechanism to maintain the preservation of Repong Damar which includes social, ecological, and cultural aspects. The inheritance of local knowledge has a profound meaning in maintaining the ecological sustainability of Repong Damar [82]. Knowledge of non-

destructive tapping techniques, proper tree selection, and ideal harvest times can only survive through a consistent intergenerational transmission process. The success of maintaining the health of the Repong ecosystem for hundreds of years in Pekon Tanjung Setia proves that this knowledge is not only a technical skill but also contains strong conservation principles. Without effective inheritance, the ecological sustainability of Repong Damar can be threatened. In addition to its ecological function, the inheritance of local knowledge also strengthens the social resilience of the community. Intergenerational relationships are built through routine in the garden and informal interactions. These activities not only inculcate skills but also the value of cooperation, discipline, and a sense of responsibility for the land [83]. Therefore, Repong Damar is not only an ecological space but also a social space that forms the identity of the people of Pekon Tanjung Setia. This social resilience is an important cultural capital in facing the changing times. The inheritance of local knowledge also has a spiritual and symbolic dimension. The community considers Repong Damar an ancestral heritage that must be maintained with full responsibility. Values such as the sacredness of nature, ethics in harvesting, and respect for ancestors become part of the inherited cultural identity. Research [84] explained that a land involving a system of inheriting local wisdom in its management tended to be more sustainable and productive. The inheritance of local knowledge forms an important basis in preserving the ecological and socio-cultural heritage of the people in Pekon Tanjung Setia, Pesisir Barat, Lampung, Indonesia.

3.2 Resin Sorting

The resin sorting process is an important post-harvest stage that determines the selling price of the commodity. Resin farmers in Pekon Tanjung Setia have a resin quality classification system which divides resin into several classes, including Quality A (Export), C, DE, CKKK, and dust. Resin sorting in Pekon Tanjung Setia is generally carried out by resin collectors, adolescent girls, and experienced mothers. Once the resin is extracted from the Repong, the collector is usually the first party to roughly group the resin. The follow-up sorting process is then handled by mothers and adolescent girls in the collector's warehouse, based on general qualities such as color, texture, block size, and resin purity. The involvement of women in sorting has been going on for generations, as this work requires precision, patience, and the ability to observe details. The quality of resin is entirely determined by visual observation that relies on eye skills and experience. The sorters pay attention to the color and size of the lumps as the main indicators of resin quality. Quality A or export grade is the highest level of resin that has the highest selling value in the global market. The main criteria for A-grade resin are clear or light yellow in color, as well as large and relatively uniform clump shapes. Resin at grade A (export) must be clean from contamination of impurities such as wood chips, dust, or soil (Figure 9). Tapping carried out with proper technique and good tree care contributes greatly to the production of Quality A resin. This export quality is usually obtained from resin that has hardened perfectly and is harvested at an ideal period. Apart from Quality A, there are other lower quality levels, namely C, DE, CKKK (Defective and Dirty Small Pieces), and Dust, which show a decrease in value or price. Quality C usually still has lumps that are cloudier in color than Quality A or have less dirt (Figure 10), while DE has smaller lumps (Figure 11). CKKK is a resin that has been broken down, dirty, and dark in color (Figure 12), while Dust is the lowest value resin flake or powder (Figure 13). This classification is very similar to the Indonesian National Standard (SNI 2900.1:2012) for cat's eye resin, which determines quality based on visual observations such as the color and size of the lumps. Local knowledge of resin sorting in Pekon Tanjung Setia contributes significantly to meet international quality standards. Although it does not use laboratory equipment such as SNI 2900.2:2013 (which tests ash content and soft spots), resin farmers/collectors are able to sort resin accurately, hence meeting the basis of SNI 2900.1:2012.

Local knowledge of resin sorting is passed down from generation to generation through hands-on practice and informal interaction at home or in the collector's warehouse. Children and adolescents, especially women, learn to identify the quality of resin by observing working mothers and listening to explanations about the color, cleanliness, and size of the blocks. The inheritance of local knowledge is not implemented through books or written guidelines, but through learning by doing (following the general pattern of inheriting local wisdom) in the management of Repong Damar. The ability to judge the quality of resin grows from practical experience that continues to be honed over a long period of time. In addition to the technical aspects, the inheritance process teaches socio-ecological values such as honesty in quality classification and the importance of maintaining the quality of resin to maintain trust between farmers and collectors [36]. The younger generation learns that the quality of resin not only reflects the condition of the resin but also reflects the reputation of a family as resin farmers. These values then strengthen the sustainability of the resin trading system in Pekon Tanjung Setia.

Children in Pekon Tanjung Setia are introduced to resin sorting activities from the age of about ten. In the early stages, they are only asked to help separate large and small chunks or clean up clearly visible dirt. They have not been told to determine the quality of resin independently because the ability to distinguish colors and cleanliness requires high precision. Through this activity, children are introduced to the basics of sorting. To be trusted to sort resin independently, a teenage girl usually needs a long learning time, about one year of active involvement in the sorting process. During this period, they gradually learned to recognize the difference among the qualities of A, C,

DE, CKKK, and Dust through the repetition of practice. Mothers and collectors usually test their children's abilities by asking them to separate a mixture of resins of various qualities. If the sorting results are accurate, then they are allowed to sort the resin themselves. This lengthy process ensures that the sorting is carried out appropriately, so the quality of the resin sold to the market could be maintained according to standards.

Figure 9. Resin quality A (Export)

Figure 10. Resin quality C

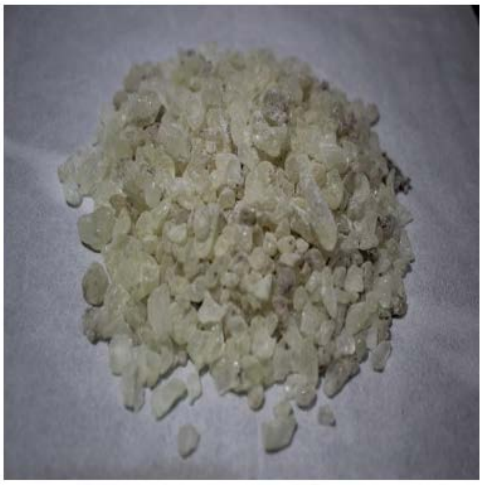

Figure 11. Resin quality DE

Figure 12. Resin quality CKKK

Figure 13. Resin quality dust

3.3 Analysis of the Socio-Ecological Dynamics of Repong Damar

The management of Repong Damar in Pekon Tanjung Setia is not a separate entity, but a system interdependent between the social system and the ecological system. From the perspective of social-ecological system, customary rules in Pekon Tanjung Setia function as a control mechanism that regulates human behavior (social system) so that it is in harmony with the regeneration capacity of the resin Repong (ecological system) [85]. This relationship creates a stable ecosystem due to the alignment between social and ecological norms. The social system in Pekon Tanjung Setia, which is manifested through local governance (governance system), puts positive pressure on ecological sustainability [86]. Customary rules ensure that land is not converted into other uses that damage the environment. Here, the social system acts as a protective filter that keeps human interaction from exceeding the threshold of the carrying capacity of the environment. The integrity of the Repong Damar structure is maintained in a sustainable manner [87]. Analytically, this relationship works through feedback loops. When the ecological system provides abundant yields of resin, the social system responds by performing rituals as a form of gratitude and protection efforts. On the other hand, if there is a decrease in the quality of the Resource Unit, social actors in Pekon Tanjung Setia will adjust to the tapping technique. This dynamic shows that the resilience of the resin Repong is highly dependent on the ability of social systems to process ecological information into appropriate managerial actions [88]. The sustainability of Repong Damar in Pekon Tanjung Setia is also greatly influenced by the transmission of knowledge as part of the social system. Local knowledge of how to properly tap without damaging trees is a form of traditional ecological knowledge. Without a social system that supports this inheritance, ecological systems will suffer degradation due to wrong exploitation practices [89]. The existence of customary rules in Tanjung Setia is an absolute prerequisite for the sustainability of ecosystem functions in the long term. Social-ecological system analysis showed that the stability of this system was tested by external pressures such as fluctuations of market prices. However, the strength of social capital and compliance with customary rules in Pekon Tanjung Setia allows the ecological system to survive.

Table 1 illustrates the systemic framework in which Resource Governance regulates Resource Actors in interaction with the Resource System. Resource Actors perform extraction on Resource Units without damaging the Resource System because they are guided by local knowledge. The condition of a sustainable Resource System provides economic benefits back to Resource Actors, who then strengthens trust in Resource Governance.

Table 1. Components of social-ecological system

No.	Social-Ecological System Variable	Components in Pekon Tanjung Setia	Analysis of Field Findings
1.	Resource System	Repong Damar Ecosystem	Repong Damar is managed as an agroforestry system by the people of Tanjung Setia.
2.	Resource Unit	Damar Tree and Resin Damar	Resources are harvested periodically with attention to tree health.
3.	Resource Actor	Damar Farmer & Repong Owner	Individuals with traditional knowledge who are responsible for maintaining the Repong Damar ecosystem.
4.	Resource Governance	Customary Rules	Customary norms regulate harvest timing and prohibit the felling of productive trees.

4 Conclusions

The transmission of local knowledge in Damar Resin management in Pekon Tanjung Setia occurs through a very natural pattern and is based on direct experience. The learning by doing mechanism is at the heart of the local knowledge transfer process, in which children not only receive verbal explanations but also directly practise what they see with their parents and other family members. The knowledge passed down includes technical skills such as nursery, planting, maintenance, tapping, harvesting, and sorting Damar Resin. This knowledge transfer is not only technical but also philosophical (ethics towards nature) that ensures the sustainability of ecosystem functions from generation to generation. This knowledge transfer is crucial because it serves as the main foundation for the resilience of the Damar Resin ecosystem. Without effective knowledge transfer, the social structures that maintain forest sustainability will collapse, which in turn will trigger environmental degradation and the loss of local biodiversity.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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