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APPLICATION OF EDU-AGROTOURISM AND AGROFORESTRY: PATTERNS OF LAND USE ON CONSERVATION IN THE BUFFER AREA

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Abstract

Sustainable development encompasses three fundamental dimensions, including the socio-cultural, economic, and ecological. Agroforestry seeks to achieve multifunctional, efficient, and environmentally sustainable production by replicating forest-like circumstances and employing management strategies that align with the cultural values of local people. The successful execution of this strategy is facilitated by the improvement of soil and microclimate conditions, which positively impact agricultural results. The Lore Lindu National Park (TNLL) is an officially declared national park in the Central Sulawesi province of Indonesia. The location plays a crucial role in conserving Sulawesi Island's rich array of biological diversity. The research findings indicate that the flora variety within the TNLL region encompasses a wide range of botanical species, including diverse trees, resin-producing plants, rattan, orchids, and medicinal plants. The agroforestry patterns seen in the buffer region of the TNLL can be categorized as the agrisilviculture model. This model represents an agroforestry system that integrates plant and agricultural components, specifically non-wood species. The pattern under consideration encompasses several components, including tree plants such as cocoa, durian, cloves, and candlenuts, alongside agricultural components like corn, vegetables, and tubers. The historical trajectory of land utilization commenced with the indigenous communities who exercised stewardship over the vicinity surrounding TNLL, employing their indigenous knowledge and practices as a consequence of their successful adaptation to the prevailing natural circumstances. The utilization of natural resources by indigenous groups within national park regions for their daily necessities is frequently perceived as exerting strain on the protected landscape's ecological integrity and long-term viability.

Keywords*: Agroforestry; Buffer area; Conservation; Edu-agrotourims; Land use*

Introduction

In a general context, the three components of sustainable development encompass economic, ecological, and socio-cultural aspects. The essential elements required for achieving sustainable agriculture consist of enhancing plant and animal productivity, establishing socio-economic viability, and protecting natural resources over an extended period [1]. Therefore, it is imperative for sustainable development to effectively attain economic objectives by fostering income growth, social objectives by promoting equality and minimizing inequities, and environmental objectives by enhancing the carrying capacity of the ecosystem [2].

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Sustainability can be conceptualized as a deliberate endeavor to enhance the well-being of the present generation while safeguarding the natural environment, thus ensuring its capacity to sustain the well-being of future generations [3].

Indonesia's forests, renowned for their remarkable biodiversity and abundance of plant and animal species, have sustained significant and enduring harm over nearly five decades. One of the contributing factors to the alteration of dipterocarp rainforests in western Indonesia is the establishment of extensive plantations and the subsequent growth of the timber industry [4]. It is imperative to implement robust protection measures in order to mitigate the occurrence of further extensive forest degradation. The endeavor to safeguard is not devoid of complexity. Forests must exhibit enhanced ecological functionality while influencing economic and social dimensions. One of the strategies employed for preserving forest regions is the establishment of National Parks [5].

In 2008, the International Union for Conservation of Nature (IUCN) established a definition for national parks. As per the provided definition, national parks are officially declared regions of natural significance, comprising both terrestrial and marine environments, which are established to fulfill the following objectives: i) the preservation of the ecological integrity of one or more ecosystems to promote the well-being of present and future generations, ii) prohibiting activities that exploit or occupy the area in a manner inconsistent with its intended purpose and iii) offering opportunities for spiritual practices, scientific research, educational endeavors, recreational activities, and tourism that align with the local environment and culture [6-7]. Category II conservation areas encompass national parks, which are designated protected areas primarily administered to protect diverse species and valuable habitats and provide recreational opportunities [8].

The basic principles of the definition of a national park include an area with a high unique value, conserved biodiversity, ecosystem services, habitat types, enchanting natural landscapes, beautiful views, and exciting culture/traditions of the community [9]. In Indonesia, establishing national parks begins by claiming the area as state property rights so that the government determines locations deemed to meet the criteria for its establishment in a top-down manner [10]. On the other hand, indigenous peoples manage the same area with local traditional wisdom, resulting from adapting life to environmental conditions [11].

The available empirical data suggests that the government faces challenges in efficiently managing the region due to persistent conflicts related to the distribution and utilization of natural resources. National parks are a sign of state territorialization that excludes the recognition of indigenous or local communities [12]. Status as a member of an indigenous community or who lives around a national park does not automatically mean you will get the rights or benefits from the existence of a national park [13]. People are expected to be aware of giving away some of their traditional territories for national interests that have broader value. The intense domination of the state causes indigenous people to be marginalized [14].

The government's mindset, reflected in statutory regulations, addresses communities in and around national park areas as managed objects that are part of the tourism development potential [15]. Sometimes, they are even positioned as parties at odds with conservation interests. The tradition of using natural resources in national park areas by indigenous communities to fulfill their daily needs is often seen as a pressure or threat to the ecological integrity of government-owned forest areas [16]. At times, they are perceived as parties that conflict with conservation interests. The tradition of using natural resources in national park areas by indigenous communities to fulfill their daily needs is often seen as a pressure or threat to the ecological integrity of government-owned forest areas [17].

Lore Lindu National Park (TNLL) is a designated national park in Central Sulawesi, Indonesia. The region in question has been officially declared as a site for ecological conservation on Sulawesi Island [18]. The TNLL site is located around 60 kilometers south of

Palu city, with geographical coordinates ranging from 119°90' to 120°16' east longitude and 1°8' to 1°3' south latitude. The Taman Nasional Lore Lindu (TNLL) spans a land area of 217,991.18 hectares, equivalent to approximately 1.2% of Sulawesi's overall land area of 189,000 square kilometers or 2.4% of the remaining wooded areas in Sulawesi, precisely totaling to 90,000 square kilometers. The elevation within the TNLL ranges from 200 to 2,610 meters above the mean sea level. Approximately 90% of the TNLL region is characterized by mountain and sub-mountain forests, constituting the predominant land cover within the territory. Approximately 10% of the area is covered by lowland woodlands. The Taman Nasional Lore Lindu (TNLL) harbors a significant array of autochthonous flora and fauna that exhibit distinctiveness within the Sulawesi region. Moreover, the region of TNLL presents alluring natural environments due to its advantageous positioning along the Wallace line, which functions as a transitional demarcation between the Asian and Australian biogeographic regions [19].

The role of the buffer zone, which is a buffer for harmful community activities in conservation areas, is vital for the conservation and sustainability of TNLL. The TNLL buffer zone is made up of green lanes, interaction lanes, and cultivation lanes [20]. The prevailing feature of the region is the presence of several interaction channels, which encompass a blend of mixed garden designs, pure gardens, and intercropping gardens. The primary focus of cultivation in this area is centered around cocoa production. The cultivation route refers to the specific location where community woods, intended to be the predominant vegetation type along the interactive route, are typically situated. Numerous dipterocarp species may be identified, among which the prominent timber varieties encompass agathis and ebony. Cocoa-based agroforestry emerges as the most optimal land utilization pattern since it satisfies the criteria of conserving biological land and providing a suitable environment for animal habitats.

The inevitability of efforts to enhance productivity in conjunction with population growth is juxtaposed with the limited expansion of land supply, resulting in pressure and exploitation of agricultural land. As suggested in the literature, one potential option to address this issue is to enhance agricultural land productivity by utilizing forest land [21]. In circumstances of this nature, the adoption of an agroforestry system emerges as a viable approach predicated on the premise that the transformation of forested areas into agricultural land can give rise to a multitude of challenges, including diminished soil fertility, erosion, the depletion of plant and animal species, inundations, arid spells, and potentially even global climate alterations [22]. Edu-Agrotourism is part of a tourist attraction that utilizes agricultural businesses as a tourist attraction. The goal is to expand knowledge, recreational experiences, and business in the agricultural sector. Through the development of Edu-Agrotourism, which highlights local culture in using land, we can preserve land resources and maintain local culture and technology (indigenous knowledge), which are generally in accordance with the conditions of the natural environment [23].

Agroforestry, a land management strategy that integrates the cultivation of trees and agricultural plants, represents an innovative approach to land use. This principle aligns with the overarching objective of achieving sustainable outcomes [24]. Agroforestry seeks to achieve multifunctional, efficient, and environmentally sound production by emulating forest conditions and employing management strategies that align with the cultural values of indigenous populations [25]. This approach capitalizes on the beneficial effects of enhanced soil and microclimate conditions to promote sustainable agricultural practices. The problem in this research is:

a. What is the potential extent of plant diversity within the TNLL area?
b. What is the agroforestry pattern based on local wisdom in the buffer region of TNLL?
c. What is the historical context of land use modifications in the TNLL buffer region influenced by indigenous knowledge and practices?

Experimental part

Description of the Study Area

The geography of TNLL exhibits a range of characteristics, including flat terrain, slopes of moderate incline, and steep to very steep slopes. In hilly regions, the soil layers are more susceptible to erosion [26]. The TNLL is geographically located inside the Central Sulawesi Province, encompassing three regencies, namely Donggala, Sigi, and Poso, as well as Palu City. The TNLL region (Fig. 1) has a crucial role in water catchment due to the existence of two prominent rivers: the Gumbasa River in the northern section, which acts as a connecting conduit between the Palu River in the western region, and the Lariang River in the eastern and southern regions [27].

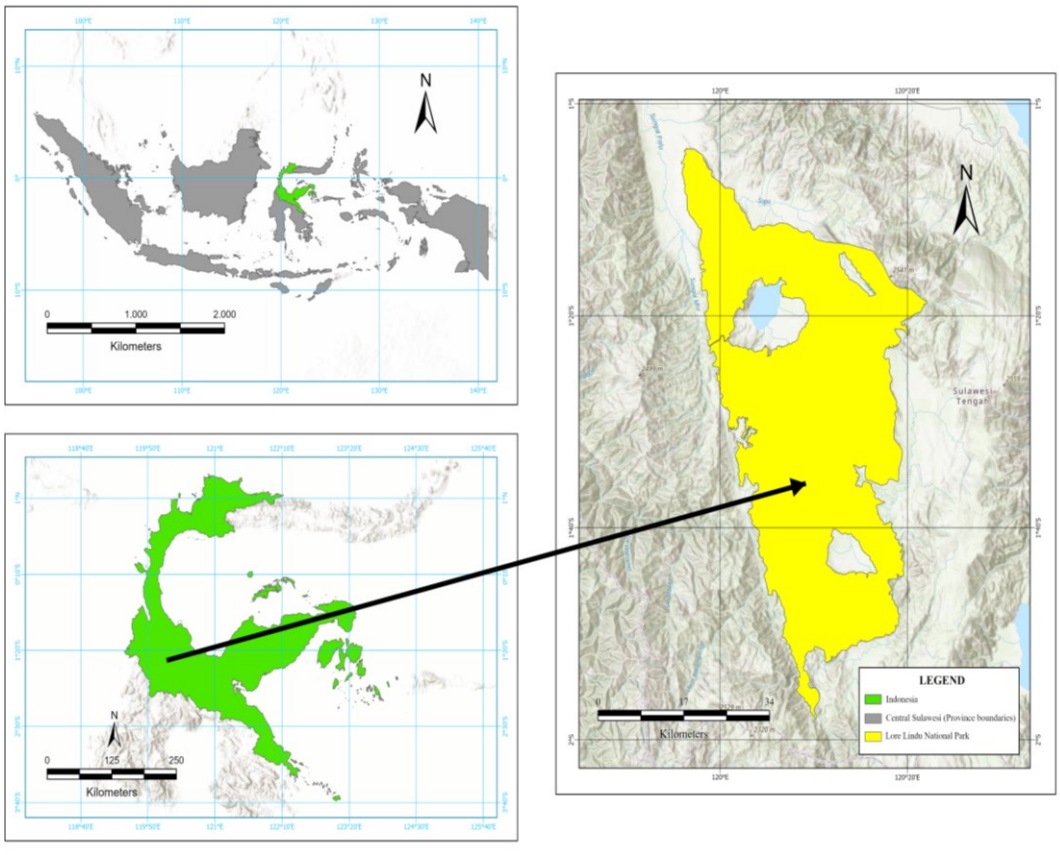

Fig. 1. Lore Lindu National Park Area

The inhabitants residing in the TNLL region exhibit a reliance on woods and perceive their locality as an inheritance from their forebears, necessitating prudent and sustainable management akin to the practices of preceding generations. The preservation of nature has been manifested in individuals' daily behavioral practices about the environment, which have been passed down through successive generations [28].

Data Collection and Analysis

Potential for Plant Diversity in the TNLL Area

Primary data was collected using observation, namely by walking through the forest along predetermined transect lines. Next, an inventory and calculation of plant diversity in TNLL were carried out. Secondary data was obtained through interviews with respondents and

literature reviews of various literature studies, including journals, books, papers, media, and information from the internet related to research [30]. Qualitative data analysis was conducted to examine and describe the current facts about the plant species in the TNLL area, designated as a biodiversity conservation zone.

Agroforestry Patterns Based on Local Wisdom in TNLL Buffer Areas

Data collection was carried out using interview methods with respondents and field observations. In-depth interviews were conducted using a questionnaire regarding New Environmental Paradigm (NEP) -based patterns to determine community motivation in implementing agroforestry systems [31]. Data regarding agroforestry models (plant types and planting patterns) obtained from respondents were analyzed using a qualitative descriptive approach. Qualitative research emphasizes the analysis of answering research questions through formal and argumentative thinking. This analysis will describe the agroforestry model in detail regarding planting patterns, types, and land use [32].

History of Land Use Changes Based on Local Wisdom in the TNLL Buffer Area

Observation data was collected using triangulation techniques, combining interview data, non-participatory field observation, and documentation. Interviews were conducted using structured interview techniques and interview guides relating to the aspects to be studied to achieve research objectives [33]. Concurrently, the research site was surveyed by implementing field observations and documentation. The research employs two primary methods for secondary data collecting, namely the Institutional Survey and Literature Study. In order to gather textual data about this research, institutional surveys are conducted through visits to offices and agencies associated with the subject matter [34].

Results and discussion

Potential for Plant Diversity in the TNLL Area

The primary objective of TNLL, being a designated nature conservation area, is to ensure the preservation of life support systems, the preservation of diverse plant and animal species, and the promotion of sustainable exploitation of biological natural resources and their related ecosystems. In line with the directive stipulated in Government Regulation Number 108 of 2015, which serves as an amendment to Government Regulation Number 28 of 2011 concerning the administration of Natural Reserve Areas and Nature Conservation Areas, the utilization of TNLL (Taman Nasional Laut Laut) can be effectively employed for diverse objectives. The objectives of forests are diverse and encompass various purposes, including but not limited to 1) conducting research and advancing scientific knowledge; 2) promoting education and increasing awareness regarding nature conservation; 3) acting as a storage and absorption site for carbon, as well as facilitating the utilization of water, energy, wind, solar heat, geothermal heat, and natural tourism; 4) enabling the utilization of wild flora and fauna; 5) supporting the utilization of germplasm sources to assist in cultivation efforts; and 6) permitting traditional use by local communities.

The geography of the TNLL area exhibits significant variation, suggesting its proximity to the intersection of two distinct plains. The highest temperature ranges from 26 to 35°C, whereas the minimum temperature is from 12 to 17°C. The rainfall distribution near TNLL exhibits variability and lacks uniformity across different year periods. The mean yearly precipitation in TNLL exceeds 3000 mm. In regions with an elevation of 1000 m or higher, precipitation typically surpasses 60 mm per month, even during the traditionally arid months [35]. The TNLL area has a lot of potential and natural resources that can be developed into attractive tourist attractions. The attraction of natural beauty, culture, and biodiversity, especially the variety of plants that can be cultivated, is the primary capital that needs to be managed as well as possible to achieve the successful development of Edu-Agrotourism [36].

Table 1. Potential Plant Diversity in the TNLL Area

No.	Local Name	Species	Family
1.	Nantu	*Palaquium obovatum* (Griff.) Engl.	*Sapotaceae*
2.	Banyan	*Ficus arsusta (*Miq) Corner	*Moracee*
3.	Mahogany	*Swietenia mahagoni*	*Meliaceae*
4.	Palapi	*Heritiera (Tarrietia) spp*	*Sterculiaceae*
5.	Grass jelly leaves	*Cyclea barbata*	*Menispermaceae*
6.	Aropi	*Baccaurea tetandra* (Baill.) Mull.Arg.	*Phyllanthaceae*
7.	Tabancoi	*Dracaena angustifolia* (Medik.) Roxb.	*Asparagaceae*
8.	Bayur	*Pterospermum celebicum* (Miq.)	*Malvaceae*
9.	Kapi wood	*Melanolepis multiglandulosa*	*Sapindaceae*
10.	Teti Mata	*Malotus barbatus*	*Euphorbiaceae*
11.	Tirotasi	*Polyscias nodosa* (Blume)	*Araliaceae*
12.	Bonoh	*Trema orientalis* (L) Blume	*Ulmaceae*
13.	Dao wood	*Knema* sp	*Myristiacea*
14.	Panggi	*Pangium edule* Reinw.	*Flacortiaceae*
15.	Dara-dara	*Horfieldia costulata* Miq.	*Myristicaceae*
16.	Benuang	*Octomeles sumatrana* Miq.	*Lythraceae*
17.	Kau alo	*Chisocheton sp*	*Meliaceae*
18.	Pinang yakis	*Areca vestiaria* Giseke	*Arecaceae*
19.	Rao	*Dracontomelon dao*	*Anacardiaceae*
20.	Palm	*Livistonia rotundifolia*	*Arecaceae*
21.	Betak	*Calophyllum soulattri*	*Clusiaceae*
22.	Teauru	*Artocarpus tesymanii* Miq	*Moraceae*
23.	Kau pia	*Dysoxylum* Sp	*Meliaceae*
24.	Rambutan Hutan	*Litsea firma* (Bl)	*Lauraceae*
25	Malapoga	*Toona ciliata M. Roem*	*Meliaceae.*
26	Puar	*Etlingera megalocheilos*	*Zingiberaceae*
27	Horse Whip	*Stachytarpheta jamaicensis*	*Verbenaceae*
28	Resin	*Agathis dammara (Lamb.) Rich.*	*Araucariaceae.*
29	Sugar palm	*Arenga pinnata*	*Arecaceae*
30	Pegagan	*Centella asiatica*	*Apiaceae*
31	Orchid	*Dendrobium*	*Orchidaceae*
32	Rattan	*Calamus rotang*	*Arecaceae.*
33	Cinnamon	*Cinnamomum burmanii*	*Lauraceae*
34	Weeds	*Imperata cylindrical*	*Poaceae*
35	Kecibeling	*Strobilanthes cripus*	*Acanthaceae*
36	Cataract Leaves	*Laurentia longifora*	*Compnulaceae*
37	Sirsak	*Annona muricata*	*Anonaceae*
38	Pakis Gajah	*Angiopteris evecta*	*Marattiaceae*
39	Pulai	*Alstonia scholaris*	*Apocynaceae*
40	Bandotan	*Ageratum conyzoides*	*Asteraceae*
41	Ulam Tikus	*Mikania micrantha*	*Asteraceae*
42	Tapak Gajah	*Elephantopus scaber*	*Asteraceae*
43	Durian	*Durio zibethinus*	*Bombaceae*
44	Gelinggang Leaves	*Cassia alata*	*Leuguminoceae*
45	Gewor	*Commelina benghalensis*	*Commelinaceae*
46	Jengkol	*Phythecelobium jiringa*	*Fabaceae*
47	Mpire	*Caryota mitis* Lour	*Arecaceae*
48	Paku Sikakeh	*Nephrolepis biserrata*	*Dryopteridaceae*
49	Jarak Pagar	*Jatropha curcas*	*Euphorbiaceae*
50	Sitawa	*Costus speciosus*	*Costaceae*
51	Saga	*Abrus precatorius*	*Fabaceae*
52	Paku Ransam	*Dicranopteris linearis*	*Gleicheniaceae*
53	Lemongrass	*Cymbopogon nardus*	*Poaceae*
54	Ulin	*Eusiderroxylon zwageri*	*Lauraceae*
55	Sikaduduak	*Melastoma malabathricum*	*Melasthomataceae*
56	Benalu	*Scurrula ferruginea*	*Lorantaceae*
57	Pepaya	*Carica papaya*	*Caricaceae*
58	Kayu susu	*Tabernaemontana sphaerocarpas* Blume	*Apocynaceae*
59	Clove	*Syzygium aromaticum L.*	*Myrtaceae*
60	Ara Sungai	*Ficus racemose*	*Moraceae*
61	Mimosa	*Mimosa pudica*	*Mimosaceae*
62	Akar Ali-ali	*Tinospora cordifolia*	*Menispermaceae*
63	Rukam	*Flacourtia rukam*	*Salicaceae*
64	Noni	*Morinda citrifolia*	*Rubiaceae*

No.	Local Name	Species	Family
65	Tarok	*Artocarpus elasticus*	*Moraceae*
66	Guava	*Psidium guajava*	*Myrtaceae*
67	Lonca ibo	*Disoxylum nutans* (Blume) Miq.	*Meliaceae*
68	Rambutan	*Nephelium lapaceum*	*Sapindaceae*
69	Ciplukan	*Physalis angulate*	*Solanaceae*
70	Pancaringek	*Rubus moluccanus*	*Rosaceae*

Agroforestry Patterns Based on Local Wisdom in TNLL Buffer Areas

Farmers in the TNLL buffer area have long been engaged in implementing agroforestry systems. Typically, this phenomenon manifests as farming seasonal plants in forested regions adjacent to residential zones, employing conventional techniques [36]. Farmers continue to employ a rudimentary agroforestry approach, wherein they integrate economically lucrative seasonal crops, such as corn, vegetables, and tubers, with annual crops that have an ecological function, such as cocoa, candlenuts, and durian. Agroforestry systems provide a relatively large opportunity to pursue an approach that combines short- and medium-term productivity and income gains with long-term sustainability goals [37]. However, increasing productivity and income in the short and medium term through agroforestry systems is often determining whether farmers are willing to accept and adopt agroforestry systems. The results of the NEP analysis of Socio-Cultural, Economic, and Ecological Values are shown in Tables 2, 3, and 4 below.

Table 2. NEP Analysis Results for Socio-Cultural Values

No	Question	Respondent's Dominant Answer
1	Do you only involve family members in managing your farming land?	Most farmers still utilize the culture of mutual collaboration (mapalus) in managing farming land
2	Do you follow ancestral habits in managing farming land?	The majority of farmers continue to employ traditional inherited practices in the management of their agricultural land.
3	Do you understand and implement customary laws protecting forest land's existence about conservation and utilization of products?	Sure, farmers possess knowledge and adhere to traditional legal systems that safeguard the preservation of forested areas while also ensuring the sustainable usage of their resources..
4	Are your female family members involved in managing farming land?	The participation of female family members in managing agricultural property is often limited due to their primary concentration on domestic responsibilities.
5	Are you an administrator/member active in Farmer Group activities?	Most farmers have assumed administrative roles or become members of Farmer Groups, actively participating in various events organized by these groups.

Table 3. NEP Analysis Results for Economic Value

No	Question	Respondent's Dominant Answer
1	Do you manage farming land with the aim of selling it (commercially)	Most farmers manage farming land to meet household needs and sell the rest
2	Do you cultivate plants according to market demand?	Most farmers cultivate plants based on their needs and the availability of their resources
3	Do you prefer to plant trees or annual plants?	Most farmers choose to plant trees because of the relatively low maintenance costs and implement an agroforestry system with annual crops as a source of family food
4	Do you fertilize when managing your farming land?	Most farmers do not fertilize because of limited farming capital and consider their land to be relatively fertile
5	Do you have other sources of income apart from managing farming land?	Most farmers do not have other sources of income outside farming

Table 4. NEP Analysis Results for Ecological Value

No	Question	Respondent's Dominant Answer
1	Do you collect wood in the forest?	In order to engage in the extraction of wood from the forest, most of farmers are required to obtain explicit authorization from the Traditional Leader and Village Government.
2	Do you manage your farming land on a slope prone to erosion?	Many agricultural practitioners are tasked with managing farmland situated on sloping terrain, which is susceptible to erosion due to the restricted availability of arable land.
3	Do you cut down trees when clearing farming land?	Many farmers are tasked with managing agricultural property situated on slopes that are susceptible to erosion, primarily due to the restricted availability of arable land.
4	Have you tried to maintain the fertility of the farming land you manage?	A significant proportion of farmers lack commitment towards preserving the fertility of the agricultural land under their management, primarily attributable to financial constraints. Conversely, the remaining farmers employ chemical fertilizers to enhance soil fertility.
5	Are you involved in forest conservation activities?	Forest preservation is a matter of concern for many farmers, various members of society and village leaders.

Values of Social Culture

The lack of sufficient public amenities hinders the individuals' ability to achieve a state of prosperity in their livelihoods [38]. In the buffer region of the TNLL, conventional establishments enforce restrictions rooted in Customary Law, which encompasses activities such as logging and clearing agricultural land. These actions are subject to the oversight and authorization of Traditional Leaders and Village Government, ensuring adherence to established protocols. The utilization of customary law holds promise for achieving sustainable forest management and protection due to its inherent flexibility and reliance on deliberative processes. Applying the culture of cooperation (mapalus) and intergenerational transmission of cultivation practices in managing agricultural land reflects significant socio-cultural values. The establishment of farmer groups to organize and facilitate the adoption of agricultural cultivation technology has positively impacted farmers' knowledge and abilities [39].

Nevertheless, optimizing several facets of capital, processing, and marketing in the agricultural sector is imperative, particularly in extracting and commercializing wood products derived from farmers' land. The participation of women in developing agroforestry systems aimed at enhancing household food security. This pertains to adopting the agroforestry system as a land management approach focusing on gender considerations.

Economic Value

The agroforestry system increases farmers' income by optimizing the prudent and sustainable utilization of forest resources while concurrently upholding the enduring viability of forest functions [40]. However, most farmers cultivate plants based on their needs and limited resources, especially capitalized ones. Most farmers choose to plant trees because of the relatively low maintenance costs and implement an agroforestry system with annual crops as a family food source. Farmers also do not fertilize because of limited farming capital and consider their land relatively fertile. The majority of farmers who do not have other sources of income outside of farming can be an obstacle to developing more modern agroforestry systems because farmers need short-term income that can be generated from annual crops.

Ecological Value

The livelihoods of local communities in proximity to forests typically rely on the resources provided by these forested areas. The individual's quality of life remains distant from

a state of prosperity due to insufficient public amenities [41]. Traditional institutions implement prohibitions in the TNLL buffer region based on Customary Law, which includes regulations against activities such as logging and clearing farming land without the prior knowledge and approval of Traditional Leaders and Village Government. The utilization of customary law exhibits promises in facilitating sustainable forest management and conservation due to its inherent flexibility and reliance on deliberative processes. Applying the culture of mutual collaboration (mapalus) and intergenerational transmission of agriculture practices in land management reflects the high socio-cultural values. The establishment of farmer groups aimed at organizing and facilitating the adoption of agricultural cultivation technologies has enhanced farmers' knowledge and abilities. However, optimizing several elements, such as capital, processing, and marketing strategies for agricultural products, particularly those derived from wood cultivation on farmers' property, is imperative. Similarly, the participation of women in developing agroforestry systems aimed at enhancing household food security.

Fig 2. Agroforestry Patterns Based on Local Wisdom in TNLL Buffer Areas

History of Land Use Changes Based on Local Wisdom in the TNLL Buffer Area

The policy of establishing a national park begins by claiming the area as a state property right. Meanwhile, indigenous communities manage the same area with traditional wisdom that is local and is the result of adapting life to environmental conditions. Status as a member of an indigenous community or who lives around a national park does not automatically mean you will get the rights or benefits from the existence of a national park. They are expected to be aware of handing over part of their traditional territory for national interests. The tradition of indigenous communities using natural resources in national park areas to fulfill their daily needs is often seen as a pressure or threat to the ecological integrity of government-owned forest areas.

History documents five significant milestones in the evolution of conservation area management. These milestones include the Yellowstone era, during which the establishment of

national parks primarily focused on safeguarding specific species as the primary objective. During the 1970s, the International Union for Conservation of Nature and Natural Resources (IUCN) Congress held in New Delhi in 1969 established the necessity of categorizing conservation areas based on specific criteria. This categorization aimed to enhance the effectiveness and efficiency of their management. In the 1980s, the Congress of the Commission on National Parks and Protected Areas (CNPPA) put forth the requirement for developing a management plan for each unit within a conservation area. The World Commission on Protected Areas (WCPA) Congress held in Caracas, Venezuela, 1993 established a mandate requiring the involvement of multiple stakeholders, particularly the local communities, in managing conservation areas. The WCPA Congress held in Durban, Jordan, 2003 resulted in a mandate that emphasized the importance of conservation area management in generating economic benefits for interested parties, including the communities residing within and adjacent to these areas.

The Indigenous communities residing in the TNLL area have demonstrated a consistent practice of spatial management across successive generations, rooted in their deep-seated local knowledge and wisdom. The TNLL Center endeavors to cater to the preferences of indigenous populations by fostering a mutual understanding of spatial arrangements [42]. Over the past three years, communities residing near TNLL have demonstrated a willingness to actively participate in forest management initiatives, particularly by implementing social forestry projects. The TNLL Center, once characterized by its exclusivity, has transformed and now maintains a positive rapport with the community, fostering effective communication. In addition to this, the TNLL Center demonstrates its adherence to customary law by giving precedence to the implementation of customary law in cases of customary transgressions that take place inside the customary territories encompassed by the TNLL region.

This TNLL zoning change was ratified on December 31, 2018. The driving factors for this zoning revision were: a) the synergy of traditional space concepts into TNLL management; b) utilization for local communities and utilization of environmental services; c) inevitable strategic development; d) Adjustment to current land cover conditions; e) accommodates space for conservation partnerships with indigenous/local communities; f) there is a new TNLL limit policy.

The TNLL buffer area is home to various ethnic communities, namely the indigenous Bada, Behoa, Pakurehua, and Kaili tribes. In the migrant community, several ethnic groups, such as the Bugis, Toraja, Javanese, Manado, Batak, Mandar, Seko, and Rampi tribes, coexist and interact socially. The primary occupation within the village predominantly revolves around agricultural activities, supplemented by a subset of individuals engaged in trading and gold mining endeavors. Based on oral history testimonies and documentary evidence, it can be inferred that local communities' exploitation of forest land precedes the formal establishment of the area as a National Park in 1982. Indigenous communities employ forested areas for critical reasons, emphasizing core necessities rather than engaging in land accumulation or pursuing extractive and exploitative activities. Local groups engage in communal land clearing and collective subsistence practices, drawing upon their experiential and locally derived knowledge [43].

The procedure for initiating the cultivation of additional agricultural land involves a sequence of preparatory measures and surveys conducted before identifying a suitable site. If the customary process reveals the presence of several trees and animals, the forest under consideration as a prospective site for agricultural purposes will not be granted access. Based on their belief system, it is anticipated that the field would not yield any productive outcomes and may bring adverse consequences for their family. Every phase of the production process entails customary rites and is carefully considered under the guidance of Traditional Leaders and

Farmers. The act of clearing the land is performed without seeking permission, so raising the question of who would undertake its cultivation after that [44]. Over time, the practice of land clearing gradually evolved into a series of individual ceremonies that continued to be observed by each household. This phenomenon occurs due to the prevalence of individuals or families with knowledge and expertise in land processing processes.

Indigenous tribes in Central Sulawesi have historically possessed a collective body of knowledge known as Kapongo local wisdom. This wisdom is widely disseminated among these communities. It elucidates the practice of shifting agriculture, including the specific norms and temporal considerations associated with returning to their ancestral fields. The efficacy of this approach in preserving soil fertility and sustaining indigenous communities has been demonstrated over several centuries without posing any significant environmental risks. Indigenous groups residing in the vicinity of the TNLL buffer woods exhibit a distinct understanding of forest and land utilization, characterized by the subsequent allocation:

- Pangale presents challenges in terms of management due to its geographical location on a high and steep plateau. Moreover, it is imperative to safeguard and conserve these regions due to their remarkable biodiversity. Indigenous individuals in this region typically have great reverence for ancestral spirits.
- Jurame/plant refers to a spatial entity often overseen by Indigenous communities that utilize their land as an arable ground for the cultivation of staple crops, including rice, sweet potatoes, and corn, employing the method of shifting cultivation.
- Pinojo'ong/joking refers to a designated area utilized to manage crops or plantation crop commodities effectively, including but not limited to cloves, candlenuts, and cocoa.

During the early 1970s, farmers shifted their agricultural practices from subsistence-oriented to income-generating to fulfill their requirements that could not be self-produced. As part of this transition, farmers constructed residential dwellings and began clearing permanent land, implementing a forest garden planting pattern. Implementing a forest garden planting pattern on forest land offers economic benefits and serves to preserve ecological elements, specifically by safeguarding soil fertility and mitigating erosion. Alternatively referred to as mixed gardens, forest gardens are a time-honored agroforestry approach that encompasses the ecological and economic principles seen in traditional societies [45].

In plantation forests, farmers deliberately cultivate various tree species (such as nyatoh, teak, durian, and candlenuts) either planned or with inconsistent spacing. This cultivation practice is typically observed near their residences or old agricultural fields, where previous cultivation activities involved primary crops, secondary crops, and medicinal plants. The integration of dynamic agricultural and forestry principles by local farmers has been effectively implemented within society's traditional socio-cultural, economic, and ecological systems, hence exemplifying commendable patterns of sustainable natural resource utilization [46].

In the 1980s, there was a notable increase in the number of immigrants originating from various locations, such as South Sulawesi (Bugis and Toraja), North Sulawesi (specifically Manado), Java, and Batak. These men introduced plantation crops with considerable economic significance, including cloves, nutmeg, and cocoa. As a result of its heightened potential for development and marketing, a significant proportion of farmers demonstrate a predilection for shifting land utilization patterns from mixed forest plantations to monoculture cocoa cultivation.

In recent years, there has been a growing trend among farmers who primarily engage in cocoa farming to adopt a cultivation strategy that aims to improve the microclimate and general circumstances of their planting area while increasing their profitability. However, the use of agricultural methods by individuals lacking extensive knowledge is lacking in a structured and empirically supported manner. Although individual farmers know cocoa and candlenut plants,

there is a limited understanding of the complex interactions between these plants and the potential for optimizing positive interactions among them and their interactions with the surrounding environment. Using an agroforestry system in land management to mitigate crop yield decline, reduce environmental pollution, and improve disaster resilience is expected to generate sustainable results [47].

During 2000-2010, there was a notable rise in population alongside a decrease in cocoa production. This fall in cocoa production can be attributed to factors such as the aging of plants, pest infestations, and the reduction of planting areas owing to land conversion. Farmers have altered their land use patterns by adopting monoculture crops such as corn, peanuts, cassava, sweet potatoes, and cocoa. The impetus for this transition is rooted in the aspiration to exploit market prospects and attain more excellent pricing stability. Furthermore, agricultural practitioners who opt for monoculture vegetable cultivation methods, mainly focusing on cabbage, beans, and tomatoes, are likelier to achieve elevated market values [48].

Edu-Agrotourism and agroforestry businesses influence local communities' socio-cultural, economic, and ecological aspects. If existing Edu-Agrotourism and agroforestry businesses do not positively impact welfare and environmental preservation, they will not be sustainable. Edu-Agrotourism and agroforestry businesses must involve the community as a whole from planning to implementation so that the community has high awareness to participate in the development of Edu-Agrotourism through the implementation of an agroforestry system [49, 50].

Conclusions

The area known as TNLL exhibits a notable level of plant diversity, a crucial factor for effective management and exploitation in the pursuit of sustainable development. Efforts to attain sustainable development goals necessitate a significant focus on managing and utilizing national parks. This entails conserving plant species, enhancing the environmental carrying capacity, implementing spatial planning, and fostering integration among natural, artificial, and human resources in TNLL areas. Achieving these objectives requires active involvement and participation of local communities in sustainable utilization endeavors. Implementing the agroforestry system within the TNLL buffer region is a strategic approach to mitigate the impacts of ecosystem disturbances. This design formulation is specifically tailored to align with prevailing land management practices and garner community acceptance, taking into account socio-cultural, economic, and ecological considerations.

Agricultural practices that incorporate agroforestry, specifically agrisilviculture, have the potential to effectively address food security concerns, enhance nutritional value, and maintain strong ties with local social and cultural traditions due to their longstanding adoption by communities across generations. It is imperative to formulate optimal agroforestry principles and frameworks that minimize the likelihood of deforestation and degradation of land and forests, particularly in the vicinity of the TNLL buffer zone. The historical account of land utilization commences with the indigenous communities who have effectively governed the surrounding TNLL, employing their local knowledge and expertise acquired through adapting to the prevailing natural circumstances. The utilization of natural resources within national park regions by indigenous tribes for their daily necessities is frequently perceived as exerting strain on the ecological integrity and long-term viability of TNLL. Ideally, the management of TNLL areas should aim to generate economic advantages for stakeholders, particularly the communities residing in buffer zones surrounding conservation areas. The application of edu-agrotourism and agroforestry activities in the TNLL area is expected to educate and train

farmers in buffer areas of conservation areas based on community empowerment in mitigating climate change.

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