Potential degradation of mamar functions in ecosystem services Production: the cases of Benlutu Village, West Timor

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Abstract. Mamar is a traditional agroforestry in West Timor which has many benefits for the people of this region. This paper aims to identify the potential degradation of Mamar functions in the production of ecosystem services in Benlutu Village which is one of the oldest Mamars in West Timor. This paper was compiled from the results of research at the end of 2020 and the results of a desk review of relevant writings in 2022. The method in this research was in-depth interviews and field observations covering changes in land cover in Benlutu Village. in 2000, 2010, 2020; identify soil damage for biomass production; and Significant Value Index. The results of the study indicate that there is a conflict of interest in the management of Benlutu Mamar which has the potential to reduce the production of ecosystem services on a large scale; For soil damage, one parameter was found that was classified as damaged, namely electrical conductivity. Based on IVI calculation data, Areca catechu as a plant with cultural characteristics is still dominant with a poles rate of 61.35%. It was concluded that there is a potential for degradation of Mamar's function in the production of large ecosystem services.

1 Introduction

Attention to ecosystem services is important and almost a necessity in the context of the sustainability of human life and other living things on this earth. Natural resources and the environment are supporting factors that are also very important in this context, for which reason their use must consider sustainability aspects. On the other hand, humans are also able to condition their environment to suit their needs.

Agroforestry has long been known as a cropping system developed by humans by combining forest plants, agricultural crops, and livestock/fish [1]. The combination of these three elements allows humans to obtain optimal benefits to support their survival. Agroforestry is said to have many positive impacts on the environment. [2] said that the agroforestry system in land use causes it to have ecological, economic and social advantages,

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therefore its sustainability must be maintained. On the other hand, [3]–[5] mentions the ability of agroforestry to increase soil productivity and profitability in a sustainable manner.

Mamar as West Timor indigenous agroforestry is one of the local wisdoms intended to conserve water and the environment where food crops grow. Some of Mamar's benefits include conserving water resources and land, as well as providing ecosystem services [6]. Mamar was established from people's awareness of the limited carrying capacity and capacity of their territory to support their lives. Local social mechanisms and their worldviews mentioned by [7] are the main considerations in managing their land resources. Communities tend to value and defend their way of life and land because they are seen as important, and will even survive extreme weather [8], [9].

With the combination of climate and soil in dry land, the challenges of living in this region are difficult. The dry area of West Timor makes Mamar very important for the survival of humans and other living things. This is reinforced by statements from several previous researchers, including [6], [10], [11].

Over time, there are several conditions that have the potential to threaten the sustainability of mamar in West Timor in general. Climate change pressures [12], [13], rapid population growth [14], lifestyle changes [15], [16], and government policies [17], [18]. These social threats were identified as social driving forces by [19] in a bibliometric analysis which is one of the state of the art in agroforestry research that needs to be studied.

Global climate pressure in the form of global warming that has occurred in the last few decades has allegedly caused various environmental impacts in various aspects. The agricultural sector is the sector that is most affected by this condition. In this sector [13], [20] states that people in dry land are the most vulnerable people, because it has an impact on soil fertility and dry land ecosystems. On the other hand [21] said that agroforestry systems have an important contribution to climate change mitigation. Because of this, Mamar is a very valuable asset.

Along with the development of the current era, the demands of people's lives are also increasing and are directly proportional to the demand for ecosystem services [14]. This is not only to meet the needs of life as a result of population growth, but also to fulfill a lifestyle that is often synonymous with an unconscious consumptive life and requires relatively large amounts of money. When the need for money has become a priority, in general there are two things that people often do, namely firstly utilizing assets owned which tend to be exploitative in nature to generate fresh funds, and secondly, prioritizing asset management with consideration of when to obtain fresh funds so that it has an impact on attention. reduced on one or more of the existing assets. The side effect that arises is asset management which tends to be not optimal and is no longer considered important.

Benlutu Village is a village in TTS District which has one of the oldest Mamars in West Timor. On the other hand, Benlutu Village also has good accessibility to the city center. This condition is believed to affect developments in the utilization and management of Mamar from time to time. The development of world civilization that is easily accessible will affect the life of the community and the village environment as a whole. If Mamar initially includes ecological and socio-cultural interests which are characterized by water conservation, microclimate, and cultural keystones in the form of areca and betel nut vegetation, it is likely to experience degradation of ecosystem services which eliminates the original purpose of establishing Mamar. Furthermore, it will affect the environment as a whole. There is a tendency to decrease agricultural production in rural communities and areca nut and areca nut production, which are two important indicators for predicting changes in the carrying capacity of existing land. The agricultural land of the village community is generally located near the Mamar area and some are even inside the Mamar area, namely in the utilization zone. On the other hand, based on the research results of several previous researchers, it is known that Benlutu Village is one of the villages that has been able to maintain its condition

well for tens of years. With the various challenges that exist, both nature (climate) and temptations to fulfill life needs and lifestyle that are supported by good accessibility, it is necessary to study the current condition of Mamar in Benlutu and potential threats to the sustainability of Mamar agroforestry in Benlutu. village. This paper aims to (1) identify the potential degradation of Mamar's function in producing ecosystem services; (2) analyzing the opportunities for environmental service tradeoffs in Benlutu Village. The results of this study are useful as material for consideration for local governments in formulating development policies, especially those related to Mamar.

2 Method

This research was conducted in Benlutu Village, TTS District. The reason for choosing this village is because it has one of the oldest Mamars in West Timor, but has good accessibility to the center of the Regency City. The method used in this study is a survey method with observations of two variables, namely (1) social, namely the community's perception of the development of Mamar in its place which is also associated with existing challenges and threats; (2) biophysical, including (a) land cover changes spatially and temporally in 2000, 2010, and 2020, using analysis of Landsat 5 (2000 and 2010) and Landsat 8 (2020) satellite imagery; (b) important value index for the mamar in that location, with the aim of getting an overview of the distribution of vegetation with a focus on areca nut as the main element of the mamar; and (c) soil damage for biomass production, which is intended to obtain an overview of the carrying capacity of mamar land for biomass production so that it can become a reference in providing input for Mamar management. Biophysical variables are intended to confirm the results of observations on social variables.

2.1 Land use Change

Observations of changes in land use were carried out using satellite imagery at 3 different times, namely in 2000, 2010 and 2020. Observations in 2000 and 2010 used Landsat 5 imagery while in 2020 used Landsat 8 OLI imagery. Land use is classified into 7 classes, namely forest, mixed farm, agricultural land, water body, shrub, open field, and utilized land.

2.2 Public perception

Collecting data related to community perceptions was carried out by means of in-depth interviews with six people in each village who are community leaders and ordinary people who have rights in Mamar and live around Mamar. The main question in this data collection is focused on the development of Mamar in the area and the impact it has felt. The data obtained was analyzed descriptively qualitatively to see Mamar's development trends and the impact felt by the community. Apart from that, challenges and threats to Mamar were also identified from the perspective of the community.

2.3 Observation of Important Value Index

Observation of Important Value Index (IVI) is intended to determine the composition of plants and the most dominant plant species in an agroforestry system in each plant phase (undergrowth, saplings, poles, and trees). To find out the most dominant species is measured by plotting. In this study, observations were made on two size plots at each plant phase. Because Mamar is closely related to meeting the social needs of the community, namely the existence of betel nut plants, more attention is paid to the existing areca plant populations. In

addition to the areca nut commodity, the number of species in Mamar was also observed. It is also used as an indicator to assess the level of sustainability of existing Mamars. IVI calculation is done using the Mueller formula (1974, in [22], namely.

$$IVI = RD + RF + RDom$$

where *KR = Relative Density; FR = Relative Frequency; DR = Relative Dominance*.
Relative Density is the percentage density of a species against the density of all species; Relative Frequency is the percentage of the frequency of a type against the frequency of all types; and Relative Dominance Data obtained from the percentage of dominance of a species against the dominance of all species.

2.4 Degradation of soil for biomass production

The parameters observed in research on the level of soil damage for biomass production refer to Regulation of Minister of Environment 07 of 2006 and Government Regulation Number 150 of 2000. There are two methods used in taking soil samples to assess the level of soil damage for this biomass production, namely the disturbed method. (disturbed soil sample) and undisturbed method (undisturbed soil aggregate).

Parameters observed and measured, critical thresholds (quality standards), and measurement methods and equipment used to observe soil conditions to conclude the occurrence of soil damage for biomass production can be seen in table 1.

Table 1. Parameters, critical thresholds, measurement methods and tools

No	Parameter	Critical threshold	Method	Tool(s)
1	Solum thickness	< 20 cm	Direct measurement	Tape measure
2	Surface rock	> 40%	Direct measurement of rock and soil balance in area units	Tape measure; counter (line in total)
3	Fraction's composition	< 18% colloid; 80% quarzitic sand	Sand color; gravimetric	Measuring tube; scale
4	Volume density	> 1.4g/cm^3	Gravimetric in volume units	Measuring tube; ring sampler
5	Total porosity	< 30%; > 70%	Calculation of volume density and specific weight	Pycnometer; analytical scale
6	Permeability	< 0.7 cm/h; > 8.0 cm/h	Permeability	Ring sampler; double ring; permeameter
7	pH (H_2O) 1:2.5	< 4.5; > 8.5	Potentiometric	pH meter; pH stick scale 0.5 unit
8	Electrical conductivity	> 4.0 mS/cm	Electrical resistance	EC meter
9	Redox	200 mV	Electrical voltage	pH meter; platinum electrodes
10	The number of microbes	< 10^2 cfu/g	Plating technique	Petri dishes; colony counter

3 Results

3.1 Land use change

Changes in land use in Benlutu village from 2000, 2010 and 2020 according to the results of satellite imagery analysis are presented in figure 1.

The results of image analysis of Benlutu Village in Figure 2 show a significant difference between the years of observation. The figure shows a change in land use in Benlutu Village which also occurred in Mamar. Observations in 2010 and 2020 show a reduction in the area of Mamar compared to 2000. The reduction in area of Mamar in 2010 was due to an increase in open land, while in 2020 it was due to an increase in agricultural land.

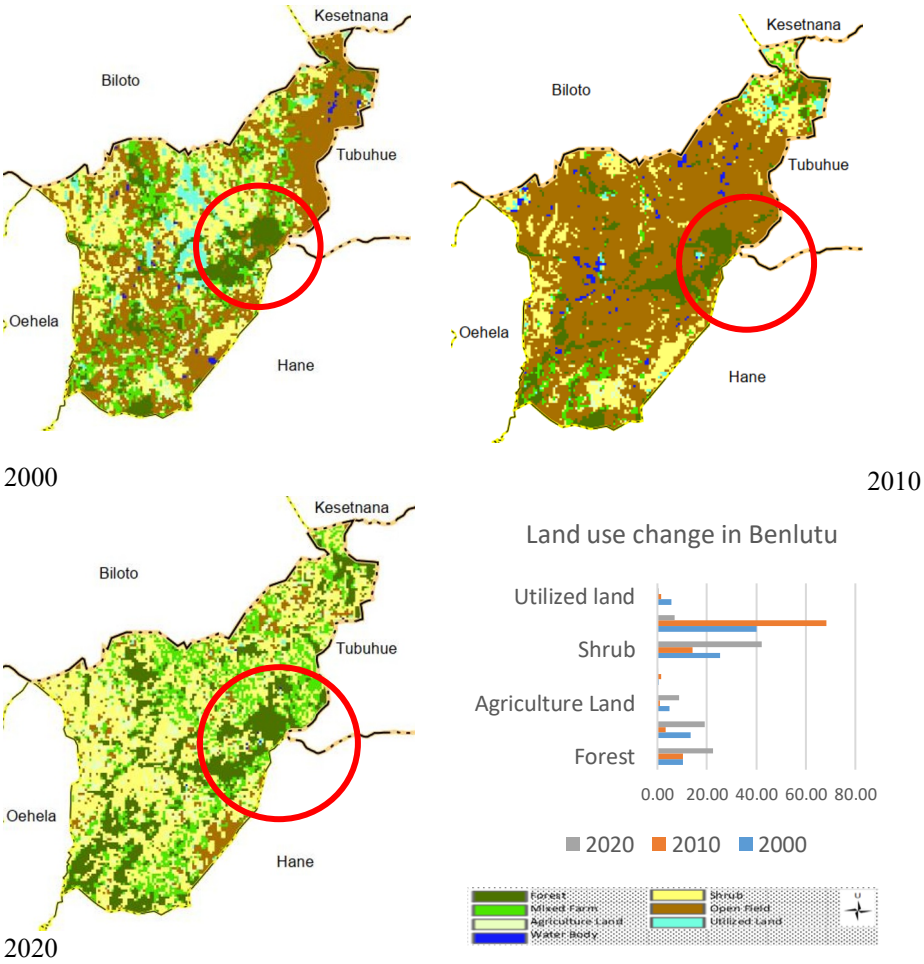

Fig. 1. Land use change in Benlutu in 2000, 2010 and 2020

3.2 Public perceptions

From the results of interviews with six members of the community who are also part of the tribe that controls and manages Mamar in Benlutu, the following facts are obtained.

A. The current condition of the springs has greatly reduced its discharge, in fact one of the existing springs is known to have dried up and is already owned by a private party that utilizes the water source for its business activities. From the results of a cursory observation, it appears that there are permanent buildings that are not related to activities in the Mamar in general, which are suspected not to belong to the local community. This was later recognized by one of the respondents as a hidden source of conflict among residents.

B. There are residents who certify the land that is part of Mamar. This was considered to contradict the fact that Mamar's land is communal land and may not be privately owned. This condition is feared to have an impact on cohesiveness among community members which has the potential to interfere with Mamar management.

C. Due to these existing conditions, a decree from the Head of Benlutu Village regarding the appointment of traditional leaders has not been issued five years ago (conditions in 2020). As a result, traditional ritual activities in Mamar stopped.

3.3 Important Value Index (IVI)

The Important Value Index for Mamar in Benlutu village is shown in table 2.

Table 2. Important Value Index for Mamars in Benlutu at several vegetation levels

No	Name	IVI
Seedling		
1	*Citrus aurantiifolia*	41.67
2	*Arenga pinnata*	58.33
3	*Psidium guajava*	58.33
4	*Swietenia mahagoni*	41.67
Saplings		
1	*Coffea sp*	107.89
2	*Swietenia mahagoni*	40.79
3	*Averrhoa carambola*	51.32
Poles		
1	*Garuga floribunda*	27.44
2	*Psidium guajava*	73.41
3	*Areca catechu*	61.35
4	*Ficus ampelas*	24.29
5	*Averrhoa carambola*	38.33
6	*Swietenia mahagoni*	23.50
7	*Mangifera indica*	15.46
Trees		
1	*Ficus ampelas*	34.76
2	*Sterculia foetida*	58.93
3	*Ceiba petandra*	21.76
4	*Coffea sp*	31.65
5	*Alstonia scholaris*	72.92
6	*Psidium guajava*	18.82
7	*Cocos nucifera*	44.49
8	*Swietenia mahagoni*	16.67

3.4 Soil damage for biomass production

The results of laboratory measurements and tests are described as follows: solum = 37.5 cm; rock on the surface = 11%; fraction composition = 73%; Content Density = 1.105 gr/cm3; porosity = 58.14%; permeability = 5.365 cm/hour; electrical conductivity = 25.6 mS/cm; oxidation reduction = -51.45 mV; microbes = 128.5x107 cfu/g. From these results, what is classified as damaged is the electrical conductivity parameter because it exceeds the existing standard value, namely > 4 mS/cm. Areca catechu was only found at the pole level with an IVI value of 61.35. In this phase the plants did not yet produce, while they were not found in the tree phase so it was concluded that areca catechu production in Mamar Benlutu did not exist during the study.

4 Discussion

4.1 Potential degradation of ecosystem services in Mamar

From the results of research on the parameters of land use change in Benlutu Village, it was obtained data that land use has changed, namely the reduced area of Mamar land, which was accompanied by an increase in open land in 2015, and agricultural land in 2020. This change occurred from the conversion of Mamar land which was increased compared to 2015 and 2020. This shows a consistent and intentional conversion trend.

This condition is supported by data from interviews which show that there was an action to reduce the area of Mamar accompanied by diverting one of the springs for commercial purposes. In addition, based on the results of observations, it was also found that there were permanent private buildings near the Mamar area.

In this study, it was also found that the IVI value of areca nut plants was relatively low and was only found at the pole level, namely 61.35%. Of the existing areca nut plantations, none has yet produced. Meanwhile, no betel plants were found in the plots that were made. This fact indicates a lack of public attention to the development of the unique Mamar plant, which is a cultural marker plant. This condition also gives the impression that these plants are no longer important in Mamar. In this regard, it is understandable if it becomes easier for the community to change the existing Mamar.

The reduction of Mamar's land, which was concluded from the results of satellite imagery analysis, is believed to have reduced the production of Mamar's ecosystem services. This statement is supported by [23]. This conclusion is also strengthened by the community's acknowledgment that there has been a decrease in the water discharge, which is one of the provisioning services. In addition, the reduction of areca and betel plants can also be interpreted as a decrease in cultural services in Mamar. Another impact that can also be caused is reduced climate regulation ecosystem services, namely that reduced land cover vegetation will affect the net energy produced, also affect carbon sequestration. Thus affecting the microclimatic conditions as well as the overall climate [24]–[26].

The community's intention to convert land is thought to be part of the impact of changing the behavior of the community itself. Notoatmodjo[27], says that human behavior is shaped by the synergy of heredity and the environment, while the theory of human ecology [28], indicates the encouragement of population, organization, environment and technology interactions in social change. From the results of the research it is clear that there is a change in behavior driven by economic motives[29], among others caused by a change in production orientation, namely the desire to fulfill personal and group needs. Developments in road infrastructure and easy access to information have made it easier for people to access markets and information, which has influenced their way of thinking. This conclusion is in line with

the theory of "thoughts and feelings" by the WHO work team[27], that knowledge, perceptions, attitudes, beliefs, and one's judgment of objects influence one's behavior.

4.2 Environmental service tradeoffs

The increase in other uses by converting Mamar land shows that there are tradeoffs for the function of ecosystem services produced by Mamar[30]. In addition, the transfer of management of one of the water sources from within the Mamar area to the private sector indicates that there is an economic motive driving this change. Neglect of the development of cultural plants is also evidence of the occurrence of cultural service tradeoffs in Mamar. Overall, it can be concluded that there have been tradeoffs involving three aspects, namely social, ecological, and economic.

5 Conclusion

Based on the research results, it was found that all the parameters studied showed a decreasing trend. Mamar's land area has shrunk due to conversion to agricultural land (2020); differences in people's perceptions and behavior that lead to efforts to change utilization and management; and the IVI value which indicates that the significant reduction in cultural keystones (betel nut and areca nut) is very strong, indicating a change in Mamar utilization and management. In the context of the production of environmental services, these changes in utilization and management will definitely have an impact on the ecosystem services produced. The worst thing is that Mamar's sustainability is in danger of extinction.

The change in utilization is thought to have occurred due to the drive to meet the needs of life and the lifestyle of the community. Adequate accessibility of both information and transportation is an important supporter of changes in community behavior related to changes in the utilization and management of the Mamar. On the other hand, Mamar's land conversion explains the tradeoff of Mamar's ecosystem services with economic interests. In the case of Mamar, which also emphasizes the socio-cultural aspect as one of the important ecosystem services apart from the ecological one, the tradeoff that occurs is the socio-ecological-economic tradeoff. The tradeoff model for Mamar agroforestry as a traditional agroforestry with various benefits for the environment is important to study in depth so that it can be utilized for its conservation efforts.

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