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Land Cover Change and Food Security in Central Sumba: Challenges and Opportunities in the Decentralization Era in Indonesia

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Citation: Ngongo, Y.; deRosari, B.; Basuki, T.; Njurumana, G.N.; Nugraha, Y.; Harianja, A.H.; Ardha, M.; Kustiyo, K.; Shofiyati, R.; Heryanto, R.B.; et al. Land Cover Change and Food Security in Central Sumba: Challenges and Opportunities in the Decentralization Era in Indonesia. *Land* **2023**, *12*, 1043. https://doi.org/10.3390/land12051043

Academic Editors: Víctor Hugo González-Jaramillo and Ruetger Rollenbeck

Received: 22 February 2023
Revised: 15 April 2023
Accepted: 28 April 2023
Published: 10 May 2023

Abstract: This study focuses on land cover and land management changes in relation to food security and environmental services in a semi-arid area of East Nusa Tenggara (ENT), Indonesia. The study was conducted in the Central Sumba District of ENT province. A classification and regression tree (CART) for land cover classification was analyzed using machine learning techniques through the implementation of the Google Earth Engine. A Focus Group Discussion (FGD) survey followed by in-depth interviews was conducted for primary data collection, involving a total of 871 respondents. The socio-economic data were statistically analyzed descriptively using non-parametric tests. The study showed that (1) there has been a substantial change in land use during the devolution era that has both positive and negative implications for food security and environmental services; (2) there has been population pressure in fertile and agricultural land as a direct impact of the development of city infrastructure; and (3) national intervention through the Food Estate program has fostered and shaped land use change and land management in the Central Sumba District. The study highlights the importance of the devolution spirit in aiding the management of limited arable/agricultural land in predominantly semi-arid areas to ensure food security and environmental services.

Keywords: devolution; land cover change; semi-arid; food security; arable land; conservation; environment services

1. Introduction

Since the Reformation era took place and Regional Autonomous Law was established in the mid-1980s in Indonesia, 11 new provinces have been established, making a total of 37 provinces [1] and a total of 514 districts/municipalities [2] as of 2022. The establishment of new provinces and districts/municipalities has vast consequences on infrastructure development, changes in land use/land cover and property rights [3], the expansion of urban landscapes, and transition in farming [4,5].

As new districts/towns were established, resulting in high population pressure, the demand for land increased. Since land size remained constant, this created land fragmentations and made crop production less competitive with land rent, particularly regarding rice production [6] and agricultural production in general [7,8]. Industrial estates typically developed in urban areas or in the pheri–pheri that attract people as a means of better access to jobs and residences. Economic growth and increases in economic scales have also contributed to the conversion of agricultural land [9].

The Government of Indonesia (GoI) is aware of protecting agricultural land, particularly concerning the conversion of rice land areas into non-agricultural land [10]. Two important legislations related to the land were Act No. 26/2006, regarding Spatial Plan Regulation (SPR) operationalized by Government Regulation No. 21/2021, and Act No. 41/2009, regarding the Protection of Sustainable Agricultural Land. Both acts relate to Provincial and Districts Regulations in accordance with the Regional Administration Law No. 32/2004.

Land reserved for rice farming is considered the most critical area requiring protection since it has the greatest contribution to food security, particularly for rice self-sufficiency. Nevertheless, the conversion of rice land is still ongoing and at an alarming level [11]. Agus and Irawan [12] reported that the land conversion rate for irrigated land during 1999–2022 was 141,000 ha/year. Firman [13] estimated that during 1991–1993 there were around 106,000 ha of agricultural land converted into urban land, the majority of which was repurposed as residential areas. A study by Mulyani et al. [14] showed that with the present conversion rate of 96,512 ha/year during 2000–2015, they predict that the current 8.1 million ha of paddy fields will decrease to 5.1 million ha in 2045 if there is no government intervention to control it. This will have a serious impact on the rice self-sufficiency program.

The main reason behind this rapid change is due to development planning biased toward economic growth and infrastructure, while the maintenance of agricultural land is comparatively overlooked, particularly that of fertile rice lands [10,15]. Rapid conversion of agricultural land has resulted agricultural land ownership decreasing to only 0.89 ha/household in 2013, and even less than 0.5 ha in some areas, e.g., Java [16]. In East Nusa Tenggara (ENT) province, agricultural land has decreased by 11,162 ha comparing data from 2007–2022 and 2013–2017 [17]. The reduced land ownership coinciding with rice farming results in less efficient farming and less competitive production compared to other crops [18]; rice farming is no longer attractive for younger generations [19,20]. The expansion of land dedicated to rice farming is crucial to increase rice production and make rice farming more attractive, as Rosyda et al. [21] concluded in their research on Java Island: "land and intermediate inputs were the factor inputs that significantly increased technical efficiency". This research is based on a case study in Central Sumba, which is used as a lens to understand the conversion of agricultural land, how government policy on land management in the devolution era operates, and its implications regarding food security and rice self-sufficiency. As the Central Sumba District is a new district and its capital district/town is placed within agricultural land, the paper also investigates the implications of new town development and offers a strategy to maintain food security and environmental services. Previous studies have focused more on agrarian injustice and conflicts pertaining to scarce fertile land in semi-arid areas [22–24]; this paper enriches the conversation surrounding land use changes in direct and indirect relation to the notions of agricultural development during the decentralization era. The working hypothesis of this research was that the creation of new district/towns during the decentralization era has considerable impacts on land cover and food security for the people living in predominantly semi-arid environments. The research employs a survey method in understanding the rate of land conversion, while spatial data are utilized to understand land cover changes.

2. Materials and Methods

2.1. Description of Study Area

The Central Sumba District of East Nusa Tenggara (ENT) province of Indonesia (Figure 1) is located in the center of Sumba Island, 9°20′–9°50′ S, 119°22′–119°55′ E [25]. The study site was chosen due to its status as a newly established district and one in which the Food Estate (FE) program was carried out in ENT province.

Figure 1. Research site of Central Sumba District, Indonesia [26].

The district is characterized as a savannah environment; however, within this district, the remnants of the dry forest area of *Tana Daru* Protected Forest in Central Sumba are located (as part of the *Taman Nasional Manupeu Tanah Daru (TNMTD*) or Manupeu Tana Daru National Park, based on Forest Ministry Regulation No. 576/Kpts—II/1998); it covers an area of 87.984 ha [27], but this was later revised as 50,000 ha based on Forest Ministry Regulation No. 3911/Menhut—VII/KUH/2014 [28]. The TNMTD area in previous Forest Ministry regulations included the traditional compounds and indigenous people's communal land. The latest assessment showed that Indigenous people's claims related to traditional housing compounds and religious, cultural, historical, and special zones, while they excluded Participative Boundary Management, resulting in the map digitization area (Shapefile), which has significant implications for the decreased TNMTD area [29]. The TNMTD area represents semi-evergreen forests, and its protection and conservation are valued in protecting endemic or near-endemic species of some flora and fauna and water resources and in improving the welfare of local communities living around the national park [30,31].

The Central Sumba District has several zone agro-ecosystems as a direct result of physical and climatic variations of the region, including a rocky and dry savannah climate in the northern region, alluvial soils and a relatively wet climate in the mid-region, and a dry climate in the southern region. People scattered following reduced access to natural resources, particularly water and agricultural land. Therefore, most people live concentrated within the mid-region and along small creeks.

2.2. The Study and Respondents

The study was conducted in 6 sub-districts of the Central Sumba District, East Nusa Tenggara (ENT) province, Indonesia. The data come from the following 3 consecutive interrelated research studies: (1) Impact of Socio-cultural and Economic Food Estate Program on People's Welfare, conducted in 2021 and involving 48 respondents [32]; (2) rice farm ownership patterns, conducted in 2022 and involving 259 respondents [33]; and (3) a study providing documents related to "Sustainable Food Crops Lands," conducted in 2022 and involving 564 respondents [34].

2.3. Materials and Research Methods

The survey method employed for primary data collection was Focus Group Discussions (FGDs) with government apparatus, village chairs, key informants, farmers groups, and agriculture extension workers. After the FGD, in-depth interviews were conducted with some respondents involved in the FGD. The remaining primary data were collected using questionnaires created with Google Forms.

2.4. Data Analysis

A classification and regression tree (CART) for land cover classification was analyzed using machine learning techniques implementing Google Earth Engine. To implement the CART for land cover classification using Google Earth Engine, Landsat 8 imagery is typically used as the main input data source. We considered using Landsat 8 because it provides high spatial and temporal resolution data that can be used to identify land cover types. We prepared Landsat 8 imagery obtained from either the USGS Earth Explorer website or from Google Earth Engine. Furthermore, through pre-processing, we removed noise and artifacts, including atmospheric correction, normalization, and data filtering. Pre-processing can be performed using software such as ENVI or Google Earth Engine. Then, image enhancements such as contrast stretching or histogram equalization were performed to increase feature visibility. Next was the image interpretation stage, during which different types of land cover were identified by examining the spectral signature and spatial pattern of the image and using additional data such as topography, vegetation index, and climate data. We did not follow this step with a subsequent validation stage, which is one of the limitations of this research.

The selection of the Landsat data used must seek to eliminate some noise in the data, such as the influence of clouds and sunlight reflections. In this case, the Landsat 8 data use TOA-corrected data and cloud-masked data implementing mosaicking data. Topographic correction is an important step in processing remote sensing data that takes into account the varying elevation of terrain. The shadow effect from hills and mountains can cause errors in the data, which can affect the accuracy of the analysis [35,36]. The Illumination Condition and Rotation model algorithm is a widely used method for topographic correction [36,37]. This method uses the sun angle and the slope of terrain to adjust the reflectance values of pixels in an image so that they are more accurate and comparable across different terrain elevations [38]. Clouds can affect the accuracy of remote sensing data, so it is important to detect and mask them.

Three algorithms were used to ensure that all clouds were detected, namely multi-temporal cloud masking (MCM) [39], new automated cloud cover detection [40], and

Sentinel data standard cloud detection algorithm-2 [41,42]. We combined single-recording datapoints that had been corrected for topography and cloud masking into annual data so that no data were empty because of clouds; the composite algorithm was carried out by taking the median value of the temporal pixels of the rice fields [40,43].

Landsat imagery was categorized into 4 classes (paddy field, forest, upland agriculture, and urban). To obtain a classified map of land cover in an area of interest, training points for manual identification were created based on high-resolution data, such as those sourced from Google Earth Map and SPOT 6/7. The training points were used to train a classifier. The classifier used the CART to classify the remainder of the Landsat image into the four aforementioned categories. The landcover categories were chosen as the class property to categorize the imagery into, and the reflectance in B2–B7 of the Landsat imagery was used as the input. The accuracy of the classification was assessed using a Classifier Confusion Matrix and the kappa index [44–50]. Image data for 2013 and 2021 were classified using the same training sample. A training sample was made using 2021 data, then a machine learning model was used to classify data for 2013 and 2021. This was performed because the initial processing used for both datasets is the same and because it produces consistent classification results.

Due to the incomplete availability of Landsat data, in addition to Landsat 8, Sentinel-1 was also used to obtain information on planting frequency every 12 days. For the cropping frequency, Sentinel-1 SAR imagery is used on a single recording (not composite), with RGB composition using bands VV, VH, and VV/VH. Image acquisition took place at planting time, in the first growing season and the second growing season. The goal was to see the growth phase. Using the Sentinel-1 toolbox from ESA (European Space Agency) in Google Earth Engine (GEE) with some processing procedures such as the use of Orbit files, removing thermal noise, removing GRD border noise, radiometric calibration, and range–Doppler terrain correction [51] to ensure the integrity of land change [52,53], a flowchart of the time series data analysis is provided in Figure 2.

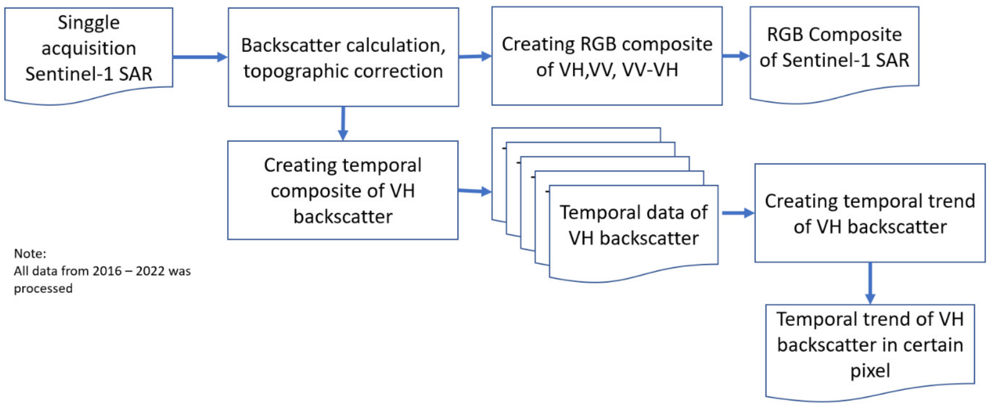

Figure 2. Data analysis steps to obtain frequency of paddies planted in a year.

The socioeconomic data were statistically analyzed descriptively and by non-parametric tests. Respondents were divided into two categories: from towns/suburbs and from rural areas. Descriptive analyses were employed to determine the economic status of the rice land (both irrigated and rain-fed lowland), while for farmers' attitudes or perspectives regarding the variables (a) change in land size, (b) changes in main function, (c) attitude to keep its main function, (d) attitude to transfer the ownership, and (e) protecting the land through legislation, we used a non-parametric Mann–Whitney 2-tailed test [54].

3. Overview of Decentralization/Regional Autonomy (RA) and Pressure on Agricultural Land

Regional autonomy implemented based on the Indonesia Act No. 22/1999 [55] actually provides more power to the local government (provincial and district) in governing their jurisdiction territory, except in national defense and security, foreign policy, fiscal and monetary policy, and legal and religion matters. Thus, the Act principally is an antithesis of the previous New Order government, which was a centralized and autocratic regime.

Based on the RA Act, governments at the provincial and district levels have created numerous regulations to facilitate and attract more business activities, particularly to boost regional income (*Pendapatan Asli Daerah* or PAD). Regional income ideally follows Indonesia Law Number 28/2009 regarding local taxation and charging [56]. RA, normatively, brings efficiency, transparency, and accountability in governing people and attracts business; unfortunately, numerous studies have shown that these local regulations are counterproductive in some aspects, including for the agricultural sector and environment [57–59], particularly in the forestry sector [60,61].

In terms of regional agricultural development, RA Act 28 limited the roles of the central government (Ministry of Agriculture) in relation to the regulations, policies, and national programs that were supported by the national budget to sustain national long-term development [62], while the majority of agricultural development functions were handed over to regional governments. Unfortunately, less support from local government (LG) in budgeting policy and weak coordination and communication among stakeholders have contributed to the low performance of the agricultural sector in general [63,64], while government-sponsored research has had little impact toward improvement [65].

The idea of decentralization/RA is actually to improve the well-being of rural dwellers through closer and better services, giving more power to local people to manage natural resources, and enhancing participation. Despite the improvement of public services during the decentralization era [66], there was a weak correlation between decentralization and poverty reduction or improvement of the well-being of people in rural areas [67], and local government failed to promote local economic growth in their jurisdictions [68], especially in marginal regions [69].

Decentralization ideally offers a better opportunity for successful agricultural and rural development [63]; however, it does not always create successful development, particularly in encouraging people's participation and the protection of traditional communities [19]. The GoI is aware of the importance of regeneration in the agricultural sector and, therefore, a number of programs have been launched to encourage (particularly among the millennial generation) interest and involvement in the agricultural sector, including through the use of modern technologies such as digitized agriculture of the Internet of Things (IoT) [19]. The latest program, the so-called YESS (Youth Entrepreneur and Employment Support) program—a collaboration program between the GoI and IFAD (International Fund for Agricultural Development)—started in 2018. The YESS program's main goal is to create opportunities for rural millennials to develop their economic livelihoods through agricultural and rural entrepreneurs [70]

Decentralization and the decision-making process are more democratic, but they also enhance fragmentations and conflicts among different parties, including in natural resource management, especially in agricultural land [71]. In the case of semi-arid land on Sumba Island, agrarian conflicts involve local/tribal communities, cultivation/livestock companies, and the government [22,23]. Agrarian conflicts related to land entitlements and recognition of the status of communal land or customary land ownership have lessened the capacity of local people/farmers for agricultural intensification [72,73] and triggered unfriendly land management in crop and livestock production [74–77].

In their study on the transformation of agricultural land use in Southeast Asia, Appelt et al. [78] showed that most reviewed cases have positive outcomes for income and employment, mixed outcomes for health, and negative outcomes for food security, gender equality, and economic equality. The transformation of land use in Southeast Asia has ultimately fostered deforestation and created substantial negative consequences to ecology [79]. Rapid urbanization in South/Southeast Asia has contributed to reduced agricultural land use and rapid deforestation [80].

4. Results

4.1. The Socio-Economic Characteristics of Central Sumba District and Respondents Description

Central Sumba District was established as a new autonomous district in 2007 based on Government Regulation No. 2/2007. Before 2007, Central Sumba District was part of West Sumba District. In 2021, the total land area of Central Sumba District was reported to be 2061 km^2 and divided into 6 sub-districts and 65 Villages [25].

The total population in 2021 was 87.260, and around 34.27% of the population was considered poor based on the poverty line of IDR 311,199 (roughly USD 22) capita^{-1}month^{-1}. The total labor force was 34,659 people or around 69% of the total working-age population [25]. The majority of the households were reported as working in the agricultural sector, with rice as the main production. The agricultural sector contributed around 39% of the district's gross regional domestic product (GRDP).

Referring to the 871 respondents' data taken from the three studies in Central Sumba District, the majority of respondents were between the ages of 40 and <50 years old (32%), followed by older ages (Figure 3). The frequency of younger ages of <30 years old was quite low (5%). This figure showed and supported the general view that younger generations are not interested in working in the agricultural or farming sector and, therefore, the old generation (>60 years old) was still working in the farming sector. Based on the FGDs, it is observed that members of the educated younger generation seem to be looking for jobs in formal government sectors (government employee), while those with low levels of education tend to look for informal jobs outside of their district and even in the neighboring country of Malaysia, mostly in palm oil estates. Limited job availability and low payment are the main reasons for emigration of younger generations from Central Sumba District.

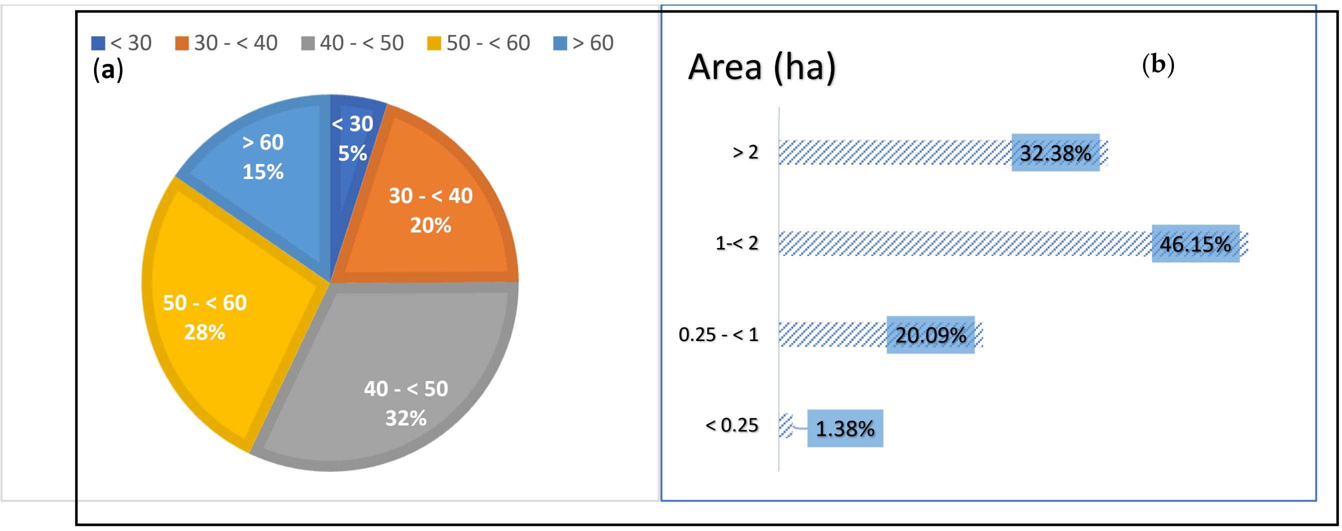

Figure 3. Farmer distribution based on age (**a**) and land tenure (**b**) (n = 871).

Agricultural land refers to irrigated rice land, rain-fed lowland rice land, and upland farming for mixed food crops. Most respondents own land 1–2 ha—an average of 1.5 ha (Figure 3b). The analysis for rice paddy farming showed that an increase in land size significantly increases rice production (t < 0.000), i.e., every one-hectare increase in land size increases rice production by 1.9 tons.

4.2. Land Use and Land Cover Change: Current and Future Potential

4.2.1. Current Land Cover Condition

Central Sumba District is one of four districts on Sumba Island and is part of the East Nusa Tenggara Province (EAT), Indonesia. This district was formed in 2006, and is a division area of the West Sumba District [81]. Climatologically, Central Sumba District is classified as a dry area because the amount of annual rainfall is relatively low, less than 1500 mm, and is concentrated in the four wet months from December to March. The characteristics of this dry area are that the local type of agriculture is dry land farming; most people rely on this sector as their economic base. An overview of land cover—specifically paddy fields, other annual crops, forest vegetation, non-forest vegetation, open land, and settlements in this district—is shown in Figure 4.

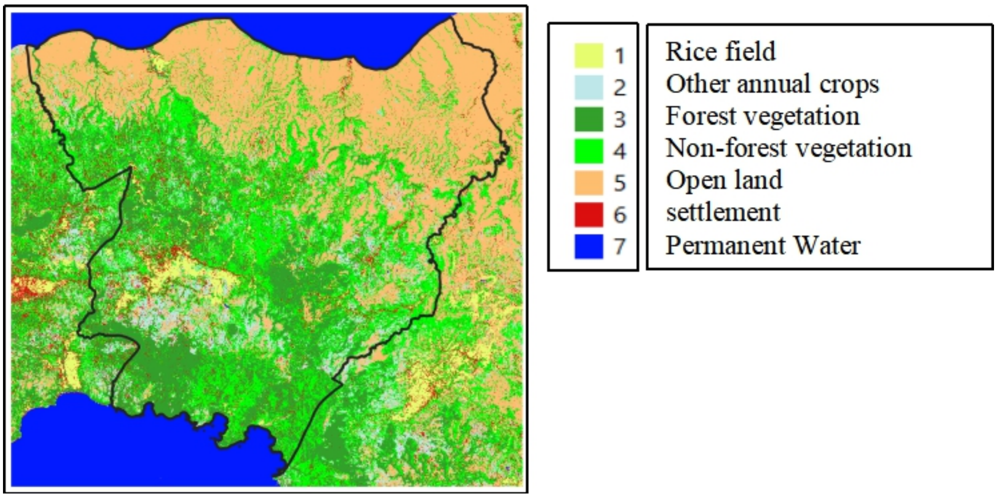

Figure 4. Current Land Cover (Processed from Sentinel-2 overlay 11 images November 2021–October 2022).

Figure 4 shows that open land in the form of savanna dominates land cover in the northern and eastern regions. This land is hardly used as an economic resource because, according to the local community, they do not have the ability to exploit this land resource for economic value. Furthermore, the second most dominant land cover is non-forest vegetation, mixed vegetation with shrubs that do not cover tightly and tend to spread from the central region to the south. Meanwhile, forests are found in the central and southern regions and tend to be concentrated at three main points in the central and southern regions.

The accuracy assessment of land cover classification using Sentinel-2 images, as shown in Table 1, determines that the overall accuracy is 91.52%.

Table 1. Result of accuracy assessment of land cover classification analysis.

	Rice	Open	Vegetation	Settlement	Permanent Water	Numbers of Samples	Producer Accuracy
Rice	0.2653	0.0131	0.0037	0.0004	0.0002	0.2827	93.85
Open	0.0359	0.2636	0.0006	0.0006	0.0004	0.3010	87.59
Vegetation	0.0056	0.0056	0.2616	0.0015	0.0002	0.2745	95.30
Settlement	0.0037	0.0093	0.0019	0.1108	0.0002	0.1259	87.98
Permanent Water	0.0000	0.0007	0.0013	0.0000	0.0138	0.0159	87.06
numbers of samples	0.3105	0.2924	0.2691	0.1132	0.0148	1.0000	
User Accuracy	85.44	90.16	97.22	97.85	93.67		

We implemented the results of the accuracy test into a population error matrix to further investigate the wide distribution of the sample when compared to other samples. From the results of this matrix, it can be seen that the dominant sampling influence on producer accuracy is that of the rice field class sample. At the same time, the majority of user accuracy is accounted for in the rice field class. The highest producer accuracy and the highest user accuracy are both within the vegetation land class. This happens because the vegetation class is the easiest to identify, and the vegetation features cover the greatest area.

Specifically for areas dedicated rice farming, we refer to the Sustainable Food Crops Land Area map, which has now become the main reference in Indonesia, as shown in Figure 5.

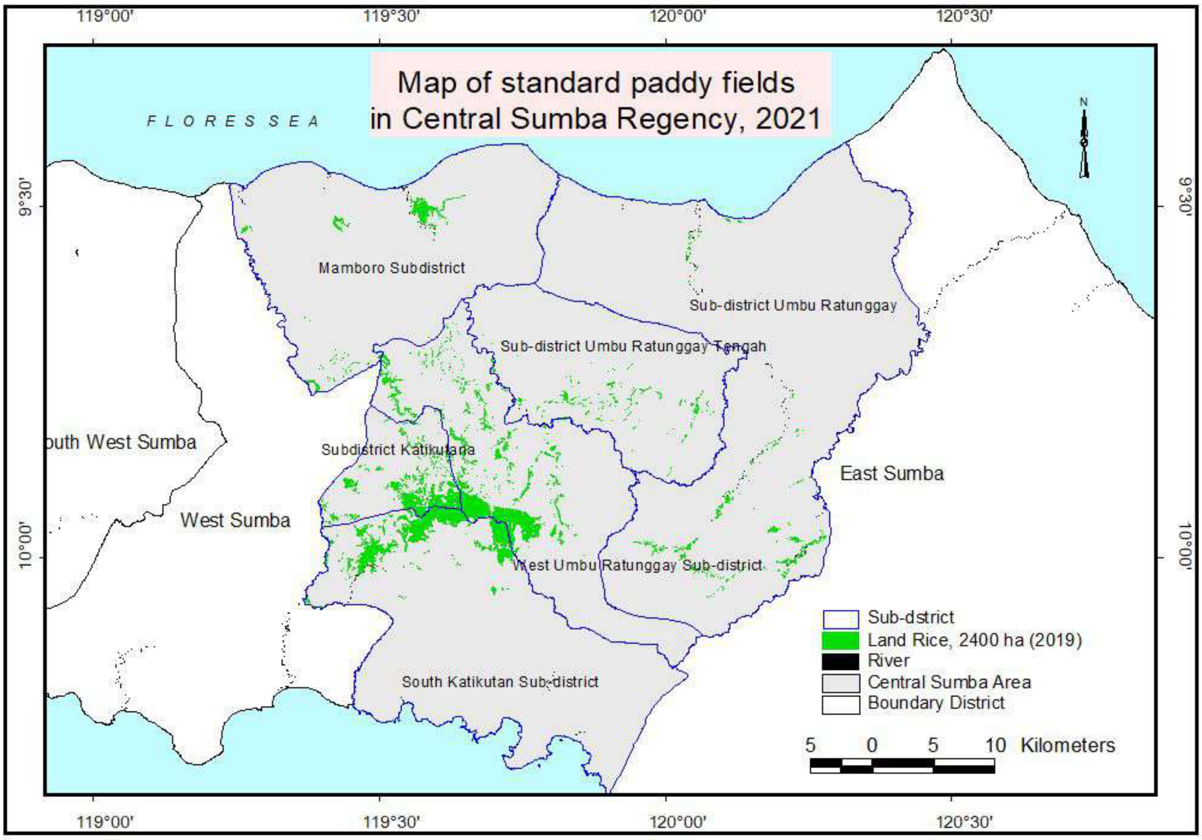

Figure 5. Map of rice fields in Central Sumba district [26].

From the picture, it can be seen that the area of paddy fields is 6400 ha, which is spread over 56 out of 65 villages in Central Sumba District. Although these paddy fields are spread over all sub-districts, most of the area comprising rice fields (79%) is concentrated in one area, which includes three sub-districts, namely Umbu Ratu Nggay Barat, Katikutana, and South Katikutana sub-districts.

4.2.2. Land Cover Changes Timeline

A summary of the changes in land cover in the period following the formation of this district, namely, changes in forest, settlements, agriculture, and dry land cover, is presented in Table 2. Figure 6 presents land cover maps for 2013 and 2021. Meanwhile, changes in paddy fields are presented in Table 2.

Table 2. Land cover changes of Central Sumba District of ENT in 2013 and 2021.

No.	Class. of LULC	Area in 2013 (ha)	Area in 2021 (ha)	Changes (ha)	Changes (%)
1.	Rice Field	7283	5906	−1377	−0.74%
2.	Open Land	66,815	58,011	−8804	−4.71%
3.	Other vegetation	91,034	87,990	−3044	−1.63%
4.	Settlements	21,459	34,638	13,179	7.06%
5.	Permanent Water	138	184	46	0.02%
	Total	186,729	186,729		

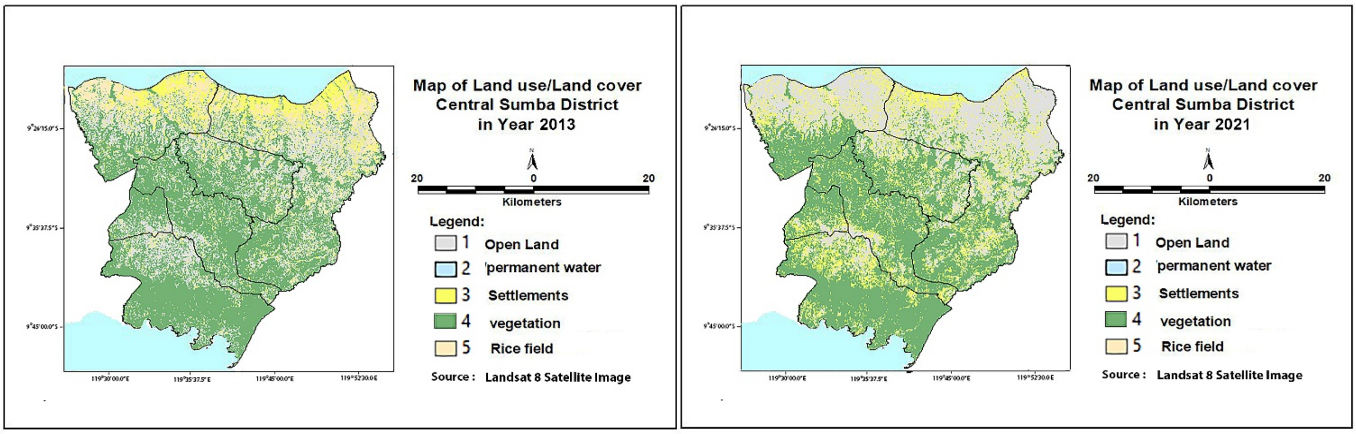

Figure 6. Landcover of Central Sumba District, 2013 and 2021 (Landsat 8).

Referring to landcover changes in Table 2 revealed that, except for settlements, all types of land cover experienced changes, tending to decrease during the period between 2013 and 2021. This condition is highly alarming, especially concerning the decline in forest land cover. The decline in forest area coverage is closely connected with the expansion of settlements, which is also related to the establishment of a new town/capital district and an additional new sub-district. Changes in the area of rice fields in the Central Sumba District, presented in Table 3, demonstrated a tendency to decrease from 2015 to 2019.

Table 3. Rice field area in 2015, 2016, 2017, 2018, and 2019 (ha).

District	Year 2015	Year 2016	Year 2017	Year 2018 (1)	Year 2019 (2)
Central Sumba (ha)	7576	7601	7601	4893	6400

Source: BPS [82–84] and Minister of ATR/BPN (2018–2019). Note: (1) The number is based on the minister decree of ATR/BPN-RI No. 399/Kep—23.3/X/2018. (2) The number is based on the Decree of the Minister of ATR/Head of BPN No. 686/SK—PG.03.03/XII/2019 dated 17 December 2019.

Calculating this land cover change uses a pixel-based approach. Each pixel in the image is classified based on its spectral characteristics for the several land cover categories previously mentioned. Land cover maps for these different time periods are then compared, and areas that have changed are identified by comparing the classification of each pixel. To calculate the area of land cover change, the number of pixels that change from one land cover type to another is multiplied by the area of each pixel. This method was used to estimate the total area of land cover change between the two time periods.

4.2.3. Physical Changes of Each Type of Landcover

Physical consequences affecting the area resulting from changes in land cover have been observed across the four types of land cover as previously mentioned. The physical changes and their impacts are summarized in Table 4.

The major physical changes affecting the four types of land cover are those pertaining to settlements and dry land agriculture. Changes in residential land cover tend to have a negative impact because they convert agricultural land, such as rice fields, into settlements in the capital area of the Central Sumba district. This threat will continue to affect land use if no regulations are implemented to control it. The Government of East Sumba through the Agriculture Service stated that the threat was indeed visible but, currently, the preparation of regulations governing sustainable agricultural land, regulations associated with so-called Sustainable Food Agriculture Land (SFAL), is underway. In the near future, this regulation will be formed under the name of the Regional Regulation on Sustainable Food Agricultural Land (SFAL).

Table 4. Physical changes and their impacts on each type of land cover in Central Sumba.

Landcover Types	Physical Changes	Impacts
Rice field	• Increase in area (government programs and community land clearing). • Shrinking due to conversion to settlement, especially along the main road.	The positive impact is that there is an increase in the area of land in the available landscape, both through government programs and local communities.
Dryland agriculture	• Increase in area because of population growth, especially in villages near district cities and sub-district cities, as well as expansion of new villages.	This phenomenon behaves similarly to the changes in the type of rice field cover. This is due to the consequences of population growth and the expansion of new areas at the village level.
Forest	• Forest encroachment and logging, as well as hunting for forest products.	Ecosystem imbalance, biodiversity degradation, soil erosion, and land degradation.
Settlements	• Increase in buildings and residences due to domestic needs such as housing, offices, and buildings for other purposes.	There has been a shrinking of potential agricultural lands that have not been cleared, as well as agricultural lands that are being cultivated.

As of 2021, 7-unit deep wells and several large ponds with a capacity of 850,000 m^3 have been built to support the Food Estate Program in Central Sumba [85]. From the results of a visual analysis, before and after the construction of the ponds, the area of paddy fields tends to be constant, but the frequency of planting may be greater after the construction of the ponds. The dynamic change in paddy field land cover is shown in Figure 7.

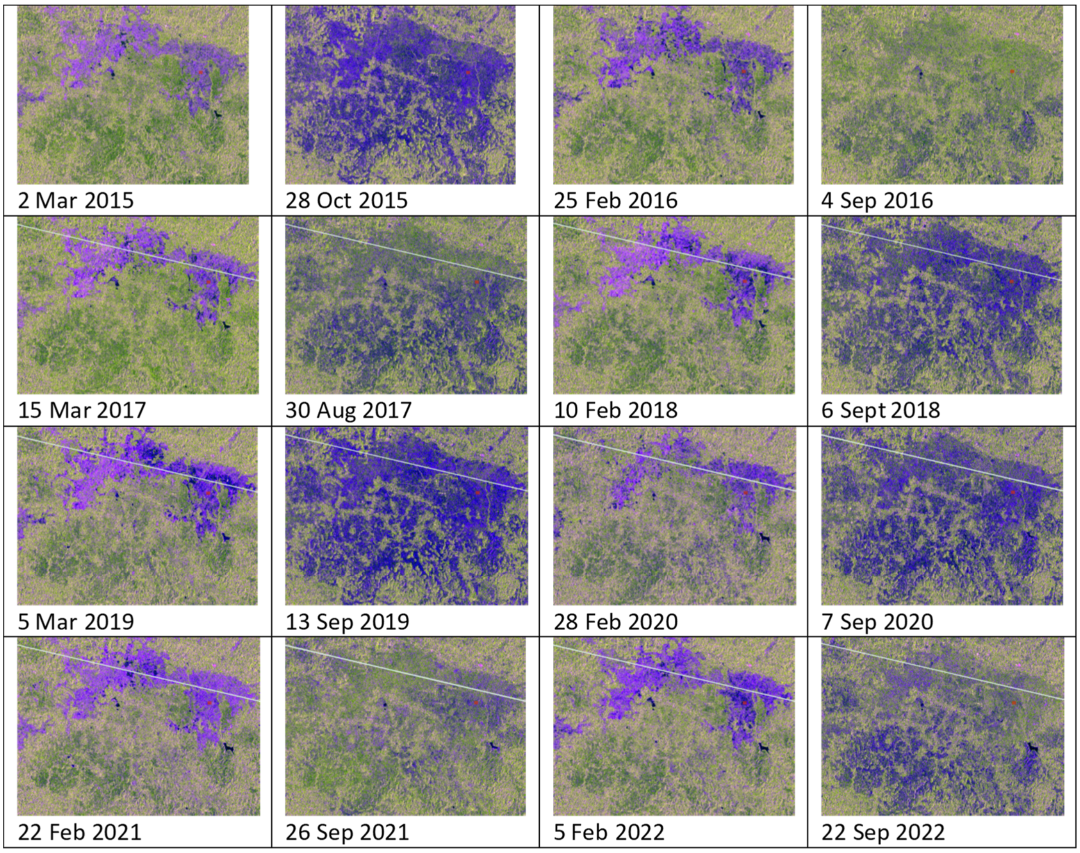

Figure 7. Sentinel-1 time series of paddy field condition.

Sentinel-1 imagery data are part of a time series obtained by observing the dynamics of land cover change from November to October of the following year, every year (Figure 7). Figure 8 shows a graph of the trend of rice growth in one of the rice fields in the district studied; in 2017, rice was planted two times in a year in the field, while in 2022, it was planted once in a year. Visually, in 2017 and 2022, there are no significant changes in paddy field and forest land cover.

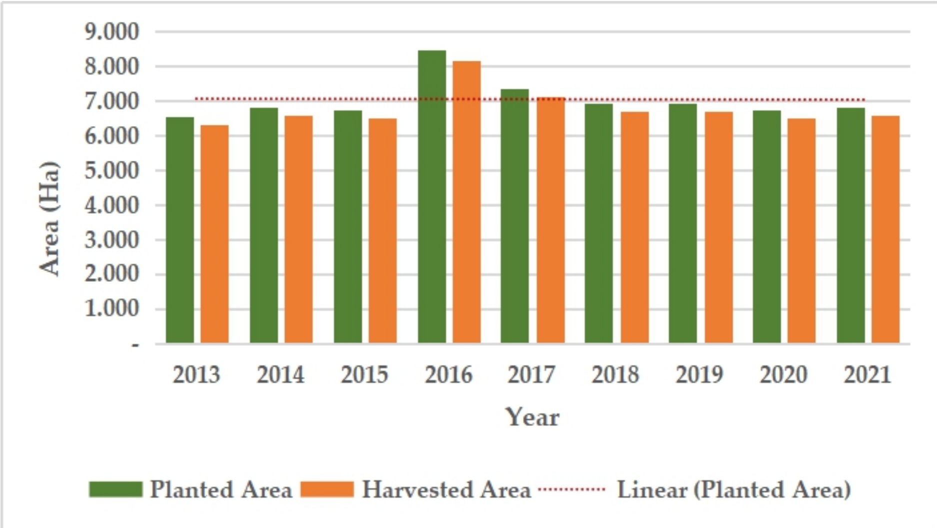

Figure 8. Planting and harvesting of paddy rice area of Central Sumba District from 2013 to 2021.

Orange arrows in Figure 9 represent dates that have a minimum value, indicating that there is an insignificant change with the planted area. The results of image analysis at several locations are as follows:

- In 2016, planting was conducted once a year in all paddy fields;
- In 2017, planting was conducted once a year in small areas, and some areas planting happened two times a year;
- In 2018, 2019, and 2020, planting occurred two times a year simultaneously;
- In 2021 and 2022, planting occurred one to two times a year, and the second growing season was not simultaneous.

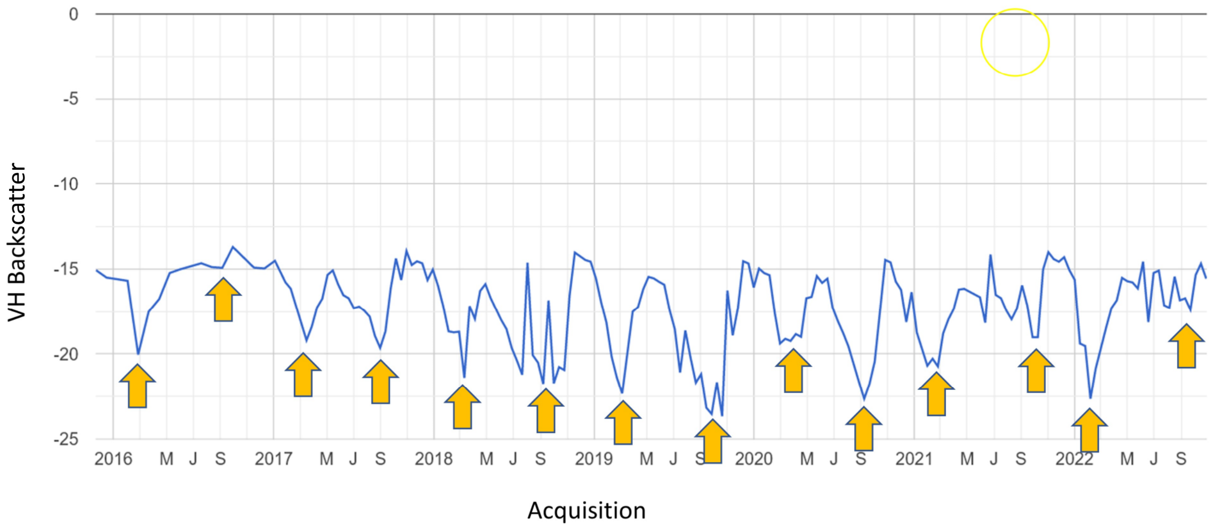

Figure 9. Trend of rice growth in one of the rice fields in the district studied.

Dominant rain-fed lowland areas were planted with rice once a year during the rainy season, while the rest simply fallowed or were grazing areas. However, rain-fed lowlands along the rivers or creeks were used during the rainy rice season and for maize and other horticultural crops during the dry season. All farmers own upland, or ladang, fields for farming mixed food crops: upland rice, maize, cassava, pumpkins, beans, sweet potatoes, and taro.

4.3. Food Security: Challenges and Opportunities

Rice is not only a main staple for Sumbanese people but also a "sacred" commodity that is related to several rituals in farming and the social lives of Sumbanese people [86]; however, there has been progressive change related to the technical aspects of farming in recent years as a direct impact of government interventions [87]. Regarding land reserved for rice farming, particularly irrigated land very limited in a predominantly savannah environment, land for rice is the most precious and protected land by the local people.

The traditional land tenure system in Central Sumba District, in general, is closely related to the social strata system where those in the upper class claim and own more land than those in the lower class; therefore, "injustice" is created in the agrarian system [22,23]. Nevertheless, land ownership, at least for rice land—both irrigated and rain-fed lowland—is still relatively equally distributed among farmers [87].

Decentralization and government interventions, especially progressive programs toward rice self-sufficiency implemented in recent years, have brought some gradual changes in social, cultural, and technical practices in rice farming (Table 5). The social and cultural ceremony related to rice farming is also gradually changing as most people are no longer under the local belief system, the so-called *Marapu*, but rather accept a new religion/belief system (predominantly Christianity) [86].

Table 5. Some socio-cultural and practical changes in rice land and farming in Central Suma District.

Aspect	Before	Current Practice/s
Land acquisition	All inherited	Dominantly inherited
Selling Riceland	Strictly prohibited	Allowed
Pawn	None	10–30% household farmers do
Planting calendar	Decided by *Marapu* elders	Decided by individual farmers/household
Ceremonies	Yes	No
Labor	Household and working together	Household and paid labor
External inputs use	None or low	High
Land preparations	Using water buffalo	Mostly by tractors/machine
Weeding	No	Yes, manual or applied herbicides
Harvesting	Manual	Manual, machines
Product orientation	Food security	Food security, partly semi-commercial

Source: Focus Group Discussions (FGDs).

All respondents had their own rice land, either irrigated or rain-fed lowland. Every clan also had "sacred" rice land of at least 1 ha. Additionally, they owned and cultivated their own rice land; although some farmers cultivated pawned land. A total of 16% of irrigated land was pawned, and 9.8 rain-fed lowlands were pawned. The pawned status was more likely to occur due to social and cultural reasons, particularly related to the burial ceremony. Pawned land transactions have been practiced in recent years correlate with a declining number of water buffalo. Water buffalo are considered "prestige" livestock offered during the burial ceremony. Since water buffalo are unaffordable, while simultaneously being desperately needed for burial ceremonies, most farmers pawn their rice land to obtain water buffalo.

Average land ownership for irrigated land was 0.91 ha and, for rain-fed lowland, was 1.2 ha. Most farmers either owned 1–2 ha of irrigated land or, for rain-fed lowland, owned 1 ha. Expenses from cultivating the land came from the farmers' budget. Some farmers adhered to a bondage system to buy chemical fertilizers and pay workers (Table 6).

Table 6. Distribution (%) status of land ownership, land size, number of land parcels, and capital for rice farming in Central Sumba District.

Aspects	Irrigated Land	Rain-Fed Lowland
Ownership Status:		
Own	74.4	85.3
Pawn	16.3	9.8
Others	9.3	4.9
Land size:		
0.2–< 1 ha	39.3	69.02
1–2 ha	52.2	26.27
>2 ha	8.2	4.71
Descriptive Statistics	min: 0.20 ha, max: 2 ha mean: 0.91 ha	min: 0.20 ha, max: 5 ha mean: 1.21 ha
Number of parcels:		
1 parcel	67.8	73.6
2 parcels	26.4	17
>2 parcels	5.7	9.4
Descriptive Statistics	min: 1 parcel, max: 5 parcels mean: 1.36 parcels	min: 1 parcel, max: 3 parcels mean: 1.38 parcels
Budget for rice farming:		
Own budget	77.45	27.56
Bank Credit/Co-operatives	2.94	1.05
Local moneylender	1.96	0.70
Pawn	17.65	6.28

There was no land ownership disparity, which was shown by the Gini index of 0.22, that is, the rice land was equally distributed [33]. This implied that (a) production, rice-based food availability, and income were well-distributed among rice farmers' households; (b) government intervention in terms of agriculture production facilities, agriculture infrastructure, and supporting systems were equally benefitted from among rice farmers' households; and (c) government programs to improve people's well-being through agriculture development instruments—including credit capital supports—were equally distributed.

All farmers had a positive attitude and perspective concerning rice land. Regarding changes in land size, the majority of respondents stated that there were no changes, around 9% of farmers experienced an increase in land size, and 5% experienced a decrease. The majority of farmers stated that the main function of both irrigated and rain-fed fields was to produce rice; however, around 3% of farmers stated that the main function was for non-agricultural purposes. The majority of farmers supported maintaining the function of the land for rice production both from cultural perspectives and those supporting the government's effort to protect the land through legislation (National and District Act of Sustainable and Land Protection (Table 7). The socio-cultural aspects related to inherited land can be incorporated and integrated into formal law to minimize the negative impacts of land fragmentation and ensure the existence of farmland for future generations [88].

Based on the 871 respondents' data taken from the three studies in Central Sumba District, most respondents were within the ages of 40 to <50 years old (32%), followed by older ages. The frequency of farmers of younger ages of $\leq$30 years old was quite low (5%). These data show and support the general view that younger generations are not interested in working in the agricultural or farming sector and, therefore, the older generation (>60 years old) is still working in the farming sector.

The tendency of farmers to be mostly older in age also occurs in various other parts of the world. Most of the world's food is produced by aging smallholder farmers from developing countries, who adopt new technologies needed to increase agricultural productivity sustainably [89]. Therefore, it is necessary to re-engage youth in agriculture. One approach that must be taken is through a vocational education program in agriculture. In NTT, this model has been implemented in several districts through agricultural schools at the high school and tertiary level, attracting rural youth to engage in agriculture and adopt environmentally friendly production methods. In addition, incentives through facilitating youth access to credit as well as market access help them become smallholder entrepreneurs, increasing their confidence that they can earn a living and be successful in rural areas. FAO notes that when there is an enabling environment, youth can find innovative ways to create a future for themselves and also contribute to the society and communities in which they live [89]

Table 7. Farmers' Attitude and Perspectives on Rice Land.

Variable	Measurement	%
Changes in land size	Remains unchanged	85.36
	Increase	8.99
	Decrease	5.47
	Do not know	0.18
Changes in main function	Remains unchanged	94.18
	Change to non-agriculture purposes	2.65
	Do not know	3.17
Attitude to keep its main function	Keep as rice field	89.10
	Allow to change	5.60
	Do not know	5.30
Attitude to transfer the ownership	Not for sale	97.0
	Not know	3.00
Protecting the land through legislation	Agree	85.00
	Disagree	15.00

Encouraging and empowering local people's participation, especially the youth, in agroforestry-based upland agriculture is expected to minimize the negative impact of changes in the role of forest areas. Local people's traditions regarding conservation and the environment by integrating the housing areas with *Kaliwu* (traditional agroforestry) could enhance land cover with various trees and crops. The average collation of land reserved for housing and house gardens in Central Sumba District is 1:7 m^2, which is lower than *Kaliwu*, which has an average of 1:193 m^2 [90], indicating that the Kaliwu area is 27.5 times larger than the area of the yard. This means that every 1 m^2 of a house's land space is attributed to a yard area of 7 m^2 and a Kaliwu area of 193 m^2. For a house with a land space of 45 m^2, a yard area of 315 m^2 and a Kaliwu area of 8685 m^2 would be expected. Nevertheless, upland agriculture needs to be vigilantly developed due to around 46.92% of cultivated land having steep elevation (25–40%); therefore, government programs for land use should establish a balance between enhancing land productivity with ecological sustainability to avoid malpractice in land resource management.

Sustainable farming through *Kaliwu* development, integrating traditional housing compounds such as *paraingu* (Anakalang), *parengu* (Manggena), and *manua* (Mamboro), comprises socio-cultural, religious, ecological, and economically strategic assets [40]. Socio-cultural and religious assets mesh with the tradition of local people who develop traditional housing compounds as a sub-system (*paraingu*), and they internalize traditional customs into a number of *kabisu* as a social clan-based organization. A social organization is characterized by a custom regulation in managing members of the clan to ensure security and social kinship (*kabisu*) and the institution of territorial symbols such as *paraingu* and *Kaliwu*. Territorial symbols have ecological implications through conservation of hilly terrain through the *Kaliwu* approach as an ecology unit and buffer of the forest ecosystem. The dependence on land resources to make a living has encouraged people to enhance environmental services from the *paraingu* ecosystem, including building materials, ropes, traditional medicines, firewood, food, and forages/feed [91]. Such environmental services have empowered local people to be more independent and supplement their livelihoods [41]. It is a lesson learned that people in Central Sumba District have traditional spatial land, utilize marginal or unfertile lands for housing, develop tree farms for building materials, and utilize more flat areas for upland farming, rain-fed lowland, and irrigated crop lands.

4.4. Environmental Services

Indonesia has increased its commitment to controlling deforestation and critical land areas (Figure 10) within and outside forested areas, indicated by a decreased deforestation rate between 444,000–918,000 ha year^{-1} (2000–2009), 780,000 ha year^{-1} (2011–2012), and 640,000 ha year^{-1} (2013–2017) [31,92,93]. Deforestation is mainly caused by the weakness of law enforcement, limited budget for security, which is around USD 0.13 ha^{-1}, and the ratio between forest rangers and total forest area to be secured: 1:60.000 ha in Java, Bali and Nusa Tenggara and 1:500.000 ha in Papua [93,94].

Figure 10. Critical Land in East Nusa Tenggara Province (BPDAS Benain-Noelmina, 2022).

Decentralization policies have contributed to increasing critical/marginal land, particularly during the transition period of land management from the district level to the provincial level. This implied an institutional arrangement regarding forest supervision in the field. Transition periods have been misused by some individuals or groups of people/institutions to perform illegal logging of high values trees and or exploit forest products. This illegal logging has most likely been performed with economic and political connections during the decentralization era that fostered deforestation in Indonesia [95]. Deforestation has broad implications for climate change, increasing death toll risks and decreasing human productivity and the livelihoods of local communities [96,97]. Human health or death risks are closely related to air pollution and malaria prevalence [98] and, therefore, the awareness of forest-based stakeholders to implement strategy, policy, and institutional reform must be raised, in addition to the efforts to minimize or even eliminate deforestation in Indonesia [99,100].

Efforts to lessen deforestation have faced challenges regarding spatial planning, the land tenure system, forest management, and law enforcement. Additionally, at least 48.8 million people in Indonesia are settled around forested areas, and 10.2 million among them are poor [101,102], and 2308 (71.58%) villages in ENT are situated in or around state forests [103]. Moreover, around 72.97% of land resources in ENT were under critical threat (Figure 11 as a result of increasing critical land up to 15,163 ha year^{-1} compared to the land rehabilitation capacity of 3615 ha year^{-1}. On the other hand, as many as 1,414,841 labor-workers in ENT are heavily dependent on land resources and, therefore, the sustainability of land function must be enhanced [104].

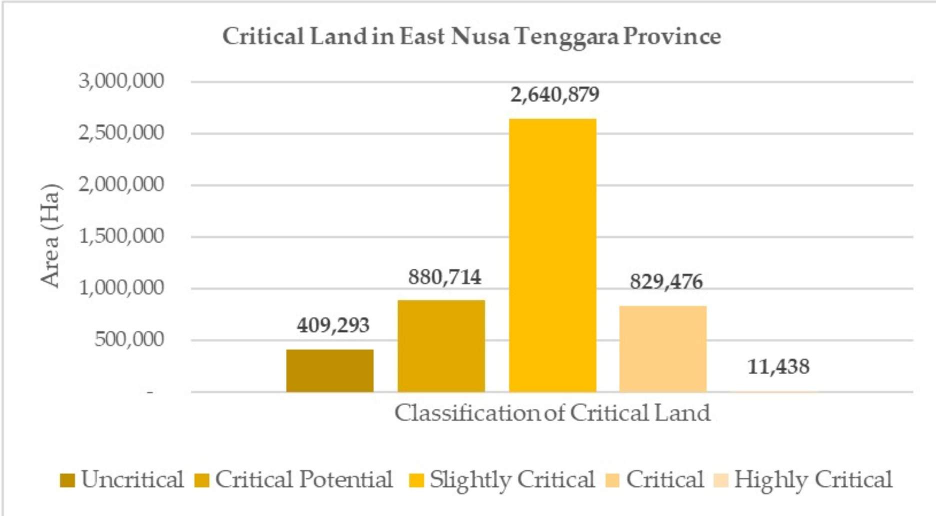

Figure 11. Critical Land in East Nusa Tenggara Province (BPDAS Benain-Noelmina, 2022).

Deforestation in Sumba Island occurs in the context of its characteristic hilly, steep landscape: land cover dominated with bush and savannah with a high risk of burning that increases the amount of critical land. The uncritical land percentage outside forest areas was only 1.84%, and the forest area coverage was also very small at 5.40% [90]. Central Sumba District, as a new autonomy district, faces dynamics of the human population, new space for housing, government offices, and land for farming, changing forest coverage from 77,664.037 ha in 1999 [105] to 59,223.765 ha in 2021 [106]. The request to review and redesign the new forest boundary has stimulated the discussion for the change in use of forested areas. Decentralization policy and the establishment of new autonomous regions/districts have conveyed implications justifying the use of forest areas for other purposes.

5. Discussion: The Link of Devolution Era, Food Security, and Environment

Indonesia has adequate acts and regulations governing land ownership/management, such as the Basic Agrarian Law (Act No. 5/1960), the Cultivation Act (Act No. 12/1992), and the Spatial Management Act (Act No. 26/2007). By referring to these regulations, it is hoped that sound coordination among stakeholders in interpreting and implementing strategies would minimize conflicts of interest concerning land management on one hand and maintain the right of all citizens to acquire and use the land for productive purposes on the other hand.

The main idea of decentralization and regional autonomy is to give more power to the local government (provincial and district levels) to provide better services to the people and improve well-being, including poverty reduction in rural areas. As the majority of poor people reside in rural areas and are heavily dependent on agricultural products for their living, the land—particularly agricultural land—should be well-protected.

The establishment of new districts and towns and increasing population pressure have ultimately led to dynamic changes in land use and land cover from national and provincial levels up to the district level in Indonesia. In the case of the ENT province, this is critical due to the region being dominated by a semi-arid environment with limited agricultural land. It was clear that there were expansions of agricultural land, particularly for rice, which led to an increase in rice production and the achievement of rice self-sufficiency, at least at the district level (Central Sumba). Unfortunately, it was revealed that the dynamic changes in land use were in negative directions, particularly in relation to food crop diversity, preservation of socio-cultural practices, and the environment in general.

Long before these formal regulations were implemented in Indonesia, the Sumbanese had their own traditional land tenure system for every tribe settled in Sumba. In the Central Sumba District, traditional land tenure somewhat follows the social strata system in which those in the upper stratum acquire more land than the lower strata. The research showed that this traditional land tenure is still acknowledged; however, all people also have their own private land, at least for rice farming.

With recent national progress in economic development and the response to the spirit of decentralization and regional autonomy, some new provinces and districts have been created, which has direct consequences regarding land conversion and land fragmentations. In the ENT province, 10 new districts have been created, making a total of 22 districts. Unfortunately, all new districts were created before the District Sustainable Agricultural Land Act was passed. In the case of Central Sumba District, the district's capital was even put in the core rice-farming area.

Land cover changes and the dynamics of social and economic perspectives of land in Central Sumba District were more likely dictated by the development of new district/town/urban areas as a direct consequence of the national policy to give more power and autonomy to local governments to foster the well-being of the people. Although the current changes so far have had little impact on land conversion and land ownership, they should be managed in such a way as to protect the agricultural land and ensure food security.

6. Limitations and Implications for Future Studies

GIS and LCC technologies provide opportunities to understand the trajectories of agricultural resource dynamics better. However, the results of the analysis sometimes experience information bias between field conditions and the results of the image analysis used. This is because, to a certain extent, there are difficulties in interpreting certain objects with field conditions. Ideally, studies using imagery should be followed by field checks. As an example of practical experience, it shows that the results of image analysis are difficult to distinguish between the conditions of the mature phases of rice and grass. Therefore, the roles of field assistance and field observation are important for further clarification.

The study focuses only on land use changes, particularly for rice land concerning the national devolution policy that led to the establishment of new districts, including Central Sumba District. Socio-cultural factors such as religion, social structure, and land/asset ownership that are closely connected to the traditional social status that might have correlated to that change were only partially taken into consideration in the analysis.

Regarding the results of image analysis and GIS for marginal areas and areas with very limited arable land, the understanding of LCC dynamics will greatly assist policy makers in designing and implementing regional development in a more sustainable way, especially in the agricultural sector. The combination of GIS, LCC insights, and socio-economic studies/confirmations offers a better understanding of dynamic changes in land use and policies to prevent and protect natural resources, especially agricultural land.

7. Conclusions

Agricultural land is very limited on Sumba Island, which is dominated by a marginal semi-arid ecosystem. Nevertheless, land use and land cover changes may continue to meet the demand for food of the growing human population. Rice land in Central Sumba District has a critical role in food security, but covers only 5% of the total district size. The ongoing conversion of the land, even at a slow rate, should be taken into consideration as it will affect the food security of the people and the environment. The semi-arid ecosystem is a fragile ecosystem that should be well-managed to ensure the provision of food security and environmental services.

New districts and new towns created during the decentralization and autonomy era in Indonesia have created a new urban society that needs land and space for urban infrastructure. The placement of the town in the core of agricultural land in the Central Sumba District has undermined the sustainability of already limited food crops and food security. The increase in land price and land rent were inevitable in the new town. Therefore, to limit the conversion of agricultural land in the town and suburb, there should be clear regulation of land ownership transfers, and at the same time, government support is needed to make the land more productive or competitive through various schemes in agricultural programs.

Author Contributions: Y.N. (Yohanis Ngongo), B.d., T.B., G.N.N., Y.N. (Yudistira Nugraha), A.H.H., M.A., K.K., R.S., J.B.M.R., P.R.M., D.O. and H.Y.S.H.N. were contributors for data collection, conceptualization, methodology, analysis, validation, manuscript writing, and review and editing; and R.B.H., J.O.M.S., R.E.S., H.d., R.T.P.H., Y.P.K., N.R.E.K., Y.L.S. and D.K.H. were contributing members who played a role in data collection, validation, and manuscript writing. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Local Government of Central Sumba District based on Central Sumba Major Decree Number: Kep/HK/295/2002, under the management of the District Development Planning Board, while the APC received no external funding.

Data Availability Statement: Not applicable.

Acknowledgments: The authors highly appreciated the contributions and the support from some institutions and individuals. We thank the government of Central Sumba District for allocating the funds to conduct the study. We thank the Chair of the Regional Research and Development Planning Agency, Martinus Jurumana, for their constructive ideas during the seminar/data collection stage and for allowing several staff members (Nevelyn Rambu Bangi Todji, Marlyn Rambu Bita, and Gusti Kadek Deddy B. Ivan) to be involved in the research. We acknowledge the contribution from agricultural extension workers of Central Sumba District in helping to collect the survey data. We also thank Ferdinand Umbu Kabalu, SE, Lasarus Thomas, S.Sos, and Neny Rambu Lawadjati, ST, for managing our administrative travel and field documents.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Nurhadi. Inilah Daftar Provinsi Baru yang Terbentuk Pasca-Reformasi. Tempo. Nasional. July 2022. Available online: https://nasional.tempo.co/read/1608931/inilah-daftar-provinsi-baru-yang-terbentuk-pasca-reformasi (accessed on 10 July 2022).
2. Fajri, D.L. Mengenal Provinsi dan Jumlah Kabupaten di Indonesia. Katadata. Berita. February 2022. Available online: https://katadata.co.id/intan/berita/6206141e9ca33/mengenal-provinsi-dan-jumlah-kabupaten-di-indonesia (accessed on 13 February 2022).
3. Pratomo, R.A.; Samsura, D.A.A.; van der Krabben, E. Transformation of Local People' s Property Rights Induced by New Town Development. *Land* **2020**, *9*, 236. [CrossRef]
4. Kelly-Fair, M.; Gopal, S.; Koch, M.; Kusumaningrum, H.P.; Helmi, M.; Khairunnisa, D.; Kaufman, L. Analysis of Land Use and Land Cover Changes through the Lens of SDGs in Semarang, Indonesia. *Sustainability* **2022**, *14*, 7592. [CrossRef]
5. Mardiansjah, F.H.; Rahayu, P.; Rukmana, D. New Patterns of Urbanization in Indonesia: Emergence of Non-statutory Towns and New Extended Urban Regions. *Environ. Urban. ASIA* **2021**, *12*, 11–26. [CrossRef]
6. Antriyandarti, E. Constraints of farm size enlargement in the rice sector of central java: A case study. *Bulg. J. Agric. Sci.* **2018**, *24*, 949–958.
7. Sui, F.; Yang, Y.; Zhao, S. Labor Structure, Land Fragmentation, and Land-Use Efficiency from the Perspective of Mediation Effect: Based on a Survey of Garlic Growers in Lanling, China. *Land* **2022**, *11*, 952. [CrossRef]
8. Tran, T.Q.; Vu, H. Van Theimpactof land fragmentation on food security in the North Central Coast, Vietnam. *Asia Pac. Policy Stud.* **2021**, *8*, 327–345. [CrossRef]
9. Oktavilia, S.; Fafurida; Pujiati, A.; Aulia, Y. Firmansyah Industrialization and Land Conversion in Indonesia. *Environ. Ecol. Res.* **2022**, *10*, 627–634. [CrossRef]
10. Handayani, S.W.; Fauzan, M.; Nasihuddin, A.A. Conversion of Agricultural Land Policy in Indonesia. In Proceedings of the 5th International Conference on Community Development (AMCA 2018), Atlantis Press, Quezon City, Philippines, 19–20 July 2018. [CrossRef]
11. Laksana, S. Some Difficulties to Protect Agricultural Land from Conversion: The Case of Sustainable Agricultural Land Policy in Tasikmalaya Regency, West Java, Indonesia. *Bappenas Work. Pap.* **2020**, *2*, 157–167. [CrossRef]
12. Agus, F. Irawan Agricultural Land Conversion as a Threat to Food Security and Environmental Quality. *J. Penelit. Pengemb. Pertan.* **2006**, *25*, 90–98.
13. Firman, T. Rural to urban land conversion in Indonesia during boom and bust periods. *Land Use Policy* **2000**, *17*, 13–20. [CrossRef]
14. Mulyani, A.; Kuntjoro, D.; Nursyamsi, D.; Agus, F. Konversi Lahan Sawah Indonesia sebagai Ancaman terhadap Ketahanan Pangan. *Indones. Soil Clim. J.* **2016**, *40*, 121–133. [CrossRef]
15. Nurliani; Rosada, I. Rice-field Conversion and its Impact on Food Availability. *Agric. Agric. Sci. Procedia* **2016**, *9*, 40–46. [CrossRef]
16. Sidipurwanty, E. Tenure and Ownership of Agricultural Land in Probolinggo Regency of East Java Province. *Pertanahan* **2016**.

17. Putri, R.F.; Rokhim, A.A.; Prakosa, M.G.; Hastari, N.R.F.; Adhesti, Y.M.P.; Junaedi, R.N.; Ramdani, H.P.; Omar, R.C. Analysis of land resources balance in Nusa Tenggara Timur Province. *IOP Conf. Ser. Earth Environ. Sci.* **2021**, *686*, 012006. [CrossRef]
18. Hutapea, R.T.P.; Ramadhan, R.P.; Tulalo, M.A.; Ngongo, Y. Competitiveness of Indonesian Rice Prices in the International Market. *E3S Web Conf.* **2022**, *361*, 01016. [CrossRef]
19. Yodfiatfinda. Effort to Improve the Interests of Young Generations in the Agricultural Sector to Attain Food Security in Indonesia. In Proceedings of the 5th International Conference on Food, Agriculture and Natural Resources (FANRes 2019), Ternate, Indonesia, 17–19 September 2019; Volume 194, pp. 291–296. [CrossRef]
20. Utami, A.; Harianto, H. Farmers' Subsistence in Indonesian Rice Farming. *J. Agribisnis Indones.* **2021**, *9*, 79–87. [CrossRef]
21. Rosyada, A.; Putra, R.E.; Gunawan, W. Dynamics of Competitiveness and Efficiency of Rice Farming in Java Island, Indonesia. *3BIO: J. Biol. Sci. Technol. Manag.* **2022**, *4*, 105–119. [CrossRef]
22. Vel, J. Law, Social Justice & Global Development Reports. *Law Soc. Justice Glob. Dev.* **2010**, *2010*, 1–27.
23. Vel, J.; Makambombu, S. Strategic Framing of Adat in Land-Acquisition Politics in East Sumba. *Asia Pac. J. Anthropol.* **2019**, *20*, 435–452. [CrossRef]
24. Fowler, C.T. Customary Rights and Freshwater Ecology in Pluralistic Societies on the Monsoonal Island of Sumba (Eastern Indonesia). *Front. Environ. Sci.* **2022**, *10*, 842647. [CrossRef]
25. District Statistical Bureau. *Kabupaten Sumba Tengah Dalam Angka 2022 (Central Sumba District in Figures 2022)*; Statistical Bureau: Waibakul, Indonesia, 2022. Available online: https://sumbatengahkab.bps.go.id/publication/2022/02/25/bb3c0995f735658efcc23423/kabupaten-sumba-tengah-dalam-angka-2022.html (accessed on 5 January 2023).
26. Geospatial, I. Available online: https://www.indonesia-geospasial.com/2020/09/download-shp-tutupan-lahan-tahun-2019.html (accessed on 5 January 2022).
27. Indra, S.; Prasetyo, L.B.; Soekmadi, R. Penyusunan Zonasi Taman Nasional Manupeu Tanadaru, Sumba Berdasarkan Kerentanan Kawasan Dan Aktifitas Masyarakat (Zoning System Development of Manupeu Tanadaru National Park on Sumba based on Area Sensitivity and Community Activities). *Media Konserv.* **2006**, *XI*, 1–16.
28. RimbaKita. Taman Nasional Manupeu Tanah Daru—Sumba, NTT. RimbaKita. 2022. Available online: https://rimbakita.com/taman-nasional-manupeu-tanah-daru/ (accessed on 10 January 2023).
29. Balai Taman Nasional Matalawa. *Revisi Zona Pengelolaan Taman Nasional Manupeu Tanah Daru dan Laiwanggi Wanggameti (TN MATALAWA) Kabupaten Sumba Barat, Sumba Tengah dan Sumba Timur*; Balai Taman Nasional Matalawa: Jakarta, Indonesia, 2019.
30. Olson, D. Sumba Deciduous Forests [Internet]. Oenerath—WWF-Hong Kong. 2022. Available online: https://www.oneearth.org/ecoregions/sumba-deciduous-forests/ (accessed on 12 January 2023).
31. Nurofiq, H.F.; Margono, B.A.; Saputro, T.; Nugroho, S.; Purwanto, J.; Ramdhany, D.; Pramono, J.; Usman, A.B.; Rovani, R.; Suharyono; et al. *The State of Indonesia's Forests 2022: Towards FOLU Net Sink 2030*; Nurbaya, S., Efransyah, Eds.; Ministry of Environmental and Forestry Republic of Indonesia: Jakarta, Indonesia, 2022; 157p. Available online: https://www.menlhk.go.id/uploads/site/post/1664894502.pdf (accessed on 12 January 2023).
32. DeRosari, B.; Matitaputy, P.R.; Ngongo, Y.; da Silva, H.; Rohi, I.; Bombo, Y.; Achadri, Y.; Kotta, N.R. Laporan Kerjasama Bapelitbangda Sumba Tengah dan BPTP NTT; Nusa Tenggara Timur, 2021.
33. DeRosari, B.; Basuki, T.; Ngongo, Y. Dampak Sosial Budaya dan Ekonomi Program Food Estate Bagi Kesejahteraan Masyarakat Suma Tengah (Impact of Socio-Cultural and Economic of Food Estate Program for People Welfare of Central Sumba Distrcit); Waibakul, Indonesia, 2022.
34. Basuki, T.; DeRosari, B.; Pari, N.U.K.; Landukara, Y.; Banunaek, S.K.I.; Bitang, B.K.; Taklal, Z.Y.; Rouna, A.R.; Winu, F.K.; Bora, Y.U.; et al. Kajian Lahan Pertanian Pangan Mendukung Perda LP2B Kabupaten Sumba Tengah (The Study to Provides Document of "Sustainable Food Crops Lands" in Central Sumba District); Waibakul, Indonesia, 2022.
35. Alavipanah, S.K.; Karimi Firozjaei, M.; Sedighi, A.; Fathololoumi, S.; Zare Naghadehi, S.; Saleh, S.; Naghdizadegan, M.; Gomeh, Z.; Arsanjani, J.J.; Makki, M.; et al. The Shadow Effect on Surface Biophysical Variables Derived from Remote Sensing: A Review. *Land* **2022**, *11*, 2025. [CrossRef]
36. Noi Phan, T.; Kuch, V.; Lehnert, L.W. Land cover classification using google earth engine and random forest classifier-the role of image composition. *Remote Sens.* **2020**, *12*, 2411. [CrossRef]
37. Dong, C.; Zhao, G.; Meng, Y.; Li, B.; Peng, B. remote sensing The Effect of Topographic Correction on Forest Tree Species Classification Accuracy. *Remote Sens.* **2020**, *12*, 787. [CrossRef]
38. Hudjimartsu, S.; Prasetyo, L.; Setiawan, Y.; Suyamto, D.; Ikbal, W. Automated Landsat 8 data preprocessing for national forest monitoring system. In Proceedings of the Sixth International Conference on Remote Sensing and Geoinformation of the Environment (RSCy2018), SPIE, Paphos, Cyprus, 26–29 March 2018; pp. 249–259.
39. Candra, D.S.; Phinn, S.; Scarth, P. Automated cloud and cloud-shadow masking for Landsat 8 using multitemporal images in a variety of environments. *Remote Sens.* **2019**, *11*, 2060. [CrossRef]
40. Ismaya, H.; Rahayu, M.I.; Adiningsih, E.S. New Automated Cloud and Cloud-Shadow Detection Using Landsat Imagery. *Int. J. Remote Sens. Earth Sci.* **2014**, *9*, 2. [CrossRef]
41. López-Puigdollers, D.; Mateo-García, G.; Gómez-Chova, L. Benchmarking deep learning models for cloud detection in landsat-8 and sentinel-2 images. *Remote Sens.* **2021**, *13*, 992. [CrossRef]
42. Phiri, D.; Simwanda, M.; Salekin, S.; Nyirenda, V.R.; Murayama, Y.; Ranagalage, M. Sentinel-2 data for land cover/use mapping: A review. *Remote Sens.* **2020**, *12*, 2291. [CrossRef]

43. Supriatna; Rokhmatuloh; Wibowo, A.; Shidiq, I.P.A.; Pratama, G.P.; Gandharum, L. Spatio-temporal analysis of rice field phenology using Sentinel-1 image in Karawang Regency West Java, Indonesia. *Int. J. GEOMATE* **2019**, *17*, 101–106. [CrossRef]
44. Andualem, T.G.; Belay, G.; Guadie, A. Land Use Change Detection Using Remote Sensing Technology. *J. Earth Sci. Clim. Chang.* **2018**, *9*, 276. [CrossRef]
45. Roy, P.S.; Roy, A. Land use and land cover change in India: A remote sensing & GIS prespective. *J. Indian Inst. Sci.* **2010**, *90*, 489–502.
46. Kumar, M.S.; Kolluru, V.; Gowthami, S.B.; Anjita, N.A.; Nayana, N.; Regi, L.; Dwarakish, G.S. Monitoring land use and land cover changes in coastal karnataka. *Trends Civ. Eng. Chall. Sustain. Sel. Proc. CTCS* **2021**, *99*, 785–795. [CrossRef]
47. Kumar, A.; Chaudhary, S.; Negi, M.S. A Study of Spatio-Temporal Landuse/Land Cover Change Dynamics in Rudraprayag District,(Garhwal Himalaya) Using Remote Sensing and Gis. *J. Glob. Resour.* **2019**, *5*, 61–69.
48. Naboureha, A.; Biana, J.; Leia, G.; Lia, A. A review of land use/land cover change mapping in the China-Central Asia-West Asia economic corridor countries. *Big Earth Data* **2021**, *5*, 237–257. [CrossRef]
49. Parveen, S.; Basheer, J.; Praveen, B. A Literature Review on Land Use Land Cover Changes. *Int. J. Adv. Res.* **2018**, *6*, 1–6. [CrossRef] [PubMed]
50. Venter, Z.S.; Barton, D.N.; Chakraborty, T.; Simensen, T.; Singh, G. Global 10 m Land Use Land Cover Datasets: A Comparison of Dynamic World, World Cover and Esri Land Cover. *Remote Sens.* **2022**, *14*, 4101. [CrossRef]
51. Filipponi, F. Sentinel-1 GRD Preprocessing Workflow. *Proceedings* **2019**, *18*, 111. [CrossRef]
52. Olofsson, P.; Foody, G.M.; Herold, M.; Stehman, S.V.; Woodcock, C.E.; Wulder, M.A. Good practices for estimating area and assessing accuracy of land change. *Remote Sens. Environ.* **2014**, *148*, 42–57. [CrossRef]
53. Ustaoglu, E.; Williams, B. Institutional Settings and Effects on Agricultural Land Conversion: A Global and Spatial Analysis of European Regions. *Land* **2023**, *12*, 47. [CrossRef]
54. Hollander, M.; Wolfe, D.A.; Chicken, E. *Nonparametric Statistical Methods*; John Wiley & Sons.: New York, NY, USA, 2014.
55. Negara, M.S. Undang-Undang Republik Indonesia Nomor 22 Tahun 1999 Tentang Pemerintah Daerah; Indonesia, 1999.
56. Ministry of Finance Repuclic of Indonesia. Law of the Republic of Indonesia Number 28 Year 2009 Concerning Local Taxation and Charges. Jakarta, 2010. Available online: https://djpk.kemenkeu.go.id/attach/post-law-of-the-republic-indonesia-number-2008-year-2009-concerning-local-taxes-and-charges/UU-559-753-uu282009verE_Edited.pdf (accessed on 12 January 2023).
57. Usman, S. Regional Autonomy in Indonesia: Field Experiences and Emerging Challenges. In Proceedings of the 7th PRSCO Summer Institute/The 4th IRSA International Conference: "Decentralization, Natural Resources, and Regional Development in the Pacific Rim", Bali, Indonesia, 20–21 June 2002; pp. 20–21.
58. Sukri; Ariana; Armunanto, A.; Nadir, S.; Ekawaty, D. Environmental dilemma under implementation of Indonesian regional autonomy. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *343*, 012088. [CrossRef]
59. Wiesner, B.J.; Dargusch, P. The Social License to Restore—Perspectives on Community Involvement in Indonesian Peatland Restoration. *Land* **2022**, *11*, 1038. [CrossRef]
60. Yakin, A.; Othman, J. Forest Resources and Policy in the Age of Regional Autonomy in Indonesia. In Proceedings of the International Seminar on "Sustainable Economic, Business, and Social Development in an Era of Globalization", Selangor, Malaysia, 13–14 October 2003.
61. Setiawan, B.; Hadi, S.P. Regional autonomy and local resource management in Indonesia. *Asia Pac. Viewp.* **2007**, *48*, 72–84. [CrossRef]
62. Republic of Indonesia. *The National Medium Term Development Plan 2020–2024*; Indonesia National Development Planning Board: Jakarta, Indonesia, 2020; p. 18. Available online: https://www.bappenas.go.id/files/rpjmn/Narasi-RPJMN-2020-2024-versi-Bahasa-Inggris.pdf (accessed on 12 January 2023).
63. Sutiyo; Maharjan, K.L. *Decentralization and Rural Development in Indonesia*; Springer: Berlin/Heidelberg, Germany, 2017. [CrossRef]
64. Nurrochmat, D.R.; Pribadi, R.; Siregar, H.; Justianto, A.; Park, M.S. Transformation of agro-forest management policy under the dynamic circumstances of a two-decade regional autonomy in Indonesia. *Forests* **2021**, *12*, 419. [CrossRef]
65. Rada, N.E.; Buccola, S.T.; Fuglie, K.O. Government policy and agricultural productivity in Indonesia. *Am. J. Agric. Econ.* **2011**, *93*, 863–880. [CrossRef]
66. Nugroho, Y. Sujarwoto Institutions, Outputs and Outcomes: Two Decades of Decentralization and State Capacity in Indonesia. *J. Southeast Asian Econ.* **2021**, *38*, 296–319. [CrossRef]
67. Johnson, C. Local democracy, democratic decentralisation and rural development: Theories, challenges and options for policy. *Dev. Policy Rev.* **2001**, *19*, 521–532. [CrossRef]
68. Nasution, A. The government decentralization program in indonesia. In *Central and Local Government Relations in Asia*; Edward Elgar Publishing: Cheltenham, UK, 2017; pp. 276–305. [CrossRef]
69. Shoesmith, D.; Franklin, N.; Hidayat, R. Decentralization and the decision making process are more democratic, but it also enhances fragmentations and conflicts among different parties, including in natural resources management, especially in agricultural land. *J. Curr. Southeast Asian Aff.* **2020**, *39*, 359–380. [CrossRef]
70. IFAD. Youth Entrepreneurship and Employment Support Services Programme. Available online: https://www-ifad-org.translate.goog/en/web/operations/-/project/2000001202?_x_tr_sl=en&_x_tr_tl=id&_x_tr_hl=id&_x_tr_pto=tc (accessed on 12 January 2023).

71. Ardiansyah, F.; Marthen, A.A.; Amalia, N. *Forest and Land-Use Governance in a Decentralized Indonesia: A Legal and Policy Review*; CIFOR: Bogor, Indonesia, 2015.
72. Garrett, L.; Lévite, H.; Besacier, C.; Alekseeva, N.; Duchelle, A. *The Key Role of Forest and Landscape Restoration in Climate Action*; FAO: Rome, Italy, 2022; ISBN 9789251370445.
73. Zhang, S. Land Use/Land Cover Change in Orange County. Ph.D. Dissertation, The University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, 2010. [CrossRef]
74. Vadrevu, K.P.; Ohara, T. Focus on land use cover changes and environmental impacts in South/Southeast Asia. *Environ. Res. Lett.* **2020**, *15*, 100201. [CrossRef]
75. Lin, H.I.; Yu, Y.Y.; Wen, F.I.; Liu, P.T. Status of Food Security in East and Southeast Asia and Challenges of Climate Change. *Climate* **2022**, *10*, 40. [CrossRef]
76. Margulis, S. Causes of Deforestation in the Brazilian Amazon. [Electronic Resource]; 22; Washington, DC, 2003. Available online: http://search-dev.trln.org/shopping-cart/search?id=UNCb5124852 (accessed on 12 January 2023).
77. Cerri, C.E.P.; Cerri, C.C.; Maia, S.M.F.; Cherubin, M.R.; Feigl, B.J.; Lal, R. Reducing Amazon deforestation through agricultural intensification in the Cerrado for advancing food security and mitigating climate change. *Sustainability* **2018**, *10*, 989. [CrossRef]
78. Appelt, J.L.; Garcia Rojas, D.C.; Verburg, P.H.; van Vliet, J. Socioeconomic outcomes of agricultural land use change in Southeast Asia. *Ambio* **2022**, *51*, 1094–1109. [CrossRef] [PubMed]
79. Zhao, S.; Peng, C. Land use change in Asia and the ecological consequences. *Ecol. Res.* **2006**, *21*, 890–896. [CrossRef]
80. Vadrevu, K.; Heinimann, A.; Gutman, G.; Chris, J. Remote sensing of land use/cover changes in South and Southeast Asian Countries. *Int. J. Digit. Earth* **2019**, *12*, 1099–1102. [CrossRef]
81. Central Sumba District Statistical Bureau. *Sumba Tengah Dalam Angka 2021 (Central Sumba District in Figures 2021)*; Central Sumba District Statistical Bureau: Waibakul, Indonesia, 2021.
82. Central Sumba District Statistical Bureau. *Sumba Tengah Dalam Angka 2015 (Central Sumba District in Figures 2015)*; Central Sumba District Statistical Bureau: Waibakul, Indonesia, 2015.
83. Central Sumba District Statistical Bureau. *Sumba Tengah Dalam Angka 2016 (Central Sumba District in Figures 2016)*; Central Sumba District Statistical Bureau: Waibakul, Indonesia, 2016.
84. Central Sumba District Statistical Bureau. *Sumba Tengah Dalam Angka 2017 (Central Sumba District in Figures 2017)*; Central Sumba District Statistical Bureau: Waibakul, Indonesia, 2017.
85. Azwartika, I. Menteri Basuki Dampingi Presiden Joko Widodo Tinjau Infrastruktur Irigasi Food Estate Kabupaten Sumba Tengah, NTT. Jakarta, 2021. Available online: https://pu.go.id/berita/menteri-basuki-dampingi-presiden-joko-widodo-tinjau-infrastruktur-irigasi-food-estate-kabupaten-sumba-tengah-ntt (accessed on 12 January 2023).
86. Ngongo, Y.; Ngongo, M. Marapu and Farming: How Tourism Shape Rural Development and Ancient Tradition of Sumba Indigenous Community–Indonesia. *E3S Web Conf.* **2021**, *316*, 04004. [CrossRef]
87. DeRosari, B.; Basuki, T.; Ngongo, Y. Kajian Pola Penguasaan Lahan Sawah di Kabupaten Sumba Tengah (Study of Rice Land Tenure in Central Sumba District); Nusa Tenggara Timur, 2022.
88. Kurnia, G.; Setiawan, I.; Tridakusumah, A.C.; Jaelani, G.; Heryanto, M.A.; Nugraha, A. Local Wisdom for Ensuring Agriculture Sustainability: A Case from Indonesia. *Sustainability* **2022**, *14*, 8823. [CrossRef]
89. FAO. *Youth and Agriculture*; The Food and Agriculture Organization of the United Nations (FAO) in Collaboration with the Technical Centre for Agricultural and Rural Cooperation (CTA) and the International Fund for Agricultural Development (IFAD): Rome, Italy, 2014; pp. 1–6.
90. Njurumana, G.N. Village Community and Flora Biodiversity Management in Home Garden System at Central of Sumba Regency. *J. Penelit. Kehutan. Wallacea* **2016**, *5*, 25–36. [CrossRef]
91. Njurumana, G.N.; Sadono, R.; Marsono, D. Irham Ecosystem Services of Indigenous Kaliwu Agroforestry System in Sumba, Indonesia. *E3S Web Conf.* **2021**, *305*, 04002. [CrossRef]
92. Margono, B.A.; Potapov, P.; Turubanova, S.; Stolle, F.; Hansen, M.C. Primary forest cover loss in Indonesia over 2000–2012. *Nat. Clim. Change* **2014**, *4*, 730–735. [CrossRef]
93. Tacconi, L.; Rodriguesa, R.J.; Maryudi, A. Law enforcement and deforestation: Lessons for Indonesia from Brazil. *For. Policy Econ.* **2019**, *108*, 101943. [CrossRef]
94. Ekawati, S. Evaluation of the Implementation of Decentralization Policy on Production Forest Management. *J. Anal. Kebijak. Kehutan.* **2013**, *10*, 187–202.
95. Cisneros, E.; Kis-Katos, K.; Nuryartono, N. Palm oil and the politics of deforestation in Indonesia. *J. Environ. Econ. Manag.* **2021**, *108*, 102453. [CrossRef]
96. Chakrabarti, A. Deforestation and infant mortality: Evidence from Indonesia. *Econ. Hum. Biol.* **2021**, *40*, 100943. [CrossRef] [PubMed]
97. Wolff, N.H.; Zeppetello, L.R.V.; Parsons, L.A.; Aggraeni, I.; Battisti, D.S.; Ebi, K.L.; Game, E.T.; Kroeger, T.; Masuda, Y.J.; Spector, J.T. The effect of deforestation and climate change on all-cause mortality and unsafe work conditions due to heat exposure in Berau, Indonesia: A modelling study. *Lancet Planet. Health* **2021**, *5*, e882–e892. [CrossRef] [PubMed]
98. Kim, Y.; Knowles, S.; Manley, J.; Radoias, V. Long-run health consequences of air pollution: Evidence from Indonesia's forest fires of 1997. *Econ. Hum. Biol.* **2017**, *26*, 186–198. [CrossRef]

99. Leijten, F.; Sim, S.; King, H.; Verburg, P.H. Local deforestation spillovers induced by forest moratoria: Evidence from Indonesia. *Land Use Policy* **2021**, *109*, 105690. [CrossRef]
100. Darmawan, A.; Hospes, O.; Termeer, C.J.A.M. Between zero-deforestation and zero-tolerance from the state: Navigating strategies of palm oil companies of Indonesia. *For. Policy Econ.* **2022**, *136*, 102690. [CrossRef]
101. Wollenberg, E.; Moeliono, M.; Limberg, G.; Iwan, R.; Rhee, S.; Sudana, M. Between state and society: Local governance of forests in Malinau, Indonesia. *For. Policy Econ.* **2006**, *8*, 421–433. [CrossRef]
102. Siscawati, M.; Banjade, M.R.; Liswanti, N.; Herawati, T.; Mwangi, E.; Wulandari, C.; Tjoa, M.; Silaya, T. Overview of Forest Tenure Reforms in Indonesia. Working Paper 223. Bogor, 2017. Report No.: 223. Available online: https://www.cifor.org/publications/pdf_files/WPapers/WP223Siscawati.pdf (accessed on 16 January 2023).
103. Njurumana, G.N.; Ginoga, K.L.; Octavia, D. Sustaining farmers livelihoods through community forestry in Sikka, East Nusa Tenggara, Indonesia. *Biodiversitas J. Biol. Divers.* **2020**, *21*, 8. [CrossRef]
104. ENT Statistical Burau. Nusa Tenggara Timur Dalam Angka 2021 (ENT in Figures 2021). Kupang, 2022. Available online: https://ntt.bps.go.id/publication/2021/02/26/28a3d01a29a82489c3f95190/provinsi-nusa-tenggara-timur-dalam-angka-2021.html (accessed on 16 January 2023).
105. Meteri Kehutanan dan Perkebunan. *SK Menteri Kehutanan dan Perkebunan Nomor: 423/Kpts-II/1999*; Ministry of Forestry and Estates Crops: Jakarta, Indonesia, 1999.
106. Menteri LHK. In *SK Menteri LHK Nomor: 6615/Kpts-II/2021*; Ministry of Environment and Forestry: Jakarta, Indonesia, 2021.