Community structure of fruit tree species on successful marginal land conservation in Jombang Regency, East Java Province, Indonesia

Zulfikar¹, E Arisoesilaningsih², S Indriani³ and A A R Fernandes⁴

¹ Student of Doctoral Program at Biology Department of Faculty of Mathematics and Natural Sciences, Brawijaya University, Indonesia
² Lecture of Informatics Department, University of KH A Wahab Hasbullah
³ Lecturer of Biology Department, Brawijaya University, Indonesia
⁴ Lecturer of Statistics Department, Brawijaya University, Indonesia

Email: zulfikardia@gmail.com

Abstract. Jombang Regency has critical land, especially in the north of the Berantas river due to a decrease in land quality including land, topography, climate, and water. This study aims to identify the structure of the fruit tree community in degraded land and the success of conservation from the cultivation of the surrounding community. The results of the study have identified 229 individuals from 21 species of fruit trees with 14 tribes on observation in 11 research sites. Analysis of fruit tree species abundance showed that longan and mango had the first and second-largest abundances with the relative abundance of 24.0% and 21.4%, respectively from the Sapindaceae and Anacardiaceae tribes. While the smallest relative species abundance is shown by melinjo with a value of 0.4%. Based on the analysis of the main components, it shows that the value of the longan and mango variance is quite high, indicated by the vector lines that move away from the centre, and while other species tend to gather at the centre because of the variance value is low. The grouping of individual fruit tree plants forms five groups and there are three species of fruit trees that are not included in the group because this species group has a fairly low AU / BP value of 51/10%, namely mango, guava, and star fruit. The results of this study indicate that the structure of fruit tree communities in degraded lands is more dominated by plants from the Sapindaceae and Anacardiaceae families which generally grow spread in 11 sample villages in the study area.

1. Introduction
Tropical land, which has a diverse plant community, has attracted the attention of researchers for decades in an effort to study its complex structure, function, and ecology [1]. However, to study ecology including the diversity of fruit crops and community organizations, no data are available on degraded land. Biotic factors such as effects that depend on seed density and durability and seed utilization play an important role in maintaining tree diversity in tropical lands [2] while such studies are lacking in degraded land areas. Like other lands, degraded land has experienced various pressures due to the level of human activity such as the exploitation of human populations, fragmentation, firewood, agricultural expansion, non-timber forest products, livestock grazing, and climate change. In fact, it is said that critical land is generally the result of more severe human impacts than other types of soil [3].
How fast-changing factors affect species composition, structure and function of fruit tree communities remains a critical gap and is not yet known with certainty in the context of conservation development plans. Tropic climate factors that are characterized by changes between the rainy and dry seasons are sometimes often followed by long dry seasons and irregular season periods. In addition, the development of species collections from each community requires a long process, which is determined by evolution and distribution events [4]. The tendency of increasing species richness in an area has proven to be very consistent in various groups of organisms and various geographical conditions [5]. Communities will only plant species that are included in the desires and needs of the species they will be planting, making the diversity of characteristics the same as the total diversity observed. It is important to consider habitat-specific species assemblages when studying diversity or planning conservation of natural communities [6]. The diversity of fruit tree species is an important aspect of ecosystem diversity [7] and quantitative floristic sampling provides the context needed to plan and interpret long-term ecological research [8]. The diversity of a community can be assessed using a number of nonparametric steps such as the diversity index and these steps gradually gain credibility.

Conservation of biodiversity is one of the main objectives to achieve land sustainability. The dominant position of trees on the land and their impact on various ecological gradients, identity, and composition of tree species can be estimated to affect plant biodiversity [9]. Although communities have relied on soil ecosystems for long and changing socioeconomic conditions, traditional approaches to biodiversity conservation have drawn little attention to the long-term sustainability of human dependence on terrestrial ecosystems. Protecting the lack of quantitative data on plant diversity, composition, community characteristics, and population structure is the reason this study was conducted to fill gaps in data about marginal land in tropical regions in particular and other lands in general.

A variety of natural diversity so far has occurred through good adaptation to sub-humid, humid tropical and semi-arid conditions. In addition to native species that have been domesticated and diversified in this region, a large number of tropical species that have previously developed agro ecological niches and are well acclimatized [10]. More than 70 main and small fruit species are currently cultivated in this region, along with some promising exotic tropical fruits [10]. However, only about 20 species are better known in cultivation and this includes bananas, oranges, mangoes, pineapples, papayas, durians, rambutans, jackfruit, lychees, longan, tamarind, camped, carambola, langsat, guava, soursop, apple custard, salacca, passion fruit and jujube, the dominant fruits are banana, pineapple, orange, mango, and papaya. The native tropical fruit species are very important for the economic well-being of small farmers in Asia. Most of these species have multi-purpose uses for food, shelter, wood, fuel, medicines, and other uses [10]. Thus, given their diverse uses, tropical fruits contribute greatly to food security and nutrition, income, poverty reduction, and ecosystems and environmental sustainability.

Recognizing the increasing importance and necessity of conservation and utilization of the diversity of tropical fruit tree species, starting research on the conservation and use of fruit plant species on degraded lands is expected to strengthen the work of supporting efforts to manage biodiversity resources. Conservation of degraded land with fruit plants plays an important role in the management and use of biodiversity resources, in changing perspectives on the contribution of tropical fruit to the economy in general and in particular, in strengthening research programs on empowering degraded lands. This study aims to identify the structure of fruit tree plant communities in critical land in Jombang Regency.

2. Materials and Research Methods
The object of study used in this study is the land and plantation community units in which there is a biodiversity of fruit trees developed by the community around residential units (villages). The equipment used was roll meters, rope, machetes, measuring tape, poles, compasses, hagameters, GPS,
cameras, personal use, field books, questionnaires, and recording devices. The stages of the implementation of the research as shown in the research methodology scheme carried out in figure 1.

![Research methodology scheme implemented.](image)

**Figure 1.** Research methodology scheme implemented.

The study uses descriptive-qualitative and descriptive-quantitative methods. Sampling was carried out in the Northern Region, a part of the Kendeng young limestone mountain, most of which have horizontal and partially hilly physiology, covering the subdistrict of Plandaan, Kabuh, Ploso, and Kudu.

![Sampling scheme through the use of transect plots according to Figure 2 was carried out in each sub-district. The determination of the sample area was carried out randomly by taking as much as 10% of 53 villages, so that 11 units of sample villages were obtained. Research targets are household units (KK), obtained by (1) proportional random sampling in each village, (2) inventory of potential respondents, (3) random determination of 10-15 KK / village units to obtain data on perceptions of biodiversity, land area, fruit tree species cultivated and their use, and (4) random determination of 11](image)

**Figure 2.** Making transect plots, sample plot sizes of 20 x 20 m² (trees), 10 x 10 m² (poles) and 5 x 5 m² (stakes)

The sampling scheme through the use of transect plots according to Figure 2 was carried out in each sub-district. The determination of the sample area was carried out randomly by taking as much as 10% of 53 villages, so that 11 units of sample villages were obtained. Research targets are household units (KK), obtained by (1) proportional random sampling in each village, (2) inventory of potential respondents, (3) random determination of 10-15 KK / village units to obtain data on perceptions of biodiversity, land area, fruit tree species cultivated and their use, and (4) random determination of 11
land community units for field observations. In each plot community unit, a plot of 20 x 20 m² was arranged, with 3 plots spaced between plots of 10 m so that the transect length was 80 m.

3. Research Sites
This research was conducted in Jombang Regency, East Java Province in January - April 2019. The research location was determined by purposive sampling, this technique is one of the sampling techniques using certain considerations [11].

![Research Location Map of Jombang Regency, East Java](Source: BAPPEDA of Jombang Regency in 2018)

Based on the general geographical appearance and thickness of vegetation at the study site, 4 study sites (A, B, C, and D) were determined which were divided into eleven sub-locations with coordinates, slope, and height as shown in table 1.

| Sites | Slope (%) | Altitude (m.asl) | Latitude | Longitude | Village         |
|-------|-----------|------------------|----------|-----------|-----------------|
| A1    | 23.50     | 68.00            | 07°27'21.3" | 112°10'41.6" | Bangsri         |
| A2    | 23.50     | 68.00            | 07°27'21.1" | 112°10'41.4" | Puri Semandeng  |
| A3    | 18.00     | 67.00            | 07°27'21.1" | 112°10'42.5" | Gebang Bunder   |
| B1    | 14.50     | 62.00            | 07°25'55.9" | 112°13'10.2" | Mangunan        |
| B2    | 16.00     | 56.00            | 07°24'46.5" | 112°15'42.2" | Kabuh           |
| B3    | 14.50     | 56.00            | 07°24'06.7" | 112°15'42.3" | Karangpakis     |
| C1    | 2.50      | 63.00            | 07°29'10.5" | 112°10'17.6" | Pager Tanjung   |
| C2    | 2.25      | 62.00            | 07°28'55.8" | 112°10'33.8" | Kebon Agung     |
| C3    | 0.45      | 55.00            | 07°27'21.0" | 112°13'31.0" | Jati Banjar     |
| D1    | 0.09      | 44.00            | 07°26'15.8" | 112°17'52.5" | Sidokaton       |
| D2    | 0.05      | 43.00            | 07°26'33.8" | 112°15'53.2" | Randuwatang     |

4. Research Result

4.1. Richess and abundance species
The structure and composition of vegetation in the study sites in 4 (four) Jombang districts with 11 locations studied and each has 3 observation points found 229 individual plant trees with a total of 21 species of fruit trees belonging to 14 tribes (families). Fruit tree species with maximum abundance are Dimocarpus longan (55 individuals) and followed by Mangifera indica (50 individuals), Pouteria sapota Jacq. H. E. More.Steam (16 individuals), Psidium guajava (14 individuals). Based on the observed fruit tree family, the Sapindaceae family was 59 individuals, Anacardiaceae 52 individuals,
Annonaceae 25 individuals, Myrtaceae 23 individuals, and Moraceae 9 individuals. This shows that in the area of degraded land the highest species abundance was identified from the Sapindaceae and Anacardiaceae tribes, while the lowest rank was shown by the Gnetaceae family with one individual fruit plant.

![Graph showing species abundance ranking](image)

**Figure 4.** Ranking of abundance of fruit tree species in degraded land and RAD compatibility test with Fisher Alpha value = 5.630241

The results of species abundance ranking from 21 species of fruit trees indicate that longan has the highest rank with species abundance of 55 individuals and relative abundance of 24.0% and abundance of the second rank of mangoes with species abundance of 50 individuals with a relative abundance of 21.4%. The last rank is indicated by gnetum with species abundance of 1 with a proportion of 0.4%. The graph display of relative abundance of species ranking relationships and abundance in Figure 4 shows that the highest abundance is in longan and is followed by mangoes with graphs decreasing to the last rank. While the distribution of wealth and abundance of fruit tree species in 11 study locations is shown in Figure 5.

![Relative abundance graph](image)

**Figure 5.** The relative abundance of fruit tree species, longan and mango have a relatively greater proportion of abundance than other species.
The relative abundance value of 21 species of fruit trees that grow in critical land is shown in Figure 4. The relative abundance of longan and mango fruit trees was found in all study locations, except in the village of Randuwatang there were no mangoes found. Almost all of the research locations were found to be relatively abundant with considerable value, apart from Jati Banjar and Sidokaton villages. Mango fruit trees with relatively large abundance were found in Bangsri, Puri Semading, Mangunan, Kabuh, Pager Tanjung, Kebon Agung, Jati Banjar villages, and Randuwatang, while a small abundance was found in the Puri Semanding and Karang Pakis locations. This shows that longan and mango fruit trees have a high enough dominance to grow on degraded land because these plants have the ability to grow on degraded land.

4.2. Growth and concentration of species

The growth of fruit tree species can be seen from the development of stem diameter, canopy projection area, and apical dominance index. The results of the ANOVA analysis of the 11 sample villages studied are summarized in the following Table 2.

One Way Anova test results showed that regional differences had an effect on the magnitude of CPA, ADI and stem diameter both on the growth of longan and mango fruit trees, except for the diameter of the longan tree which did not show a significant difference. This shows that there are variations in growth from 11 village areas that were sampled as research samples in degraded land. Longan and mango growth variations for each village were then tested differently in order to obtain a different level of growth. More clearly the results of differences in growth of longan and mango fruit trees as shown in the following figure.

### Table 2. Results of the One Way ANOVA analysis of the value of CPA, ADI and stem diameter as indicators of growth of fruit tree species in 11 villages that have critical land.

| No. | Species | Measurement Indicator | F value | Pr (>F) | Significance level (α) |
|-----|---------|------------------------|---------|---------|------------------------|
| 1.  | Longan  | CPA                    | 16.43   | 8.49 x 10^{-12} | *** (0.001) |
| 2.  | Mango   | CPA                    | 477.60  | <2.0 x 10^{-16} | *** (0.001) |
| 3.  | Longan  | ADI                    | 2.77    | 9.55 x 10^{-3}  | ** (0.01)   |
| 4.  | Mango   | ADI                    | 4.36    | 2.88 x 10^{-4}  | *** (0.001) |
| 5.  | Longan  | Diameter               | 1.66    | 0.122             |             |
| 6.  | Mango   | Diameter               | 29.12   | 3.4 x 10^{-16}   | *** (0.001) |

Note: CPA = Canopy Projection Area, ADI = Apical Dominance Index

Analysis of growth on the canopy projection area in longan and mango plants is shown in Figure 6. Figure 6 shows that the projected area of longan tree canopy tends to be high in the study area in the villages of Bangsri, Puri Semanding and Gebang Bunder where these three villages are included in the Plandaan sub-district. The same thing is also shown in the canopy projection area on mango trees, except in Puri Semanding village. Figure 6 (A) shows that the projected area of the longan canopy (CPA) has no significant difference in the villages of Bangsri, Puri Semanding, and Gebang Bunder. But it has a significant difference with other villages. Whereas in Figure 6 (B) it can be seen that the projected area of mango tree canopy in Bangsri village is not significantly different from Gebang Bunder village and Kabuh village, whereas for other villages it tends to give significantly different CPA values.

When viewed from the variation in growth of the apical dominance index value as shown in Figure 6 below. Figure 7 (A) shows that the growth of the apical dominance index value of the highest longan tree is in Bangsri village which is not significantly different from Puri Semanding village, while for other villages it gives a very significant different value. The apical dominance index value of the mango tree also shows the same thing. Bangsri village has a higher ADI value, and is not significantly different from Parang Pakis village and is significantly different for other villages.
Figure 6. Distribution of apical dominance index values of longan (A) and Mango (B) fruit in 11 research villages in Jombang with a significance level of 0.001.

The tendency of the index to decrease based on differences in research locations shows that the location of the Bangsri village is higher and leads to the next location until the village of Randuwatang decreases. This means that the growth of longan and mango fruit trees tends to be better in the village of Bangsri. The same thing can also be seen in the canopy projection area which tends to give the highest value in Bangsri village for longan and mango fruit trees as shown in Figure 7.

Figure 7. Apical dominance index value distribution Longan fruit tree (A) and Mango (B) in 11 villages in Jombang with a significance level of 0.001.
The measurement results of the apical dominance index on longan and mango trees show that in Bangsri village has a greater index value than other villages, even the index value tends to decrease. The same thing is also shown by the results of the measurement of the apical dominance index, in Bangsri village having a greater ADI value compared to other villages. The high value of the dominance index shows better growth of longan and mango in the Bangsri village.

Based on the results of the measurement of the diameter of the trunk shows that the longan tree does not provide a significant difference in value, although the highest value is in the village of Bangsri. This shows that there is no variation in growth based on the value of the diameter of the stem as shown in Figure 8 (A). However, mango growth varies because it has a significant difference in the diameter of the stem as shown in Figure 8 (B). The largest stem diameter growth is in Bangsri village and the value is significantly different from other villages.

Figure 8 shows that Bangsri villages tend to give a greater diameter value compared to other villages, but do not provide a significant difference. This means that the diameter of the stem does not give variation to the 11 villages studied.

![Figure 8](image)

**Figure 8.** Distribution of diameter values of longan (A) and mango (B) tree trunks in 11 study villages in Jombang with a different test at the significance level of 0.001.

### 4.3. Species Grouping and Concentration

The results of grouping fruit tree plant species based on species richness from 33 observation points show that there are five groups of plants, namely group one with two species namely Sizygium cumimi, Dimocarpus longan with an AU / BP value of 96/21%, group two with three species namely Citrus reticulata, Durio zibethinus and Tamarindus indica with AU / BP values of 99/20%, groups of three with five species namely Artocarpus heterophillus, Spondias dulcis L, Sizygium aqueum, Artocarpus atiis and Nepheleium lappaceum.L with AU / BP values of 100/16 %, group four with two species namely Cocos nucifera and Percea americana Mill with AU / BP values of 100/33%, and
group five with six species namely Annona squamosa, Salacca edulis, Annona muricata, Pouteria sapota. Jacq. H. E. More. Steam, Carica papaya, and Gnetum gnemon with AU / BP values of 97/17%. There are three species that are not included in the group because they have a low AU / BP value of 51/10%, consisting of Mangifera indica, Psidium quajava and Averrhoa bilimbi.L.

**Figure 9.** Dendrogram classifies the fruit tree vegetation hierarchy using the average method using correlation spaces, the best grouping based on the largest AU/BP (%) value.

PCA test results showed that the sum of all species variance was 6.85, with the first axis being able to explain at 28.49% and the second axis at 20.2% of the total variance. Based on the PCA biplot graph display, it is explained that setting the scale = -1 is to form the direction and length of the arrows of each species by giving a negative score where the species score is divided by the standard deviation of the species so that abundant and rare species will be far from the center. Species that have the greatest variance tend to have high abundance and rarity and when viewed from a PCA biplot chart farther from the center. In Figure 9 it can be seen that longan and mango tend to be far from the center and have a high abundance which is characterized by high variance compared to other species.

**Figure 10.** The plot of PCA test results with a -1 scale biplot against fruit tree species variants, height variants tend to move away from the centre point indicated by longan and mango.
5. Discussion

The structure of tree communities on degraded lands is dominated by the Sapindaceae and Anacardiaceae tribes so that the land area has characteristics of species that are able to grow on degraded land because species are one of the main analytic characteristics of plant communities [12]. Critical land in Jombang has 21 species that form plant communities that play a role in land conservation. Critical soils overgrown with fruit tree plants can form communities and play an important role in soil conservation, where the formation of plant communities is a collection of plant species that grow together in certain locations with definite associations with each other [13]. More and more species of fruit plants are found in degraded land which indicates that there are successful conservation activities.

The growth of fruit trees in degraded land at the study site showed that the abundance of species was most abundant in the Sapindaceae and Anacardiaceae families, with relative abundances of 24.0% and 22.0%. Geographically Sapindaceae and Anacardiace and several other species are spread evenly throughout Indonesia and tend to be better able to adapt to the environment. Some tribes such as Myrtaceae, Lauraceae, Anacardiaceae, Annonaceae, and Sapindaceae have an even distribution in Indonesia [14].

As an indicator to see the condition of the tree community is to observe the richness of fruit tree species. Species richness is a simple and easily interpreted indicator of biodiversity [15]. Knowledge of species composition and diversity of tree species is essential not only for understanding the structure of forest communities but also for planning and implementing community conservation strategies [12] [16]. An understanding of soil structure is a prerequisite to describe various ecological processes and also to model land functions and dynamics.

In addition, growth indicators that are very important in seeing conservation success are the magnitude of the apical dominance index value and the width of the canopy projection because these indicators determine tree architecture that is in direct contact with environmental conditions. Plant conditions generally vary based on environmental conditions [17]. Information about plant characteristics in the form of stand height, biomass and productivity are important to know, especially on the growth of fruit trees. Growth of plant stands results in changes in plant organs both in size and biomass so that it impacts on changes in crop productivity [18].

Assessment of the composition and structure of marginal land communities is very helpful in understanding the status of tree populations, regeneration, and diversity for conservation purposes [19]. The nature of soil communities depends greatly on the ecological characteristics of the location, species diversity, and regeneration status of tree species. Quantitative information about the composition, distribution, and abundance of wood species is an important key to understanding the shape and structure of soil communities and also to the planning and implementing community conservation strategies. Tree species richness and diversity are fundamental to soil biodiversity because trees provide resources and habitat for almost all other plant species [12]. In the case of marginal land ecosystems, trees are responsible for the overall physical structure of habitats, and hence, they fundamentally define the structural complexity and heterogeneity of the environment [16].

6. Conclusions

Based on the results of research that has been done it can be concluded that:

a. The results showed that there were 229 individuals and 21 species of fruit trees with 14 families from observations in 11 study sites.

b. Analysis of fruit tree species abundance shows that longan and mango have abundance of species ranked first and second with a proportion of 24.2% and 21.8% respectively from the Sapindaceae and Anacardiaceae families. While the lowest species abundance is indicated by gnetum with a proportion of 0.4%.

c. There were variations in fruit tree growth in critical land from 11 villages as a research sample due to differences in growth due to differences in the value of the canopy projection area, apical
dominance index and stem diameter both for longan and mango with the best location found in Bangsri village.
d. The grouping of individual fruit tree plants forms five groups and there are three species of fruit
trees that are not included in the group because they have a fairly low AU / BP value of 51/10%,
namely mango, guava, and star fruit.

Acknowledgment
Special thanks were conveyed to the promoter team for their guidance and gratitude was also
conveyed to UB's ecology laboratory staff that facilitated research data collection tools in the field. He
also expressed his gratitude to the Government of Jombang Regency for providing research
permission.

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