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Mangrove Species Diversity and Structure at Kudat and Banggi Island, Sabah

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Abstract

The aim of the study is to determine and record mangrove species biodiversity and structure at Kudat Mainland and Banggi Island. The sampling plots with size of 100 m x 10 m and four (4) replication was established to measure the species diversity by using Shannon-Wiener Index (H'), Shannon Evenness Index (E) and Simpson's Diversity Index (D). From the results, a total of 10 mangrove species were recorded from both study areas. There are eight (8) species at Kudat Mainland and six (6) species at Banggi Island. The diversity indexes gives the value of H', E and D with the similar value at both study areas. At Kudat Mainland, H' = 1.51, E = 0.73 and D = 0.29 while at Banggi Island H' = 1.50, E = 0.84 and D = 0.29. The results of these value shows the value of diversity at both areas is less diverse. The findings show the represented of mangrove species at both areas are may be affected by the water salinity, tidal inundations, soil conditions and propgules size. While the dependency of local people to mangrove's wood and tree's age will affected to the distribution of mangrove diameter. Meanwhile the current of winds and types of species represented in a plots assume affected the results of distributions of mangrove height. Represented of species less than 8 species assume affected the values of mangrove species diversity. As the conclusion, the mangrove species at Kudat district can be determine and recorded and the diversity of mangrove species at both areas is less diverse.

1. Introduction

Mangroves occur in the waterlogged, salty soils of sheltered tropical and subtropical shores. They are subject to twice-daily ebb and flow of tides, fortnightly spring and neap tides, and seasonal weather fluctuations. They stretch from the intertidal zone up to the high-tide mark. These forests are comprised of 12 genera in 8 different families comprising about 60 species of salt-tolerant trees in the Indo- West Pacific (Anon, 1989) and 20-30 species in Sabah (Ong & Petol, 2007). The genera include from the families of Avicenniaceace, Chenopodiaceae, Combretaceace, Meliaceae, Myrsinaceae, Plumbaginaceace, Rhizophoraceae and Sonneratiaceae.

With their distinctive character of stilt and prop roots, mangroves can thrive in areas of soft, waterlogged, and oxygen-poor soil by using aerial and even horizontal roots to gain a foothold. According to Anon (1989), stated that the roots also absorb oxygen from the air, while the tree's leaves can excrete excess of salt. Associated with the tree species are a whole host of aquatic and salt-tolerant plants. Together they provide important nursery habitats for a vast array of aquatic animal species.

Mangrove communities are remarkable for their uniformity. In a mangrove swamp, only a few types of trees grow together and they are usually of rather similar habit and appearance. Different types of mangrove species have several adaptations to various kinds of soil and geographical site. Thus, the information of different vegetation zone exists in mangrove community.

Mangrove species zonation can be considered at different scale. On a tide dominated shore, a clear vertical sequence of species often appears. At slightly larger scale, regular sequence of species may also occur with increasing distance up a river, interacting with vertical zones related to tide level (Hogarth, 1999).

The aim of the research study is to determine and record mangrove species biodiversity and structure at Kudat Mainland and Banggi Island.

2. Materials and Methods

2.1. Sampling Design

The plot sampling with 10m width and 100m long were develop to collect the species' sample. From the tangent point (sea and river bank) transect line is setup 90^0 then other at 45^0 to setup the plot sampling. The plot is replicate in different location to avoid the bias. Replication is the key to species richness estimation. Within plot, all mangrove trees were determined and recorded (Figure 1).

2.2. Data Collection

To determine the species density, the numbers of trees species present in the plot were recorded. The dbh of each tree also recorded and tag have used to make it more systematic and not confuse. The height of tree is measured by using Suunto Klinometer and measured whether using percentage (%) or degree (0).
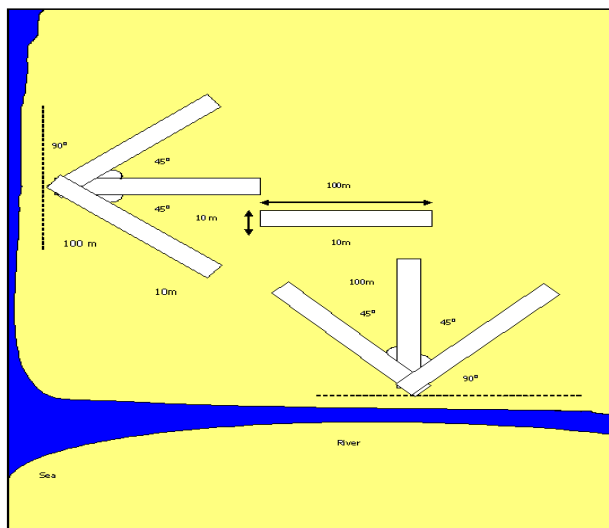
Figure 1: Sampling design established for study

2.3.   Data Analysis

The data was being analysed using the Shannon-Weiner, Shannon Evenness and Simpson's indexes (Magurran, 2004). The data were analysed using Microsoft Excel.

Mangrove diameter measured by recorded 10 cm diameter breast height (dbh) and above using dbh tape at both areas. The diameter of mangrove tree have calculated based plot at every plot areas.

In measuring mangrove height at both areas it depends on the species and abundance of trees that present within the research plots. Trees height calculated by using Suunto Klinometer.

Diversity of mangrove species is measured by using Shannon-Weiner (H), Shannon Evenness and Simpson (D) index (Magurran, 2004). The formulas of that use as following:

Measure of richness + evenness
Shannon-Wiener Diversity (H')
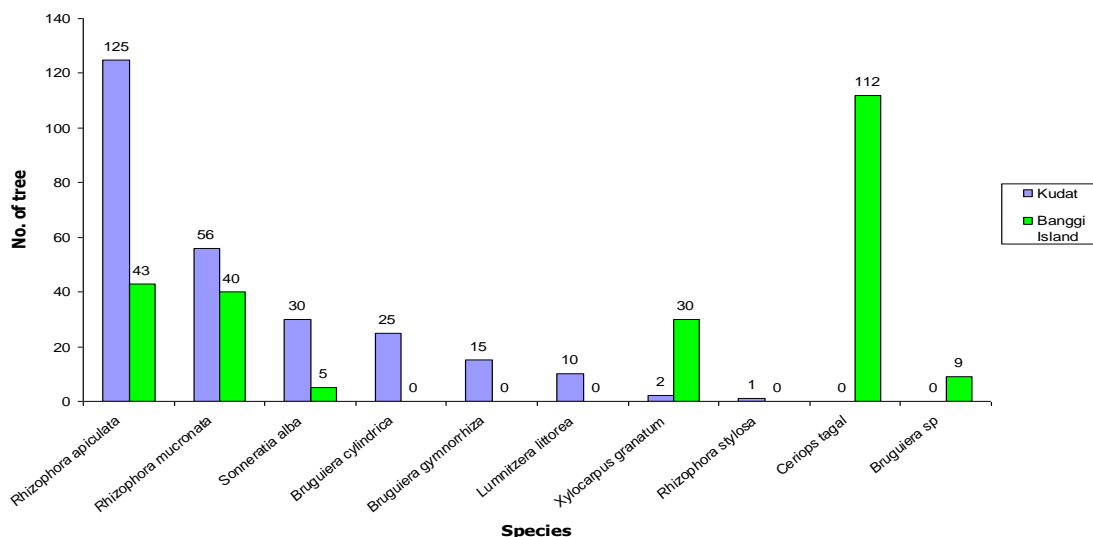
$$H' = -\sum P_i \ln P_i$$

P_i = number of individuals found in i the species

Measure of evenness (weighted on species & richness)
Shannon Evenness (E)

$$E = H'/ Ln\ S$$

S = number of species present

Measure of dominance (weighted on abundance)
Simpson's Index (D)

$$D = \sum (n/N)^2 \text{ or } D = \frac{\sum n (n-1)}{N (N-1)}$$

N = the total number of organisms of all species
n = the total number of organism of a particular species

3.   Results and Discussion

3.1   Mangrove Species Composition

About four (4) families and ten (10) mangrove species with total number of 503 mangrove individuals tree has been recorded within both Kudat Mainland and Banggi Island. There were 264 of mangrove trees at Kudat Mainland and 239 of mangrove trees at Banggi Island (Figure 2).

The represented of mangrove species at both areas most may affected by the salinity of water which affects the productivity, growth and the distribution of mangrove species (Peter, 1999; Hogarth, 1999; Blasco, 1984).

Otherwise it also may influences by the tidal inundations that description of mangrove species in one region (Tomlinson, 1986). The represented of mangrove species also assume have related to soil condition which nutrient availability may limit growth and production of mangrove. Varying nutrient concentration also change competitive balances and affect species distribution (Chen and Twilley, 1998).
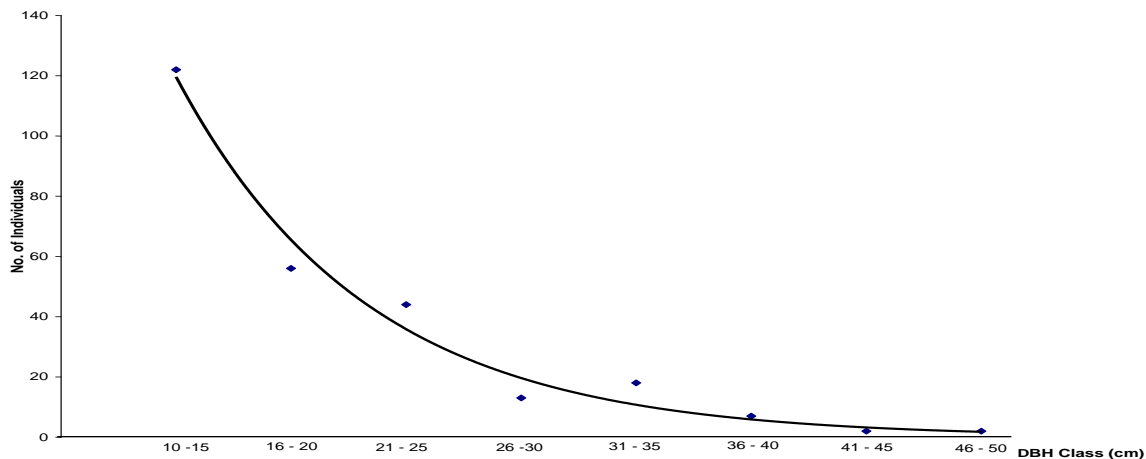

Figure 2: Distribution of mangrove species at Kudat Mainland and Banggi Island

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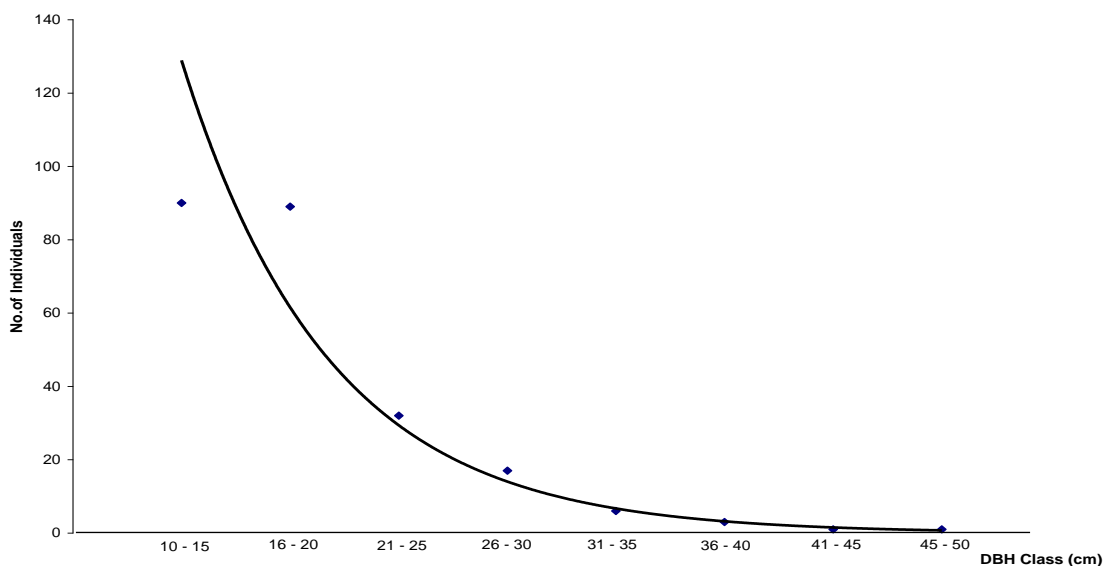**Figure 3:** Graph of relations between mangrove dbh (cm) with number of individuals at Kudat Mainland

Figure 4: Graph of relations between mangrove dbh (cm) with number of individuals at Banggi Island

This also may affect to another factor such as propagule size and competitions that more defined as biotic factors. Result by Tomlinson (1986), propagules sorting according to the size with the heavier propagules occupying the seaward habitats because they are less readily dispersed landward and also become established more easily in deeper water and more frequently inundated sites. Species such *Soneratia sp*, which has relatively small propagules are mostly dominant at seaward.

3.2   Diameter Distribution of Mangrove Species

The most dominant mangrove tree diameter at Kudat Mainland and Banggi Island is at dbh class 10-15 cm while the least mangrove tree diameters are at dbh class 41-45 cm at Kudat Mainland and 45-50 cm at Banggi Island. The graph shows the relations between mangrove diameters with number of individuals at both areas are normal invest J – curve (Figure 3 and 4). It means the distribution of mangrove trees at both areas are in varying age (Hamid, 1998).

Otherwise it influence due to the dependency of local people to the mangrove's wood which at Banggi mostly local people used it rather than at Kudat Mainland.

3.3   Height Distributions of Mangrove Species

The results show most mangrove heights at Kudat Mainland are between range 7.00 to 7.99 m and 12.00m to 12.99 m at Banggi Island. Meanwhile the graphs show the relations between mangrove heights with number of individuals are normal curve (Figure 5 and 6).

Graphs in Figure 7 and 8, both shapes of the graphs show the normal curve. However the distribution of mangrove height and diameter at Kudat Mainland is more normal distribution than Banggi Island where there is cluster at range of 10-20 cm dbh with height range 12 to 16 m.

These may influence to the species that represented in the study plots and current of wind which mostly study plots at Banggi Island is located at meandering tidal creek sway and forth where the percentage to expose to the current of winds is less.
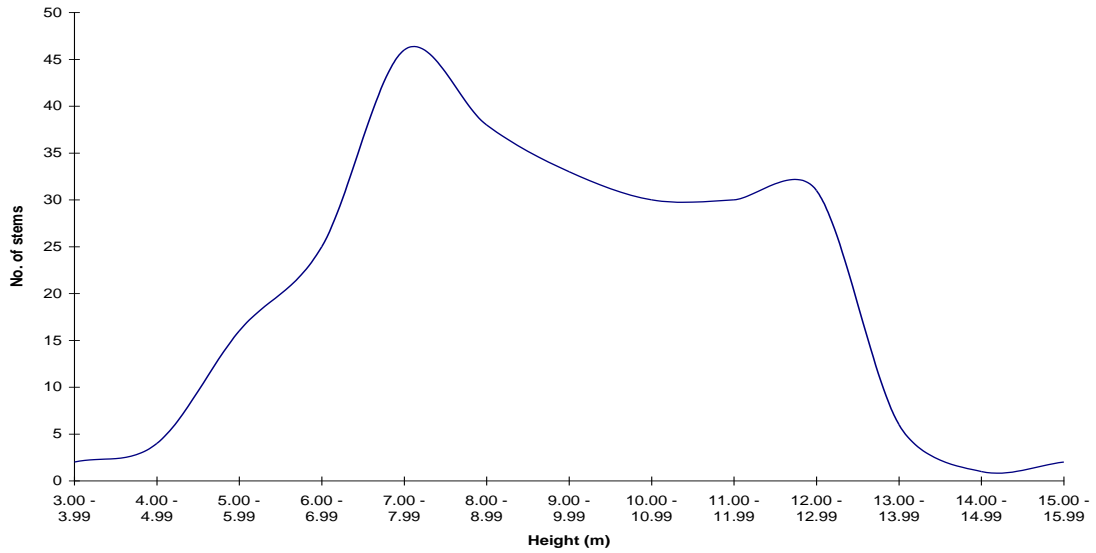
Figure 5: Graph of relations between mangrove heights (m) with number of stems at Kudat Mainland
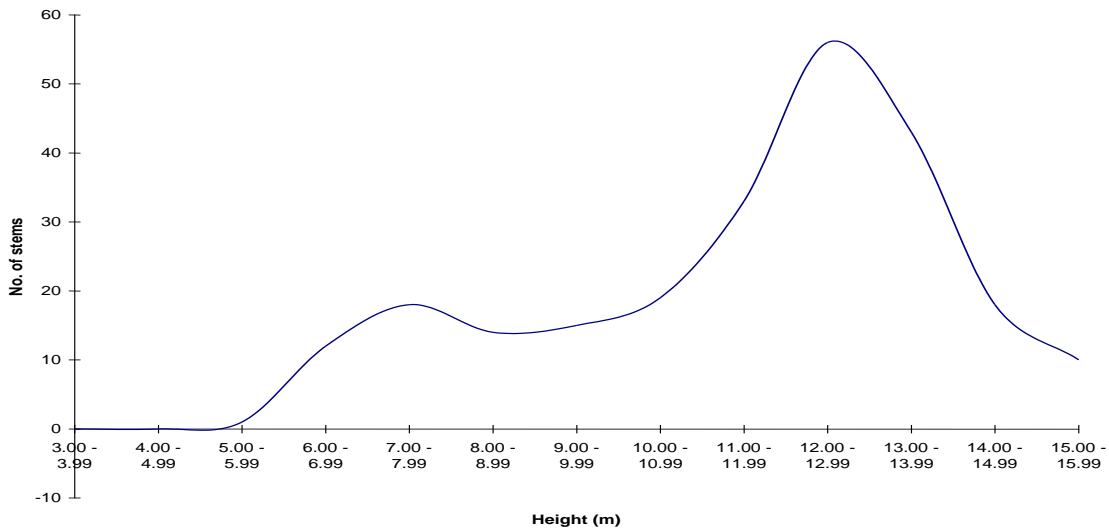

Figure 6: Graph of relations between mangrove heights (m) with number of stems at Banggi Island
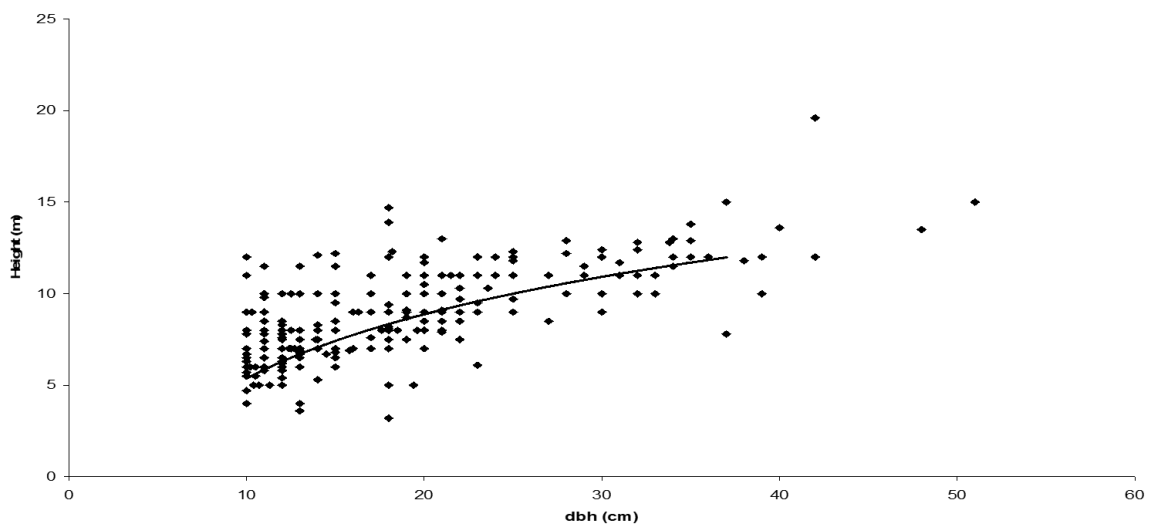

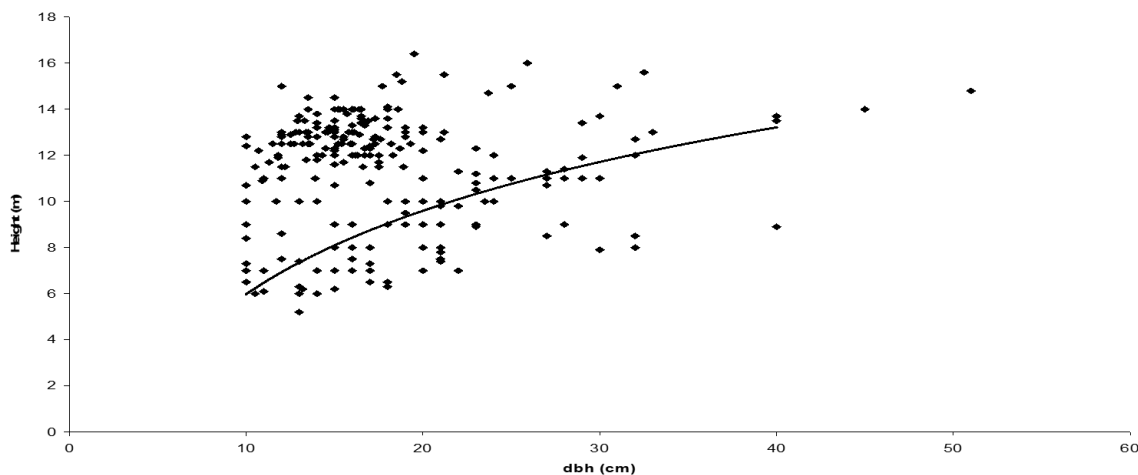**Figure 7:** Distribution of mangrove heights and diameters at Kudat Mainland

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Figure 8: Distribution of mangrove heights and diameters at Banggi Island

3.4 Mangrove Species Diversity Index

The measuring species diversity based on the Shannon-Wiener Diversity Index (H'), Shannon Evenness (E), and Simpson's Index (D), the value for these three indexes at both study areas have similar diversity (Table 1).

According to Magurran (2004), when H' increase, the diversity increase. However Margalef (1972) noted that, the value of the Shannon index obtained from empirical data usually falls between 1.5 and 3.5 and rarely surpasses 4. The result shows that the H' value at both areas is less than 1.5; these mean that mangrove species diversity at both areas is less diverse.

The reason is the number of mangrove species that present in the study area is less than eight species. Magurran (2004) noted to get the best value of index diversity species, the species represent should be more or equal to eight species. The species that represent at Kudat Mainland is eight species while at Banggi Island is six species.

Table 1: Value of mangrove species diversity according to the indexes

Index Area	Shannon – Wiener (H')	Shannon Evenness (E)	Simpson's (D)
Kudat Mainland	1.51	0.73	0.29
Banggi Island	1.50	0.84	0.29

The Simpson's Diversity Index (D) is a measure of heavily weighted towards the most abundance species in the sample while being less sensitive to species richness. From the result, the value of D at Kudat Mainland is same with value at Banggi Island. Magurran (2004) gave that the value of D ranges is between 0 and 1 which 0 represent as infinite diversity and 1 represent as no diversity. That is the bigger the value of D, the lower the diversity. Thus, the result shows that the diversity of mangrove species at both areas approximately near to 0.

This may affect by the represent of species in the plots and locations of the study areas.

As referred to Duke et al. (1998) mangrove tends to arrange themselves into relatively homogeneous, almost monospecific patches or bands, often aligned with physical gradient of the environment. At a scale of hectares, a mangrove forest may encompass many species and be regarded as relatively diverse. At a scale of square meters, in contrast, diversity appears low and a sample may be included only a single species. Tree diversity may not appear to correlate with productivity because at the spatial scale relevant interactions the species scarcely intermingle. This facts influence the result of diversity values at both study areas.

4. Conclusion

As conclusion there was 10 species mangrove was identified and recorded at both of study areas. About 8 species was recorded at Kudat Mainland named as *Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, Bruguiera cylindrica, Bruguiera gymnorrhiza, Lumnitzera littorea, Xylocarpus granatum* and *Rhizophora stylosa*. While 6 species recorded at Banggi Island are *Rhizophora apiculata, Rhizophora mucronata, Bruguiera cylindrica, Xylocarpus granatum, Ceriops tagal* and *Bruguiera sp.*

Measuring species diversity based on Shannon-Wiener Diversity Index (H') shows the species diversity at both areas is similar in value where Kudat Mainland 1.51 and Banggi Island 1.50. Meanwhile Shannon Evenness Index (E) also shows the similar value of mangrove species' evenness where 0.73 at Kudat Mainland and 0.84 at Banggi Island. Furthermore, Simpson's Index (D) gave that species dominance at Kudat Mainland and Banggi Island was same with the value 0.29. Overall conclusions, the mangrove species at Kudat district can be determine and recorded and the diversity value of mangrove species at both areas is lower.

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