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Biomass Percentage of Organic Soil Layers in The Rasau Jaya Tiga Village

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ABSTRACT

Peat is a wetland ecosystem characterized by a high accumulation of organic matter with a low decomposition rate. Rasau Jaya Tiga Village is one of the villages in the Rasau Jaya District with peat soil type characteristics of 1,885,478,466.83 m^2, which are shallow or thin, and the medium category is 1,825,792,728.85 m^2. Therefore it is necessary to do research on the proportion of biomass contained in organic soil layers in the village of Rasau Jaya Tiga with descriptive quantitative research. The sample used is a soil sample. Soil samples were taken to determine peatland biomass using the survey method and the Walkley & Black and Dennstedt methods for testing soil samples. The results of testing the soil samples obtained the highest organic carbon content in the A4 C sample (11-20 cm), namely 56.37% and the lowest organic carbon in the E4 sample code (11-20 cm), namely 7.41%, which means that the peat soil content will be released. Organic biomass is the proportion that is contained in organic soil and turns into carbon dioxide (CO_2).

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1. INTRODUCTION

The ecosystem's capacity is a component that helps the ecosystem itself carry out the natural process of providing special materials and services necessary to meet human needs, both directly and indirectly (Waskita et al., 2022). Peatland is a wetland ecosystem characterized by a high accumulation of organic matter with a low decomposition rate. In Indonesia, tropical peatlands comprise 50% of 40 million hectares (Maltby and Immirzi, 1993). Peat soils are soils with high organic content that are the result of historical partial decomposition of vegetation, often under anaerobic conditions that slow the decomposition process. Functional peatlands are peatlands that continue to grow and accumulate organic matter through slow cycling of organic inputs (Smith et al., 2021).

West Kalimantan is one of the islands in Kalimantan with peatlands besides Sumatra and Papua, with a total peat area of around 14,9 million hectares (Saritha Kittie Uda et al., 2017). Peatlands are often found in back swamp areas or areas with poor drainage basins (Heinselman, 1970). According to the Peat Ecosystem Protection and Management Plan (RPPEG), peat ecosystems in West Kalimantan are spread across 124 Peat Hydrological Units (KHG) with an area of 2.8 million hectares.

Based on the allotment of peatlands in West Kalimantan, they are divided into protection and cultivation functions. Regulation of the Minister of Environment and Forestry Number 60 of 2019 states that the function of the peat ecosystem is to protect water availability, preserve biodiversity, store carbon reserves, produce carbon, and balance the climate, which is divided into the function of protecting peat ecosystems and the function of cultivating peat ecosystems (Peraturan Menteri Lingkungan Hidup dan Kehutanan RI, 2019). (Syaufina, 2016) argues that peat has essential functions, including protecting biodiversity, balancing hydrology, and providing a livelihood for the surrounding community.

Of the 124 KHG West Kalimantan, the area of peatland with a protective function is 210,997 hectares or 9%, while the area of peatland with a cultivation function is 2,033,323 or 91%. Peatlands in West Kalimantan are spread over several areas. According to Soil Taxonomy (soil classification), the distribution of peatlands in West Kalimantan includes Pontianak, Mempawah, Sambas, Ketapang, Putussibau, Sintang and Kubu Raya (Medhina and Harjanti, 2023). The soil type map of Kubu Raya Regency above shows that in Kubu Raya Regency, there are 5 types of soil, most of which are dominated by organosol (peat) soil types.

According to the Agricultural Land Resources Center, Kubu Raya Regency is the district that has the largest peatland area of the 14 regencies in West Kalimantan, with an area percentage of 33.69% or an area of 521,517.52 hectares (Medhina and Harjanti, 2023). Based on the results of field observations, the type of soil in Rasau Jaya Tiga Village is dominated by peat soil covering an area of 2,360 hectares with a percentage of 95,9% which, judging by its maturity, consists of hemic peat, fibric peat, and sapric peat (Suswati et al., 2011). Peat soils have different characteristics and specifications related to constituent materials, maturity, and living environment.

Rasau Jaya is a transmigrant area with a type of food transmigration pattern which means all the necessities for survival are provided prepared. Rasau Jaya is a tidal area that has a high level of acidity So if it is used as farming land, it is not suitable because the pH is low. So to overcome the acidity of the soil, channels or ditches were made (Safitri et al., 2023). Rasau Jaya is a independent with its main agricultural products are corn and vegetables. Region Rasau Jaya was built and developed on top land with peat soil type. With under these conditions, the processing of peatlands into agriculture is a problem a particular challenge for the Rasau community Jaya (Arini et al., 2021).

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The specific characteristics of peat soil are that it dries quickly (irreversible drying), easily sinks or collapses (subsidence), has low carrying capacity (bearing capacity), chemical nutrient content and low fertility (nutrients), resistant to pressure, and a limited number of microorganisms (Dekker, L. W., & Ritsema, C. J., 2000). Peat soils with a moisture content <100% according to weight generally have undergone an irreversible drying process. These conditions make peat flammable and easily carried away by water (Aguilera et al ., 2016).

This irreversibly dry characteristic is a characteristic of peat soils that mineral soils do not have. Peat that has undergone irreversible drying has a sand-like surface (possibly imitation) and becomes poor/non-functional as soil due to inherent changes in its organic matter. Peat soils that cannot hold water will easily burn during the dry season. Conversely, during the rainy season and on wetlands, peat soil will float up, causing the plants above to move with the water flow. Therefore, it is necessary to control irreversible drying so that peatland can be exploited in the long term (Y. Lestari and Mukhlis, 2021).

The role of peat forests as carbon sinks and stores is undeniable in reducing the amount of carbon in the atmosphere, thereby preventing the greenhouse gas (GHG) effect, which will lead to global warming. The formation of peatlands in Southeast Asia functioned as a long-term carbon sink for thousands of years, with most peatlands emerging in the mid-Holocene about 6,000 to 8,000 years ago (Warren et al., 2017).

One of the contributors to greenhouse gas emissions is carbon dioxide (CO2), which contributes 55% of the total increase in global warming. Peat forest as biomass is the largest carbon store among existing forest types. In recording forest carbon, (Kellner, 2001) says that there are at least four carbon pools that can be accounted for, including above-surface, sub-surface biomass, dead organic matter, and soil organic carbon.

Globally, peatland biomass stores around 329-525 Gt Carbon, or equal to 15-35% of total terrestrial carbon. About 14% (70 Gt) of carbon in these peatlands is stored in the tropics. In contrast, the remaining 86% (455 Gt) is found in areas with temperate or temperate climates (Canada and Russia) (Moore, 2004) if it is estimated that the average depth of peat in Indonesia is 5 m with a bulk density of 114 kg/m^3.

Peat has an essential hydrological role because it functions as a water reservoir with a considerable capacity. If the peat is not disturbed, the peatland can store as much water as 0,8 – 0,9 m^3/m^3. Thus, peatlands can regulate the water discharge by themselves during the rainy and dry seasons.

The conditions that result in the release of carbon from peatlands usually arise from human activities and peat forest fires (Sufrayogi & Mardiatmoko, 2022) Peatland biomass has a potential carbon content. Nearly 50% of forest vegetation biomass is composed of carbon elements. Under natural conditions, if peatlands are correctly protected, they can increase their ability to absorb carbon. Meanwhile, suppose peatlands are burned or disturbed. In that case, these elements can be released into the atmosphere in the form of carbon dioxide (CO_2) and have the potential to become a significant source of methane (CH_4) and Nitrous Oxide (N_2O) (Signor and Cerri, 2013), so that the amount can increase drastically in the atmosphere and become a global environmental problem. Therefore, this research was conducted to find out what percentage of biomass is contained in the organic soil layer in the village of Rasau Jaya Tiga.

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2. METHODS

The method used in this research is quantitative descriptive research. The descriptive analysis method as defined by (Sugiono in Tuejeh et al., 2023) is the method that describes the subject of study using samples collected empirically by researchers. The data sources in this study were primary data in the form of soil samples representing certain areas and secondary data in the form of administrative shapefiles of the village of Rasau Jaya Tiga.

The determination of sampling points aims to map carbon stocks on a stretch or peat dome. Soil samples were taken at a depth of 10 cm. This was used as a need for the analysis of carbon content (C-organic) and soil bulk density (T. L. Lestari et al., 2019). Determination of soil sampling points is carried out using a grid, namely in the form of regular points or from several transects that cross the peat dome in the direction of the wind.

The total area and observation points represented by each grid are determined by the map's scale or the level of accuracy required in the study. If detailed data is required, the distance between one point and another on each transect is approximately 500 meters. The coordinates at each point must be measured and recorded with a global positioning system (GPS).

Tools and Materials

Tools used in soil sampling include a peat drill, knife, ziplock bag, label paper, marker, GPS meter, sample ring, hoe, hammer, board, and digital scales.

Laboratory Measurement of Chemistry and Soil Fertility

Determination of the carbon content of peatland biomass needs to be done to determine C-carbon or C-organic in peatland by testing soil samples taken and tested through chemical laboratories and soil fertility. According to the Agricultural Land Resources Research Center (BBSDLP), the level of organic matter content is divided into several categories, including if it is less than 2%, then it is categorized as low. If 2-3%, the organic matter content is medium, and 3% is categorized as high (Ompusunggu et al., 2015).

Carbon C was determined using the Dennstedt wet method (Walkley & Black) and the dry method (combustion). (Nelson and Sommer in Ramamoorthi and Meena, 2018) said that generally, the Walkley & Black wet oxidation method is used to determine the soil's organic content.

In the process, the oxidizing organic carbon is mixed in a dichromic acid solution, which is then back-titrated from the remaining chromic acid (which does not react with organic carbon), assisted by an appropriate indicator. Meanwhile, (Nelson and Sommer, 1983), explained that the dry combustion method is a process of converting organic matter or soil into CO_2 without requiring a correction factor to estimate the C content in soil or organic matter.

3. RESULTS AND DISCUSSION

Soil sampling is carried out according to predetermined points using a grid. Based on the results of field sampling, 50 soil samples were obtained with codes A, B, C, D, and E, each with 5 middle soil samples.

Image of the code A soil sampling point. The number of sample points above was 14 sample points 5 sample points were taken.

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Figure 1. Image of soil sampling point A

Table 1. Results of sampling code A soil

Code	Coordinate Point	Depth (cm)	Content Weight (gram)
A1 C	00°15'33.62" LS and 109°20'58.98" BT	0-10 cm	332
		11-20 cm	328
A2 C	00°15'35.81" LS and 109°21'06.65" BT	0-10 cm	369
		11-20 cm	356
A3 C	00°15'31.37" LS and 109°20'42.39" BT	0-10 cm	294
		11-20 cm	274
A4 C	00°14'32.77" LS and 109°20'18.87" BT	0-10 cm	170
		11-20 cm	277
A5 C	00°15'20.67" LS and 109°21'26.25" BT	0-10 cm	379
		11-20 cm	388

Source: Data analysis (2022)

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A sampling of code A soil is located in the south of Rasau Jaya Tiga Village. Code A soil samples were taken from 5 center points with codes A1, A2, A3, A4, and A5. The soil samples taken have a bulk density of 170 - 388 grams. The heaviest soil sample weight is A5 C code soil sample with a depth of 11-20 cm, while the lightest soil sample weight is A4 C code soil sample with a depth of 0-10 cm.

Figure 2. Image of soil sampling point B

Soil samples with code B were taken randomly, located in the eastern part of Rasau Jaya Tiga Village above the soil sample code A. The distribution of points in the image above was determined randomly with a total of 14 points, and 5 points were taken by taking two soil samples at each point.

Table 2. Results of sampling code B soil

Code	Coordinate Point	Depth (cm)	Content Weight (gram)
B1 C	S 00˚14'42.19" E 109˚20'34.05"	0-10 cm	192
		11-20 cm	265
B2 C	S 00˚15'00.08" E 109˚21'27.28"	0-10 cm	376
		11-20 cm	372
B3 C	S 00˚14'50.12" E 109˚20'51.59"	0-10 cm	60
		11-20 cm	260

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B4 C	S 00˚14'55.49" E 109˚21'13.41"	0-10 cm	222
		11-20 cm	358
B5 C	S 00˚14'45.48" E 109˚21'09.75"	0-10 cm	280
		11-20 cm	203

Source: Data analysis (2022)

Code B soil samples were taken from as many as five centre points with codes B1, B2. B3, B4 and B5. The soil samples each have a bulk density of 60 - 376 grams. The heaviest soil sample weight is code B2 C at a depth of 0-10 cm, while the lightest soil sample weight is code B3 C at a depth of 0-10 cm.

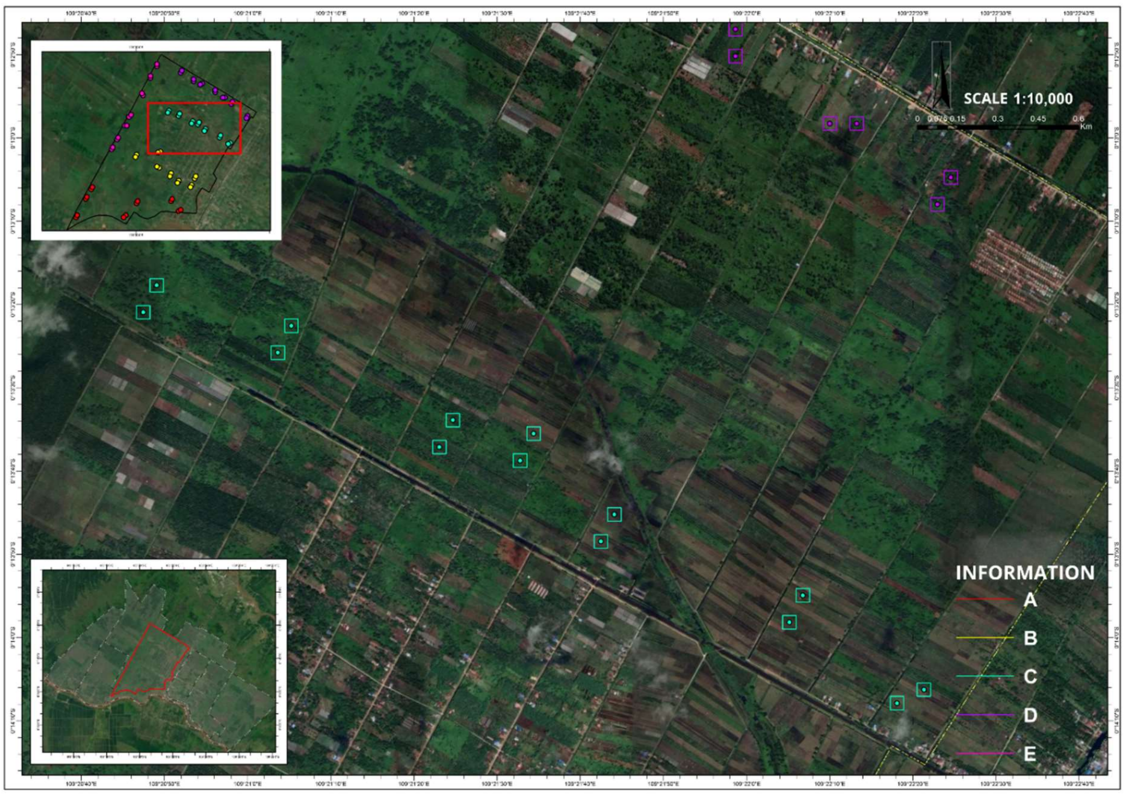

Figure 3. Image of soil sampling point C

There are 14 points for taking soil sample C, located on a stretch of land in the eastern part of the village of Rasau Jaya Tiga to the west of Rasau Jaya Tiga. Soil sampling was carried out only at 5 sample points and taken two times with different depths.

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Table 3. Results of sampling code C soil

Code	Coordinate Point	Depth (cm)	Content Weight (gram)
C1 C	S 00˚13'48.80" E 109˚21'42.40"	0-10 cm	394
		11-20 cm	360
C2 C	S 00˚13'32.25" E 109˚21'39.03"	0-10 cm	363
		11-20 cm	401
C3 C	S 00˚13'36.21" E 109˚21'26.46"	0-10 cm	335
		11-20 cm	335
C4 C	S 00˚13'58.27" E 109˚22'04.56"	0-10 cm	352
		11-20 cm	361
C5 C	S 00˚13'55.21" E 109˚22'06.56"	0-10 cm	250
		11-20 cm	304

Source: Data analysis (2022)

Code C soil samples consist of codes C1, C2, C3, C4, and C5. Weights soil with a weight of 250 – 401 grams. The weight of the heaviest soil sample is coded C2 C at a depth of 11-20 cm, while the weight of the soil sample is the heaviest. Light, namely soil samples coded C5 C with a depth of 0-10 cm.

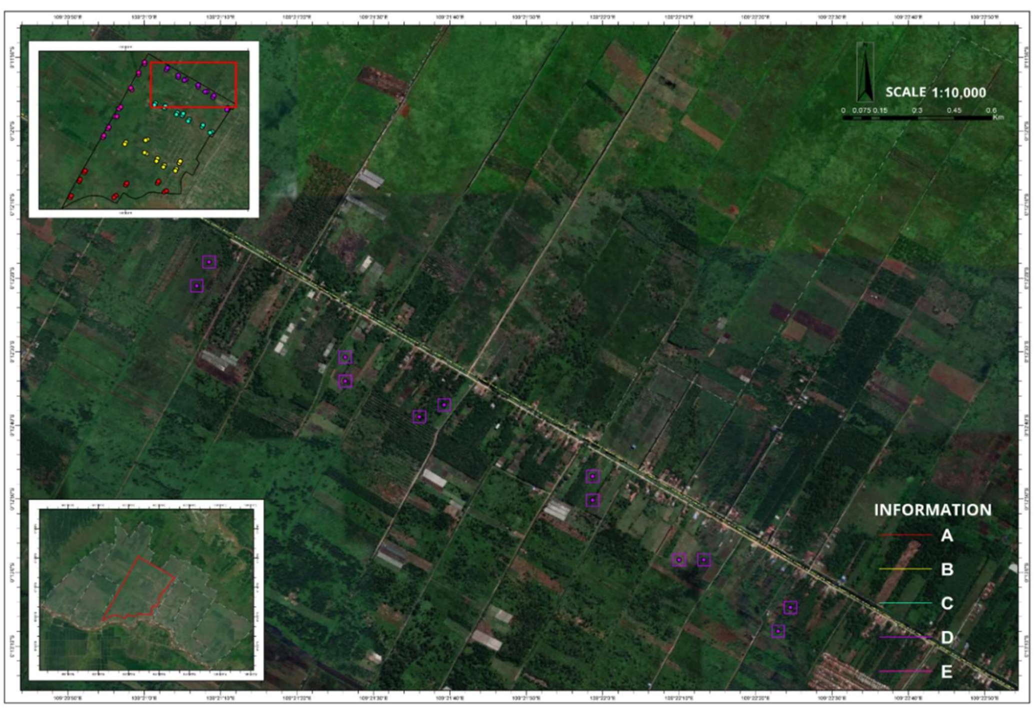

Figure 4. Image of soil sampling point D

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There are 12 points for sampling D soil located in the northern part of the village of Rasau Jaya Tiga. A total of 12 soil sampling points were carried out at only 5 sample points and taken two times with different soil depths.

Table 4. Results of sampling code D soil

Code	Coordinate Point	Depth (cm)	Content Weight (gram)
D1 C	S 00°12'17.53" E 109°21'07.98"	0-10 cm	178
		11-20 cm	303
D2 C	S 00°12'29.79" E 109°21'11.24"	0-10 cm	257
		11-20 cm	309
D3 C	S 00°12'49.63" E 109°22'05.45"	0-10 cm	295
		11-20 cm	357
D4 C	S 00'12'49.88" E 109°22'05.81"	0-10 cm	308
		11-20 cm	363
D5 C	S 00°12'50.93" E 109°22'04.99"	0-10 cm	317
		11-20 cm	331

Source: Data analysis (2022)

Code D soil samples consist of codes D1, D2, D3, D4, and D5. Each soil sample that has been taken has a bulk density of 178 - 363 grams. The weight of the heaviest soil sample is coded D4 C at a depth of 11-20 cm, whilethe weight of the lightest soil sample is soil sample code D1 C with a depth of 0-10 cm.

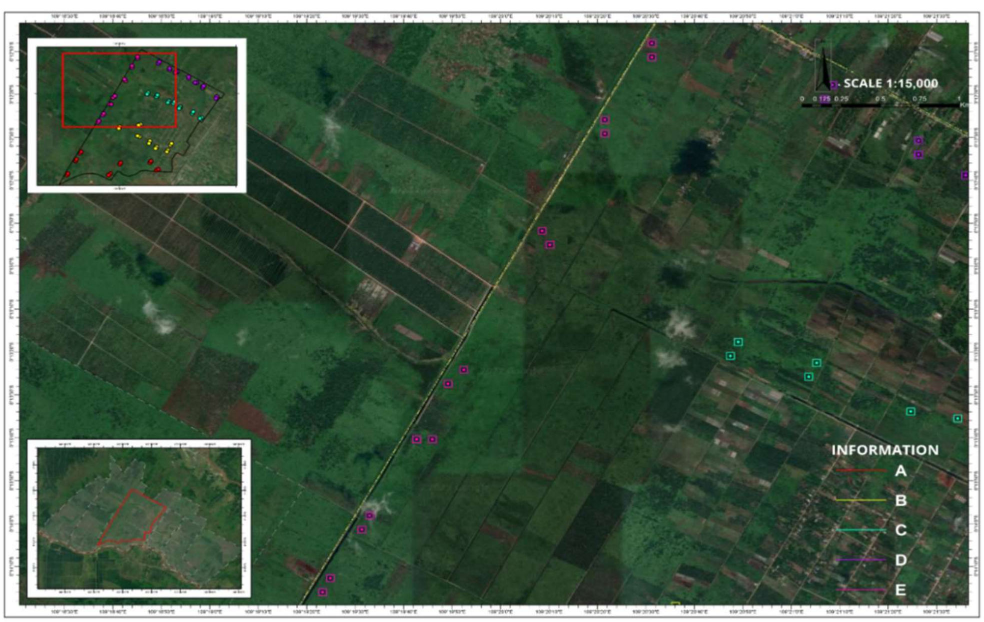

Figure 5. Image of soil sampling point E

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Soil samples with code E were taken randomly from the western part of the village of Rasau Jaya. A total of 14 points were taken, and 5 points were taken by taking soil samples two times at each point.

Table 5. Results of sampling code E soil

Code	Coordinate Point	Depth (cm)	Content Weight (gram)
E1 C	00°14'22.66" LS and 109°19'24.95" BT	0-10 cm	267
		11-20 cm	236
E2 C	00°13'39.96" LS and 109°19'42.12" BT	0-10 cm	308
		11-20 cm	244
E3 C	00°13'10.07" LS and 109°20'18.37" BT	0-10 cm	314
		11-20 cm	333
E4 C	00°12'36.77" LS and 109°20'14.54" BT	0-10 cm	440
		11-20 cm	460
E5 C	00°12'09.59" LS and 109°20'30.23" BT	0-10 cm	285
		11-20 cm	322

Source: Data analysis (2022)

Code E soil samples include E1, E2, E3, E4, and E5. Each soil sample that has been taken has a bulk density of 236 - 460 grams. The heaviest weight of the soil sample is coded E4 C at a depth of 11-20 cm, while the lightest weight is coded E1 C with a depth of 11-20 cm.

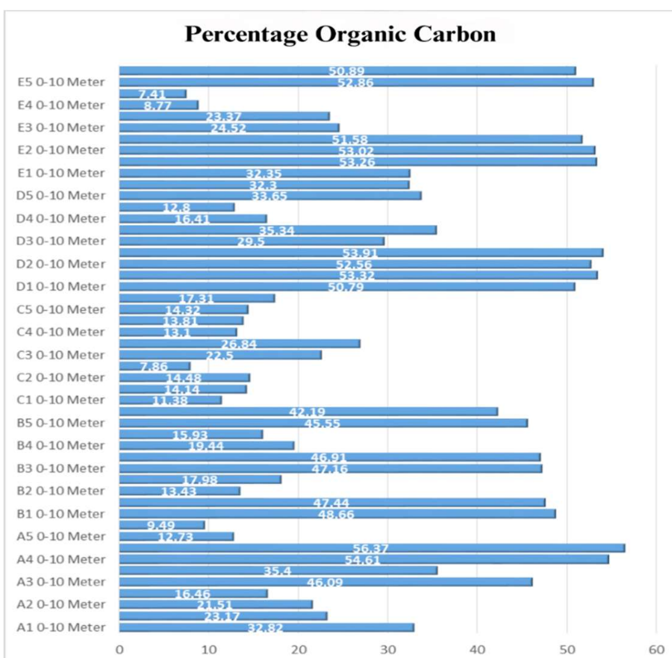

Figure 6. Percentage organic carbon

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The highest percentage of organic carbon content was found in sample code A4 C at a soil depth of 11-20 cm with a percentage of 56,37%. The high organic carbon content was proven by the observation results, namely the A4 C soil sample was taken in oil palm plantations, with land conditions which do not function as usual, and the soil conditions on this land tend to be drier, and at some points, there are traces of fire on the ground.

The lowest percentage of organic carbon is found in sample code E4 at a soil depth of 11-20 cm with an organic carbon content percentage of 7,41%. The observation results prove the low content of organic carbon in the E4 sample, namely the soil sample code E4 was taken on land use in the form of vacant land with ferns, areca nut and rambutan vegetation, with soil conditions that tended to be wet.

It was concluded that land with wet soil conditions and land use in the form of vacant land tended to have a lower percentage of organic carbon content compared to soil samples with non-functioning land conditions and vegetation in the form of oil palm plantations and soil conditions tended to be drier, and several points had traces of fire. The land has a higher percentage of organic carbon content. This is in line with research results (Edwin, 2016), which say that the highest soil organic carbon lies in land use in the form of mixed gardens, while (Wildayana, 2017) also states that peatland is used as agricultural land, especially for food crops and horticulture such as coconut plantations. Palm and rubber.

The percentage of high or low organic carbon levels with different soil sampling depths at the exact soil sample location. The comparison of each sample point has a percentage of carbon content which is the criterion in yellow, which means soil samples with a depth of 0-10 cm, while green means soil samples with a depth of 11-20 cm. The soil samples spread out in the central, western, eastern and northern parts of the village of Rasau Jaya Tiga. The highest percentage of organic carbon content is located in the central part of Rasau Jaya Tiga Village, namely, sample A4 C. While the lowest percentage of organic carbon content is located in the western part of Rasau Jaya Tiga Village, namely sample E4 C.

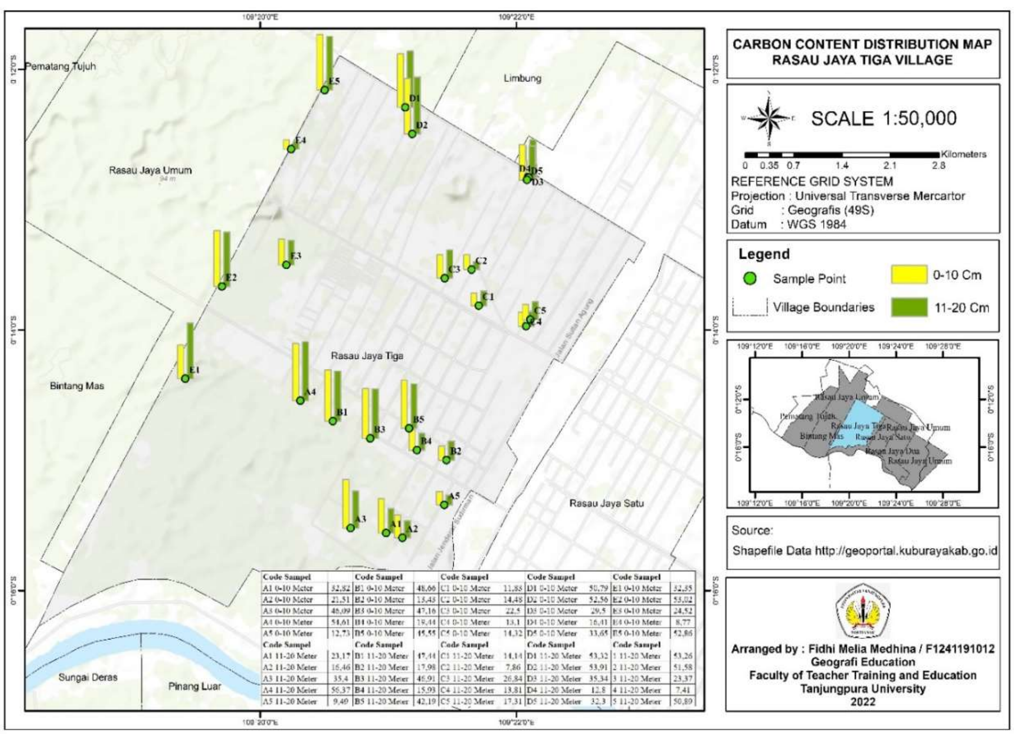

Figure 7. Map of the distribution carbon content

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The distribution of peat along with the peat's depth and the soil sample points' distribution. Most of the land in the village of Rasau Jaya Tiga is of the organosol or peat type. In (Masganti et al., 2017), peatland with a thickness of 50-100 cm is classified as shallow or thin peat. Total of 13 sample points were spread on shallow or thin peat soil criteria (50-100 cm) covering samples A4, B1, B3, D1, D2, D3, D4, D5, E1, E2, E3, E4, and E5 which contained organic carbon. Tend to be high.

While the 12 samples covering A1, A2, A3, A5, B2, B4, B5, C1, C2, C3, C4 and C5 were spread over non-peat soil types and had a relatively low organic carbon content, the organic carbon content in peat soils ranges from 18% - 60% and in mineral soils ranges from 0,5% - 6%. Overall the soil samples scattered on shallow or thin peat soil types have a percentage of between 7,41% - 56,37%. The high carbon content in high-volume peat is influenced by the maturity level of the peat (H Nasution et al., 2023), and the higher the average peat density, the higher the peat maturity level (Robinson and Moore, 2000).

The highest organic carbon content was found in soil sample A4 with a percentage of 56,37% at a depth of 11-20 cm, while the lowest organic carbon content was found in sample E4 with a percentage of 7,41% located at a depth of 11-20 cm.

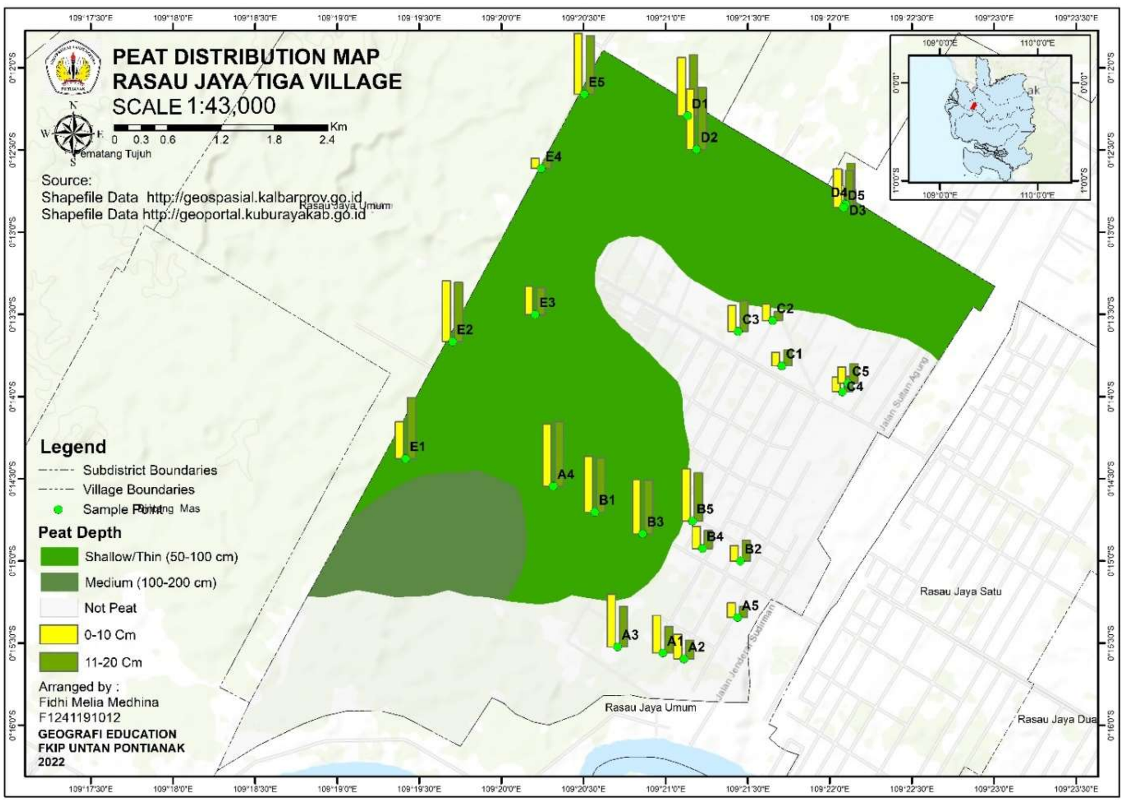

Figure 8. Map of peat distribution in the village of Rasau Jaya Tiga

Figure 8 shows that some of the soil in Rasau Jaya Tiga Village is not peat. However, laboratory results show that at 12 sample points, the type of soil located on non-peat has an organic carbon content of > 0,5% – 0,6% with a percentage range of 7,86 % - 49,09%, so it can be concluded that when viewed from the organic carbon content, as many as 12 sample points include samples A1, A2, A3, A5, B2, B4, B5, C1, C2, C3, C4 and C5, the soil representing the area belonging to the type of peat soil.

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4. CONCLUSION

Soil sampling obtained as many as 50 samples with a depth of 0-10 and 11-20. Soil samples were coded using A, B, C, D, and E, with each sample code consisting of 5 middle samples. Laboratory test results showed that the highest percentage of organic carbon content was found in sample code A4 C at a soil depth of 11-20 with a percentage of 56,37%. At the same time, the lowest percentage of organic carbon is found in sample code E4 at a soil depth of 11-20 with an organic carbon content percentage of 7,41%.

5. RECOMMENDATIONS

The advice that can be given is for the government of Rasau Jaya Tiga Village and Kubu Raya Regency to review the use of both organic soil (peat) in the management of agricultural and non-agricultural land so that it follows the function of the ecosystem.

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