JOURNAL OF SOILSCAPE AND AGRICULTURE

Volume 1, Number 1 : (15 – 21), 2022

J o u r n a l h o m e p a g e: http://journal.unej.ac.id/JSA

Carbon Footprint Analysis of Household Activities and CO_2 Reduction Efforts in Pondambea Village, Kadia District, Kendari City

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A R T I C L E I N F O

Article History:
Received: 24 - 08 - 2022
Accepted: 03 - 09 - 2022
Published:05 - 09 - 2022

Keyword:
Carbon footprint;
Houshold activities;
Pondambea village;

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A B S T R A C T

The increase in population causes an effect on increasing CO_2 production, especially from the household energy sector. The increase in the concentration of CO_2 in the atmosphere is the main trigger for climate change and the effects of greenhouse gases. Indications of the occurrence of this phenomenon can be seen from the increase in air temperature and the formation of an urban heat island in Kendari City in the last 10 years. This study aims to determine the amount of CO_2 emissions from household activities and the absorption of CO_2 gas from tree species in Pondambea Village, Kadia District, Kendari City. The method used is a quantitative technique to calculate primary and secondary CO_2 emissions. The results show that the total CO_2 emission in Pondambea Village is 424.22 tons/month. Meanwhile, the carbon absorption capacity of tree species in Pondambea Village is 421.15 tons/month, so that the remaining carbon emissions are 3.07 tons/month. Therefore, to maintain emission absorption and create zero emission in Pondambea Village, this study recommends maintaining the number of existing trees and adding at least 6 glodokan pole trees or at least 5 king palm trees

INTRODUCTION

Environmental protection, especially on climate change and the effects of greenhouse gases, has become a serious concern for the international community following the increasing negative impacts caused. Carbon emissions are a significant cause of climate change (Syafrudin et al., 2020). Carbon dioxide is the most common greenhouse gas emitted by human activities (Kijewska & Bluszcz, 2016). The main elements that produce large amounts of carbon dioxide are fossil fuels (especially oil and coal), through burning to obtain energy (Radu et al., 2013) In line with this, according to Wiratama et al. (2016) household activity is the third largest energy user sector after industry and transportation, where energy use in the household sector is related to the need for electric power (for lighting, air conditioning, other electronic equipment) and heat energy for cooking.

Kendari City is the capital of Southeast Sulawesi Province, with an area of 267.37 km^2 which has a population in 2020 of 345,107 people with a population density of 1270 people/km^2(BPS, 2020) The increase in population causes an effect on increasing CO_2 production, especially from the household energy sector. This condition can be seen in the increase in the average air temperature in Kendari City in the last 10 years. In 2010 the average air temperature in Kendari City was recorded at 24℃, in 2016 it was 28℃ and in 2020 it was 33℃ (BPS, 2021). From the data above, it can be seen that the air temperature in Kendari City has increased every year and if it will continue to increase.

In an effort to support emission reductions in Kendari City, data on energy consumption is very much needed, especially from activities in the household. To support this, it is necessary to study the calculation of the carbon footprint of household activities. The carbon footprint is a calculation of the total CO_2 emissions that are directly or indirectly caused by an activity or accumulated through the product life cycle (Gui et al., 2019). The purpose of this study was to determine the amount of CO_2 emissions from household activities and the absorption of CO_2 gas from tree species in Pondambea Village, Kadia District, Kendari City. One area that needs to be calculated on the carbon footprint is Pondambea Village, Kadia District. This area is one of the urban villages in Kendari City with a dense population which in 2020 will reach 11,763 people/km^2 (BPS, 2021). According to Ode Alwi et al., 2022, almost all areas of Kadia District experienced the urban heat island (UHI) phenomenon, where this phenomenon is the main factor in climate change and the greenhouse effect.

Along with the increase in population, household activities in Pondambea Village also increased. These activities include the use of LPG and kerosene for cooking and the use of electrical energy such as lamps for lighting, irons, washing machines, refrigerators and the use of other electronic equipment to meet daily needs. The use of energy from household activities is allegedly causing large CO_2 emissions. The purpose of this study was to determine the amount of CO_2 emissions from household activities and the absorption of CO_2 gas from tree species in Pondambea Village, Kadia District, Kendari City.

METHOD

Location and Time

The location of this research is in Pondambea Village, Kadia District, Kendari City, which is located at coordinates 3º58'19" South Latitude and 122º51'16" East Longitude. This research was conducted from November to December 2021. The map of the research location is shown in Figure 1 below.

Method of Collecting Data

The population in this study is the total number of households in Pondambea Village as many as 1741 families. The number of samples in this study was determined using the Slovin formula (Supriyanto & Iswandari, 2017) as follows:

$$n = \frac{N}{1+Ne^2} \quad \text{.....(1)}$$

Keterangan:

n = Number of study area samples
N = The total number of all households in the study area
E = The level of leniency of the sampling discrepancy that can still be tolerated

So from the results of the calculation of the number of samples with an error rate of 10%, as many as 95 families.

This research is a type of quantitative research. The types of quantitative data used in this study include the type and amount of fuel consumption used for cooking and the amount of electricity consumption (kWh) based on the use of electronic devices.

Sources of data used in this study are primary and secondary data. Primary data is data obtained directly through interviews with the help of a questionnaire at the research site. While secondary data is data obtained from the research of previous researchers, where the results of the research are used as the standard values used in the study.

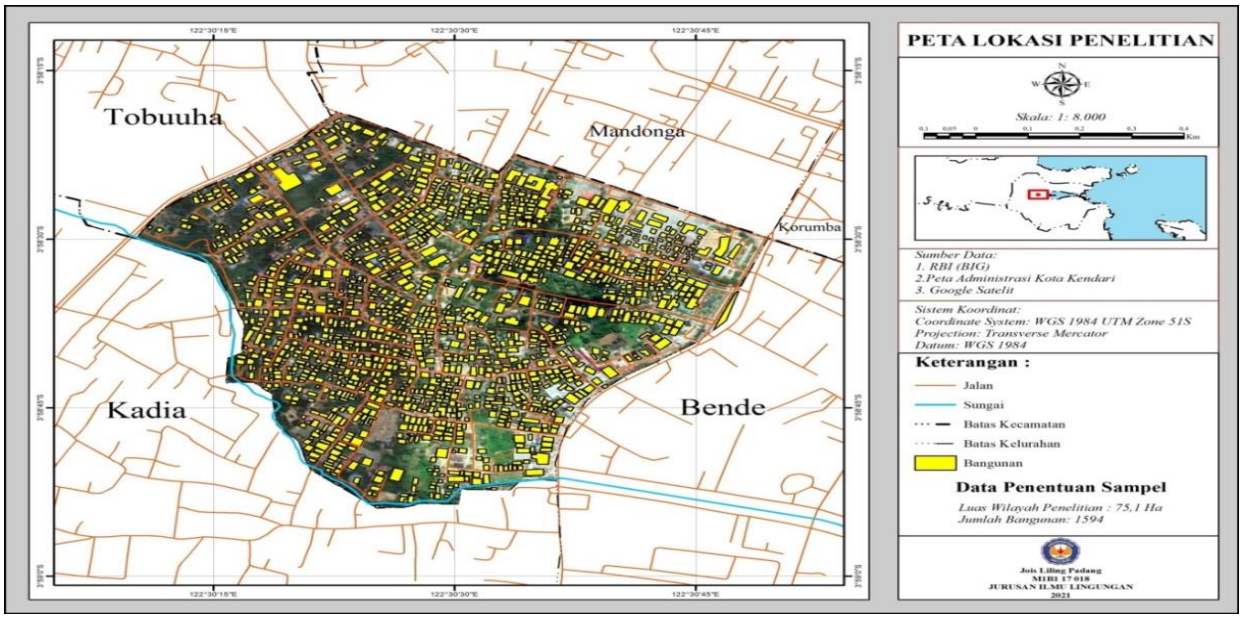

Figure 1. Research Location Map

Data Analysis

Analysis of the data used to determine the amount of CO_2 gas emissions from household activities and the absorption of CO_2 gas from tree species in Pondambea Village is using quantitative techniques. This analysis technique uses quantitative data, quantitative data is data related to the numbers obtained from the measurement results. This study uses the calculation of carbon dioxide (CO_2) emissions from household activities (calculation of primary CO_2 emissions and secondary CO_2 emissions) and the calculation of the absorption capacity of tree species CO_2 emissions in Pondambea Village.

1. Calculation of primary CO2 gas emissions

The data used for calculating primary CO_2 emissions are the type of fuel used for cooking and the amount of fuel used per household (head of household) for one month. Then calculate the amount of primary CO_2 gas emissions using the following equation (Astari, 2015):

Formula for calculating CO_2 gas emissions for LPG fuel:

$$ET = EK \times EF \times NCV\ LPG \quad \text{.....(2)}$$

Keterangan :
ET : Total CO_2 gas emission
EK : LPG fuel consumption (kg)
EF : LPG Emission Factor 17.2 gram Carbon/MJ

NCV: LPG Net Weight 48,852 MJ/k

The formula for calculating CO_2 gas emissions for kerosene fuel:

$$ET = EF \times FC \times NCV\ Kerosene \quad \text{..... (3)}$$

Information:
ET : Total CO_2 gas emission
EF : Kerosene emission factor 19.4 grams Carbon/MJ
FC : Consumption of kerosene fuel (kg)
NCV: 44.75 MJ/kg

2. Calculation of Secondary CO2 Emissions

Secondary CO_2 gas emissions are CO_2 gas emissions that are generated indirectly from the use of electrical energy. The data needed in calculating secondary CO_2 emissions is data on electrical energy consumption (kWh) obtained from the use of electronic devices per household. Then calculate the amount of secondary CO_2 gas emissions using the following equation:

$$CO_2\ Emissions = Ef \times KL \quad \text{..... (4)}$$

Information:
KL : Electrical energy consumption (KWh)
EF : CO_2 emission factor of electricity consumption (0.000794 ton CO_2 gas/KWh.

3. Calculation of total CO_2 gas emissions

With a simple mathematical calculation, the calculation of total CO_2 emissions from household activities uses the following equation:

$$\text{Total } CO_2 \text{ gas emission} = \text{Primary } CO_2 \text{ gas emission} + \text{Secondary } CO_2 \text{ gas emission} \quad \text{..... (5)}$$

4. Absorption of Tree Type CO_2 Emissions

Carbon absorption per tree species can be done by simple mathematical calculations based on CO_2 absorption per tree species (Roshintha & Mangkoedihardjo, 2016) as follows:

$$\text{Tree Absorption Ability} = CO_2 \text{ absorption} \times \text{Number of Trees} \quad \text{…….(6)}$$

To determine the number of trees, identification and calculation of the number of trees is carried out and then conversion of carbon sequestration is carried out. Furthermore, to control the remaining CO_2 gas emissions from household activities that can be absorbed by the type and number of trees in the Pondambea Village area, it is determined by the following formula (Astari, 2015)

$$\text{Remaining emissions} = TE\ (\text{tons } CO_2/\text{year}) - TP\ (\text{tons } CO_2/\text{year}) \quad \text{.....(7)}$$

Information:
E : Total CO_2 Emissions
TP : Total carbon absorption of trees

RESULT AND DISCUSSION

Amount of Primary CO_2 emission in Pondambea Kelurahan Village

Primary CO_2 gas emissions are emissions produced by the community directly from the use of LPG and kerosene for cooking. The total amount of primary CO_2 gas emissions from household activities in the Pondambea sub-district is presented in Table 2. Based on Table 2, it can be seen that the total emission resulting from the use of LPG fuel is 14.6 tons/month. While the amount of emissions generated from the use of kerosene fuel is 0.4 tons /month. So the amount of primary CO_2 emissions from household activities in Pondambea Village is 14.9 tons/month.

Table 2. Results of calculation of primary CO_2 emissions in Pondambea Kelurahan Village

No.	Type of fuel	Number of Household Samples	Average fuel consumption (kg/month)	Emission factor (g)	NCV (Kg)	Total CO2 emisi emissions g/month
1	LPG	93	915	17.2	44.75	14.6
2	Kerosene	2	24	19.4	48.86	0.4
			Total			14.9

Source: Analysis Results, 2022

Secondary CO_2 Emissions in Pondambea Village

Secondary CO_2 gas emissions are emissions resulting from the use of household electronic devices that utilize electrical energy to operate. The amount of secondary CO_2 gas emissions from household activities in Pondambea Village is presented in Table 2.

Table 2. Total secondary CO_2 emissions from household activities in Pondambea Village

No	Electrical power (VA)	Number of Family Head Samples	Electricity Consumption (kWh/month)	Emission factor (tons/kWh)	Secondary Carbon Footprint (tonnes/month)
1	900	34	7164.27	0.000794	5.69
2	1300	37	9811.72	0.000794	7.79
3	2200	19	7519.48	0.000794	5.97
4	3500	4	2712.6	0.000794	2.15
5	4500	1	988.1	0.000794	0.78
			Total		**22.39**

Source: Analysis Results, 2022

Based on the calculation of the amount of secondary CO_2 gas emissions from household activities in Pondambea Village, it can be seen that the amount of CO_2 gas emissions generated from the use of 900 VA electrical power is 5.69 tons/month, 1300 VA electrical power is 7.79 tons/month. month, 2200 VA electric power of 5.97 tons/month, 3500 VA electrical power of 2.15 tons/month and 4500 VA electrical power of 0.78 tons/month. The amount of secondary CO_2 emissions based on the number of samples from household activities in Pondambea Village, Kadia District, Kendari City is 22.39 tons/month. The average CO_2 emission per household shows a value of 0.24 tons/month. Based on the number of household heads in Pondambea Village as many as 1,741, the total CO_2 emissions produced are 410.29 tons/month.

Total CO_2 Emissions in Pondambea Village

The total CO_2 emission is obtained from the sum of primary CO_2 emission and secondary CO_2 emission. Based on the calculation results, the total CO_2 gas emissions from household activities in Pondambea Village, Kadia District, Kendari City are 424.22 tons CO2/month.

Absorption of Trees in Reducing CO_2 Gas

The results of the survey of tree species and number in Pondambea Village showed that there were 10 tree species, namely Mahogany with a dominant number, Trembesi, Palm Raja, Glodokan Tiang, Mango, Teak, Ketapang, Breadfruit, Tanjung, and Jackfruit. The total absorption of CO_2 from all types and the number of trees is 421.15 tons/month. The types and number of trees found in Pondambea Village are presented in Table 3.

Table 3. Types and Number of Trees in Pondambea Kelurahan Village

No.	Plant Name	CO_2 absorption (tons/month)	Number Of Tree	Total CO_2 absorption (tons/month)
1	Mahoni	2.24	157	351.68
2	Trembesi	2.34	16	37.44
3	Palem raja	0.63	22	13.86
4	Glodokan tiang	0.52	19	9.88
5	Mangga	0.04	153	6.12
6	Jati	0.01	41	0.41
7	Ketapang	0.02	17	0.34
8	Sukun	0.02	11	0.22
9	Tanjung	0.05	18	0.9
10	Nangka	0.02	15	0.3
	Total		469	421.15

Source: Analysis Results, 2021

The remaining carbon emission from household activities after deducting carbon absorption is 3.07 tons/month. Based on the results of the analysis, the remaining emissions show a positive number, so this study recommends maintaining the number of existing trees and adding at least 6 glodokan pole trees or at least 5 king palm trees. The selection of this type of plant takes into account the conditions of densely populated areas. In addition, the selection of plants has considered the root system and fibers so that they do not have the potential to damage the building. Glodokan poles and palm kings are suitable to be planted outside fences as roadside plants or planted inside fences (Werdiningsih, 2007).

CONCLUSION

This study concludes that the total CO_2 emissions from household activities in Pondambea Village are 424.22 tons/month. Carbon absorption from the type and number of trees in Pondambea Village is 421.15 tons CO2/month, so that the remaining CO_2 emissions are 3.07 tons/month. To maintain emission absorption and create zero emission in Pondambea Village, this study recommends maintaining the number of existing trees and adding at least 6 glodokan pole trees or at least 5 king palm trees.

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