



Mapping of Greenhouse Gas (CO₂) Due To Domestic Energy and Household Electricity Consumption in Padang City

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Abstract

Residential area is one of the contributors in the increase of CO₂ emissions. Padang, a big city in Indonesia with a large population within it is potential contributor of CO₂ emissions. Unfortunately, there was no database collected of CO₂ emissions from this activity. The CO₂ emissions from domestic activities are divided into two i.e primary and secondary CO₂ emissions, known by the term 'carbon footprint'. The primary CO₂ emissions are resulted from domestic energy consumption, while the secondary CO₂ emissions are resulted from household electricity consumption. Questionnaire of sampling was conducted to get the CO₂ emissions data. The number of samples was obtained based on the equation of Slovin were distributed evenly at Padang City. The CO₂ emissions were calculated based on Puslitbangkim 2002. The calculations showed 92.327,59 ton CO₂/year of primary CO₂ emissions and 317.287,2 ton CO₂/year of total secondary CO₂ emissions. While the total CO₂ emissions reaching up to 409.614,79 ton CO₂/year. Based on the calculations the highest number of emissions were in the District Koto Tengah. While the highest number of secondary CO₂ emissions were conducted in the Indarung area.

Keywords: Carbon footprint, CO₂ emissions, domestic energy consumption, household electricity consumption, residential area

1. Introduction

Global warming and climate change are phenomena of increasing concentration of Greenhouse gases (GHGs) in the atmosphere due to human activities, such as fossil fuel use, land use, forest changing, as well as agricultural activities and livestock. One of the greenhouse gases that have the largest contribution to global warming and climate change are carbon dioxide (CO₂) (Mauliyani, 2009).

The Kyoto Protocol 1997 that has been ratified by 141 countries, including Indonesia, states the need to reduce emissions by 5,2 percent from the level emissions in 1990. The commitment from various countries to control CO₂ emissions is needed to implement the Kyoto Protocol. Indonesia itself has a comprehensive national action plan to reduce CO₂ emissions that is associated with climate change which are mitigation and adaptation. In supporting the action plan, some data is urgently needed related to energy consumption, especially activity in the residential as one of the main sources of CO₂ emissions. (Renandia, 2009).

Integrated prevention efforts among the relevant area in a particular area need to be done to overcome the problems of pollution. Pollution control directly from emission sources is an effective attempt to overcome the impact of these emissions. Meanwhile, the availability of systematic information about the sources of the emissions and emission load for a particular region in Indonesia is still lacking, making it difficult to estimate and evaluate emissions that is required to make the air pollution control policy decision. Therefore, a study of the emissions inventory from various sources is required (Adolf, 2008).

Emission inventory is accounting the amount of information about the quantity of overall air pollution located in a geographic area within a specified time span, usually a specific year.



The emission inventory will be used as the basis for preventive measuring against air pollutions and help to analyze some activities that contribute to increase pollution in the geographic area in which the study area (Canter, 1996).

Padang as one of the big city in Indonesia has a total population that is quite high. Based on a data from Dinas Perindagtamben, Padang City (2010) has 182.822 households within 11 sub-districts namely Bungus Teluk Kabung, Lubuk Kilangan, Lubuk Begalung, Padang Selatan, Padang Timur, Padang Barat, Padang Utara, Nanggalo, Kuranji, Pauh and Koto Tengah. The high number of households with various household activities leads to a high level of pollution and it will eventually cause an increase to the earth's temperature. Energy used by humans in all activities especially household activities is very high. The increasing use of energy used, also resulted a sharp increase of fossil fuel use such as kerosene, coals, gases as an energy sources. It has led to increased exhaust gases like CO₂ which is the main contribution to greenhouse gases. Hence the resulting of increasing in emissions is also very high which causes CO₂ levels in the atmosphere is unstable.

The resulting of emissions in Padang City can be seen in human activities in residential. Population growth resulted in so many activities in residential that can lead to increasing of CO₂ in atmosphere. Beside the views of so many human activities that cause increasing of emission, the type of fuels used for cooking and electric power plan also play the important role in emissions resulting. But there is no valid data that shows the number of CO₂ emissions in the Padang city that come from household activities. Therefore a research is needed to be carried out into how CO₂ emission's amount in Padang city from household activities.

The research of emission inventory of CO₂ from domestic activities carried out by the domestic energy consumption and household electricity consumption. The results of this research can be used to aid the decision making process in effort to control air pollution in Padang City, mainly due to domestic activities.

2. Research Method

The data that's going to be collected for this research is primary and secondary data. The primary data comes from questionnaires and interviews with 400 respondents (household) which were determined by the equation of Slovin with 182.822 households, while secondary data is used come from various department in Padang City such as the number of households in Padang City based on the use of fuels for cooking from Dinas Perindagtamben, electricity usage in Padang City from Perusahaan Listrik Negara, the value of emission factor from Puslitbangkim 2002). These values are used as data for a calculation to determine how much CO₂ emissions resulted in residential of Padang City. Primary CO₂ emissions are resulted from the domestic energy consumption for cooking (LPG, kerosene, and woods), while secondary CO₂ emissions are resulted from household electricity consumption. The results of CO₂ calculations form the basis of CO₂ emissions level scaling in each sub-district.

- a. To calculate the primary CO₂ emissions for each respondent (household):

Puslitbangkim 2002

$$CO_2 \text{ Emission} = EF \times \text{Fuel Consumption} \quad (1)$$

Description:

EF = Emission factor from Pulitbangkim (2002)

EF of Kerosenes : 2,5 CO₂kg/kg

EF of LPGs : 3 CO₂kg/kg



EF of woods : 0,37 CO₂kg/m³

- b. To calculate the average primary CO₂ emissions for each sub-district

$$\text{The average} = \frac{\text{Primary CO}_2 \text{ Emission in each sub - district}}{\text{The total of respondent}} \quad (2)$$

- c. To calculate primary CO₂ in each sub-district

$$\text{Primary CO}_2 \text{ emission} = \text{Average CO}_2 \text{ emission} \times \sum r \text{Households} \quad (3)$$

- d. To calculate secondary CO₂ emissions in each sub-district

$$\text{Secondary CO}_2 \text{ emission} = \text{EF} \times \text{Household electricity consumption} \quad (4)$$

Description:

EF = Emission factor from *World Resources Institute* (WRI) and *World Business Council for Sustainable Development* (WBCSD, 2001).

EF for Indonesia : 454 CO₂/kWh

- e. To obtain total CO₂ emissions is calculated by the value of overall primary CO₂ emissions and secondary.

$$\text{Total CO}_2 \text{ emission} = \text{Primary CO}_2 \text{ emission} + \text{Secondary CO}_2 \text{ emission} \quad (5)$$

Processing data in this research is done based on the calculation of CO₂ emissions from domestic energy consumption and household electricity consumption as well as the analysis of the calculation results itself. Data analysis in this research is such a descriptive analysis of a simply overview of the results. It is represented in forms of graphs, tables, and mapping and will be showed the comparison of the results of calculations based on domestic energy consumption and household electricity consumption.

3. Result and Discussion

3.1 Data of Energy Consumption for Household Activities in Padang

The data of energy consumption for household activities is resulted from secondary data analysis done before such as the data of energy consumption for cooking and household electricity consumption in Padang City.

3.1.1 Data of Domestic Energy Consumption for Cooking

The result of processed data from each fuels showed an overview of the high and low CO₂ emission loads in Padang City. The more the fuel consumptions are used so the more CO₂ emission loads are emitted. The amount of fuel consumptions depend on the number of household members, the level of welfare, the size of the house, and culture within the area. For more details of fuel consumptions for cooking activities in Padang City can be seen in Table 1 and Figure 1 with equal size of LPG and Kerosene that has been set is 1 kg of LPG = 1,74 litres kerosenes.

Table 1 Fuel Consumptions for Cooking in Padang City

| No | Fuel | Fuel Consumption (Kg/month) |
|----|------|--------------------------------|
| 1 | LPG | 7,96 |



| | | |
|---|----------|--------|
| 2 | Kerosene | 34,82 |
| 3 | Wood | 142,14 |

Based on Table 1, woods as fuel for cooking requires a considerable amount of burning, it is 142,14 Kg/month for one household due to wood itself need large enough quantities so that the heat energy can be resulted to perform adequate cooking activities. While the needs for kerosenes compared to LPGs, Kerosenes requires higher amounts (in Kg) to be able do burning.

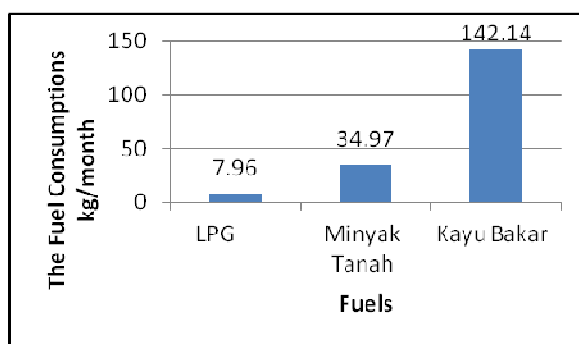


Figure 1 Fuel Consumptions fo Cooking in Padang City

3.1.2 The Data of Household Electricity Consumptions

The calculation of power consumptions is done by PT PLN (Persero) Branch Padang every year in December. They serve four areas in Padang City and nine areas for other areas. The number of electricity customers increased significantly each year except for the reduction in the number of customers in 2009 due to the earthquake that occurred in Padang City. While in 2011, there was ascension of customers due to the number of customers building got repaired after the earthquake. Table 2 shows household electricity consumptions in Padang City.

Table 2 Household Electricity Consumptions in Padang City

| No | Year | Number of Customer (KK) | Daya Tersambung (VA) | Electricity Consumption (kWh) |
|----|------|-------------------------|----------------------|-------------------------------|
| 1 | 2007 | 353.365 | 478.468.270 | 100.927.706 |
| 2 | 2008 | 368.019 | 508.984.930 | 115.673.758 |
| 3 | 2009 | 368.546 | 507.051.730 | 102.456.136 |
| 4 | 2010 | 386.210 | 547.029.850 | 129.585.989 |
| 5 | 2011 | 411.397 | 598.941.850 | 142.270.309 |

3.2 Carbon Dioxide Emission Loads in Padang City

Carbon dioxide from residential is divided into two i.e primary CO₂ emissions from domestic energy consumptions for cooking activities and secondary CO₂ emissions from household electricity consumptions. The primary CO₂ emissions were calculated based on Puslitbangkim (2002) meanwhile secondary CO₂ emissions were calculated based on the Riswandi's research for Pekanbaru City.

3.2.2 CO₂ Emission Loads Based on Domestic Energy Consumption for Cooking Activities in Padang City (Primary CO₂ Emissions)

The calculation of carbon dioxide emission loads from domestic energy consumption for cooking (primary CO₂ emissions) are based on the amount of consumption of each fuels per month for each respondent (house) that represented in each sub-district in Padang City (Primary CO₂ emissions/house/month). From this calculation would be known the total



amount of primary CO₂ emissions/sub-district/month). Table 3 shows the results of calculation of primary CO₂ emission.

Table 3 Carbon Dioxide Emission Loads Based on Domestic Energy Consumption for Cooking in Padang City (Puslitbangkim 2002)

| No | Sub-district | CO ₂ Emission Loads (KgCO ₂ /month) | | | Total CO ₂ Emission Loads (KgCO ₂ /month) |
|-------|---------------------|--|-------------|-----------|--|
| | | LPG | Kerosene | Wood | |
| 1 | Bungus Teluk Kabung | 42.090,9 | 208.885,6 | 0,0 | 250.976,5 |
| 2 | Lubuk Kilangan | 67.389,0 | 497.709,1 | 20.979,1 | 586.077,1 |
| 3 | Lubuk Begalung | 145.962,0 | 730.197,9 | 14.485,5 | 890.645,4 |
| 4 | Padang Selatan | 175.333,8 | 431.869,1 | 0,0 | 607.202,9 |
| 5 | Padang Timur | 153.755,4 | 504.298,0 | 29.637,0 | 687.690,4 |
| 6 | Padang Barat | 116.616,0 | 269.425,2 | 0,0 | 386.041,2 |
| 7 | Padang Utara | 128.563,8 | 377.742,0 | 95.904,0 | 602.209,8 |
| 8 | Nanggalo | 105.491,1 | 409.2768 | 20.979,0 | 535.746,9 |
| 9 | Kuranji | 376.824,4 | 824.006,9 | 46.453,5 | 1.247.284,77 |
| 10 | Pauh | 72.754,00 | 368.385,8 | 20.812,5 | 461.952,3 |
| 11 | Koto Tengah | 222.373,3 | 1.215.765,2 | 0,0 | 1.438.138,6 |
| Total | | 1.607.153,8 | 5.837.561,7 | 249.250,5 | 7.693.966,0 |

As presented in Table 3, it is known that the primary CO₂ emission loads based on Puslitbangkim 2002 in Padang City amounted to 7.693.966,03 KgCO₂/month or 92.327,59 tonCO₂/year with each amounted to 1.607.153,82 KgCO₂/month of LPG or 19.285,84 tonCO₂/year of LPG, kerosene amounted to 5.837.561,71 KgCO₂/year or 70.050,74 tonCO₂/year and wood amounted to 249.250,50 KgCO₂/month or 2.991,01 tonCO₂/year.

This number shows that kerosene has an important role for resulting CO₂ emissions in Padang City. This is caused by the amount of kerosene users which are more than woods or LPG users in Padang City. People of Padang City mainly use kerosene as fuel for cooking because of misunderstanding of people by using kerosene is much more efficient that wood and also cheaper that LPG.

Koto Tengah Sub-district is the largest emitter of CO₂ emission in Padang City. It emits 19 % of total primary CO₂ emissions in Padang City. It amounted to 1.438.138,6 kg CO₂/month or 17.257.663,2 tonCO₂/year. This is mainly caused by Koto Tengah Sub-district is the larest sub-district in Padang City which lead largest number of household that used kerosene and woods as fuel for cooking. The following sub-districts which are emitted large enough primary CO₂ emissions are Kuranji dan Lubuk Begalung Sub-district.

The comparison of CO₂ emission from the use of LPG, kerosene and woods in eleven sub-district in Padang City shows the district with the largest of CO₂ emissions from LPG as fuel is located in Kuranji Sub-district, it is amounted to 376.824,4 KgCO₂/month or 4521,89 tonCO₂/year. This is caused by Kuranji Sub-district is the second of highest number after Koto Tengah Sub-district.

3.2.2 CO₂ Emission Loads Based on Household Energy Consumption in Padang City (Secondary CO₂ Emissions)



The calculation of carbon dioxide emissions from household electricity consumption (secondary CO₂ emissions) is based on the number of the amount of electricity consumption (kWh) at Desember, 2011 for each area in Padang City. Each area distributes electricity to each sub-district. Table 4 shows the calculation of secondary CO₂ emissions.

Table 4 CO₂ Emission Loads Based on Household Electricity Consumption in Padang City

| N o | Rayon | Number of Customer | Electricity Consumption kWh | Emission Factor gr/kwh | Secondary CO ₂ Emission TCO ₂ /mnth |
|--------|----------|-----------------------|-----------------------------------|------------------------------|---|
| 1 | Belanti | 47.970 | 19.911.700,1 | 454,0 | 9.039,9 |
| 2 | Tabing | 41.145 | 9.867.153,4 | 454,0 | 4.479,7 |
| 3 | Indarung | 53.293 | 19.935.123,2 | 454,0 | 9.050,5 |
| 4 | Kuranji | 43.154 | 8.525.238,0 | 454,0 | 3.870,6 |
| Total | | 185.562 | 58.239.214,7 | | 26.440,6 |

Table 4 presents the total of electricity consumption per month is derived from four areas, are Belanti, Tabing, Kuranji and Indarung Area. Belanti and Indarung Area is two of area which consumed more electricity than the other areas. Electricity consumption amounted to 9.050,55 TonCO₂/month in Indarung area while Belanti area is about 9.039,91 TonCO₂/month. Figure 2 shows the rest.

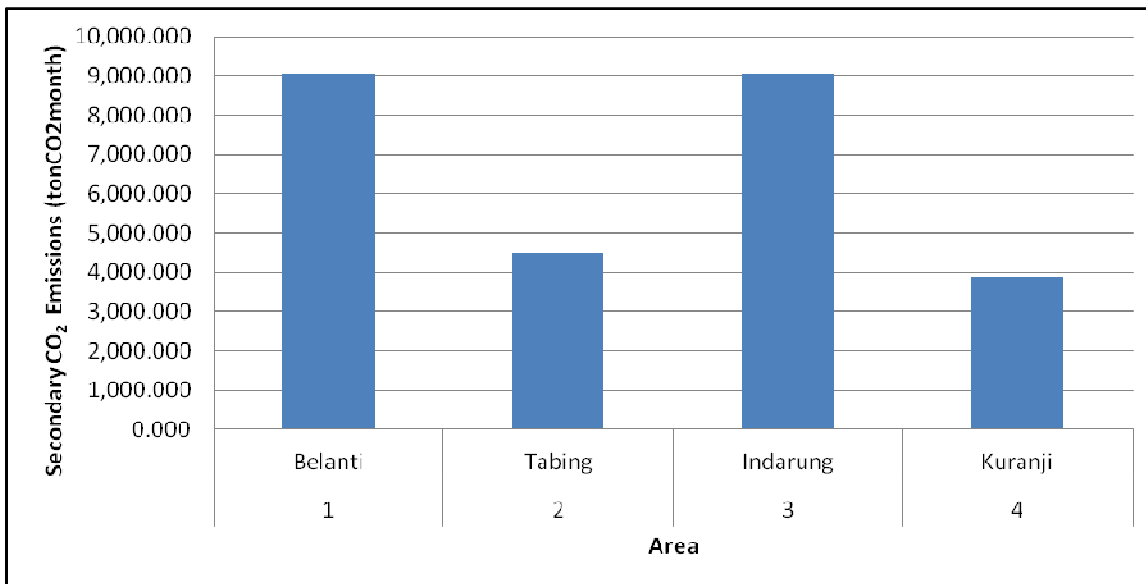


Figure 2 Secondary CO₂ Emmission Loads in Padang City

Household electricity consumption include various use such as cooking, lighting other needs that use electricity. The more electricity used, it will result in much more indirect CO₂ emission load.

Factors that affect the amount of electricity consumption in one house are welfare of the family and the size of house. Indarung's electricity consumption take a lead with 34,23 % of electricity consumption followed by Belanti Area with 34,19 % of total secondary CO₂ emissions. Indarung and Belanti area as the main emitter of secondary CO₂ emission have so many customers than the other areas that lead so much electricity consumption.



3.2.3 Total Carbon Dioxide Emmissions Charges Based on Domestic Energy Consumption and Household Electricity Consumption

The value of total emissions of carbon dioxide (total CO₂ emmissions) is calculated from the consumptions of energy in Padang City which are domestic energy consumption and household electricity consumption. Primary CO₂ emmissions are derived from the emission charge calculation based on Puslitbangkim (2002). The resulting of total CO₂ emmissions calculation can be seen in Table 5.

Table 5 Total Carbon Dioxide Emmissions Charges Based on Domestic Energy Consumption and Household Electricity Consumption

| No | Sub-district | CO ₂ Emmissions Charges | | |
|-------|---------------------|---|---|---|
| | | Primary CO ₂ Emmissions KgCO ₂ /mounth | Secondary CO ₂ Emmissions KgCO ₂ /mounth | Total CO ₂ Emmissions KgCO ₂ /mounth |
| 1 | Bungus Teluk Kabung | 250.976,5 | | |
| 2 | Lubuk Kilangan | 586.077,1 | 9.050.545,93 | 10.778.244,93 |
| 3 | Lubuk Begalung | 890.645,4 | | |
| 4 | Padang Selatan | 607.202,9 | | |
| 5 | Padang Timur | 687.690,4 | | |
| 6 | Padang Barat | 386.041,2 | 9.039.911,85 | 11.858.803,05 |
| 7 | Padang Utara | 602.209,8 | | |
| 8 | Nanggalo | 535.746,9 | | |
| 9 | Kuranji | 1.247.284,77 | | |
| 10 | Pauh | 461.952,3 | 3.870.458,06 | 5.579.695,13 |
| 11 | Koto Tangah | 1.438.138,6 | 4.479.687,64 | 5.917.826,24 |
| Total | | 7.693.966,0 | 26.440.603,48 | 34.134.569,35 |

The following Tabel 5 shows the value of Carbon Dioxide in Padang City that derived from domestic energy consumption and household electricity consumption is 34.134.569,35 KgCO₂/month atau 409.614,83 Ton CO₂/year. It shows Padang Selatan Sub-district, Padang Timur Sub-district, Padang Barat Sub-district, Padang Utara Sub-district and Nanggalo Sub-district lead in total carbon dioxide emissions.

Household electricity consumption contributes to the most carbon dioxide emissions in Padang City for about 26.440.603,48 kg CO₂/month or 317.287,24 tonCO₂/year. It's followed by kerosene consumption. Figure 3 shows the rest.

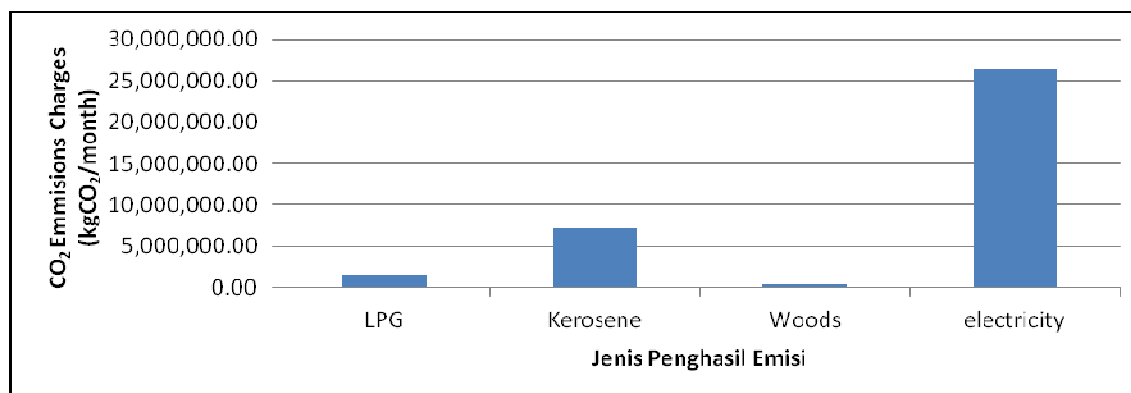


Figure 3 Total Carbon Dioxide Emmissions by Source In Padang City

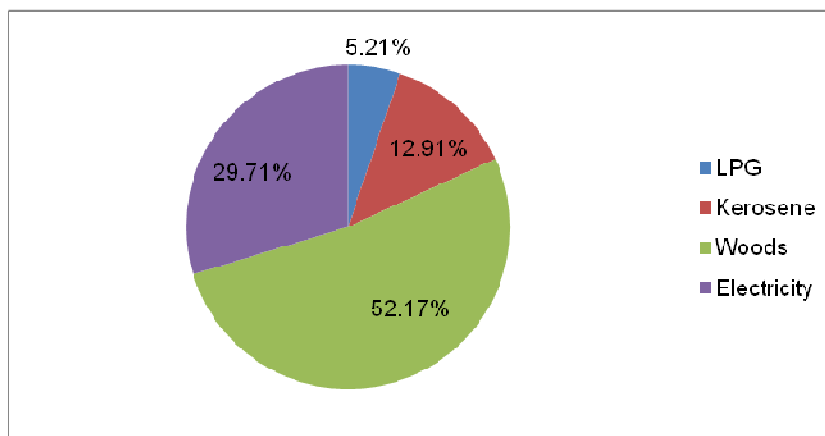


Figure 4 Average Carbon Dioxide Emissions by Source in Padang City

3.3 Carbon Footprint in Padang City

The mapping of this study use color-coded to indicate the amount of emissions at each of sub-district. The color-coded it self will show which one the sub-district that produce the largest emissions, medium and low emissions. It will be used by giving a specific range as symbol that represent the color it self.

3.3.1 Primary Carbon Footprint

The mapping of primary carbon dioxide emissions use color-coded by assigning colors that are differentiated by the level of emissions emitted in Padang City. So it can be divided into high-level ($\leq 1.500.000$ KgCO₂/month) is represented by the black color and low-level (≥ 499.999 KgCO₂/month) is represented by the blue color. The Range of primary carbon dioxide emissions can be seen in Table 6.

Figure 5 shows Koto Tangah Sub-district is one of the sub-district which emits the largest primary emissions in the Padang City. It emits more than 1.500.000 kg of CO₂/month from the domestic energy consumption. Meanwhile Bungus Teluk Kabung Sub-district and Padang Barat Sub-district emit the lowest primary carbon dioxide emissions which is lower than 4.999.999 kgCO₂/month.

Table 6 Range of Mapping Primary CO₂ emissions in Padang City

| No | Color | Range | Primary CO ₂ Emmisions KgCO ₂ /month | Sub-district |
|----|-------|---------------------|---|---------------------|
| 1 | Blue | ≥ 499.999 | 250.976,5 | Bungus Teluk Kabung |
| | | | 461.952,3 | Pauh |
| | | | 386.041,2 | Padang Barat |
| | | | 586.077,1 | Lubuk Kilangan |
| 2 | Green | 500.000-9.999.999 | 607.202,9 | Padang Selatan |
| | | | 687.690,4 | Padang Timur |
| | | | 602.209,8 | Padang Utara |
| | | | 535.746,9 | Nanggalo |
| | | | 890.645,4 | Lubuk Begalung |
| 3 | Red | 1.000.000-1.499.999 | 1.247.284,77 | Kuranji |
| | | | 1.438.138,6 | Koto Tangah |
| 4 | Black | $\leq 1.500.000$ | - | - |

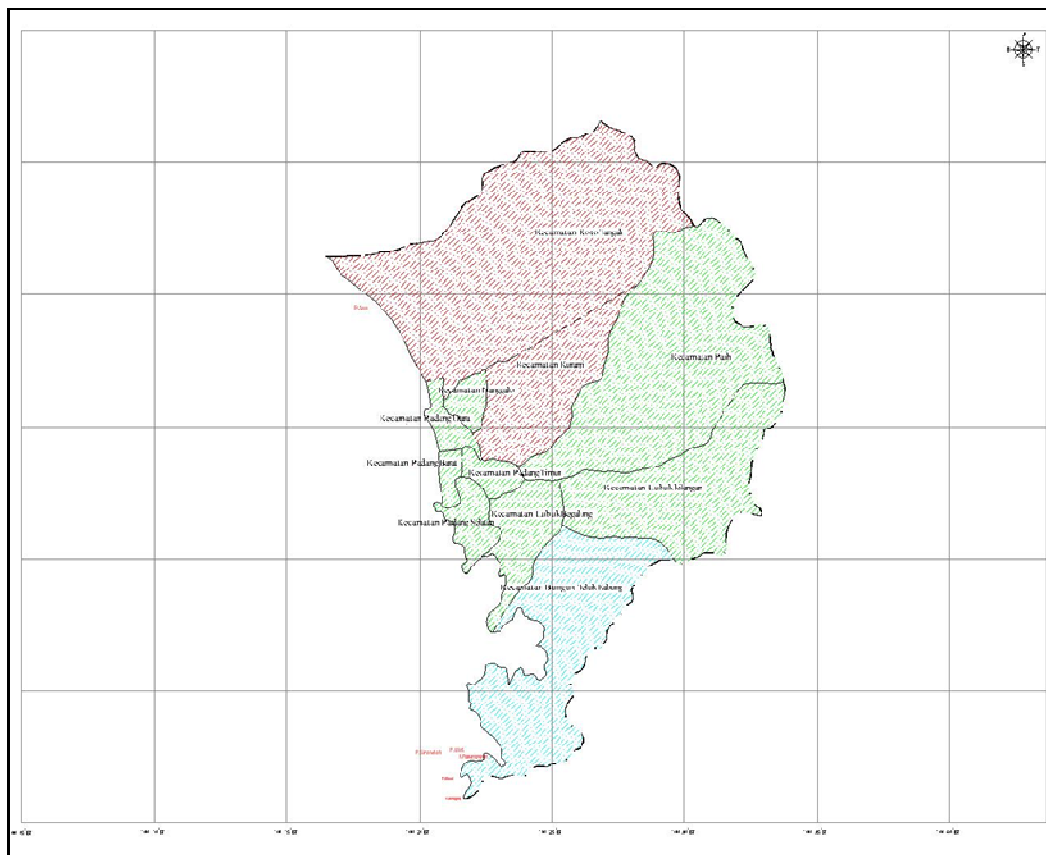


Figure 5 Primary Carbon Footprint in Padang City

3.3.2 Secondary Carbon Footprint

The way of mapping secondary carbon footprint has almost the same way with primary. The difference between mapping secondary carbon footprint and primary is the way of range determining. The range of secondary carbon dioxide is determined by the level of emissions emitted. So it can be divided into high-level ($\leq 7.500.000\text{kgCO}_2/\text{month}$) that represented by black color and low-level ($0-2.499.999\text{kgCO}_2/\text{month}$) that represented by blue color. The Range of secondary carbon dioxide emissions can be seen in Table 7.

Figure 6 shows Belanti area and Indarung area is two of emitter that emits the largest secondary carbon dioxide emissions in Padang City. It emits more than $7.500.000\text{kgCO}_2/\text{month}$, meanwhile Tabing area and Koto Tangah area is two of emitter that emits the secondary lowest carbon dioxide emissions. It is about $2.500.000-4.999.999\text{kgCO}_2/\text{month}$.

Table 7 Range of Mapping Secondary CO_2 emissions in Padang City

| No | Color | Range | Secondari CO_2 Emissions $\text{KgCO}_2/\text{month}$ | Area |
|----|-------|--------------------|---|-------------|
| 1 | Blue | 0-2.499.999 | - | - |
| 2 | Green | 2500.000-4.999.999 | 3.870.458,06 | Tabing |
| | | | 4.479.687,64 | Koto Tangah |
| 3 | Red | 5000.000-7.499.999 | - | - |
| 4 | Black | $\leq 7.500.000$ | 9.039.911,85 | Belanti |
| | | | 9.050.545,93 | Indarung |

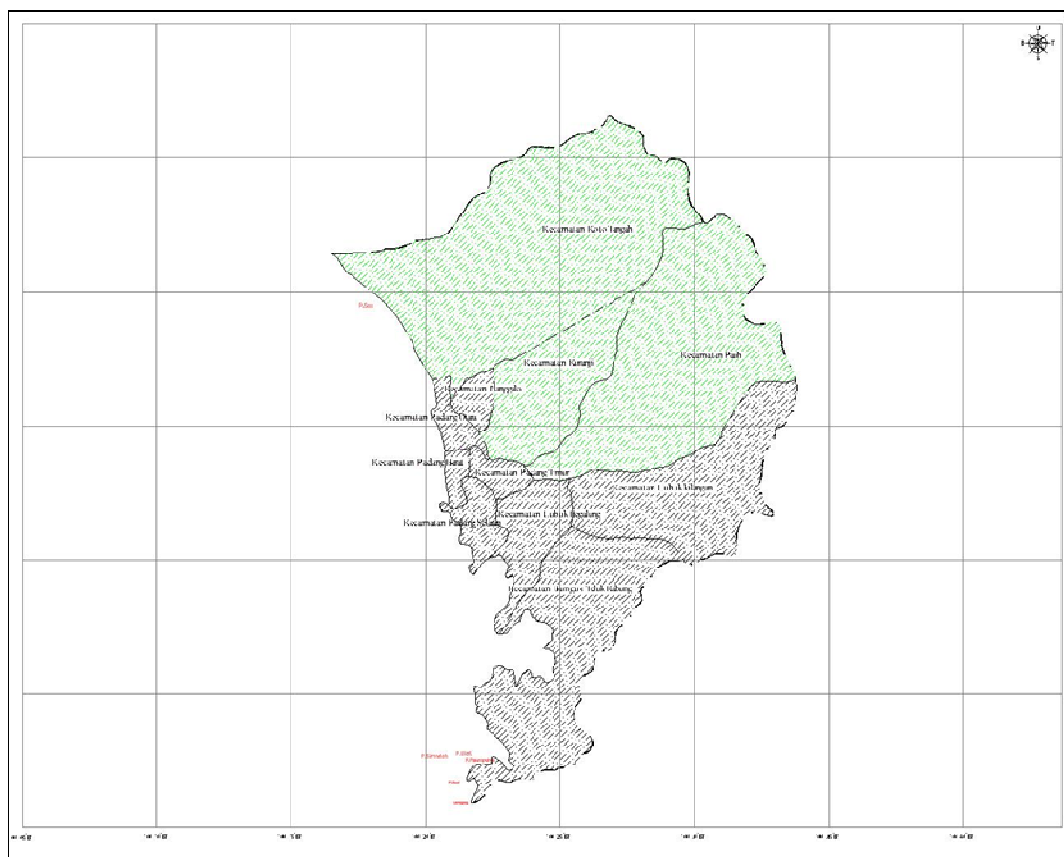


Figure 6 Secondary Carbon Footprint in Padang City

3.3.3 Total Carbon Footprint

The way of mapping total carbon footprint has almost the same way with primary and secondary. The difference between them is the way of range determining. The range of total carbon dioxide is determined by the level of emissions emitted. So it can be divided into high-level ($\leq 12.000.000 \text{ kgCO}_2/\text{month}$) that represented by red color and low-level ($0-5.999.999 \text{ kgCO}_2/\text{month}$) that represented by blue color. The range of secondary carbon dioxide emissions can be seen in Table 8.

Figure 6 shows Belanti area and Indarung area is two of emitter that emits the largest in total carbon dioxide emissions in Padang City. It emits more than $12.000.000 \text{ kgCO}_2/\text{month}$, meanwhile Tabing area is the emitter that emits the lowest in total carbon dioxide emissions. It is about $0-5.999.999 \text{ kgCO}_2/\text{month}$.

Table 8 Range of Mapping Total CO_2 Emissions in Padang City

| No | Color | Range | Total CO_2 Emissions $\text{KgCO}_2/\text{bulan}$ | Area |
|----|------------|----------------------|---|-------------|
| 1 | Biru Muda | 0-5.999.999 | 5.579.695,13 | Tabing |
| | | | 5.917.826,24 | Koto Tangah |
| 2 | Hijau Muda | 6.000.000-11.999.999 | 11.858.803,05 | Belanti |
| | | | 10.778.244,93 | Indarung |

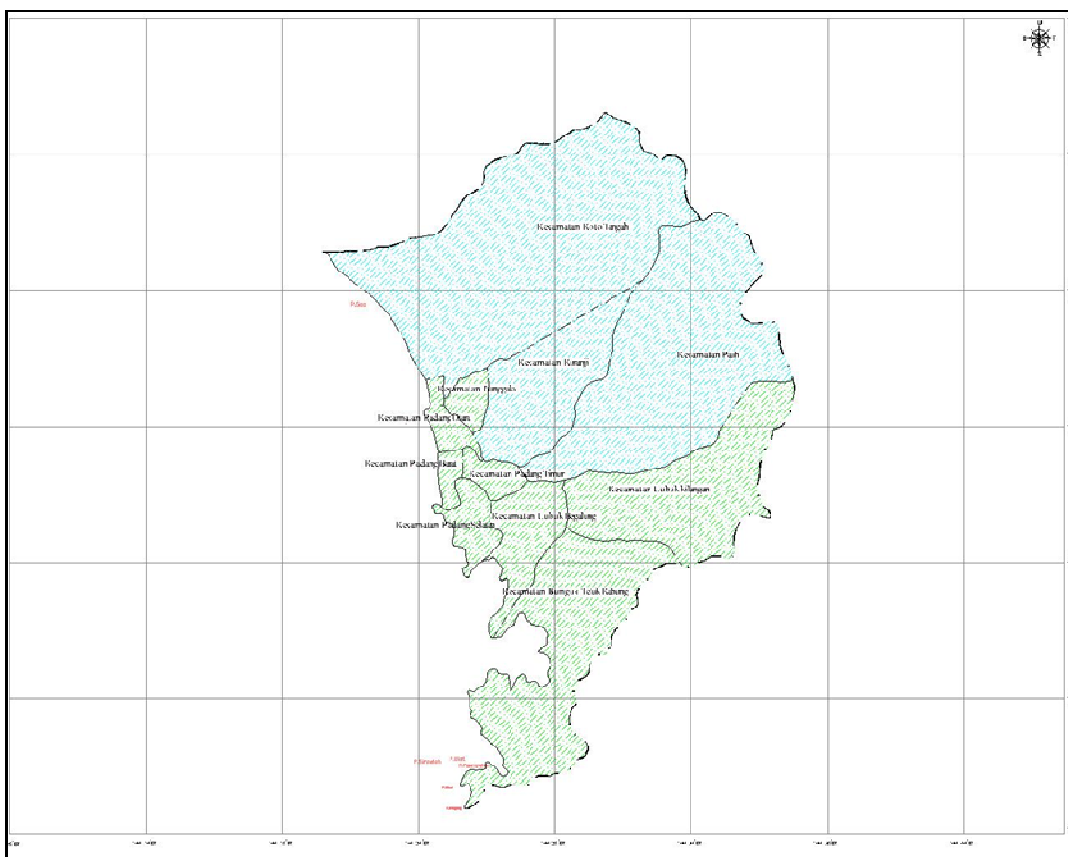


Figure 7 Total Carbon Footprint in Padang City

4. Closure

4.1 Conclusion

Based on survey result and calculations can be concluded as follows:

1. CO₂ emission loads from domestic energy consumption for cooking emits about 92.327.592 ton CO₂/year which is divided into LPGs amounted to 19.285,84 ton CO₂/year, kerosenes amounted to 70.050,74 ton CO₂/year and wood about 2.991.01 ton CO₂/year, meanwhile CO₂ emission loads from housesold energy consumption is amounted to 317.287,2 ton CO₂/year so the total CO₂ emissions from domestic activities in Padang City is about 409.614,83 ton CO₂/year;
2. The results of carbon footprint mapping based on domestic energy consumption for cooking (primary CO₂ emissions) and household electricity consumptions are resulted Koto Tengah sub-district as a largest emitter of primary CO₂ emissions, meanwhile Belanti Area and Indarung area is two of area that emitted secondary CO₂ emissions the most.

4.2 Suggestions

The suggestionss can be given to further progreess of this research are:

1. Making emission inventory in Padang City due to manufacture of building materials, the transport of building materials and the using of equipment during the construction process;



2. In order to make this emission inventory valid should be calculated based on the type of house, number of family one house and the income of the family;
3. Do make an emission inventory of greenhouse from other sources such as landfill, the mining sector, so that it can be calculated the total of all greenhouse gases emitted into earth's atmosphere.

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