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Estimation of CO_2 Emissions from Meat Consumption in Indonesia

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Abstract: Increasing of green house gases cause climate change and it goes up world temperature 2°C. CO_2 emissions are one of GHG and it is resulted by anthropogenic. Their source can be derived by primary, secondary and tertiary sources. There is no study about relationship between meat consumption as tertiary source and CO_2 emissions in Indonesia. This study analyzed how meat consumption produces CO_2 emissions in Indonesia and its province. The calculation used linier regression created from 169 countries in the world. The result of study shows that the average annual of meat consumption is 0.32 kg per capita produce 510 kg CO_2 emissions from 2007-2014. Meanwhile in 2015 Kalimantan Tengah (Central Borneo) and Riau become two big provinces which produce CO_2 emission come from meat consumption both urban and rural.

Key words: Climate change, green haouse gases, meat consumption, CO_2 emission, source

INTRODUCTION

Climate change causes adverse impact for health of human being and the environment. It happens because Green House Gases (GHG) in atmosphere is scientifically increased (Rattanachot *et al*., 2015; Nejat *et al*., 2015). Meanwhile kyoto protocol cannot maintain CO_2 emission as GHG below 450 ppm so the temperature in the earth rises to 2°C (Wang and Chen, 2013; Wang *et al*., 2016a-c; Bartolai *et al*., 2015).

Estimation of CO_2 related energy consumption has been studied (Rafindadi, 2016; Shahbaz *et al*., 2016; Wang *et al*., 2016a-c; Ziaei, 2015; Shafiei and Salim, 2014; Raphaely and Marinova, 2014; Liu *et al*., 2015; Song *et al*., 2016; Shahbaz *et al*., 2015; Achour and Belloumi, 2016; Summerbell *et al*., 2016; Jamali-Zgha *et al*., 2013; Cai *et al*., 2016; Kajaste and Hurme, 2016; Abdul-Wahab *et al*., 2016; Xu *et al*., 2015; Shen *et al*., 2015; Zhang *et al*., 2013; Nabavieh *et al*., 2015; Orikiasa *et al*., 2015; Lopez-Gonzalez *et al*., 2016; Peng, 2016; Tettey *et al*., 2014; Wang *et al*., 2014; Zhou and Liu, 2016; Wang *et al*., 2016a-c; Kareem *et al*., 2017). However, it is important to study in more detail source of CO_2. It can be primer, secondary source or tertiary sources. For third sources, estimation of CO_2 emissions from food consumption as primer human need is require to study for carbon foot print.

In the world meat consumption produces 30% CO_2 emissions (Raphaely and Marinova, 2014). In Indonesia, there is no publication which calculates relationship between meat consumption (including cow, buffalo, broiler and local chicken) and CO_2 emission. So the estimation of CO_2 emissions rom meat consumption require to study. The aim of this study is to know potency of CO_2 emission from meat consumption in Indonesia and in each province.

MATERIALS AND METHODS

To serve the objective this study uses equation of linear regression which is generated by meat consumption of 169 countries to estimate CO_2 emission (Raphaely and Marinova, 2014). Figure 1 which shows CO_2 emissions as a function of meat consumption was resulted by Table 1.

Table 1 estimates per capita average annual CO_2 emission which is calculated by per capita average weekly or daily meat consumption in many countries in the world. Meanwhile recommendation of meat consumption for health reason is not exceed 36.4 kg/capita average annual consumption or below 0.7 kg/capita average weekly consumption or <100 g/capita average daily consumption.

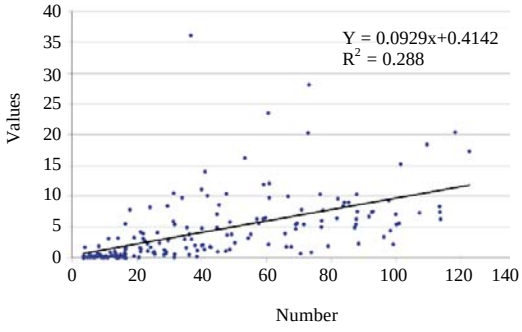

Fig. 1: CO_2 emissions as a function of meat consumption in 2009 (Raphaely and Marinova, 2014)

Table 1: Per capita meat consumption and CO_2 emissions in 2009 (Raphaely and Marinova, 2014)

Variables	Per capita average annual consumption (kg)	Per capita average weekly consumption (kg)	Per capita average daily consumption (g)	Per capita average annual CO_2 emissions (tonnes)
Recommended*	<36.4	<0.7000	<100	-
United states of America	120.2	2.3120	330	17.3
Kuwait	119.2	2.2920	327	28.1
Australia	111.5	2.1440	306	18.4
Bahamas	109.5	2.1060	301	7.3
Luxembourg	107.9	2.0750	296	20.4
New Zealand	106.4	2.0460	292	7.4
Austria	102.0	1.9620	280	7.4
Bermuda	101.7	1.9560	279	7.1
Spain	97.0	1.8650	266	6.3
Israel	96.0	1.8460	264	9.0
Denmark	95.2	1.8310	262	8.3
Canada	94.3	1.8130	259	15.2
Portugal	93.4	1.7960	257	5.4
Italy	90.7	1.7440	249	6.7
Slovenia	88.3	1.6980	243	7.5
Germany	88.1	1.6940	242	9.0
Ireland	87.9	1.6900	241	9.3
Serbia and Montenegro	87.7	1.6870	241	6.3
Hungary	87.2	1.6770	240	4.9
France	86.7	1.6670	238	5.6
Iceland	86.2	1.6580	237	6.4
Netherlands	85.5	1.6440	235	10.3
Malta	84.5	1.6250	232	6.0
Antigue and Barduda	84.3	1.6210	232	5.4
United Kingdom	84.2	1.6190	231	7.7
Greece	83.6	1.6080	230	8.4
Czech republic	83.4	1.6040	229	10.3
Mongolia	82.1	1.5790	226	5.4
Belgium	82.0	1.5770	225	9.6
Sweden	80.2	1.5420	220	4.7
Belarus	78.4	1.5080	215	6.3
Cyprus	78.1	1.5020	215	7.5
United Arab Emirates	72.8	1.4000	200	20.3
Switzerland	71.5	1.3750	196	5.4
Poland	70.8	1.3620	195	7.8
Barbados	69.4	1.3350	191	5.6
Finland	66.6	1.2810	183	10.0
New Caledonia	60.8	1.1690	167	12.1
Norway	60.8	1.1690	167	9.7
Brunei Darussalam	60.5	1.1630	166	23.5
Venezuela, RB	59.6	1.1460	164	6.5
Estonia	59.1	1.1370	162	11.9
Bulgaria	57.6	1.1080	158	5.6
Slovak republic	57.0	1.0960	157	6.3
Saudi Arabia	53.3	1.0250	146	16.2
Chain	48.7	0.9370	134	5.8
Koera, Rep	47.6	0.9150	131	10.4
Japan	45.3	0.8710	124	8.6
Malaysia	44.7	0.8600	123	7.1
Lebanon	44.7	0.8600	123	4.9
South Africa	41.7	0.8020	115	10.1
Kazakhstan	41.0	0.7880	113	14.0
Suriname	40.0	0.7690	110	4.8
Russian Federation	39.9	0.7670	110	11.1
Trinidad and Tobago	36.6	0.7040	101	36.1
Croatia	35.4	0.6810	97	4.9
Turkmenistan	33.3	0.6400	91	9.7
Libya	31.3	0.6020	86	10.5
Ukraine	31.2	0.6000	86	5.9
Seychelles	29.4	0.5650	81	8.4
Iran, Islamic Republic	24.0	0.4620	66	8.2
Bosnia and Herzegovina	17.8	0.3420	49	7.8
Azerbaijan	16.4	0.3150	45	5.5
World average	41.9	0.8060	115	4.6

Subsequently based on Indonesia meat consumption from Central Bureau of statistics the relationship between CO_2 emission and meat consumption was analyzed for 34 provinces.

RESULTS AND DISCUSSION

Some studies calculated CO_2 emission from primary emission, i.e., transportation (Liu *et al*., 2015; Song *et al*., 2016; Shahbaz *et al*., 2015; Achour and Belloumi, 2016; Summerbell *et al*., 2016) wood burning (Shahbaz *et al*., 2016) and secondary emission, i.e., fossil fuel plant (Wang *et al*., 2016a-c) cement plant (Wang *et al*., 2016a-c; Summerbell *et al*., 2016; Cai *et al*., 2016; Kajaste and Hurme, 2016; Abdul-Wahab *et al*., 2016; Xu *et al*., 2015) and power plant (Zhang *et al*., 2013; Nabavieh *et al*., 2015). However, few publication is presented to determine CO_2 emission from tertiary emission i,e food consumption (Raphaely and Marinova, 2014; Orikiasa *et al*., 2015) and no-food consumption, i.e., building (Lopez-Gonzalez *et al*., 2016; Peng, 2016; Tettey *et al*., 2014). Figure 2 show that meat consumption is tertiary emissions from food consumption.

Figure 3 shows meat consumption in Nations, Indonesia. It show that the CO_2 emission is relatively similar from 2007-2014 around (0.44 ton CO_2 emissions). The average annual meat consumption per capita is 0.32 kg. From this data per kg meat consumption will produce 0.51 ton CO_2 or 510 kg CO_2. In addition trend of urban population will increase in the future as shown in Fig. 4. Regarding to the relationship between meat consumption and CO_2 emissions in urban area it will be rise up to 2050 (Wang *et al*., 2014; Zhou and Liu, 2016; Wang *et al*., 2016a-c).

Figure 5 shows meat consumption in urban area is higher than rural area in 2015 (Levy and Patz, 2015). It is equal with CO_2 emission in Fig. 6. In urban area the top 5 provinces within meat consumption (2.3 kg per year per capita) and CO_2 emission (0.63 ton per year per capita) is Kepulauan Riau (Riau Island) Kalimantan Tengah (Central Borneo), Kalimantan Barat (West Borneo), Riau and Kalimantan Selatan (South Borneo), respectively. Whereas in 2015, Fig. 7 represents rank of meat consumption (Levy and Patz, 2015) and CO_2 emissions in rural area it confirmed that Kalimantan Tengah (Central Borneo) and Riau has first and second position in both urban and rural from previous (Fig. 5 and 6). Kalimantan Tengah produces CO_2 emissions 0.63 ton in urban and 0.58 ton in rural. It consumes meat 6.57 kg in urban and 5.09 kg in rural.

In other hand Riau uses meat 6.27 and 4.08 kg in urban and rural, respectively. It results 0.62 ton in urban and 0.55 in rural for CO_2 emissions. Based on Fig. 7, the rural population will go down slowly 1% per year so the meat consumption and production CO_2 emission is relatively similar up to 2050.

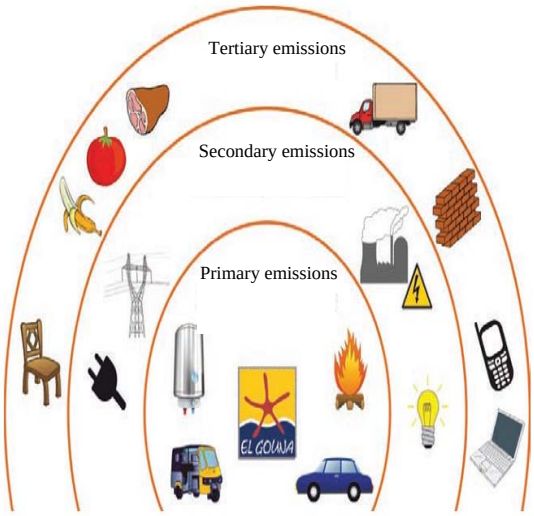

Fig. 2: GHG emitters and emission boundaries

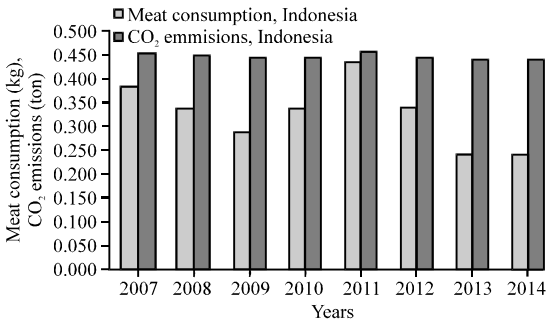

Fig. 3: Meat consumption and CO_2 emissions in Indonesia

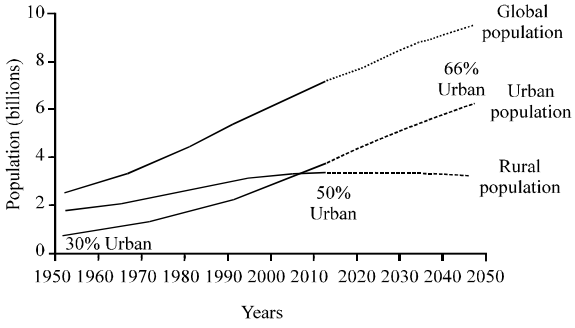

Fig. 4: Global urban and rural population from 1950-2050; LSE Cities in 2014

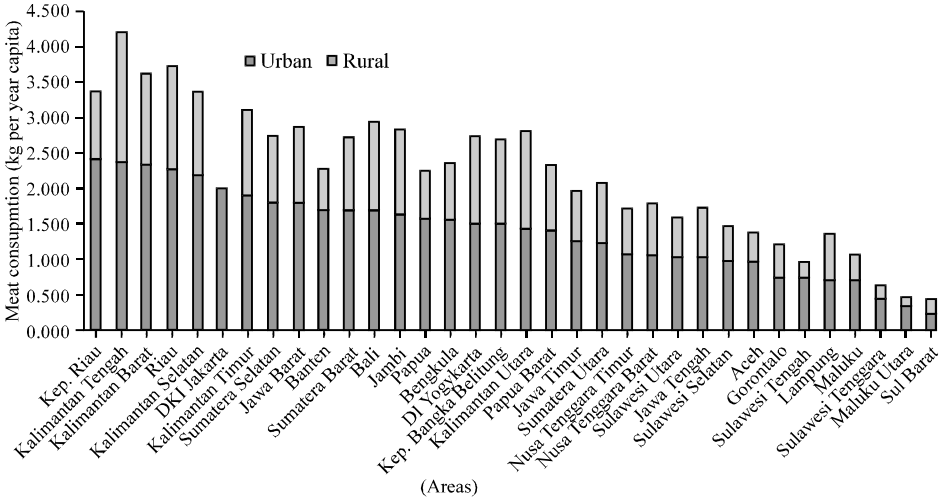

Fig. 5: Meat consumption in urban and rural for each province in 2015

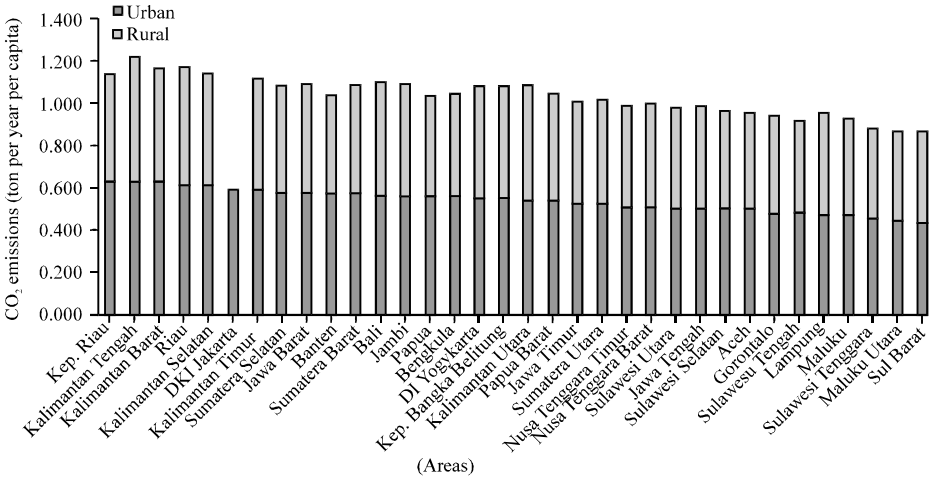

Fig. 6: CO_2 emissions in urban and rural for each province in 2015

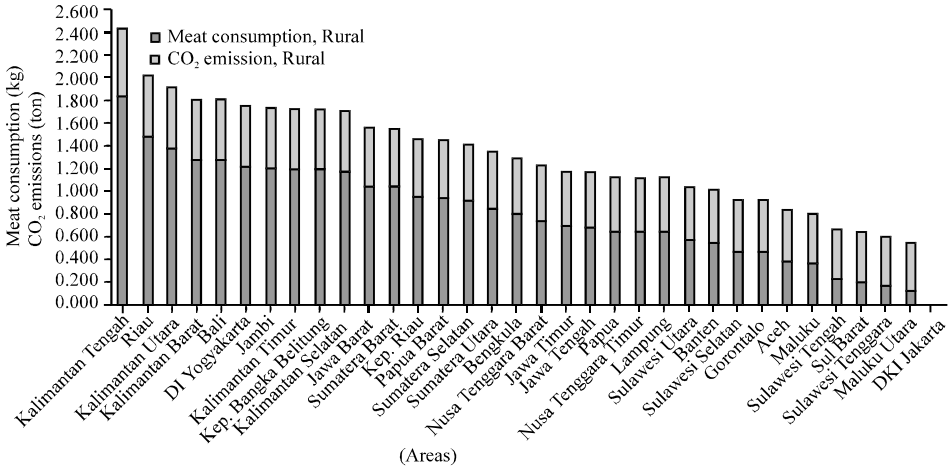

Fig.7: Meat consumption and CO_2 emissions in Rural for each province in 2015

CONCLUSION

This study concludes that Indonesia average annual CO_2 emission per capita is 0.44 ton per year where 1 kg meat will result 510 kg CO_2 In addition Kalimantan Tengah and Riau is two big provinces within meat consumption and CO_2 emission.

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