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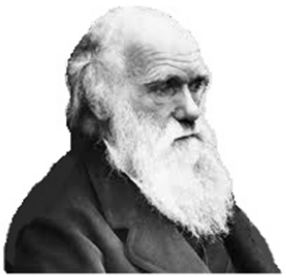

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Measuring a University's Environmental Impact through its Carbon Emissions

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ABSTRACT

To determine the environmental impact of Central Mindanao University, a carbon emissions inventory was conducted. Data from carbon emission sources, such as fuel use, agricultural production, electricity consumption, food purchases, and travel were gathered from various offices of the university. Consumption data were then processed and converted using carbon emission factors derived from previous literature and studies. Results revealed that the total annual carbon emissions of CMU based on the determined sources is 2,271.26 tCO_2e. The primary carbon emission source is agricultural production - which comprises 61% of the total carbon emissions computed. The least source of carbon emission is food purchase - which is 0.3% of the total carbon emissions.

***Keywords*:** Campus Sustainability, Carbon Emissions, Philippine University

1. INTRODUCTION

There has been a persistent call for institutions of higher learning specifically colleges and universities to pave the way for achieving sustainability goals (Shriberg, 2002). First, it has been accepted that higher education institutions (HEIs) have the necessary capacity to assist in the realization of sustainable development (Segovia and Galang, 2002). Second, it is necessary that in order to promote sustainable development HEIs should rightfully start within its premises (Cortese, 2003). After all, allegedly HEIs are the ones who produced the future environmental violators (Rees, 2003). Thus there is a need to inculcate environmental

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protection especially among the young minds in which HEIs have the necessary capacity and essential role in achieving it.

Central Mindanao University (CMU) is a Level IV state university operating in the island of Mindanao, Philippines specifically in the province of Bukidnon. As stated in Republic Act 4498, CMU is mandated with its fourfold function in instruction, research, extension, and production. Through time CMU undeniably has created ecological impacts in pushing through with its day to day operations. In fact, the university administration admittedly wants to attain sustainability as stated in its vision statement: "An academic paradise of higher learning actively committed to the total development of people for a globally sustainable environment and humane society".

In achieving the above goals, CMU needs to bank upon initiatives to measure its impact to the environment (Medina, 2015; Medina and Catalon, 2015; Medina and Toledo-Bruno, 2016, Toledo-Bruno et al, 2016; Medina, 2018).

With such measurement, several sustainability programs and policies can be institutionalized for CMU to achieve the above vision.

It is with this purpose that this study was conducted. Global warming and climate change is an issue that HEIs should interact with. Just like corporate organizations who felt the need to monitor their ecological impact in terms of their contribution to climate change in the form of greenhouse gases (Penela et al, 2009; Parigiani et al, 2011), universities can also continue in this direction as in the case of recent studies (Aroonsrimorakot et al, 2013; Ozawa-Meida et al. 2013; Larsen et al. 2013). With results from this study, viable environmental programs and policies can be initiated by CMU to attain its sustainability goals in the form of climate change mitigation. The objective of this paper is to determine the carbon emissions of Central Mindanao University.

2. MATERIALS AND METHODS

2. 1. Data Sources

Table 1 shows the data gathered for the study. These data are generally annual consumption and production data of CMU categorized as follows: fuel use (diesel, gasoline, and liquefied petroleum gas), agricultural production (rice production, and livestock production), electricity consumption, food purchases (pork, beef, chicken, rice, vegetables), and travel (field trips, and air travel). Most of the data were gathered from respective offices of CMU where such information is available. The data gathering was done from September 2014 to February 2015. Only the annual consumption and production data of CMU in 2013 was utilized due to the incomplete data for 2014 and 2015 during the data gathering period.

2. 2. Carbon Emission Conversion Factors

To convert the consumption and production data into its equivalent carbon emissions, conversion factors were derived from previous literature and studies. Due to the lack of a single document or publication which contains all the conversion factors to be used in the study, desk review was done to search and filter the necessary conversion factors from several accepted literature. Conversion factors however are not readily available as a numerical value but rather as equations and constants. Hence, conversion factors were derived by manual

computations using the provided constants applicable to the study area. From this procedure, conversion factors were derived. Table 2 shows the derived conversion factors.

2. 3. Data Analysis

Table 1. Nature and sources of data for the study

Carbon Emissions Component	Data Needed	Units	Data Sources
Fuel Use	Fuel Consumed by Vehicle Fleet and Cooking/Heating Activities	Liters (Diesel & Gasoline) Kilograms (LPG)	General Services Office, Chemistry Laboratories, College of Human Ecology, University Food and Lodging Services
Agricultural Production	Land for Rice Cultivation	Hectares of irrigated rice fields	University Income Generation Program
	Number of Livestock	Heads of livestock and poultry (Cattle, Carabao, Goats, Swine, Poultry)	University Income Generation Program
Electricity Consumption	Electricity Consumed	Kilowatt-hour consumed	First Bukidnon Electric Cooperative
Food Purchases	Food Purchased	Kilograms of food purchased (Pork, Beef, Chicken, Rice, Vegetables)	University Food and Lodging Services
Transportation	Length of Travel in Field Trips	Kilometers traveled by field trip vehicle	Office of Student Affairs
	Length of Air Travel	Kilometers travelled per passenger	Accounting Office

Table 2. Carbon emissions conversion factors used in the study

Carbon Emission Sources	Carbon Emissions Conversion Factor	Basis for Conversion Factors
Diesel	0.00284995 tCO_2e/L	IPCC, 2006
Gasoline	0.002411652 tCO_2e/L	IPCC, 2006

LPG	0.00327754 tCO_2e/kg	IPCC, 2006
Irrigated Rice Paddies	6.55 $tCO_2e/has/season$	RP-UNDP-GEF, 2011
Cattle	2.861942857 $tCO_2e/head$	IPCC, 2006
Carabao	1.799628571 $tCO_2e/head$	IPCC, 2006
Goats	0.242888571 $tCO_2e/head$	IPCC, 2006
Swine	0.349851429 $tCO_2e/head$	IPCC, 2006
Poultry	0.006119429 $tCO_2e/head$	IPCC, 2006
Electricity Consumed	0.000528773 tCO_2e/kWh	Brander et al, 2011
Pork	0.0002076 tCO_2e/kg	Pathak et al, 2010
Beef	0.0002076 tCO_2e/kg	Pathak et al, 2010
Chicken	0.0001436 tCO_2e/kg	Pathak et al, 2010
Rice	0.0001012 tCO_2e/kg	Pathak et al, 2010
Vegetables	0.0001064 tCO_2e/kg	Pathak et al, 2010
Vehicle travel	0.024824131 tCO_2e/vkm	USEPA, 2008
Air travel	0.000175 tCO_2e/pkm	USEPA, 2008

Descriptive analysis such as the use of percentage was done to present the results of the study. Tabular presentation was also done to provide a visual presentation of the results.

3. RESULTS AND DISCUSSIONS

As shown in Table 3, CMU's carbon emissions in 2013 based on the identified sources is equivalent to 2,271.26 tCO_2e (tons of carbon dioxide equivalent). This is equal to burning 5,223.9 barrels of crude oil or 1,030.23 kilograms of coal. Most of the carbon emissions came from agricultural production (around 1193.87 tCO_2e from rice production and 193.16 tCO_2e from livestock production). This is equivalent to around 61% of the total carbon emissions from the studied sources. CMU's chances for decreasing its carbon emissions could somehow lie mostly on this aspect. Agricultural practices that could help reduce carbon emissions in crop production as well as in livestock production should be taken into consideration. (Lokupitiya & Paustian, 2006; Monteny et al, 2006; Garnett, 2009; Popp et al, 2010).

On the other hand, the source with the lowest contribution to CMU's carbon emissions is from food purchases which comprise less than 1% of the total.

Furthermore, it is also interesting to note that fuel use (by the university vehicle fleet and for cooking/heating) only resulted to 136.35 tCO_2e of carbon emissions, a mere 6% of the

total. Transportation sources, on the other hand, are equivalent to 312.29 tCO_2e or around 14% of the total. This could mean that indirect sources (travel using external means such as rented vehicles and air travel) contribute largely to carbon emissions compared to direct use of university vehicles. Most of these indirect travel emissions come from field trips (264.53 tCO_2e) while around 47.76 tCO_2e came from air travel.

This can be addressed by optimizing field trip travels by limiting these trips to closer destinations as well as conducting/combining related educational trips at one time instead of separately. However, this should be done in such a way that the intended learning of the students from the said activities will not be affected.

Electricity consumption resulted to around 19% of the total carbon emissions (428.64 tCO_2e). This is higher than the university's emissions from travel. In fact this is around 1/3 of the emissions from agricultural production. Given this fact, because it is somewhat difficult to minimize agricultural production just to decrease carbon emissions, the more likely candidate for minimization is from electricity consumption. It is suggested that renewable energy options should be taken into consideration as well as to intensify the energy conservation initiatives of the university.

Table 3. Annual Carbon Emissions (tCO_2e) of CMU in 2013 Categorized by Sources

Source	Annual Carbon Emissions	Percentage
Fuel Use	136.35	6.0
Agricultural Production	1,387.03	61.1
Electricity Consumption	428.64	18.9
Food Purchases	6.95	0.3
Transportation	312.29	13.7
Total	**2,271.26**	100.0

It should be noted that the emission sources used for in this study does not really reflect the whole carbon emissions of CMU. Thus, what we have so far achieved in this study is provide at least an underestimate of the real carbon emissions of the university. Being an underestimate this means that the carbon emissions of CMU can be more than what's reflected above. Due to some problems with acquisition of data (lack of records, incomplete information, etc.) carbon emissions from some sources such as paper consumption or waste generation were not included in the study (although there are available conversion factors for this items).

4. CONCLUSIONS AND RECOMMENDATIONS

The study revealed that agricultural production is the primary source of carbon emissions in CMU. This is followed by electricity consumption. This means that aside from technological interventions in crop productions leading to minimization of methane production in rice cultivation, the next best option for the university to decrease its carbon emissions is through energy conservation as well as options for renewable energy production. It is also important to note that another viable option for reducing carbon emissions is the optimization of field trips which includes limitation of distance to be traveled for such purposes.

Furthermore, carbon offsetting schemes of the university (tree planting and forest cover) is a viable option to achieve carbon neutrality. This suggests future researches dealing with the carbon sequestration rates of forests and plantations in the university.

As previously mentioned, other carbon emissions sources weren't included in the study due to incomplete data (e.g. paper consumption and solid waste generation). Nevertheless, the above results are helpful in the development of policies and programs related to achieving the sustainability goals of CMU specifically in the light of climate change mitigation.

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