ESTIMATION OF GREENHOUSE GAS (GHG) EMISSION LEVEL FROM WASTE AND GARBAGE DISPOSED IN THE COASTAL BARANGAYS OF DAPITAN CITY: IMPLICATIONS TO THEIR WASTE MANAGEMENT PRACTICES

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Date Submitted: March, 2010
Date Revised: April, 2010
Word Count: 2, 346

Abstract

Wastes and garbage disposed of by the coastal barangays of Dapitan City were analyzed as to volume, composition and manner of disposal in order to estimate the approximate level of daily greenhouse gas (GHG) emissions using an international conversion factor by the International Panel on Climate Change (IPCC) conversion manual. The waste management practices of the barangays were likewise established as these determine to a large extent the degree of GHG emitted through household wastes. Results revealed that roughly 43.8 kilo-tons of CO2, 2.52 kilo-tons of methane and .515 kilo-tons of nitreous oxide per year are derived from the household wastes alone due to their poor waste management practices. If open burning and other improper waste disposal practices were strictly banned and violators apprehended, the greenhouse gas emissions can be condensed by as much as 50% of their present levels.

Keywords: *biomass conversion factor, greenhouse gas, waste management*

Introduction

Much of the accumulation of greenhouse gases in the atmosphere can be attributed to the activities of man: from the mundane household wastes to the wastes generated by large industrial plants. The protocols in which these wastes are disposed of also establish the quantity of harmful gases, particularly carbon dioxide and methane, which these wastes give off. Two (2) of the more seriously damaging manner of waste disposal that greatly contribute to rise in global temperature are open dumping and burning (IPCC, 2009).

The absence of environmentally friendly, affordable and sustainable waste management has led to open dumping and open burning of solid wastes in various parts of the world. Open dumping encourages scavenging for recyclable materials that pose

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real health hazards to the community. On the other hand, open burning results in particulate matters or black carbon in the higher altitudes of the earth , where ice is common, resulting in greater absorption of the sun's energy thus trapping heat in the earth's atmosphere. Global warming results from the excess heat entrapped in these areas causing ice to dissolve and as a result, generating various kinds of atypical weather patterns.

In Dapitan City, solid wastes are collected by a garbage truck on a regular basis and dumped in an open landfill in a distant barangay of the City. However, many residences and several commercial establishments still practice open dumping and open burning (right in their backyards). Around 10% of homes have neither toilet facilities nor sewage treatment. Some have concentrations of cesspools or septic tanks which leak bulky amounts of wastes into the shallow waters of Liboran and Dapitan Rivers. Both rivers deplete into Dapitan Bay where solid and liquid wastes from residences, agricultural lands and fishponds are spilled. The Pulauan wharf poses yet another source of wastes from both the inhabitants and the casual travellers and tourists.

The current study attempts to determine the volume of solid and liquid wastes generated by inhabitants of coastal barangays in Dapitan City on a daily basis and evaluate their waste management practices. A systematic procedure of factor conversion (from waste biomass to one of the harmful GHG) is adopted from the IPCC (2006) conversion guide to determine how much GHG is actually caused by the residents sans good waste management program. Eventually, it is anticipated that once the residents apprehend the magnitude of harm that an un-managed waste disposal scheme can result on the earth's climate, they will voluntarily follow the waste disposal regulation of the City of Dapitan.

Research Method and Design

The study followed the descriptive-analytical procedure in obtaining and analyzing the information necessary to achieve the purported objectives:

Research Locale. The study was conducted in Dapitan Bay particularly on the northwestern stretch of nine(9) barangays: Bucana, Sicayab, Canlucani, Poblacion, Polo, San Pedro, San Vicente, Taguilon, and Tag-ulo (map shown). It is noted that there are existing local ordinances for waste management in these nine barangays.

Waste Identification and Analysis. The nine (9) barangays have a total of 880 households of which 275 households were chosen at random (approximately 31% of the overall number of households). The waste disposal practices of the households chosen for the study are shown in Table 1:

These information will be important when we apply the IPCC-approved conversion factors for biomass to GHG outputs. Meanwhile, it is important to note that only 18.18% of the households actually follow the Ordinance for Waste Management (Collection and Landfilling) with waste segregation policy (9.09%) for a total of 27.27%

law-abiding households in the study (less than one third of the households follow the law on waste management).

Table 1: Waste Management Practices of Sample Households

Waste Disposal Practice	Number	Percentage
Littering	50	18.18
Open Dumping	60	21.82
Open Burning	70	25.45
Composting	10	0.01
Landfilling/Collection	50	18.18
Recycling/Re using/Segregation	25	9.09
Selling	20	7.27
Total	**275**	**100%**

IPCC-Approved Conversion Factors.

The IPCC approved in 2006 the following conversion factors for converting waste biomass to approximate greenhouse gas output:

Table 2: Biomass Conversion Factors for Household Wastes

Source	Description	CO2 Output g/kg	Methane g/kg	Nitreous Oxide g/kg
Wood/Paper/Yard Trimmings/Textiles	Combustion Non-Combustion	950 570	.05 .08	.02 .03
Biodegradables/Common Trash	Combustion Non-Combustion	900 540	.10 .17	.08 .13
Plastics/Styrofoams/ Rubber	Combustion Non-Combustion	200 0	500 0	100 0
Aluminum/Steel/Tin/ Copper/Cans/Bottles	Combustion Non-Combustion	NA NA	NA NA	NA NA
Batteries/Old Machines	Combustion Non-Combustion	NA NA	NA NA	NA NA

Source: Canadian National Inventory Report, 2006 as Approved by IPCC

The wastes generated by the households were identified by volume and by type daily for seven days. The average of each type of waste material was then obtained. The volume of waste (by type) was then converted into the corresponding GHG using the conversion factors above. A typical example is illustrated below for clarity:

Type of waste : Wood/Paper/Yard Trimmings/Textiles
Mean Volume Per Day : 38 kgs
Equivalent GHG Output by Burning (Combustion):
CO2 = 36100 gms (36.1 kg),
Methane = 0.76 gm,
Nitreous Oxide = .76 gm
(*Using Conversion Factors Above*)

Contingency Analysis. The GHG outputs were then further analyzed by looking into the standard waste disposal practice of every barangay and their resultant GHG outputs (low/high) to assess how the GHG outputs recount with the corresponding waste disposal practices of the barangays. That is, we wanted to know the extent to which the waste disposal practice influenced the harmful gas emissions of the barangays. The analysis was done through a simple chi-square test.

Results

Table 3 shows the mean volume of wastes produced by the barangays over a seven-day observation period classified by type and by disposal method. Note that there were several doubts noted as to the reaction of the key informants with respect to the waste disposal practices. The researchers triangulated the responses by asking at least two other members of the households (independently of the main informant). If two of the three informants approved on the process in which their garbage are disposed, then that particular waste disposal practice is noted in the table below. The two other members of the household interviewed were those who were less likely to lie (i.e. no motive to lie).

Table 3: Volume of Wastes by Type of Wastes

Source	Description	Mean Volume Per Day	Standard Error of the Mean	Remarks
Wood/Paper/Yard Trimmings/Textiles	Combustion Non-Combustion	20 18	3.50 2.00	Uncertainties in responses may be present
Biodegradables/Common Trash	Combustion Non-Combustion	50 83	5.25 2.50	-
Plastics/Styrofoams/Rubber	Combustion Non-Combustion	5 33	1.25 4.50	-
Aluminum/Steel/Tin/Copper/Cans/Bottles	Combustion Non-Combustion	0 38	0 6.70	-
Batteries/Old Machines	Combustion Non-Combustion	10	2.50	-

Table 4 shows the net GHG output based on the average daily output of each type of waste and each type of waste disposal (combustion and non-combustion):

Table 4: Total GHG Ouput Per Type of Waste/Garbage

Waste	CO_2 Grams	Methane Grams	Nitreous oxide Grams
Wood/Paper/Yard Trimmings/Textiles	29260	2.44	0.94
Biodegradables/Common Trash	89820	19.11	14.79
Plastics/Styrofoams/Rubber	1000	2500	500
Aluminum/Steel/Tin/Copper/Cans/Bottles	0	0	0
Batteries/Old Machines	0	0	0
TOTAL	120080	2521.55	515.73

Discussions

The average daily GHG emissions from the barangays show an output of about 120 kg of CO2, 2.52 kg of methane and 0.515 kg of nitreous oxide per day. Over a regular one-year period these translate to : 43.80 kilo-tons of CO2, 0.92 kilo-ton of methane and 0.20 kilo-ton of nitreous oxide just for the nine barangays of Dapitan City. We can extrapolate on the figures if we consider the entire city and its designated landfill area. The figures could easily inflate by a factor of 10 i.e. roughly 438 kilo-tons of CO2, 25.2 kilo-tons of methane and 5.15 kilo-tons of nitreous oxide. With the growing population of the City (estimated at roughly 2.6% per annum), the resultant volume of garbage and wastes will double in the next 15 years and, thus, so will the emission of detrimental GH gases into the atmosphere.

However, much of this volume of GH gases can be attributed to the poor waste management practices of the households in the barangays. For instance, if open burning is strictly prohibited, the average daily GH emissions can be reduced by as much as 25% and with other mitigating practices such as closed composting and waste segregation, the GH emissions can be further reduced to 50% of its current levels. Stricter execution of laws and ordinances overriding waste disposal and management needs to be observed if the condition is to be arrested within the next few years.

One potential reason for the relatively loose implementation and adherence of people to apt waste management ordinances is their lack of appreciation and understanding of these laws. For example, the harmful gases emitted from either natural process or by burning the wastes are not perceived as damaging by the ordinary citizen. In reality, in the old credence and tradition, burning of such wastes is regarded as a good practice for driving away mosquitoes. Driving away harmful mosquitoes for them is a far more critical issue than decreasing the expulsion of harmful greenhouse gases into the atmosphere. The problem actually boils down to gratifying a present need (protecting ones health) against mitigating a slow, continuing and largely disregarded climate change. For this reason, an effective educational intervention program will have to be crafted simultaneously focusing on (a.) addressing their health concerns such as driving away mosquitoes and bugs, and (b.) the harmful effects of greenhouse gases to the ozone

layer. If these concerns are simplified and well-understood by the citizens of the City, then conformity to the waste management ordinances will be significantly enhanced.

The greenhouse gas contribution of open dumping of batteries, old machines, iron and steel could not be quantified in the current study given that no conversion factors are accessible in the literature. Nevertheless, we deduce that these waste materials depreciate over time through natural processes and also give off a considerable amount of harmful greenhouse gases in the atmosphere knowing that iron and other such metals counter with free oxygen and nitrogen in the atmosphere. This, of course, will be a matter for the chemists and environmentalists to deal with in future studies. We however wish to stress the necessity of such a quantification process since more and more of this variety of waste products are being generated at the household level e.g. discarded cellular phones, radio batteries, and others.

Finally, more than 95% of the greenhouse gas emissions from the household wastes is carbon dioxide (CO2). This gas is naturally needed by plants for their photosynthetic processes with oxygen as a by-product. Hence, if more plants and trees were sowed in the backyards of these households, then the magnitude of CO2 directly released to the atmosphere could be further reduced. Possibly, this can be implemented as element of the waste management protocols which will be crafted by the City Officials.

In the end, reducing the greenhouse gas emissions from household wastes boils down to the design and strict implementation of a city waste management program.

Conclusions

Household wastes and garbage when improperly disposed of contribute a significant amount of harmful greenhouse gases to the atmosphere. If proper waste management programs are implemented by the City, the amount of GHG can be drastically reduced (by at least 50%). Similarly, since we found that over 95% of the greenhouse gas emissions from the household wastes and garbage is carbon dioxide (CO2), planting of trees in the backyards of these households can help in significantly reducing the free CO2 directly released to the atmosphere by their recent practices. Proper implementation of waste management programs also implies that the citizens be properly educated about the value of good waste disposal practices as these relate to the mitigation efforts to combat climate change and also, to safeguard the health of the people in the community.

Acknowledgment

The authors wish to thank Dr. Roberto N. Padua for the expert advice on the quantification aspect of this study and an anonymous referee for the practical suggestions to improve this paper.

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