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## **Waste Analysis and Characterization Study (WACS): Measures Towards Effective Municipal Waste Management in Batad, Iloilo, Philippines**

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### **ABSTRACT**

*Waste Analysis and Characterization Study (WACS) is the process of gathering information on the quantity and composition of solid wastes generated from various sources in the Municipality of Batad, Iloilo, Philippines. This is part of the bigger process of the Municipal Solid Waste Management (MSWM) practices. The study will also assess how well these different sources in the socioeconomic areas are able to separate their wastes into organic and non-organic materials labeled on the bins as “biodegradable,” and “non-biodegradable” wastes. A descriptive method using survey questionnaire and checklist was used to determine the wastes sources generated by the municipality and to assess the percentage of wastes composition. The respondents of the study included households, institutions commercial establishments, and public market within the Municipality. The results of the 5-day WACS revealed that the wastes composition consists largely of biodegradable, 50.47%, followed by recyclables, 29.26% with potential for recycling, residual wastes with 16.05%, 1.04% for special wastes and 3.19% for fine residuals. Data provided basis for planning and the implementation of relevant waste management activities of the College and the LGU on Vermicomposting Project of the Municipality. The biodegradable wastes that comprise the highest percentage generated by the Municipality were delivered to the Vermi Facility Site for the vermicomposting/organic fertilizer project of the College in collaboration with the LGU-Batad, Provincial Environment and Natural Office (PENRO-LGU) and the Commission on Higher Education (CHED) Central Office. This was continuously being done daily for the sustainability of the project. In support to the environmental programs of the locality, several policies, resolutions, ordinances and executive orders were promulgated. These further strengthen the Local Governments drive on environmental protection.*

**Keywords:** Waste Analysis Characterization Study, Municipal Wastes Management, wastes utilization, Vermicomposting Project, waste segregation

## INTRODUCTION

Solid Waste Management (SWM) remains a pressing environmental issue in most developing countries like the Philippines. To take initiatives in managing these daunting problems on ecological solid waste disposal, the Philippine legislative bodies decreed RA 9003 or the Ecological Solid Waste Management Act. This Act provides for an ecological solid waste management program which shall ensure proper segregation, collection, transport, storage, treatment and disposal of solid wastes. Solid waste management is a form of waste control, often associated with storing, collecting, transporting, processing, and disposing of solid wastes that is in agreement with the codes of conservation, engineering, economics, public health, and other environmental responsibilities.

The implementation and enforcement of the provisions of this Act shall be the primary accountability of the Local Government Units (LGUs) within their respective jurisdictions as stipulated in the RA 7160, otherwise known as the Local Government Code of 1991. The law also mandates that segregation and collection of solid wastes shall be conducted at the *barangay* level while collection of non-recyclable materials and special wastes shall be the duty of the municipality or city level. Therefore, it is the responsibility of LGUs to practice segregation because segregation facilitates the processing of wastes and substantially decreases the amount of wastes directed to the dumpsite.

City and Municipal wastes are often generated from several sources where variable human activities are encountered. Wastes from these sources are highly heterogeneous in nature and have variable physical characteristics depending on their sources which would be difficult to classify. The heterogeneity of the generated waste is the main hindrance in its utilization as a raw material to produce valuable products through the process of recycling. Thus, waste source segregation significantly cuts budget allotted to waste collection and transport which are the most expensive element in the total process of waste management (RA 9003).

There is therefore a need for every Municipality to have a reliable waste management data to process critical and informative evaluation of wastes before they can be subjected to any meaningful waste utilization process. Unfortunately, these required fundamental statistics are lacking in most cities and municipalities nationwide. Although some claimed to have this information, still these are inconsistent because they come unvalidated sources which cannot be authenticated and are sometimes based on assumptions but not scientific measurements. The net effect of these misleading data are often a source of confusion and doubt in providing valuable wastes management programs in every cities and municipalities nationwide. Hence, Wastes Analysis and Characterization Study (WACS) is the right source to obtain correct data for managing waste (Gequinto, 2017; Chung, *et al*, 2001; and Gentil, *et al*, 2011).

The purpose of this study was to generate a comprehensive data of WACS of the Local Government Unit of Batad, Iloilo, Philippines. The result would provide basis in planning and the implementation of relevant waste management activities specifically in the implementation of the joint project of the College and the LGU on vermicomposting venture of the Municipality. The study will also assess how well these different sources in the socioeconomic areas are able to separate their wastes into organic and non-organic materials labeled on the bins as “biodegradables” and “non-biodegradable” wastes.

The generated result would provide baseline information to formulate strategies, programs, projects, policies and activities that would address the issues and concerns of the locality in terms of Solid Waste Management (SWM).

### **Benefits of WACS to the solid waste management program of LGU**

The following are benefits of Waste Analysis and Characterization Study (WACS) to the Ecological Solid Waste Management Program (ESWMP) of the Municipality of Batad, Iloilo.

1. Develop an effective 10-Year Solid Waste Management Plan (SWM Plan of the Municipality. It could define how much the LGU will have to allocate for its ESWM Program;
2. Set realistic targets. It could determine how much should the LGU reduce its waste disposed;
3. Develop Municipal Solid Waste Management diversion strategies. The result of WACS would define what Information Education (IEC) strategy would be very effective;
4. Design SWM facilities. Data from WACS would determine how big would be the structure of the Material Recovery Facility (MRF), Vermicomposting Facility (for compostable wastes) and its capacity; and how big would be identified for the safe sanitary landfill; and

5. Provide baseline information for LGUs to monitor and evaluate its SWM performance in reducing waste generation. The Waste Diversion requirements of the Philippine Law (for recyclables/compostable from waste disposal facility), is 25% 5 years after the effectivity of the Republic Act 9003 otherwise known as the Ecological Solid Waste Management Act of 2000.

### **Objectives of the study**

This study aimed to (1) determine the wastes sources generated by the municipality, (2) assess the percentage of waste composition in terms of compostable, recyclables, residuals, special and fine residuals produced daily from these various wastes source, and (3) design measures toward effective sustainable solid wastes management project, legislation policies, and strategies in the municipality.

### **METHODOLOGY**

A descriptive method using survey questionnaire and checklist validated by experts from Wastes Management Division of the Provincial Environment and Natural Resources Office of the Province of Iloilo to determine the wastes sources generated by the municipality and to assess the percentage of waste composition in terms of compostable, recyclables, residuals, special and fine residuals produced daily from these various wastes source. The respondents of the study included households, institutions (schools, government offices, and health center), commercial establishments, and public market within the Municipality. To determine the sample size, Slovin's formula was used with 0.05 margin of error. Stratified random sampling was employed to get the size proportional to each group.

The survey questionnaire was divided into two parts namely: Demographic Data of the Municipality containing the total number of households and the total number of commercial establishments (restaurants, stores, etc.), industries (including classification) and institutions (schools, hospitals, government offices) located within the municipality to determine the point sources of wastes and the Checklists containing tally sheets of percentage of waste composition generated by the Municipality daily. Data collection started with the request sent to the Office of the Municipal Mayor to conduct the study, copy furnished the Municipal Environment and Natural Resources Office, and NIPSC Batad College Administrator. Data gathered were tallied and analyzed using mean and percentages.

The conduct of WACS has three (3) stages: Pre-WACS activities, five (5) day Waste Characterization Study and data consolidation and analysis. This was based on the recommended guidelines of the Waste Management Division of the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR-RO6):

**Stage 1. Pre-WACS activities.** Preparation and training in the the WACS are necessary in order to create the Technical Working Group (TWG), Recorder, Sorters of wastes. This group were responsible in handling the following activities (a) Identification & groupings of the sources of waste; (b) Sampling Plan Preparation (Data on the number of households-HHs & Non HHs Sources); (c) Prepare and identify WACS material requirements; (d) Conduct orientation on WACS; and (e) sending of communication letters to the concerned officials of the LGU and the implementing institution.

**Stage 2. The Conduct of five (5)- day WACS.** There were six major activities conducted in this stage namely: (1) Distribution of plastic bags labeled properly as biodegradable (*nabubulok*) and nonbiodegradable (*di-nabubulok*) to the indentified sources/cooperators: households, institutions (schools, government offices and health centers), commercial establishment and public markets. There was a letter and instructions contained in each bag. The survey questionnaires for SW practices were also distributed to the identified sources/cooperators; (2) For five consecutive days, all the plastics bags were collected from the identifiedsources/cooperators; (3) The collected wastes were delivered to the sorting area; weighed all collected wastes from sample sources, obtained the net weight of the mixed waste and recorded it in the field data entry form; (4) The wastes were sorted out into biodegradables, recyclables, residual and special wastes; (5) The segregated wastes were placed in the plastic containers, to obtain the representative weights and volumes; (6) Before disposal, all the characterized waste by source were mixed thoroughly. To get the volume of wastes by composition, one (1) cubic meter the randomly collected characterized wastes were weighed and recorded in a separate tally sheets to have baseline data of wastes by volume. All the gathered materials in the characterization were properly disposed.

**Stage 3. Data consolidation and analysis.** The data consolidation and analysis include ensuring quality of

data; data entry in Microsoft Office Excel; and data analysis. The purpose of the waste characterization studies was to provide important information on wastes that is currently being disposed of to enable the LGUs to develop well-founded solid waste management plans and programs (Varey, 2003 and Kristopher,2017).

## RESULTS AND DISCUSSION

Waste Analysis and Characterization Study (WACS) is the process of gathering information on the quantity (such as tons per day, cubic meter, per day and kilograms per household/day) and composition (such as biodegradable and non-biodegradable) of solid wastes generated from various sources. This is part of the bigger process of the municipality's Solid Waste Management (SWM) practices by different sectors. Solid waste generation and characterization are some of the most important parameters which affect environmental sustainability. Table 1 shows the identified wastes sources, inventory of the establishments, and institutions in the Municipality Batad, Iloilo stratified by type and size from the chosen samples.

Table 1. Wastes sources and inventory of the establishments in the municipality of Batad

Sources of wastes	Number of WACS cooperators
Households	33
Institutions (schools, government offices and health center)	8
Commercial establishments	16
Public market	1
<b>TOTAL</b>	<b>58</b>

In the result of 5-Day WACS conducted in the Municipality of Batad, of the total wastes generated amounting to 463.61-kilogram, large percentage of wastes from households, institutions, commercial establishments, and public market are compostable wastes (233.94 kg) while recyclable wastes ranked the second amounting to 135. 66-kg (Table 2). It is clear that most of the generated MSW constituencies in most municipalities and developing countries are decomposable and recyclable. If properly managed, such MSW would provide high opportunities for the development of the socio-economy of the Municipality (Chung and Poon, 2001).

Table 2. Composition of wastes generated from different sources (in Kilogram)

Sources of wastes	Wastes Composition					Total wastes generated (kg)
	Compostable wastes	Recyclable wastes	Residual wastes	Special wastes	Fine wastes	
Household	125.30	45.96	18.81	2	2.95	195.02
Institutions (schools, government offices and health center)	59.04	55.10	32.90	3.70	0.5	151.24
Commercial Establishments	28	17.7	12.4	1.4	3.95	63.45
Public market	21.6	16.90	10.30	0.90	4.20	53.90
<b>Grand Total</b>	<b>233.94</b>	<b>135.66</b>	<b>74.41</b>	<b>8.00</b>	<b>11.60</b>	<b>463.61</b>

Based on the result of 5-Day WACS conducted in the Municipality of Batad, Table 3 shows the Percentage Share of the Municipal Waste Composition at All Sources. Data revealed that the highest percentage share of the municipal waste's composition was from compostable wastes amounting to 50.46% and generated mostly by the households. Amounts of Municipal Solid Waste (MSW), and its composition, have been changing due to the changes in consumption behaviors of people along with the rapid advances of technology (WACS Report, 2017 and Ozcan, *et al*, 2017).

Table 3. Municipal waste composition % share at all sources

Major sources	Total waste generation		Wastes composition				
	Kg/day	%	Compostable	recyclables	residuals	special	Fine residuals
Households	195.02	42.07	125.3	45.96	18.81	2	2.95
Institutions (schools, government offices and health center)	151.24	32.62	59.04	55.10	32.90	0.5	3.7
Commercial	63.45	13.68	28.00	17.70	12.40	1.4	4.2
Public market	53.9	11.63	21.60	16.90	10.30	0.9	3.95
<b>TOTAL</b>	<b>463.61</b>		<b>233.94</b>	<b>135.66</b>	<b>74.41</b>	<b>4.80</b>	<b>14.80</b>
<b>% of Total WACS</b>		<b>100.00</b>	<b>50.46</b>	<b>29.26</b>	<b>16.05</b>	<b>1.04</b>	<b>3.19</b>

In general, the wastes composition in the locality based in Table 3 is consists of largely of biodegradable, 50.47%, followed by recyclables, 29.26% with potential for recycling, residual wastes with 16.05%, 1.04% for special wastes and 3.19% for fine residuals (Figure 1).

The abundance of composite materials in the waste stream solicits attention from the waste management authority to step up the monitoring of their generation pattern and to consider imposing control measures (Integrated Waste Management, 2005).

In terms of waste segregation, data revealed that the different sources are able to separate their wastes into organic and non-organic materials label on the bins as “biodegradable”, and “non-biodegradable” wastes. This indicates that composting of organic materials was more effective and can be adopted by the Municipality. Overall, it is viewed that the presence of Vermicomposting Technology is substantial in solid waste management for it contributes to waste minimization and reduction and income generation as observed in the existing composting facility. This can be done because higher percentage of waste generated in the Municipality is made up of organics.

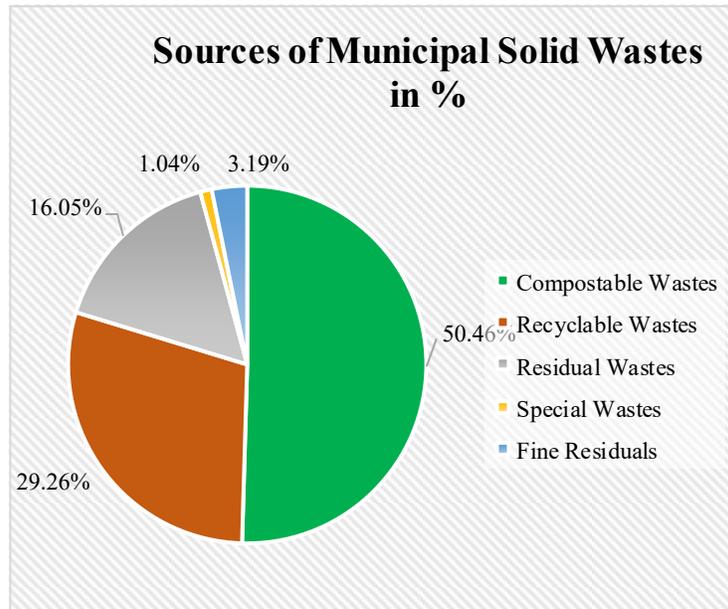


Figure 1. Percentage of waste sources and its characteristics

Table 4 below, shows the summary of the quantity and composition of waste disposed from various wastes sources. The maximum waste generated of the Municipality was 6,938.2 kg/day. In the

industrial practice, the choice and evaluation of strategies of recycling and reuse of solid wastes could be based on ecological risk assessment and life cycle assessment studies of wastes (Tirura-Barna, *et al*, 2007).

Table 4. Wastes composition of all sources in different measurements

Wastes source	Kg/day	Ton/day	Ton/year	Cubic meter/year
Household	6,669.67	6.67	2,434.43	8
Institutions (schools, government offices and health center)	151.24	0.151	55.20	0.184
Commercial	63.45	0.0635	23.16	0.077
Public market	53.90	0.0539	19.67	0.066
<b>Grand total</b>	<b>6,938.26</b>	<b>6.94</b>	<b>2,532.46</b>	<b>8.327</b>

### Activities undertaken by the municipality of Batad as a result of WACS

- The Northern Iloilo Polytechnic State College, the implementing agency through the Office of Research, Development and Extension Services (RDE), conducted a Capability Building Activities on Wastes Recycling. Various cultural activities were also initiated by the College showcasing the talents of the local folks in singing (*enviro-composo* in their own local dialects), *enviro-dancing*, *enviro-painting*, and mangrove rehabilitation projects expressing their concern to their own environment.
- The construction of Vermicomposting Facility from the funding source of the national government through Commission on Higher Education- National Agriculture and Fisheries Education System (CHED-NAFES), in collaboration with the LGU Batad, PENRO and NIPSC Batad as the implementing institution.
- Municipal Wastes' Strategies/Programs/Projects and Strengthening of Existing Ordinances and Policies like the "*Baranggay Ko Linis Ko*", and the "*May Pera sa Basura Project*" which were initiated by the Local Government Unit of Batad, Iloilo to strengthen its drive on environmental protection.

### CONCLUSION

Wastes generated by the Municipality generally came from households, institutions, commercial establishments and public market. These sources are able to separate their wastes into organic and non-organic materials label on the bins as "biodegradable" and "non-biodegradable" wastes. The highest percentage of wastes generated by the municipality was compostable and produced primarily by the households. The most effective SWM/IEC strategy to be employed by the Municipality is the Vermicomposting Technology and Recycling Method (MRF). This is the most operative SWM measures in the Municipality of Batad.

### RECOMMENDATIONS

The following recommendations were forwarded: (a) Intensify the campaign on Segregation at Source through Education and Information Drive of both the RDE of the College and the LGU; (b) Likewise, enforcement through penalties (ordinances) to those violators of laws and giving of incentives to barangays with high level of compliance; (c) Develop technology (through RDE of the College) to process recyclable wastes into useful products as income generating project; (d) Enhance the vermicomposting facility of the College in partnership with LGU for the consideration that 50% organic waste (biodegradable) were generated by the locality per day to increase the waste diversion of the Municipality (e) Biodegradable shall be recovered and process into high grade compost to prolong the lifespan of the Municipality disposal facility (Vermicomposting Project).

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