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Research Article

Determine greenhouse gas emissions from landfills and suggest a household solid waste classification system in Dong Hoi, Quang Binh province

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Abstract: The distribution network model is one of the sophisticated strategies being used in research to assess the state of household solid waste (HSW) management and calculate the quantity of greenhouse gas emissions from landfills in Nghia Ninh and Bao Ninh communes. Traditional and modern techniques are also being used in this study. The results have assessed the existing state of household solid waste (HSW) management for home sizes ranging from four to six people. The daily average for garbage per person is 0.31 kilogram. The corresponding CO_2 emissions from the two communes are 0.42 kg/person/day (Bao Ninh) and 0.47 kg/person/day (Nghia Ninh); study and survey data from these two districts show that the average cost for households to collect HSW is 27,000 VND/family/month. 2698.72 kg CO_2 equivalent per ton of garbage, the same amount of emissions from solid waste. Nghia Ninh and Bao Ninh communes, as well as the Dong Hoi city government in general, rely on it to limit the amount of waste that families emit into the environment while encouraging improved information exchange and sharing. Share responsibility for waste management and encourage waste separation at the source.

Keywords: HSW; GHG emission; MSW; Landfilling; Dong Hoi, Quang Binh.

1. Introduction

An estimated 60,000-70,000 tons of residential solid waste are produced daily in the nation as a whole, with 60% of that amount occurring in urban areas. The rest is burned to normal destruction, dumped into water sources, or buried in trash landfills [1]. Many case studies exist around the world; for example, in Putrajaya, Malaysia, community participation in solid waste segregation operations was achieved through a trash recycling program [2]. A significant link has been found between community engagement in recycling programs and attitudes toward solid waste classification (r = 0.343) and community knowledge about solid waste classification (r = 0.251), according to analytical results based on a survey of 382 persons. The study suggests ways to improve the community's capacity for recycling and classification in light of the analysis [2]. When researching the solid waste management system and the role of community engagement in Jigjiga town, Somali state, Ethiopia, it was discovered that social and environmental concerns still exist. The garbage collection system's solid waste management mechanism is ineffective... [3].

Similarly, the research "Community-based waste management: experiences of Asian countries" detailed this strategy in seven Asian countries. Difficulties in the model are caused by insufficient solid waste management policies, a lack of human resources, a lack of community awareness, and a lack of collaboration capability between the government and the community [4].

Dong Hoi City authorities at all levels have hastened the process of industrialization, modernization, and urbanization in recent years in an effort to increase the local economy and improve people's quality of life. The province encourages an approach that prioritizes environmental protection over economic benefits in communes such as Bao Ninh, Nghia Ninh, Thuan Duc, and Quang Phu, while also prioritizing investment in the service and tourism sectors and implementing solid waste management in daily life in accordance with Section 2, Article 75 to 80 of the Law on Environmental Protection 2020 [5]. Therefore, to properly conserve the environment, production processes must be considered and integrated with the surrounding ecosystem in addition to avoiding, managing, and treating waste between places with favorable development conditions. many advancements in the economy. Many groups, including Nghia Ninh, Duc Ninh, Loc Ninh, Thuan Duc, and Quang Phu, who reside in communes outside of Dong Hoi city, are adversely impacted by the urbanization process.

Landfilling is the most often used waste treatment method worldwide. Landfill cleaning technology has evolved greatly in recent years [6]. The majority of emerging Asian countries, including Vietnam, continue to process trash in open, uncovered landfills and engage in open dumping and burying without gas recovery. As a result, when sanitary landfill technology is employed, there may be no landfill gas collection system, which means that the majority of emissions are released untreated or uncontrolled into the atmosphere. Municipal solid waste (MSW) is anaerobically digested in open dumps and landfills to produce landfill gas (LFG), which is mostly carbon dioxide (CO_2) and around 60% methane (CH_4). LFG's CO_2 component is of biological origin and is not a greenhouse gas, however LFG's CH_4 component contributes to global warming [7]. According to the IPCC, uncontrolled CH_4 emissions from landfills are the third-largest source of man-made CH_4 emissions. Numerous variables, including trash quantity and composition, moisture content, pH, and waste management practices, will affect the amount of methane generated in landfills. Methane concentrations in trash dumps rise as organic matter and moisture content rise [8].

The IPCC 2006 waste model may calculate emissions from a variety of solid waste disposal sites based on the default assumptions of a country or region's specific waste composition, such as climate and landfill status. The IPCC Waste 2006 calculation model was used in this work to assess greenhouse gas emissions from typical waste treatment in landfills. Under the supervision of the IPCC, the first order (FOD) analytical model, which captures the rate of waste breakdown at the disposal site and delivers more accurate results than emissions estimates, has been suggested for usage [9].

Urbanization includes things like the loss of arable land, changes in the occupational structure, accessibility to urban life (which is mostly dependent on public services and consumer culture), gentrification and urban construction, and the emergence of several local environmental issues. Specifically, there is a lot of household solid waste, and because of the introduction of new materials, raw materials, and products, its qualities and composition have changed from before, making management challenging. The inability of local solid waste management to meet regulations results in significant environmental degradation on a small- to large-scale basis, negatively affecting the community's quality of life and health. Implementing the Research Team's "Determine the greenhouse gas emissions from landfills in the communes of Nghia Ninh and Bao Ninh, Dong Hoi city, Quang Binh province, and suggest a system for classifying household solid waste at the source" is crucial in light of the aforementioned concerns. essential and significant from a practical and scientific standpoint.

2. Materials and Methods

2.1. Description of the study area.

East of the city is the beach commune of Bao Ninh. Due to its advantageous location near the Nhat Le River and a lengthy shoreline, Dong Hoi (Quang Binh) is home to a large number of service restaurants that cater to tourists. One of the factors raising the possibility of environmental contamination is these commercial operations. The total area of Nghia Ninh commune is approximately 1,570 hectares, of which 145 hectares are used for agriculture, primarily for the production of rice.

A step toward increasing public awareness is the selection of two economically disparate communes in Dong Hoi City for the purpose of surveying and calculating greenhouse gas emissions for urban solid waste collection and treatment activities.

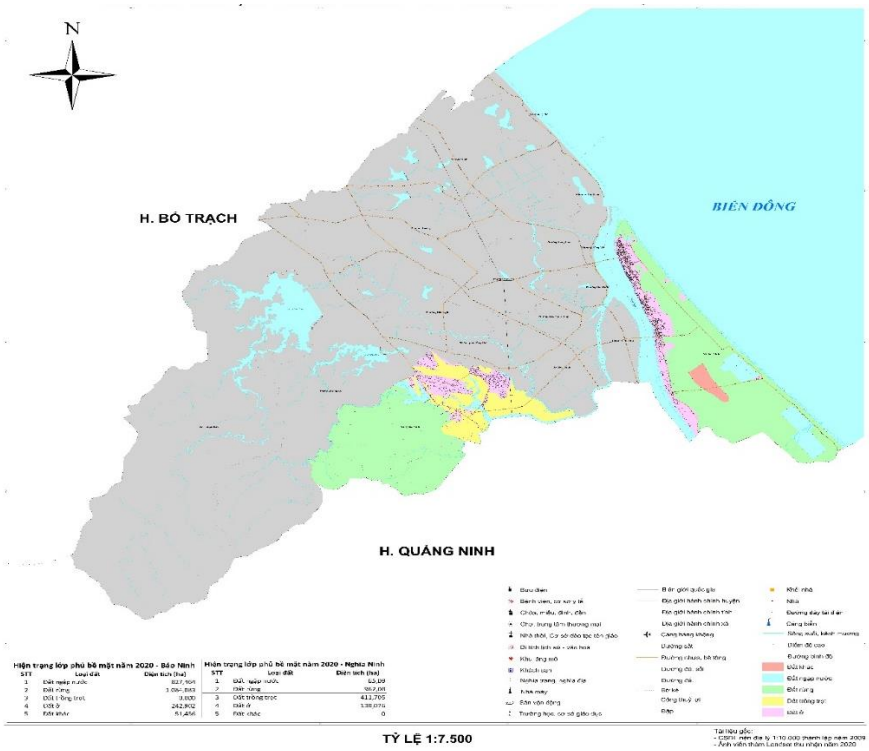

Figure 1. Map of the communes of Nghia Ninh and Bao Ninh.

2.2. Field survey method, determination of generation coefficient and waste composition

The study randomly selected 25 households living in two villages, Trung Nghia 5 and Trung Nghia 6, Nghia Ninh commune, and 25 households in My Canh and Ha Thon villages, Bao Ninh commune. Plastic bags to store waste for research households, and after 24 hours, return to use a scale to weigh the amount generated. Record the amount of waste and the demographics of each household.

Determine the emission coefficient:

$$\text{Emission coefficient} = \frac{Volume\ of\ household\ solid\ waste}{\text{Number of household members}} (\text{kg/person/day}) \quad (1)$$

Determine the composition of household solid waste:

Based on the instructions in Article 75, Law on Environmental Protection when distributing plastic bags for waste to people the study guided and distributed 3 bags marked: Solid waste capable of being reused and recycled; food waste; other HSW for households randomly selected from 4 villages in 2 communes, Nghia Ninh and Bao Ninh. Along with weighing to determine the emission coefficient, three types of weighing will be carried out to determine the composition by volume.

The CTR percentage component is calculated as follows:

$$\text{Ingredients \% by type} = \frac{Volume\ according\ to\ each\ type}{Total\ volume\ of\ solid\ waste\ of\ the\ sample} \times 100\% \quad (2)$$

Each commune chooses 25 families to deliver rubbish bags and weigh waste. These 25 homes were chosen at random depending on their living conditions in order to assess the association between income and the amount of solid trash created.

2.3. Sociological investigation methods

The study has developed 03 survey forms, of which: 01 survey form for local management officials, 01 form for households and 01 form for workers. Collection by self-management team. How to determine the sample: Based on Yamane's formula for calculating sample size [10].

$$\boldsymbol{n} = \frac{N}{1+N*e^2} \quad (3)$$

where n is the survey sample size; N is the total number of households in the study area; e: Acceptable error level (e ranges from 0.005 to 0.1; choose e = 0.1 to match the number of survey questionnaires and provide accurate results about the research object).

Due to limited time, human resources, and material resources, this study only conducted a survey with 100 random households in the two research communes. Along with that was a survey with 02 household solid waste collection workers and 02 local management officials. Details are as Table 1 below:

Table 1. Survey subjects in Nghia Ninh and Bao Ninh communes.

No.	Subject matter investigated	Quantity	Purpose
first	Officer in charge of environmental affairs in the area	02	Evaluate household waste management in the area. Collect information about waste collection equipment throughout the commune. Assess the impact of household waste on the locality. Assess people's awareness and level of compliance with the HSW classification.
2	Collection workers or self-management teams	02	Collect information about compliance awareness, waste collection situations, and difficulties. Collect information about equipment, tools, vehicles, and preventive measures.
3	Family	100 votes, including 46 votes in Bao Ninh commune and 54 votes in Nghia Ninh commune	Evaluate people's awareness when classifying household waste at source. People's assessment of household solid waste collection People's assessment of environmental fees and propaganda work Awareness about environmental protection.

Calculate the sample size using formula (3) with a marginal error of 0.1, or 10%, and the above sample size is sufficient.

2.4. SWOT method

This paper will identify the strengths, shortcomings, opportunities, and challenges in household solid waste management and source classification in two communes: Bao Ninh and Nghia Ninh. According to formula (3), survey samples in these places meet the criterion. Propose adequate solutions for identifying household solid trash at the source in the study region from there.

2.5. Data processing methods

The sociological investigation will utilize software like Word and Excel to synthesize, analyze, and present collected information and data scientifically.

2.6. SPSS data processing method

The study utilized SPSS software to assess the awareness, attitudes, and behavior of 100 households in Nghia Ninh and Bao Ninh communes regarding HSW management and classification.

2.7. Estimation of GHG emissions from landfilling

The following mathematical formula has been used in IPCC model to quantify GHG emissions from the landfilling:

$$DDOC_m = DDOC_{m(O)} \text{ x } e^{-kt} \quad (4)$$

where $DDOC_{m(0)}$ is the initial mass of decomposable degradable organic carbon (DDOC), when t=0 and e^{-kt}=1, k is the reaction constant and t is the time in years. $DDOC_m$ is the mass of DDOC at any time.

3. Results and discussion

3.1. Current status of HSW generation in Nghia Ninh and Bao Ninh communes

a) Sources of household solid waste generation

Sources of HSW generation in Nghia Ninh commune, through the commune's environmental status report, combined with actual investigation and survey, the main sources are identified as follows:

Table 2. Sources of household solid waste generation in Nghia Ninh commune.

Nghia Ninh commune			
No.	**Waste sources**	**Stationary sources**	**Solid waste composition**
first	Residential area	Households	Excess food; Goods packaging; Broken electronics and appliances; Leaves and tree branches are scattered.
2	Business and trading activities	People's markets and spontaneous markets	Plastic bags, foam, packaging; Excess food; Paper, plastic, glass, metal; Damaged fruits and vegetables;
3	Agencies, offices, schools	Primary and secondary schools in Nghia Ninh commune; Commune People's Committee; Commune medical station	Paper, plastic, glass, metal; Excess food; Broken items.
4	Traffic activities	Gathering areas and rest areas for container trucks	Goods packaging; Damaged goods; Broken items
5	Agricultural activities	Crop fields and cattle barns	Livestock waste; Damaged agricultural products; Packaging; Humus

The study reveals that waste generation in Bao Ninh commune is sourced from various sources, including residential areas and administrative agencies, in addition to similar waste sources in Nghia Ninh commune, including aquaculture and tourism business activities, as determined through data collection and analysis.

Table 3. Sources of household solid waste generation in Bao Ninh commune.

Bao Ninh commune			
No.	**Waste sources**	**Stationary sources**	**Solid waste composition**
first	Residential area	Households	Excess food; Goods packaging; Broken electronics and appliances; Leaves and tree branches are scattered.

Bao Ninh commune			
No.	**Waste sources**	**Stationary sources**	**Solid waste composition**
2	Business activities	People's market and shops	Plastic bags, foam, packaging; Excess food; Paper, plastic, glass, metal; Damaged fruits and vegetables;
3	Agencies, offices, schools	Primary and secondary schools in Bao Ninh; Commune People's Committee; Commune medical station	Paper, plastic, glass, metal; Excess food; Broken items.
4	Tourism activities	Resorts, hotels, restaurants, homestays...	Goods packaging; Excess food
5	Aquatic exploitation activities	Aquaculture areas and fishing grounds	Livestock waste; Damaged agricultural products; Packaging; Broken fishing gear; Mesh piece
6	Construction sites	Urban areas, hotels, resorts... are under construction	Leftovers; Paper, plastic, glass, metal; Broken tools

b) Volume of household solid waste generated

Through the process of survey, actual research and weighing of household solid waste in 50 households in the study commune. We get the results of the emission coefficient and amount of HSW of each study area as follows:

Table 4. Indicating the HSW discharge coefficient in the communes of Bao Ninh and Nghia Ninh.

TT	**Name of area investigated**	**Demographics were investigated**	**Mass of solid waste weighed during the day according to 3 types (kg)**			**HSW emission coefficient (kg/person/day)**
			Food solid waste	**Solid waste is recyclable**	**Solid waste is different**	
Nghia Ninh commune						
1	Trung Nghia 5 (15 households)	60	14.07	5.6	0.41	0.33
2	Trung Nghia 6 (10 households)	45	9.53	2.5	1.29	0.29
Total			23.6	8.1	1.7	
Average HSW emission coefficient (kg/person/day)						0.32
Bao Ninh commune						
1	My Canh (14 households)	59	16.26	6.95	0.92	0.42
2	Ha Thon (11 households)	45	12.71	5.3	0.5	0.4
Total			28.97	12.25	1.42	
Average HSW emission coefficient (kg/person/day)						0.41

Nghia Ninh Commune: Nghia Ninh commune with an area of 15.71 km^2, population of 5,317 people [11]0.

The investigation's findings show that there were 105 peoples living in 25 houses in the Nghia Ninh commune, generating a total of 32,796 (kg) of household solid trash every day. The average daily production of HSW in the ward is 0.31 kg per person, per survey results. Estimated total volume of solid trash generated by households in the ward:

$$0.31 \text{ (kg/person/day)} \times 5{,}317 \text{ (person)} = 1{,}648 \text{ (ton/day)}$$

The results are displayed in Table 4, where we can observe that the total emission coefficient is 0.13 kg/person/day, with the lowest emission amount in the research households being 0.13 kg/person/day and the greatest being 0.65 kg/person/day. Compared to the average household waste generation per capita in Quang Binh province in 2019 of 0.52 kg/person/day and the generation index of rural areas in the North Central and Central Coast regions of 0.51 kg/person/day [1], the average generation volume is 0.31 kg/person/day. People spend less time at home and more time in the fields and working regions, which accounts for the population's mostly agrarian lifestyle and somewhat lower living standards than in the surrounding area.

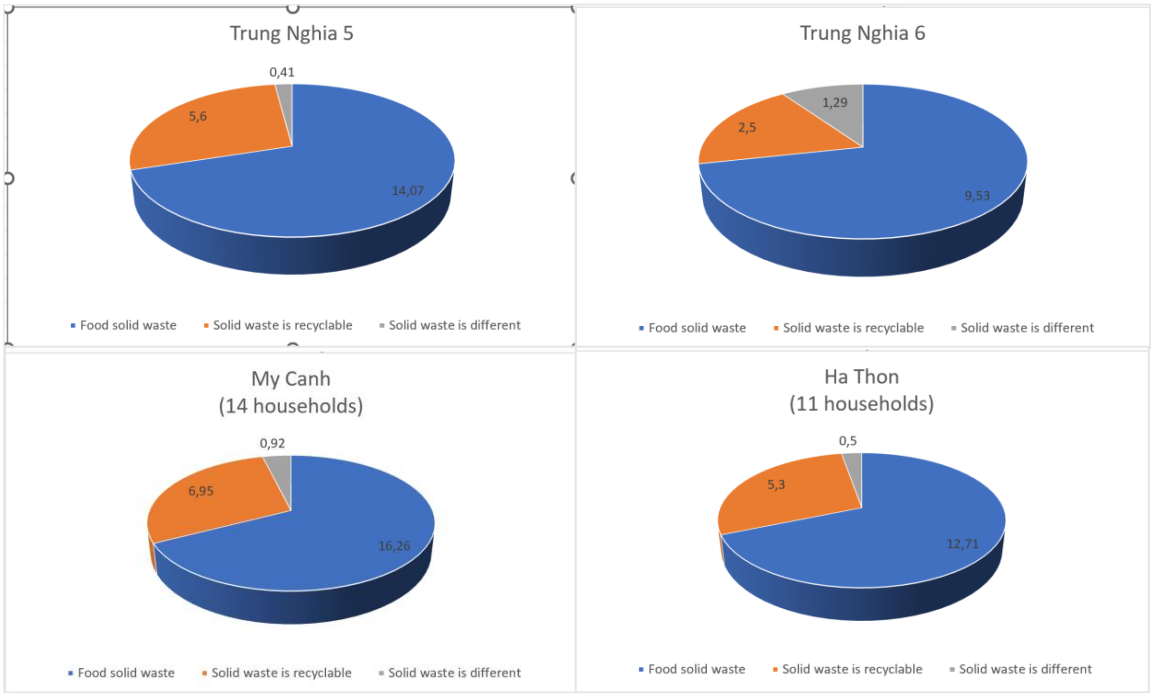

Figure 2. Mass of solid waste weighed during the day according to 3 types.

Bao Ninh commune: With an area of 17.67 km^2, the population is 11,136 people 00.

According to the results of the investigation, the total volume of household solid waste in 25 households in Nghia Ninh commune: 42.64 (kg/day), with 104 people in 25 households. According to survey results, the average amount of HSW generated per person in the ward is 0.41kg/person/day. Estimated total volume of household solid waste in the ward:

0.41 (kg/person/day) x 11,136 (person) = 4,565 (ton/day)

Table 4 displays the acquired data. It is evident that the research households had daily emission amounts ranging from 0.23 kg/person to 0.7 kg/person, with the lowest emission amount being 0.23 kg/person. The disparity is not so great, but in a commune with potential for tourists, household commerce and trading are rather active, which raises HSW. When compared to the average volume of household waste generated per capita in Quang Binh province in 2019 - 0.52 kg per person per day and the generation index of rural areas in the North Central and Central Coast regions 0.51 kg per person per day (as reported in the 2019 Environmental Status Report) [1-the average total generation coefficient is 0.41 kg/person/day. These differences are not very great. The sole steps in the waste treatment process in communes are collection, transportation to the waste treatment classification plant, production of biogas, and the use of organic mineral fertilizers 0. From the table above, we can calculate the average percentage composition of different types of HSW in the two study communes as follows:

Table 5. Household solid waste composition in the communes of Nghia Ninh and Bao Ninh.

TT	Investigation area	Composition % HSW		
		Food solid waste	**Solid waste is recyclable**	**Solid waste is different**
1	Nghia Ninh commune	70%	25%	5%
2	Bao Ninh commune	68%	29%	3%

Figure 3 there is a significant amount of organic matter in the HSW component; Metal, cardboard, wood, plastic, and glass are examples of recyclable and reusable materials; the following materials are inorganic, non-recyclable, and reusable; A negligible percentage of home solid waste is made up of hazardous materials such batteries and packaging that

contains chemicals for plant protection. The utilization of growth factors default discharge is the primary cause of the computation findings about 59.6% uncertainty 0.

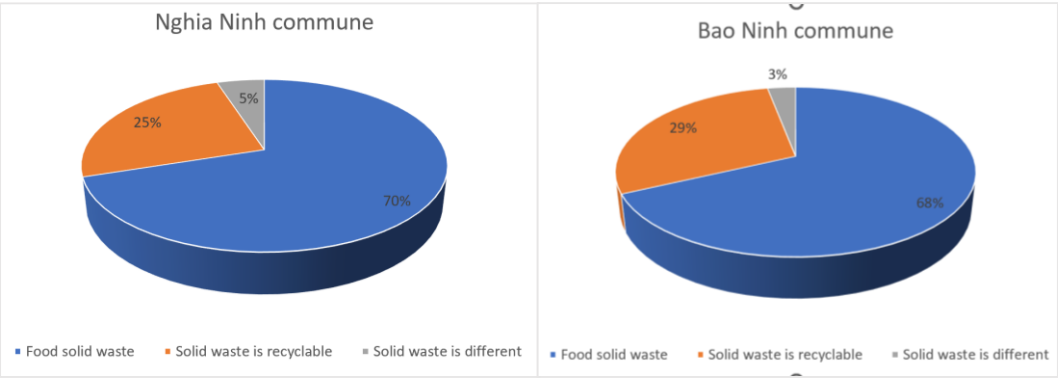

Figure 3. Household solid waste composition.

3.2. Analyze the connections between home solid waste and the age, occupation, and income of the households residing in the neighborhood

The volume and makeup of household garbage vary according on family size, occupation, and income, according to surveys conducted among homes in the communes of Nghia Ninh and Bao Ninh.

Income: Is a significant element influencing the amount and kind of solid waste that every home produces. According to the report, households earning at least $10 million will have greater shopping demands than households earning less than $10 million, which will result in a higher volume of HSW.

Occupation: Occupation is another crucial factor that has a big impact on the emissions that homes create. Since they labor most of the day, there won't be much demand for goods. People who work overtime, in government agencies or offices, or in homes where people work, trade, grow crops, clean, etc., typically have lower emissions than households.

Number of family members: Families with four or more individuals typically produce two to three kilograms of solid trash, and their solid waste composition is more varied than that of families with fewer members, per the survey.

Age: Based on the survey, it was discovered that respondents between the ages of 20 and 40 were more knowledgeable about HSW categorization than those over 45. Compared to older individuals, young people are more likely to have faster and better access to information, which encourages them to conserve the environment.

Along with Bao Ninh commune's advantages in growing tourism services, Nghia Ninh commune has elements that are comparable to those impacting the volume and composition of household solid trash. The tourist season is one of the reasons Bao Ninh communes is situated outside of the city center. Businesses, dealers, restaurants, lodging facilities, and other institutions all agree that during the low season, solid waste generation is quite low, averaging 2 to 3 kg, but it is extremely low during the tourist season. As a matter of fact, trash production rises. This indicates how closely the aforementioned parameters relate to the amount and make-up of solid trash generated by households as well as the province-wide average emissions.

3.3. Current status of household solid waste management

Sorting and recycling activities: Nghia Ninh commune had the largest percentage of households performing partial categorization, according to a survey conducted among 100 houses in the two communes. Not a single household completed complete classification. According to 50% of respondents, most people in the population work in agriculture and animal husbandry because people frequently make pet food, compost fertilizer, or gather

scraps to sell. Other types of HSW are also kept together and are rarely classified, and there is no suitable treatment method [15, 16].

While just 24% of households in Bao Ninh classify, food waste is still primarily collected and classified in small amounts. The biggest percentage of non-recycling is found in the Bao Ninh area, where 76% of the population is non-agricultural and each household has a small plot of land. In Nghia Ninh, 50% of the population is unclassified, and most of these houses are non-agricultural.

Households whose HSW has not been classified prior to collection believe that the following are the causes: Individuals have not been informed and encouraged to classify HSW; Collection vehicles do not fulfill the requirements for classification; There are no locations for waste groups to gather after classification; Collection and transportation activities:

Nghia Ninh commune: The commune's primary producers of solid waste are homes, individuals, a small number of business buildings, administrative spaces, and educational institutions. The principal constituents of this kind of garbage include food scraps, plastic, nylon, and organic waste from agricultural items. The homeowner's solid waste will be stored there until the collection team uses containers, hand carts, sweepers, small trucks, and other vehicles to order its loading onto tricycles at collection stations. Move garbage from the location of collection to the collecting site. It is necessary to dispose of solid trash in a way that makes it as easy as possible for collectors to access it in hospitals, schools, or other central locations. Household solid garbage is collected twice a week, between the hours of 5 and 8. The filling coefficient of the vehicle is 1.3-1.5. In certain heavily inhabited regions, the vehicle's filling coefficient can reach 2. These areas include Trung Nghia 4 village and market area. Vehicles are still in use today. Just let the container loose so that it can fall onto the road easily when hauling household solid trash. The majority of self-made collection vehicles are still simple carts and motorcycles.

Bao Ninh commune: The commune's primary industries include daily operations, tourism services, and aquatic exploitation. Thus, the majority of waste is composed of plastic, nylon, and leftover food waste. Garbage trucks, hand carts, motorbikes with bins on the back, and each household's allotted trash will all be used to collect the waste. At collection stations, solid garbage will wait to be placed onto tricycles. The frequency of collection was twice a week; in tourist locations, it occurs once or twice daily. The collection hours vary depending on the season and are from 3:00 to 6:00 p.m. To keep beaches and roadways clean, there are extra street cleaning crews.

The vehicle uses hand carts with extra walls surrounding spilled trash, and its filling factor ranges from 1.5 to 1.8. Right now, the following types of trash are being delivered to the waste treatment plant:

Inorganic waste A biogas line that combines the production of electricity and fertilizer is made from organic waste; products like shredded plastic, shredded nylon, rags, wood, etc., are used as raw materials for waste power lines; metals (iron, aluminum, copper...), plastics, glass, rubber, paper, etc., will be collected and sold for recycling.

The Dong Hoi - Bo Trach general waste landfill is where the debris will be buried (before being used as input material for the unburnt brick production process).

Waste fee collection activities: As of right now, the cost of home solid trash collection in the city is determined by Decision No. 36/2018/QD-UBND, which states 0: Families in communes and wards: 27,000 VND a month per household.

The collection cost in Nghia Ninh (69%) and Bao Ninh (76%), the two communes studied, is 27,000 VND per month per home. Most respondents in these communes believe the fee is excessive given their income. But according to 24% and 31% of Nghia Ninh and Bao Ninh communes, respectively, the price is reasonable given the quality of the services they receive.

Most respondents indicated that they would not choose to hire Nghia Ninh 65% and Bao Ninh 76% when asked whether they would be prepared to pay additional collection service costs because they believed the cost was reasonable. The remaining families are unsure, whereas those that selected Bao Ninh (22%), Nghia Ninh (26%), and other reasons wanted better services, better equipment, and more frequent collections.

3.4. GHG emission from the mix MSW landfilling

One liter of fossil fuel is required to treat one kilogram of solid waste. According to Tables 6 and 7, the amount of solid waste in the two communes is the same. If fossil fuels are used simultaneously, greenhouse gas emissions range from 44,4 to 49 tons per month. As a result, in urban waste treatment activities, developing approaches for identifying household solid waste at the source is critical.

Baseline survey results, which are comparable to the values in the communes mentioned above, will aid in increasing the accuracy of computing greenhouse gas emissions for solid waste in urban areas (better than 60%) of Dong Hoi City.

Table 6. GHG emissions at the landfill of Nghia Ninh commune.

Diesel consumption for operating matchineries at landfill	49000	L/month
Total waste handled at the landfill	49	tons/month
A diesel requirement	1000	L/ton of waste
Total energy in consumed diesel	36420	MJ/ton of waste
Default CO_2 emission factor for combustion	74100	kg CO_2/TJ
GHG emissions due to fossil fuel consumption	**2698.72**	**kg of CO_2 eq/ton of waste**

Table 7. GHG emissions at the landfill of Bao Ninh commune.

Diesel consumption for operating matchineries at landfill	44400	L/month
Total waste handled at the landfill	44.40	tons/month
A diesel requirement	1000	L/ton of waste
Total energy in consumed diesel	36420	MJ/ton of waste
Default CO_2 emission factor for combustion	74100	kg CO_2/TJ
GHG emissions due to fossil fuel consumption	**2698.72**	**kg of CO_2 eq/ton of waste**

3.5. Propose solutions to improve management efficiency

The management of household and individual solid waste in Quang Binh province is governed by a number of regulations on solid waste management, which include duties and powers pertaining to the classification, storage, collection, transportation, and treatment of domestic solid waste in the region, as well as the responsibilities and powers of agencies, organizations, communities, households, and individuals 0.

The following guidelines are used to categorize domestic solid waste produced by homes in the two communes: Reusable and recyclable solid waste (paper, plastic, metal, glass, etc.); Food waste (vegetable scraps, fruits, veggies, tubers, animal carcasses, plants, etc.); Other solid garbage from the home (bulky waste, non-recyclable waste, hazardous waste category).

Putting forward ideas for separating household solid waste at the source. According to the survey, while some people in the communes of Nghia Ninh and Bao Ninh have started using the separation at source and composting with biological products model, the great majority of people still do not classify garbage at source. Two strategies can be put forth to increase the effectiveness of local waste management, particularly the classification of household solid waste at the source in Nghia commune, when combined with the previously indicated scientific and practical foundation. These are Ninh and Bao Ninh:

Educating the public about the HSW classification system, source classification, and the way waste categories are categorized with an emphasis on scrap, cans, plastic boxes, and salable metal goods. In Bao Ninh (87% of households) and Nghia Ninh (91% of households), meetings are held, or environmental news is disseminated.

garbage groups need to be trained, and people in the communes of Nghia Ninh and Bao Ninh still don't comprehend the rules governing garbage classification. Need financial assistance (equipment and monthly labor wage) to support collection work in the communes of Nghia Ninh and Bao Ninh. Because the waste rates in the research regions are lower than those in the province as a whole, frequent health checks and staffing are carried out in tourism and heavily populated areas. Large trash containers and additional collection vehicles are required in places with congested roads and homes distant from collection points.

Create collection groups in communes or villages to assist environmental workers with rubbish collection; also, establish guidelines for the Collection Team and designate personnel to oversee and assist the team's operations. According to the survey, 67% of respondents think that labels are useful for collection and classification, and that garbage bags or expandable storage containers are required for sorting household solid waste.

4. Conclusion

The study illustrates the difficulties in gathering and categorizing the quantity of solid trash produced in households. In the communes of Nghia Ninh and Bao Ninh, the monthly cost of solid trash collection is 27,000 VND. Seventy-six percent of Nghia Ninh households and sixty-nine percent of Bao Ninh households value this fee. Based on research, the household solid waste generation coefficients for Nghia Ninh commune and Bao Ninh commune are 0.3 kg/person/day and 0.4 kg/person/day, respectively. Bao Ninh has a coefficient of 0.4 kg/person/day for domestic solid waste generation, compared to 0.3 kg/person/day for Nghia Ninh commune.

In line with the demands of socioeconomic growth, solid waste emissions in Quang Binh province are low at 0.52 kg/person/day and 0.51 kg/person/day in rural regions, according to the 2019 National Environmental Report. corresponding to one ton of garbage at 2698.72 kg CO_2 equivalent.

In both communes, the actual rate of garbage classification is low - 61 percent of homes have not received a classification. This type of waste management is used by 39% of homes; it primarily targets salable waste materials such cans, bottles, canned foods, leftover food, and fruit and vegetable peels. No household has yet received a thorough classification.

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