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Current Generation and Management of Domestic Solid Waste at Nhon Nghia Village, Phong Dien District, Can Tho City, Vietnam

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ABSTRACT: This study was conducted to investigate the generation, composition and management of domestic solid waste in Nhon Nghia commune, Phong Dien district, Can Tho city in Vietnam. Households, garbage collectors and environmental managers were interviewed for the required information. The results showed that the rate of domestic solid waste generation is 0.65 kg/person/day with the total amount of domestic waste generated 3,998 tons/year. In which, 74.32% of waste is biodegradable and recyclable. The separation of waste at source in the study area is relatively good, accounting for 67%, most of the waste is classified into waste that can be reused and recycled, accounting for 45%. Waste collection and transportation system in Nhon Nghia commune has not been completed since among the four studied hamlets, only two hamlets, Nhon Hung A and Nhon Khanh A, have solid waste collection services. The results presented that the majority of households self-treat their waste by burning, burying (23%) and discharging directly into the environment (27%). The remaining amount of domestic solid waste is treated at the landfill. People's awareness about the negative impacts that solid waste brings to the environment and health is relatively high. It is forecasted that by 2025, the amount of domestic solid waste will increase along with the population growth rate, increasing from 3,998 tons/year (in 2022) to 4,164 tons/year (in 2025). Strengthening segregation at source, improving the collection and transportation system, raising public awareness and strictly handling violations of discharge should be done to improve the efficiency of domestic solid waste management.

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The process of urbanization, industrialization, economic growth, population growth and improved living standards in recent decades have led to the change of a number of phenomena such as mass production, mass consumption and mass disposal, especially domestic solid waste is constantly increasing in quantity and type (Astane and Hajilo, 2017). In the world, the total volume of solid waste generated was about 7-10 billion tons in 2016 and it is forecasted that the amount of domestic solid waste will continue to increase in the future (Thang, 2019). In Vietnam, the amount of municipal solid waste (MSW) generated is about 64,658 tons/day, of which the rural areas generate about 28,394 tons/day (equivalent to 10,363,868 tons/year) (MONRE, 2020). Notably, the total volume of MSW generated nationwide in 2019 increased by 46% compared to 2010 (MONRE, 2020). Along with the increasing amount of solid waste, the composition of solid waste is very diverse including organic matter, plastic and nylon, metal, glass, hazardous waste and other components. Domestic solid waste is generated more and more and the consequences of its decomposition in the environment can cause serious damage to the ecosystem (Astane and Hajilo, 2017). Together with inappropriate solid waste management has led to problems that degrade human and animal health, and ultimately lead to economic, environmental and biological losses

(Ferronato and Torretta, 2019). The majority of MSW is not segregated at source and the main form of MSW treatment is incineration and unhygienic burial. Unregulated disposal creates serious heavy metal pollution in soil, water and plant environments (Vongdala *et al*., 2019). Outdoor waste incineration is the cause of CO, CO_2, SO_x, NO_x, PM_{10} and other polluting emissions that affect the atmosphere (Wiedinmyer *et al*., 2014). Furthermore, leachate at disposal sites contains large amounts of organic matter (BOD and COD), ammonia, chloride and heavy metals (Al-Yaqout *et al.,* 2020). When leachate leaks into the environment, especially the underground environment, it seriously affects the quality of water sources serving the community's daily living and eating needs (Sharma *et al.,* 2020; Udamadura and Samarakoon, 2022). At the same time, scavenging in open-air landfills poses serious health risks to those working in these areas (Gutberlet *et al.,* 2008).

Can Tho be one of the cities directly under the Central Government, is the busiest and most developed city in the Mekong Delta. Every day, the total amount of solid waste (mainly domestic waste) is about 700 tons.

However, the collection, transportation, and treatment of garbage are still slow and inadequate, leading to backlog of waste causing environmental pollution. Phong Dien is a suburban district, a new rural district of Can Tho city with a natural area of about 119.1 km^2 and a population of 102,621 people.

The district is known as the green belt of Can Tho city and has experienced remarkable socio-economic development in recent years.

In which, Nhon Nghia commune is an area with potential economic development of the city in the future in general and Phong Dien district in particular (Phong Dien District Department of Natural Resources and Environment, 2022).

Before the speed of development, environmental issues, especially the arising of MSW, are of particular concern to the district. Daily-life solid waste that has not been collected thoroughly can cause environmental pollution. Besides, there is no specific data source on the generation, composition and collection rate of MSW in Nhon Nghia.

Faced with this situation, the objective of this study is to investigate the generation, composition and management of domestic solid waste in Nhon Nghia commune, Phong Dien district, Can Tho city in Vietnam.

MATERIALS AND METHODS

Study area: Nhon Nghia commune is located in the southeast of Phong Dien district, with a natural area of 21.79 km^2 (ranked second) and a population of 16,853 people (ranked first) across the district. The commune is geographically located in coordinates 9º58'5" B – 105º41'50" E, bordering My Khanh commune to the North, Hau Giang province to the South, Cai Rang district to the East and Nhon Ai commune to the West. Domestic solid waste generated in the commune is partly collected and treated at Co Do landfill in Dong Thang commune, Co Do district, Can Tho City. While a part of the remaining waste is discharged directly into the receiving environment by households, causing unsightly urban beauty and environmental pollution.

Data collection: Interviewing households: To assess the current situation of MSW generation and management, the study conducted direct interviews with three groups of subjects including households, garbage collectors and environmental managers in Nhon Nghia commune by questionnaire. For households, the study randomly interviewed 60 households in four hamlets of Nhon Khanh, Nhon Khanh A, Nhon Phu and Nhon Hung A in Nhon Nghia commune, Phong Dien district, Can Tho city. The content of household interviews related to the status of generation, classification, collection and treatment of MSW at the household and the household's awareness of environmental and health issues. For waste workers, the study interviewed four garbage collectors in Nhon Nghia about the collection, transportation and collection of solid waste in the study area. For officials, the study conducted interviews with two officers from Phong Dien District's Department of Natural Resources and Environment, in order to survey the current status of MSW management and treatment in Nhon Nghia commune. The location of the study area is shown in Figure 1.

Domestic solid waste collection: To determine the volume and composition of MSW generated, the study collected solid waste samples from 20 households in four hamlets of Nhon Khanh, Nhon Khanh A, Nhon Phu and Nhon Hung A. The households were given with plastic bags for storage the wastes. The solid waste samples at the household were collected within a week. After that, the study conducted the classification of MSW according to the provisions of Article 74 of the Law on Environmental Protection 2020 including biodegradable organic waste, waste that can be reused - recycled, hazardous waste and remaining waste. Each waste component will be placed in a separate tray, weigh and record the weight of each respective component.

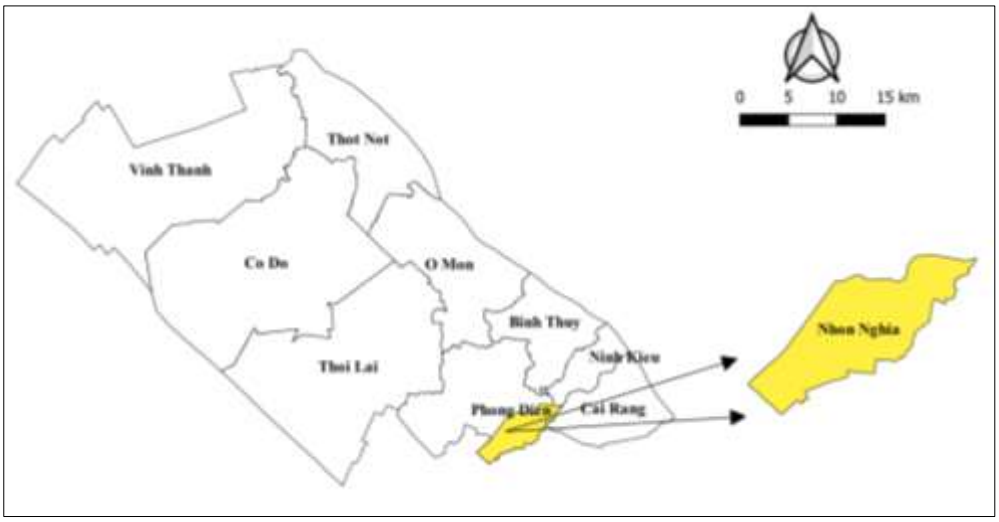

Fig 1. Demonstrating study area in Nhon Nghia commune, Phong Dien district, Can Tho city

Data processing: - Determining the percentage of composition of all types of waste according to the equation:

$$\%\ \text{waste type} = \frac{m_i}{m} \times 100$$

Where: m_i is the volume of waste to be calculated (kg) and m is the total volume of waste collected (kg).

The coefficient of waste generation is calculated according to the equation:

$$\text{Waste generation coefficient (kg/person/day)} = \frac{Mass\ of\ solid\ waste}{\text{Number of HH members}}$$

Method of forecasting the amount of MSW generated in Nhon Nghia commune by 2025:

+ The population growth rate is forecasted by the improved Euler method, calculated according to the equation (Oanh, 2021):

$$N_{i+1} = N_i + rN_i \Delta t$$

Where N_i is the initial population (people), N_{i+1} is the population after 1 year (persons), r is the population growth rate (%) where r = 1.04% and Δt is the time period (years).

+ The amount of generated solid waste is calculated according to the equation of Oanh (2021):

$$\text{Amount of domestic solid waste } (\frac{\text{ton}}{\text{year}}) = \frac{N_{i+1} \times g \times 365}{1000}$$

Where N_{i+1} is the population in the period under consideration (person) and g is the waste generation coefficient (kg/person/day), g = 0.65 kg/person/day.

RESULTS AND DISCUSSION

Current generation of domestic solid waste: After 7 days of sampling, the total volume of MSW generated by days of the week in 20 households in the study area varied from 32.84-41.94 kg/day (Figure 2a). The average volume of MSW generated per day was about 36.13 kg/day. The results showed that the highest amount of MSW generated on weekends was due to the fact that households had a habit of going shopping on weekends, when they could buy a lot of goods and food for weekend consumption. Another possible cause is that family members are often at home on weekends, leading to an increase in the number of people and the number of meals, which in turn contributes to increased waste (Thanh *et al*., 2010). Figure 2b showed that the rate of MSW generation ranged from 0.59 kg/person/day to 0.75 kg/person/day, reaching an average of 0.65 kg/person/day. Based on the population in 2022 of Nhon Nghia commune is 16,853 people and the MSW generation rate is 0.65 kg/person/day, the total MSW generated is equivalent to about 3,998 tons/year. The rate of MSW generation in this area is estimated to be higher than in some other areas, such as Suzhou (0.2805 kg/person/day), Khodabandeh (0.588 kg/person/day), and Hanoi (0.52 kg/person/day) (Gu *et al*., 2015; Astane and Hajilo, 2017; Oanh, 2021). However, this result is within the threshold of the global average MSW generation rate of about 0.74 kg/person/day (Thang, 2019). The level of education, local customs and culture, consumption patterns and lifestyle of the population have a great influence on the generation of solid waste (Gu *et al*., 2015).

Table 1 shows the composition of domestic solid waste in four communes Nhon Hung A, Nhon Khanh A, Nhon Khanh and Nhon Phu in Nhon Nghia commune.

The proportion of wastes of all kinds increases gradually from hazardous waste (accounting for 4.36%) < waste that can be reused – recycled (20.29%) < residual waste (21.25%) < organic waste easy to decompose (accounting for 54.03%). From this it can be seen that most of the MSW generated in Nhon Nghia commune is organic waste with high moisture content, therefore the treatment and separation of waste at source is the most important step in waste management (Fadhullah *et al*., 2022). In the group of biodegradable organic waste, leftovers and discarded foods accounted for the highest proportion in the group with 31.23%. Degradable organic waste is converted into organic fertilizer through composting, vermicomposting and anaerobic digestion to create fertilizer for agricultural use, contributing to reducing the volume of waste generated out (Parkar *et al*., 2021). For the group of waste that can be reused - recycled, plastic bags and plastic bottles accounted for the majority with 9.25%. Plastic is the third highest source of waste globally, with the total volume of plastic waste increasing with population growth and per capita consumption (Chen *et al*., 2021). Plastic consumption and use per capita in Vietnam increased significantly, from 3.8 kg/person (1990) to 41.3 kg/person (2018) (Thanh *et al*., 2022).

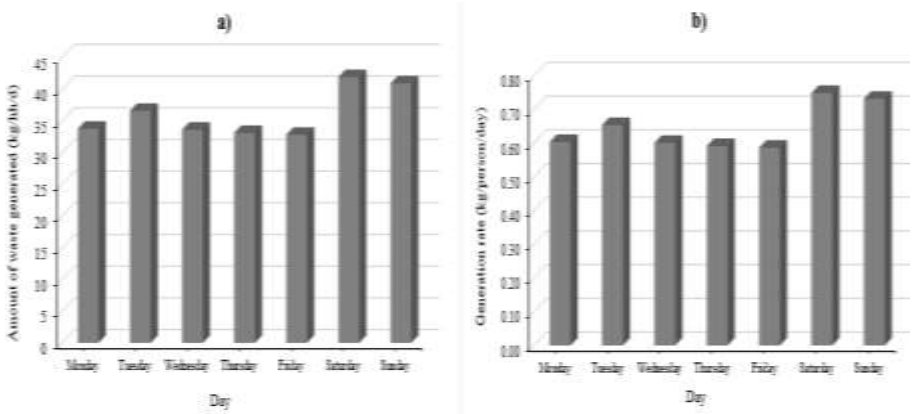

Fig 2. Weight (a) and rate (b) of domestic solid waste generation in the study area

Table 1. Composition of domestic solid waste in the study area

No.	Composition	Proportions (%)				Mean
		Nhon Hung A	Nhon Khanh A	Nhon Khanh	Nhon Phu	
I.	**Degradable organic waste**	**54.95**	**51.8**	**58.67**	**50.68**	**54.03**
1	Leftovers, food wastes	34.03	28.79	33.6	27.35	31.23
2	Leaves, flowers, grass, tea grounds, coffee, ...	8.79	9.78	12.06	10.5	10.12
3	Vegetables, tubers, fruits of all kinds	11.33	13.07	12.42	11.17	11.98
4	Animal carcasses and excrement	0.8	0.16	0.59	1.66	0.77
II.	**Waste can be reused - recycled**	**22.96**	**19.17**	**14.84**	**23.41**	**20.29**
5	Nylon bags, plastic bottles	9.06	11.58	7.17	8.92	9.25
6	Milk cartons, aluminum cans	3.93	2.66	3.11	5.26	3.7
7	Glass bottle	3.41	1.88	1.38	4.28	2.75
8	Magazines, newspapers, paper, books, notebooks of all kinds	6.56	3.05	3.18	4.95	4.59
III.	**The remaining waste**	**18.13**	**24.22**	**22.16**	**21.13**	**21.25**
9	Bandages, diapers, toilet paper	9.56	10.09	12.51	12.53	10.96
10	Packaging, cake, candy, rubber	4.98	10.25	6.75	5.91	6.9
11	Crockery, porcelain, broken pottery, cigarettes	3.19	3.52	2.36	2.21	2.89
12	Cloth, yarn, towel, knife, scissors	0.4	0.36	0.54	0.48	0.5
IV.	**Hazardous waste**	**3.97**	**4.54**	**4.35**	**4.76**	**4.36**
13	Used batteries, accumulators	1.49	1.41	1.47	2.24	1.62
14	Old, broken light bulb	1.3	1.56	1.63	2.52	1.69
15	Empty bottles and bottles containing hazardous chemicals	1.18	1.41	1.25	0	1.01
16	Electronic waste	0	0.16	0	0	0.04

Notably, the volume of plastic waste and plastic bags of the whole country accounts for about 10-12% of domestic solid waste and will continue to increase in the future leading to a large amount of waste floating in rivers, lakes, estuary wetlands and coastal areas (Thanh *et al*., 2022). The characteristic of plastic is

that it is difficult to decompose and it takes hundreds to thousands of years to break down into smaller pieces, also known as microplastics (Chen *et al*., 2021). Currently, microplastics are considered as an emerging source of pollution, polluting ecosystems and human health (Kurniawan *et al*., 2021). Therefore, this type of waste needs to be sorted and recycled. Waste recycling reduces the need for new raw materials, reduces waste in landfills, thereby contributing to reducing environmental pollution (Huang *et al*., 2022). The study identified the lowest proportion of hazardous waste (4.36%). However, this rate is already outside the range of hazardous waste normally generated by households (1-4%) and its potential risks to the environment and health are disproportionate to the size of the waste (Letcher and Slack, 2019). Household hazardous waste in the study area includes batteries, accumulators, light bulbs, electronic waste and bottles containing hazardous chemicals. People's problem of not separating waste at source has caused hazardous waste and ordinary waste to be mixed. The negative consequences of household hazardous waste can occur at the source (household), waste collection point, during transportation and after deposition at landfill or incinerator, with the potential to cause permanent damage to the environment and public health (Gu *et al*., 2014). In addition, household hazardous waste can cause changes in other waste streams by reacting directly with the waste or by changing the redox environment (Letcher and Slack, 2019).

Current management of domestic solid waste in the study area: For waste separation at source, the results showed that households' awareness of this issue was relatively good with about 67% of total households having MSW classification at source. Segregation at source refers to the separation of proposed useful materials from the waste stream at the point of generation. Waste segregation can save valuable resources, typically in the form of time savings required for waste disposal (Otitoju and Seng, 2014). With the separation of waste at source, the amount of waste sent to treatment sites and landfills is greatly reduced (Cheng *et al*., 2021). Furthermore, in the absence of waste segregation, composting or recycling is not possible (Otitoju and Seng, 2014). For households with waste segregation at source, the study investigated how solid waste was classified (Figure 3). The results showed that the majority of households classified MSW into waste that can be reused - recycled (accounting for 45%). The purpose of this form is to help households in the study area have more income from the sale of recyclable wastes. Notably, the benefit of this approach is that the volume of waste transferred to the disposal site is significantly reduced (Barma and Modibbo, 2022). Next, classifying MSW into groups of recyclable and reusable waste and easily degradable organic matter accounts for 37.5%. Composting is widely used to convert biodegradable waste such as animal manure and food waste into compost for fertilizer (Wang *et al*., 2022). The form of classifying MSW into groups of recyclable and reusable waste, easily degradable organic matter and hazardous waste accounts for only 12.5% and the lowest is classified into 04 waste groups according to regulations in Article 74 of the Law on Environmental Protection 2020 (accounting for 5%). It is really necessary to classify household hazardous waste into a separate group, in order to limit its negative impacts on health and the environment. However, 33% of households still do not pay attention to the separation of waste at source, leading to hazardous waste being mixed with other types of waste, bringing potential risks to the environment and human health. For this case, it is estimated that 55% of households will perform waste separation at source when provided with sorting tools by local authorities and 45% of households will do it when they are administratively sanctioned. A number of factors such as the level of propaganda from local authorities, the accessibility of the recycling facility, the accessibility of the sorting facility, the willingness to participate in the sorting and the environmental awareness of the people proved to be the five most important influencing factors on people's garbage sorting behaviour (Meng *et al*., 2019). In addition, the application of mandatory policies on waste separation at source also has a significant impact on people's waste segregation behaviour (Li *et al*., 2020).

Currently, the collection and transportation of solid waste arising in Nhon Nghia commune, Phong Dien district is contracted by the Department of Natural Resources and Environment of Phong Dien district with Minh Thong Trading Service Company Limited and Thien Phuc Public Service Company Limited implements the process of collecting and transporting MSW in Nhon Nghia commune. In four hamlets of Nhon Hung A, Nhon Khanh A, Nhon Khanh and Nhon Phu, only two hamlets, Nhon Phu and Nhon Khanh, have a solid waste collection service. However, through the interview results, only 50% of households in each of these hamlets have registered for collection service. On the contrary, due to unfavourable geographical location and narrow roads, domestic waste collection service has not been implemented in 02 hamlets Nhon Khanh A and Nhon Hung A. For the form of collection, MSW generated in two hamlets Nhon Khanh and Nhon Phu is collected once a day. In Nhon Phu hamlet, the collection time is from 12:00 to

17:00 daily with an estimated volume of 460 kg/day stored in a 660L tow truck.

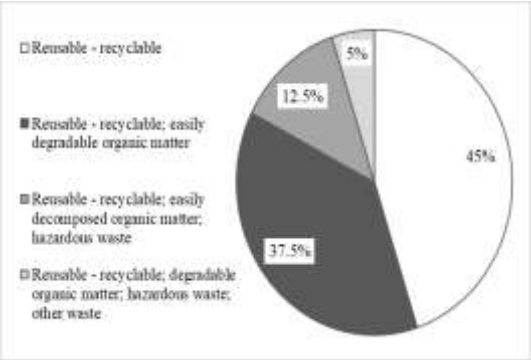

Fig 3. Classification of domestic solid waste in the study area

However, in this area, households have to put their waste in the 240L garbage bins located in the middle of the hamlet and near the end of the hamlet, then workers will move the trash to a tow truck at the beginning of the hamlet. In Nhon Khanh hamlet, the collection time is from 8-12:00 daily and the waste volume is estimated at 580 kg/day by 660L tow truck. Here, the traffic route is more convenient, so workers directly move to each household to collect solid waste. After that, the solid waste is brought to the collection point, transferred to a garbage compactor and transported to Co Do landfill in Dong Thang commune, Co Do district, Can Tho city for waste treatment. With garbage collection service, the fee that households have to pay ranges from 20,000-30,000 VND/month, because the households are located in the frontage area and have business activities. Waste disposal is one of the major environmental problems in the world. Improper waste disposal can cause infectious diseases such as cholera, smallpox, plague and increase environmental pollution problems (Shahzadi *et al*., 2018). From Figure 4, it can be seen that there are 4 forms of MSW treatment applied by households in the study area, including (1) putting in public trash, (2) registering for collection service, (3) discharging directly into environment and (4) burning, burying. In which, the form of direct discharge of waste into the receiving environment (rivers, canals) accounts for the highest proportion with 27%, due to the habits of households. The consequences of indiscriminate solid waste disposal can clog drainage systems, spread infectious diseases, clog waterways and affect aquatic life (Ifeoluwa *et al*., 2018). Besides, the form of voluntarily burying and burning domestic waste is also applied by most households. Open-air solid waste incineration causes air pollution and health risks for those who are directly exposed to the smoke (Daffi *et al*., 2020). Some toxic substances generated during solid waste combustion include dioxins, furans, arsenic, mercury, polychlorinated biphenyls (PCBs), lead, carbon monoxide, nitrogen dioxide, sulphur dioxide and hydrochloric acid (Ebi *et al*., 2014). Notably, CO is one of the pollutants with significant effects on the environment, humans and animals, it is a greenhouse gas and is usually formed when something is burned (Daffi *et al*., 2020). While improper landfilling of MSW has been reported to be associated with various environmental pollution problems, namely (1) groundwater pollution due to leaching of organic, inorganic and many other pollutants. Other concerns, (2) air pollution from suspended particles, (3) odour pollution from solid waste deposition, (4) even marine pollution from any potential runoff, and (5) possible health effects from groundwater and air pollution, leading to carcinogenic or non-carcinogenic effects in humans (Siddiqua *et al*., 2022). From that, it can be seen that the level of knowledge of households in the study area about MSW treatment methods is still limited, which can cause serious consequences for health and significant impacts on the environment. For the form of registration for collection service, only 25% of households apply, mainly in Nhon Phu and Nhon Khanh hamlets. Solid waste in Nhon Nghia commune is collected by Minh Thong Trading Service Company Limited and Thien Phuc Public Service Company Limited. Then, it is treated at Co Do landfill in Dong Thang commune, Co Do district, Can Tho city. The waste incineration capacity at this landfill is 103.63 tons/day and burying about 250 tons/day.

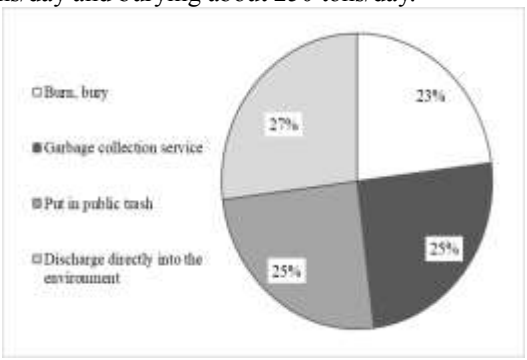

Fig 4. Ways of treatment of domestic solid waste in the study area

People's awareness of environmental and health issues: Interviewing results showed that up to 88% of households said that MSW negatively affects the environmental components of soil, water and air. However, 12% of the total households believed that MSW does not negatively affect environmental components. More and more MSW is generated, if not properly managed, it will have a great impact on the ecosystem, including humans. Air pollution and odours arising from open-air landfills and indiscriminate burning of solid waste have been reported in many areas (Ferronato and Torretta, 2019).

Approximately 37 million tons of CO and 1.4 billion tons of CO_2 are generated each year from open burning solid waste (Daffi *et al*., 2022). The biodegradation of organic waste produces biogas that pollute the atmosphere by contributing to the greenhouse effect and global warming, especially CH_4 (Mouhoun-Chouaki *et al*., 2019). Improper burying of solid waste causes serious deterioration of soil quality and pollution. The effect of bio-solids on the physicochemical properties of the soil was reported through increasing the organic matter content in the soil and increasing the content of heavy metals (Cu, Zn, Cd, Pb, Ni and Cr) (Mouhoun- Chouaki *et al*., 2019). The process of burying garbage is not guaranteed and negatively affects the underground water system. At Nonthaburi landfill (Thailand), the concentration of some heavy metals detected in groundwater such as chromium, cadmium, lead, nickel and mercury were always 10 times higher than the WHO recommended limit for quality of drinking water (Prechthai *et al*., 2008). In addition, leachate generated from open-air, unsanitary landfills has the potential to pollute the soil, surface water and groundwater around the landfill (Ferronato and Torretta, 2019; Javahershenas *et al*., 2022; Afolabi *et al*., 2022). Typically, the groundwater environment around landfills affected by leachate is of moderate to poor quality in the presence of organic matter, total coliform, total phosphorus and total nitrogen (Benaddi *et al*., 2022). According to research by Mishra *et al*. (2018), leachate contains large amounts of organic pollutants including BOD of 3,120 mg/L and COD of 11,980 mg/L. Besides, leachate also contains many environmental pollutants including microorganisms, NH_3-N, TNK, TP, and heavy metals (De *et al*., 2016; Benaddi *et al*., 2022). Notably, the waste generated after the use of plastic products causes many environmental problems. Microplastics have been found in a wide variety of environments, including oceans, rivers, lakes, even distant waters (deep sea), marine species, and drinking water (Wang *et al*., 2021). Along with the negative impacts of MSW arising on the environment, human health issues are of concern. As a result, many health problems are related to the MSW management system including skin diseases, respiratory diseases, gastrointestinal diseases and insect-borne diseases (Table 2). Waste is not regularly collected and treated, leading to a backlog that promotes the breeding of rodents, flies and mosquitoes that transmit human diseases such as dengue fever and malaria (Abubakar *et al*., 2022). Similarly, organic waste often makes up a large part of the solid waste composition, which has high moisture content and causes odours (Fadhullah *et al*., 2022), thereby creating a favourable environment for intermediate organisms. Reproduce and transmit diseases to the community such as dengue fever and zika virus (Olay-Romero *et al*., 2020). In addition, diseases related to the gastrointestinal tract due to the use of contaminated water such as intestinal worms, tetanus and diarrhoea (Abubakar *et al*., 2022). The emission of CH_4, CO_2 from landfills causes adverse effects on human health such as skin, eye, nose irritation and respiratory diseases. The process of burning domestic solid waste produces large amounts of CO and CO_2, inhaling high CO_2 air reduces the amount of oxygen that can be transported in the blood to vital organs such as the heart, while CO_2 causes skin irritation and suffocation. Adversely affect the respiratory process (Daffi *et al*., 2022). In addition, the process of burning plastic waste produces hydrochloric acid and dioxins that can cause allergies, haemoglobin deficiency, and serious carcinogenicity in humans (Brahimi *et al*., 2019). In general, households interviewed in the study area are very aware of the negative impacts of MSW generation and improper MSW management on environmental components and public health.

Table 2. Environmental and health issues

No.	Issues	Levels of concern	
		Number of respondents	Proportion (%)
I.	**Environment (soil, water, air)**		
1	Very affected	16	27
2	Affected	20	33
3	Less affected	17	28
4	Not affected	7	12
II.	**Health**		
1	Skin diseases	5	8
2	Respiratory disease	15	25
3	Digestive tract disease	20	33
4	Diseases caused by insects	20	33

Forecast of domestic solid waste generation: Quantifying and predicting the amount of solid waste generated is very necessary, which is the foundation and prerequisite for an effective solid waste management plan. Figure 5 shows the amount of domestic solid waste generated in Nhon Nghia commune from 2022 to 2025. According to the analysis results, when the population of Nhon Nghia commune increases from 16,853 people to 17,554 people in the period 2022-2025 the volume of generated bio-solids also tends to increase, from 3,998 tons/year (in 2022) to 4,164 tons/year (in 2025). The volume of MSW generated in 2025 is 1.04 times higher than that in 2022. It can be seen that the increase in MSW volume is proportional to the population growth rate. The results of correlation analysis

demonstrate that the volume of MSW generated in the future strongly correlates with the population growth rate, the coefficient R^2 reaching 0.9661 ($p<0.05$). From that, it can be seen that the amount of domestic solid waste is expected to increase significantly in the coming years due to rapid population growth. According to Kaza *et al*. (2018), as the world population continues to increase, the generation of domestic solid waste will also increase at the same time, it is expected to reach 3.40 billion tons per year by 2050. Future estimates of solid waste generation as a basis in the development of existing waste management infrastructures and their further sustainable development and optimization (Abbasi and Hanandeh, 2016). However, the process of predicting domestic solid waste generation is often challenging and complicated due to the rapidly changing and uncontrollable parameters (Beigl *et al*., 2008). Notably, the continuously increasing generation of solid waste will lead to serious environmental pollution, resource consumption and health problems if solid waste management is not ensured and improved. For public health can be divided into pathological, biological, non-communicable diseases, psychosocial health risks and ergonomics (Fadhullah *et al*., 2022). Therefore, sustainable solid waste management plays an important role as it includes the minimization of solid waste at the point of generation, appropriate collection and treatment, and the use and recovery of waste for energy production (Al-Dailami *et al*., 2022).

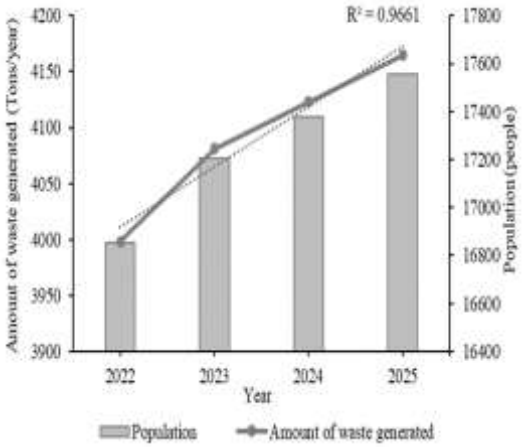

Fig 5. Estimating domestic solid waste production during 2022-2025

Conclusion: The research results showed that a large amount of domestic waste has been generated in the study area. The proportion of waste components gradually decreases according to biodegradable organic waste > reusable and recyclable waste > hazardous waste. People in the study area have a habit of separating waste at source. However, the domestic waste collection service has not been implemented synchronously. Therefore, domestic waste in there is mainly treated by burning, burying or directly discharged into the environment. Thereby, there are potential risks of causing environmental pollution and affecting public health in the study area.

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