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A STUDY ON THE GENERATION AND COMPOSITION OF SOLID WASTES IN CHO MOI DISTRICT, AN GIANG PROVINCE, VIETNAM

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Abstract:

The study was conducted to investigate the current situation of generation and composition of domestic solid waste in Cho Moi town, Cho Moi district, An Giang province, Vietnam. The current status of generation and composition of solid waste was evaluated through the placement of garbage bags in households in rural and urban areas. Current management status was assessed by direct interviews with the households. The research results showed that the solid waste generated in the rural and urban areas of the whole town was about 8.5 tons/day, the collection rate was only 60.5% of the total solid wastes generated. The average amount of waste generated in rural areas was 0.31 kg/person/day and in urban areas was 0.44 kg/person/day. In the composition of classified domestic solid wastes, the organic composition in rural areas was slightly higher (82.3%) than that in urban areas (80.6%). The proportion of nylon in urban areas (10.1%) was higher than that in rural areas (6.78%). The remaining compositions had a low percentage, ranging from 0.04-7%. The interview results showed that only 70% of the respondents agreed to place their garbage in the waste bins for the collection while 30% of the respondents chose to burn or directly release the wastes into the environments. The behaviours of the respondents showed that people's awareness of the importance of domestic solid waste management was not high. Domestic solid waste management still faces many difficulties because the Cho Moi district does not have an infrastructure to ensure efficient treatment of domestic solid waste. Raising the community's awareness and investment in solid waste management are urgently needed to keep a clean environment.

Keywords:

Environment, Solid Waste, Generation Rate, Organic Matter, Nylon, Cho Moi, An Giang

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Introduction

Vietnam is in a strong process of industrialization and modernization. Along with the population growth and the formation of concentrated residential areas, the demand for goods and materials is increasing. Since then, it has created conditions for production and service industries to develop to serve the needs of people. On the other hand, this development led to a large amount of waste being released into the environment, especially domestic solid wastes. According to the Ministry of Natural Resources and Environment (2019), currently, domestic solid waste (MSW) is generated in urban areas (mainly from households, public areas such as streets, markets, offices, schools) about 38,000 tons/day, in rural areas about 32,000 tons/day. It is estimated that the amount of domestic solid waste generated in urban areas nationwide increases by an average of 10-16% per year. In most of the urban areas, the volume of domestic solid waste accounts for about 60-70% of the urban solid waste (this rate is up to 90% in some cities). An Giang is an important hub for the inter-regional relationship between the Vietnamese Mekong Delta. In which, Cho Moi town, Cho Moi district, An Giang province is the center of agricultural - fishery development of the province. With the criteria of type IV urban areas, the distribution of population is increasingly crowded and the demand for living and consumption of products becomes higher, thereby generating a significant amount of solid wastes, leading to poor environmental quality. Currently, the landfills in 11 districts, towns and cities in the province are in a state of overload, not being handled according to regulations causing serious environmental pollution. Local domestic solid waste landfills are open-pit, improperly constructed, wastewater from landfills has not been collected and treated, and odors arising from the landfills have not been controlled, causing environmental pollution of soil, water and air, especially in the rainy season. The study was conducted to assess the current situation of solid waste generation and composition as well as solid waste management in Cho Moi district, An Giang province. The results of this study could provide valuable information for the management units to have effective measures in solid waste management, to solve pollution problems and improve the quality of life of local people.

Materials and methods

Information on the current status of solid waste generation, collection, transportation and management in Cho Moi town, Cho Moi district, An Giang province was collected by questionnaires with 60 households. The content of the interview questionnaire included general information about the interviewees such as gender, age, education level, occupation; information on the current state of generation, source classification, collection time, harms of solid waste on the environment and health, assessment of the current state of solid waste management in the study area, participation in solid waste management process was also gathered by questionnaires. To assess the generation rate and solid waste composition in Cho Moi town, Cho Moi district, An Giang province, 20 households in the surveyed area in urban and rural areas were selected to distribute nylon bags to contain all the solid waste in the households for seven consecutive days. Every day, garbage bags were collected at 5:00 PM to classify and calculate the composition of solid waste and solid waste generation rate. Waste separation at source was conducted according to the guidance of the Department of Natural Resources and Environment of Ho Chi Minh City, Vietnam. Specifically, organic waste includes biodegradable waste including leftovers, vegetables, roots, fruits, leaves, branches, and persistent plastic bags, straws, bottles, cups, and plastic jars; inorganic waste includes glass, bottles and jars; toxic waste includes batteries, bulbs, batteries, rubber, and pesticide casings; other waste includes soil, stone, and rubble. Interview results were imported into Excel

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spreadsheets (Microsoft Excel 2016, Microsoft, USA) to calculate mean, percentages and present data in the forms of simple tables and charts.

Results and Discussion

Generation And Composition Of Solid Wastes

Solid waste samples were collected within one week, from Monday to Sunday. The samples were collected from 20 selected households in rural and urban area in Cho Moi town. All of the waste generated was daily collected and transported to the laboratory to classify and determine the composition and rate of generation of each household in rural and urban areas. The results were presented in Table 1.

Table 1. The Amount of Solid Wastes in The Households

No.	No. of members in the family		Rural		Urban	
	Rural	Urban	Mean weight (kg/hh/d)	Mean weight (kg/person/d)	Mean weight (kg/hh/d)	Mean weight (kg/person/d)
1	3	3	0.98	0.33	1.2	0.4
2	5	3	1.5	0.3	1.3	0.43
3	3	4	0.78	0.26	1.4	0.35
4	4	2	1.05	0.26	1.03	0.52
5	6	4	1.35	0.22	1.42	0.3
6	4	3	1.4	0.35	1.3	0.43
7	4	3	0.71	0.18	1.32	0.44
8	5	4	1.72	0.34	1.47	0.37
9	2	2	0.87	0.43	1.1	0.56
10	4	3	1.78	0.45	1.5	0.5
Mean	**4**	**3.1**	**1.21**	**0.31**	**1.3**	**0.44**

The data from Table 1 showed the households in the two areas that generate the highest waste were the family with number of members from 3 to 6 people with the amount of solid wastes ranged from 1.2 to 1.78 kg/household/day. The amount of solid wastes was generated lowest (0.87-1 kg/household/day) at the household with the family of two members. As can be seen

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that the amount of solid wastes is very much dependence of the numbers of members in a family. In general, the amount of waste generated in the urban and rural areas was not significantly different. On average, each household in the rural area generated 1.21 kg and 0.31 kg/person/day. In urban area, the solid waste generated was 1.3 kg per household and 0.44 kg/person/day. In general, the amount of solid wastes was generated in weekend was higher than that in weekday in both rural and urban areas (18.6 kg and 21.4 kg, respectively). The amount of waste generated in urban areas in a week was higher than that in rural areas because there are more activities of the urban people compared to the rural people. For example, people generated domestic wastes and wastes from small business activities while people from the rural area only generate domestic activities. The analysis results the composition of solid wastes from 20 households in a week were presented in Figure 2. The organic components in the waste stream in rural area (82.3%) was slightly higher than that in the urban area (80.6%). In contrast, the nylon composition in the urban area (10.1%) was higher than that in the rural area (6.78%). Plastics in rural and urban occupied 3.1 and 2.7%, respectively. Papers in the rural area (6.1%) was also higher than that in the urban area (4.1%) The other compositions (foam box, recyclable metals, and clothes) only accounted for very small proportion (0.04-1.4%). There was no toxic wastes (batteries, bulbs, batteries, rubber, and pesticide casings) found during the study period.

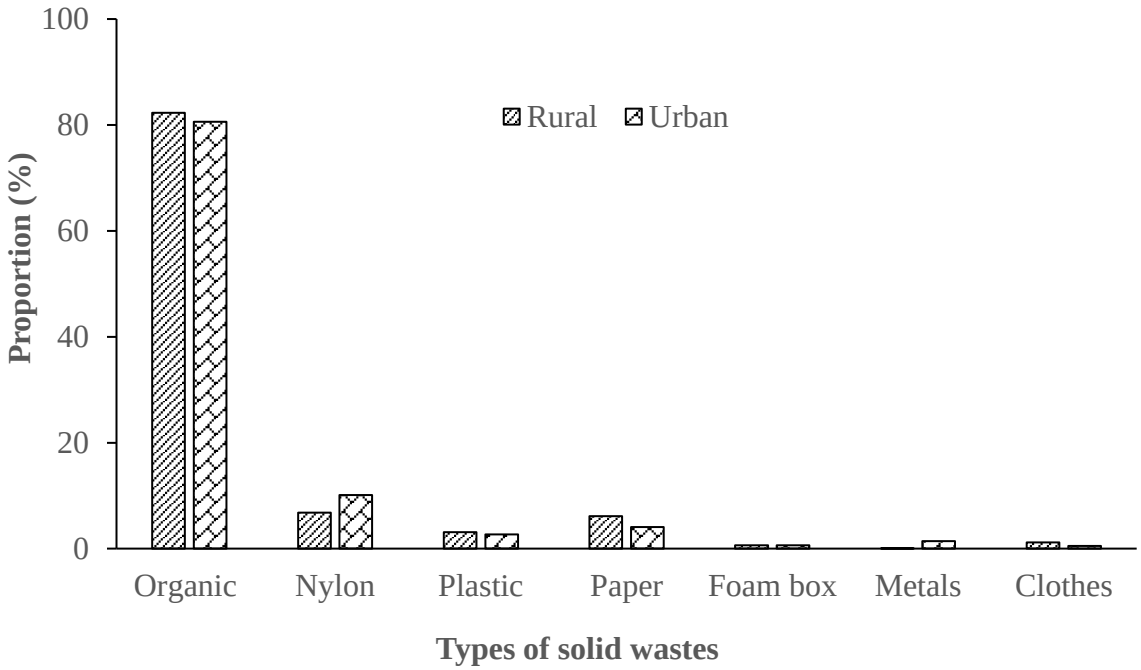

Figure 2. Composition of Solid Wastes in the Study Area

Solid Waste Generation Rate

The survey results showed that the amount of solid wastes generated in Cho Moi town was estimated at about 8.5 tons/day, accounting for 6.7% of the total amount of waste generated in the Cho Moi district. The table below presented the fluctuation of solid wastes in the study area by day in the week. The amount of solid waste generated at weekends (41.11 kg) was higher than in the first days of the week (30.55 kg) and in the middle days of the week (28.18 kg). However, the composition of the solid waste was identical that organic always accounts for a higher proportion than inorganic composition. The result of the current study was in accordance with the study of Lieu (2018) reporting that the amount of waste in at the end of the week was

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the highest at 106 kg, of which organic composition was 70kg (66.04%) and inorganic composition was 36 kg accounted for (33.96%); the lowest amount of waste was found in the middle of the week (69.9 kg), of which organic composition was 50 kg (71.53%) and inorganic composition was 19.9 kg accounted for 28.47%.

The rate of solid waste generation in rural areas was 0.31 kg/person/day which was lower than that in urban areas (0.44 kg/person/day). Compared with the statistics of the Ministry of Natural Resources and Environment 2019, the rate of solid waste generation in the Mekong Delta in rural areas was 0.45 kg/person/day and in urban areas was 0.82 kg/person/day. The rate of generation of solid waste in the current study is lower than that in the former study. This could be because the sample size in the former study is more relevant. However, the rate of solid waste generation in rural area is lower than that in the urban area. This could be because the standard living of the rural people is lower than that of the urban dwellers

Table 2. Variation of Composition of Solid Wastes by Day

Composition		Day					
		The begin of the week		The middle of the week		Weekend	
		Amount (kg)	Proportion (%)	Amount (kg)	Proportion (%)	Amount (kg)	Proportion (%)
Organic		24,68	80,8	24,1	85,5	33,4	81,2
Inorganic	Nylon	2.82	9.15	1.98	7.03	3.42	8,32
	Plastic	0.90	2.9	0.58	2.13	1.26	3,16
	Papers	1.58	5.23	1.14	4.04	1.53	3,72
	Foam	0.36	1.18	0.13	0.46	0.25	0,61
	Metal	0.2	0.66	0.05	0.18	0.83	2,02
	Clothes	_	_	0.2	0.71	0.4	0,97
Total		30,55	100	28.18	100	41.11	100

Current Status of Solid Waste Management

The interviewing results presented that 87% of solid waste was collected, and 13% was discharged directly to the environment, especially the rivers to save the solid waste collection fee VND 15,000/household/month. By this result, it could be implied that the awareness of small proportion of the residents is needed to be raised. The actions of throwing solid waste into the river could lead to serious water pollution. The cost for water treatment and the consequences of water pollution could be far exceeded the fee of the waste collection. The finding also revealed that the common way of handling the household solid waste was to place it in the waste bins without classification for the collection (70%). Some households treated the waste by open burning (13%) and some households disposed solid wastes into the environment (17%). The results indicated that the ways of solid waste management at the household level is still inappropriate. During the interviewing, it was found that more residents in the urban areas tended to classify the solid waste to collect the wastes (for example plastics and metals) that could be sold to the vendors to earn extra money than the people in the rural area. The classifying the wastes is the most important target in future efficient solid waste management.

According to Decree 155/2016/ND-CP regulation on sanctioning of administrative violations in the field of environmental protection, issued on November 18, 2016, waste collection,

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transportation and treatment are the responsibility of the Department of Natural Resources and Environment of Cho Moi district and the People's Committee of Cho Moi town. Cho Moi Town People's Committee is responsible for coordinating with the Office of Natural Resources and Environment to develop a plan for the collection, transportation and treatment of waste in the town area; arrange the waste transit system according to the regulation. Currently, waste collection and transportation; the arrangement of the waste bins, recruitment of the waste collectors, purchases of waste collection means are managed by the Cho Moi town People's Committee while the treatment of the collected wastes (for example, handling and treating wastes at the landfill) is the duty of the Department of Natural Resources and Environment, Cho Moi district. Up to the present time, The People's Committee is managing 12 waste collection workers, 2 truck drivers and 2 specialized garbage trucks of 1.5 tons, 6 hand-pushed garbage collectors. The generated solid waste from the households was placed in the arranged waste bins, then collected by the waste collection workers, transported to the landfill. It was informed by the environmental authority that solid wastes in the urban area was better collected than that in the rural areas because the households in the rural area did not pay the collection fee. In addition, infrastructure for waste collection in the rural area was not good as in the urban area. The solid waste collection system in Cho Moi town covers only urban areas, markets and a small portion in rural areas. The collection vehicle follows the routes with fixed time. Every day, the waste collection workers only collected 2 times from 5:45 to 7:45 AM and 16:00 - 18:00 PM. As can be seen that the current collection scheme is not really suitable since huge amount of wastes being generated while the time of collection is limited, vehicles is insufficient and waste collection workers are not enough.

The collected solid waste will be transported by collecting trucks to the landfill of Kien An commune, Cho Moi district. The landfill has been in operation for 8 years with an area of 1 ha and the total volume of solid wastes up to 14,400 tons. This is an open landfill located near the residential area of Kien Binh. There are housing around the landfill. Over the past time, this area has been the gathering place for solid wastes in the district, including Cho Moi town. On average, there are over 24 tons of solid waste/day is gathered. Solid waste after collected mainly transported to landfills, dumped, buried, sprayed with bio-products and lime. There is no cover for the landfill and the leachate is not collected and appropriately treated. This can be considered as not environmentally safe landfill.

Solutions to The Solid Waste Management in The Study Area

Due to the large proportion of organic waste generation, it must be collected at a frequency of 3 times/day and avoid peak hours such as 7:00 - 8:00 am and 4:00 pm - 5:00 pm, avoid storing for organic waste a long time since this type of waste fast and easily biodegradable generating toxic gases. For major roads, wastes in the market area must be completely and timely collected. For small roads, suitable collecting trucks must be used. There is a need to raise awareness of the residents who still do not place the wastes in the waste bins.

Currently, the common method for the treatment of solid wastes is the open landfill and the landfill is in the overloaded state. The collected wastes at the landfill is treated by open burning and burying. These methods are inappropriate and could result in air, soil and water pollution. Due to the overload situation, Cho Moi District People's Committee has built a Cho Moi district solid waste treatment plant in My Luong town with a design capacity of 100 tons/day, to be put into operation in 2021. For the landfills, it is urgently needed to establish barrier fences. The landfills must be lining with the qualified bottle liner materials, establish the leachate

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collection systems, leachate treatment systems, garbage gas collection systems, and regular monitor water, air, and soil environment. Efficient solid waste management really needs the participation of the community, so it is necessary to raise the community's awareness of solid waste as a foundation for easier and quicker implementation of management plans. The relevant environmental agencies should carry out communication campaigns such as raising awareness of the community in schools and communities by means of television, radio, banners, etc. with the contents guiding methods of environmental protection, encouraging participation in activities of sorting garbage at source.

Waste separation at source is a highly effective solution in solid waste classification. But in reality, the area has not yet been able to classify garbage at source because there is no investment budget for trash cans for separate types of trash and special-use collection vehicles must be invested. In addition, the separation of waste at source still has difficulty in understanding of the composition of the solid wastes. The separation of many types of wastes before being dumped in different waste bins is difficult to convince the response of people even though they are aware of the benefits of garbage classification. Therefore, the ability to classify waste at source is difficult to do immediately, but must be done step by step. Step 1, practicing at source classification of solid wastes in some small areas, announcing on the media to give a brief guide on how to classify the wastes. Then set up a group of volunteers to each household calling for a response to the movement, at the same time distributing sorting bags, waste bins and guiding people how to classify the solid wastes. During this period only instructions are given to classify garbage into two biodegradable organic wastes and others. Step 2, expanding the classification area, continue to encourage and guide households to classify waste at source according to the same process as the previous period in step 1. Environmental agencies and schools must classify 100% of generated solid wastes. In addition to commercial areas, markets began to carry out the garbage classification. On the other hand, it is necessary to continue to invest in containers and trucks to collect and classify waste into biodegradable organic matters, recyclable scraps, and other solid waste composition. Step 3, invest in equipment to classify and classify garbage into more solid waste types. Proposal to classify garbage into biodegradable organic matter components, papers, plastic, and metals. Putting the criteria of environmental protection into the cultural family assessment. Families responsible for protecting the environment should be commended and families with lack of awareness such as littering will be punished and not recognized by cultural families.

Applying the 3R method (Reduce - Reuse- Recycle) is strongly recommended for solid wastes practices. 3R is an environmental solution that many countries around the world are applying to protect and limit environmental pollution. Reduce is the lifestyle changes, consumption patterns and improvements in the production process which will reduce the amount of waste generated in the environment. The largest amount of product generated, the most efficient use of the resource, but the least amount of waste generated is the optimization needed. Reuse is to make the most of the product's lifespan and to use it for different purposes for maximum savings. Recycle is by creativity that takes advantage of waste and waste materials to make other useful products. Waste should be applied in waste treatment to reduce the amount of waste by recycling and reusing waste to limit environmental pollution and avoid wasting natural resources. Mobilizing people to give up the bad habit of littering indiscriminately, together building a civilized healthy lifestyle with a sense of common hygiene. Launching the tree planting and street sanitation movement, promulgating standards for green, clean, beautiful households and integrating these standards into the culture family. The functional agencies

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need to intensify the inspection of the collection and treatment of waste to promptly handle violations of environmental hygiene.

The environmental protection agencies and local authorities should establish an environmental fund to pay for environmental activities, encourage and resolve environmental incidents in the locality are also needed. They also need to increase the state budget for solid waste collection, transportation and treatment, investment in equipment, facilities and technology. Propaganda and education combined administrative measures, economic measures and other measures to build a culture of environmental protection. Conserving biodiversity, replacing and rationally using natural resources, developing clean and renewable energies, promoting recycling, reusing and reducing solid waste are urgently needed. Prioritizing handling of the environmental problems, serious environmental pollution, water pollution, focus on environmental protection in residential areas, development of technical infrastructure for environmental protection. Heavy taxes on non-biodegradable plastic bags and policies to encourage the use of biodegradable plastic bags, paper bags to limit the amount of plastic bags emitted. Combining activities of environmental protection, protection of natural resources to respond to climate change to ensure environmental security are essential.

Conclusions

The results indicated that solid waste composition of the interviewed households is relatively diverse in which organic matter in solid waste accounted for a relatively high proportion in rural areas (82.3%) than in urban areas (80.6%). Plastic composition accounted for a high proportion in urban areas (10.12%) than that in the rural areas (6.78%). The remaining solid waste composition occupied a low percentage, ranging from 0.04% to 7%. There was no hazardous solid wastes found during the study period, however, it may exist. The amount of waste generated daily in Cho Moi town was about 8.5 tons/day. According to the results of weighing domestic solid waste, on average, a household produced about 1.21-1.3 kg/household/day; The average amount of solid waste per person in urban areas was about 0.44 kg/person/day and in rural areas was 0.31 kg/person/day, indicating that the rate of waste generation in urban areas was higher than that in rural areas. In general, solid wastes management in Cho Moi town has not achieved high efficiency specifically, the classification of solid waste at source has not yet been planned to be implemented in the area. Solid waste collection rate was over 60.5%, the collection frequency of 2 times/day which did not meet the actual demand of solid waste collection. There were no appropriate measures to handle the solid wastes regarding the treatment methods, leachate treatments and environmental monitoring in the landfilling area. More attention should be paid on the management of solid waste management in the study area. Building capacity, fundraising, environmental regulation enforcement, and raising community's environmental protection awareness and community's active participation in solid waste management are urgently needed to improve the solid waste management scheme.

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