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Promoting classification of domestic solid waste at source in NA RI district, BAC KAN PROVINCE, VIET NAM

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Abstract
The study was conducted with the aim of assessing domestic solid waste (DSW) management status and proposing solutions to improve the efficiency of DSW classification at source in Na Ri district, Bac Kan province, Viet Nam. The results showed that the total amount of DSW is 7,800 tons/year. The composition of DSW includes organic matter (71.38%), inorganic matter (28.38%) and hazardous waste (0.24%). The rate of collected and treated DSW is 5,402 tons/year, reaching 69.25%. Na Ri district currently has 03 incinerators (Yen Lac, Con Minh, Tran Phu). The DSW management still has many shortcomings such as lack of human resources and equipment for collection and labor protection; many localities do not have DSW collection points and have not yet implemented environmental protection fees for DSW. Inspection and supervision work is still limited, so the treatment of waste at the incinerators has not followed the correct process; DSW has not been classified at the source, so the treatment and classification at the incinerator is very difficult; Funding to support the waste collection and treatment working group is still low...To improve the effectiveness of DSW classification at source, it is necessary to promote propaganda to raise public awareness about how to identify waste types and the importance of DSW classification at source; DSW can be classified into three main types: organic waste, inorganic waste and recyclable waste; Require households to use three-compartment trash cans or three separate trash cans (with pictures/letters representing waste types) to store three different types of waste (inorganic waste, organic waste and recyclable waste); The color of bags/compartments/trash cans, images for each type of waste need to be synchronized in all management areas; There must be sanctions and discipline for organizations and individuals who do not classify waste at source...

Keywords: *Solid waste, environmental management, waste, pollution, Na Ri*

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I.Introduction

In recent years, household waste has become an urgent problem for the whole society. Urbanization and economic development often lead to increased resource consumption and solid waste generation rate per capita. Urban residents in developed countries generate six times more waste than in developing countries. It is estimated that in developed countries the amount of solid waste can reach 2.8 kg/person/day and in developing countries it is about 0.5 kg/person/day [1]. The average rate of domestic solid waste generation worldwide is about 0.74kg/person/day; in which, the rate in the lowest country is 0.11kg/person/day and the rate in the highest country is 4.54kg/person/day. In 2016, the total volume of municipal solid waste generated globally was about 2 billion tons. In which, the largest amount of urban solid waste is in the East Asia - Pacific region with 468 million tons; The lowest was in the Middle East and North Africa with 129 million tons [2]. In Vietnam, the amount of generated DSW is about 25.5 million tons in 2018, of which urban DSW is about 38,000 tons/day and rural domestic waste is about 32,000 tons/day [2]. DSW in urban areas currently accounts for more than 50% of the total DSW of the country and accounts for about 60-70% of the total amount of urban solid waste [2]. It is forecast that the amount of DSW in Vietnam will increase to 54 million tons by 2030 [3]. The average waste generation standard per capita for each type of waste is specific to each locality and depends on the standard of living, civilization and population in each area. However, regardless of the region, there is a general trend in the world that the higher the standard of living, the more waste is generated. According to a report by the World Bank, in big cities, the rate of solid waste generation in New York is 1.8 kg/person/day while in Singapore and Hong Kong it is 0.8 - 1.0 kg/person/day. In Vietnam in 2015, the total amount of DSW generated in cities was 38,000 tons/day. Estimation of DSW amount generated by 2030 will be 2.59 billion tons, and by 2050 it will be 3.4 billion tons [1].

In the world, there have been many studies on solid waste management such as: "Analysis of solid waste collection and disposal in oversea, Nasarawa town, Nasarawa state" [4]; "Analyzing key drivers for a sustainable waste management system in Ethiopia: an interpretive structural modeling approach" [5]; Optimal management of solid waste in smart cities using internet of things" [6]; "Urban solid waste management in Chongqing:

challenges and opportunities" [7]; "Waste management in Switzerland – Achievements and prospects" [8]; "Solid Waste Management Practices at a Private Institution of Higher Learning in Nigeria" [9]; "Assessment of Domestic Solid Waste Disposal and Management System in Tangail Municipal Area" [10]; "Analysis of Economical and Environmental Costs for the Selection of Municipal Solid Waste Treatment and Disposal Scenarios through Multicriteria Analysis (ELECTRE Method" [11]; "Compliance with household solid waste management in rural villages in developing countries" [12]; " Improving urban household solid waste management in developing countries based on the German experience" [13]; "Household solid waste management practices and perceptions among residents in the East Coast of Malaysia" [14]; " Knowledge, attitudes and practices on household solid waste management and associated factors in Gelemso town, Ethiopia" [15]; " Household solid waste characterization in Tandil (Argentina): Socioeconomic, institutional, temporal and cultural aspects influencing waste quantity and composition" [16]; " Status of household solid waste in Bengaluru and its periphery: synergies and disjunctions between waste management practices and circular economy" [17]... However, there has been no research on the current status and solutions for domestic solid waste management in Bac Kan province, Vietnam.

Na Ri is a mountainous district in the Northeast of Bac Kan province, Viet Nam. Na Ri has a complex terrain, mainly hills and mountains with many limestone mountains, narrow valleys, steep slopes, belonging to the Ngan Son arc. The district is home to many ethnic groups such as Tay, Nung, Dao, Kinh, Mong... (the largest of which are Tay and Nung), with a slow urbanization rate and underdeveloped industrial activities. The economic life of the people is still difficult, the intellectual level is low, environmental issues such as: The amount of domestic waste increases; waste has not been properly collected and segregated; many communes/wards do not yet have a domestic solid waste treatment plant. These problems have the potential to affect the quality of the natural environment and reduce the beauty of the area. Before that situation, topic *"Promoting classification of domestic solid waste at source in Na Ri district, Bac Kan province, Viet Nam*" was conducted with the aim of assessing domestic solid waste management status, proposing solutions to improve the efficiency of DSW classification at source in Na Ri district, Bac Kan province, Viet Nam. The research results aim to contribute to reducing the amount of solid waste that must be transported and treated, improving the efficiency of waste treatment processes, and reducing the amount of waste discharged into the environment.

II. Research methods

Methods of data collection:

In this method, some information collected from books, newspapers, magazines, the internet. From there, the authors synthesized and analyzed documents and data related to the research content.

Methods of actual investigation and survey in the study area:

The field survey method in the study area is used for the purpose of correcting information, verifying existing documents, adding missing or incorrect information, especially focusing on waste collection and treatment activities. The survey method is applied mainly by interviewing with a set of open-ended questions with prepared topics. The study has conducted field surveys in the study area to collect specific information and objectively evaluate the research problem such as domestic solid waste collection route, domestic solid waste classification at source, domestic solid waste treatment area... The actual survey areas are residential areas, solid waste collection points, collection routes, domestic solid waste treatment areas...

Methods of statistics and data processing:

All collected documents must be processed, evaluated to check and detect possible errors, thereby taking measures to correct and supplement relevant documents in a timely manner. The data is processed by Microsoft Excel software.

Expert interview method:

Interview with staff from the Department of Natural Resources and Environment of Bac Kan province to verify the results of the interview survey.

III. Results and discussion

3.1. Domestic solid waste management status in Na Ri district, Bac Kan province, Viet Nam

Na Ri is a mountainous district in the Northeast of Bac Kan province, with a total natural area of 85,299.76 hectares, accounting for 17.54% of the natural area of Bac Kan province, including 16 communes and 01 town (Yen Lac) with 222 villages and hamlets; located in geographical coordinates from about 210 55' to 220 30' North latitude, 1050 58' to 106018' East longitude. The North borders Ngan Son district. The South borders Cho Moi district and Thai Nguyen province. The East borders Binh Gia and Trang Dinh districts (Lang Son province). The West borders Bach Thong district. Na Ri has a complex terrain, mainly hills and mountains with many limestone mountains, narrow valleys, steep slopes, belonging to the Ngan Son arc. The district is home to many ethnic groups such as Tay, Nung, Dao, Kinh, Mong... (the largest of which are Tay and Nung), with a slow urbanization rate and underdeveloped industrial activities. The economic life of the people is still difficult, the

intellectual level is low, and infrastructure such as roads, schools, national grid electricity, and commune health stations, despite the State's investment, still face many difficulties.

Domestic solid waste originates from many different sources, they differ in quantity, size, composition, spatial distribution... Domestic solid waste originates in personal activities as well as in social activities from residential areas, restaurants, hotels, companies, offices and industrial factories and from agricultural production activities...

Na Ri district currently has over 9,000 households (with a population of 42,513 people), 26 state administrative agencies and over 50 public service units located in the area. The average amount of DSW generated is 0.5 kg/person/day. The total amount of DSW generated in the area is about 7,800 tons/year, of which the amount of urban DSW is about 4,380 tons, the amount of rural DSW is about 3,420 tons.

The composition of domestic solid waste includes: inorganic substances (glass, ceramic, metal, paper, rubber, plastic, nylon bags, fabrics, electrical appliances, toys...), organic substances (discarded plants, fallen leaves, spoiled vegetables, leftovers, animal carcasses, animal manure...) and other substances.

Determining the composition of domestic solid waste is very important in choosing processing equipment, processing technology, reuse as well as planning management programs for the domestic solid waste management technical system. The volume of domestic solid waste components is not the same due to different usage needs. The needs in the lives of households are different, so the composition of domestic solid waste from different sources is also different. The results of classifying domestic solid waste samples collected during the process of weighing domestic solid waste in the study area show that organic domestic solid waste accounts for the highest proportion (accounting for 71.38%), followed by inorganic waste at 28.38%, the smallest component is hazardous waste at 0.24% and the difference between the survey points is insignificant.

People in general are not aware of waste classification. The functional unit has collected and processed about 70-75 vehicles each month, each vehicle has a load capacity of 6 tons of waste, equivalent to about 5,402 tons/year, reaching 69.25%. In communes with collection points, the rate of waste collected and transported to the district's waste treatment area for treatment is about 90%. The main method of treating domestic solid waste in the study area is burial or burning.

In Na Ri district, there are currently 03 incinerators (located in Yen Lac town, Con Minh commune, Tran Phu commune). Domestic solid waste generated in Yen Lac town and neighboring communes is collected and processed at the waste treatment area of Yen Lac town; Urban solid waste is collected, transported and treated at incinerators located in Yen Lac town, while rural solid waste is collected and treated mainly at min incinerators, in many places waste is spontaneously burned and buried in the premises of households.

Currently, the waste treatment area of Na Ri district located in Po Chet village, Lam Son commune and Gia Dia village people's group, Yen Lac town has shown signs of overload, greatly affecting the environment and the lives of neighboring people. The waste disposal site of Na Ri district located in Yen Lac town was invested in and built in 2000, with an area of about 2,000m2. This is a freely dumped landfill, without any thorough treatment measures. All waste in Yen Lac town and some neighboring communes is gathered here, around the landfill area there are many households living and working. Because the landfill is located on high ground, the main treatment process is burning and burying, so the waste smells and on rainy days flows down the hillside to the residential and farming areas.

In response to this situation, Na Ri district has also invested in building a waste treatment area located in Khum Man village, Kim Lu commune, which has been completed and put into use on an area of 7.51 hectares; the total investment is nearly 15 billion VND, invested by the district People's Committee from the local budget. This is a large-scale project, including items such as a road leading to the landfill over 5km long and a waste treatment area including a waste treatment tank system, drainage system, garbage drying house, waste incinerator, waste treatment classification area, collection pipeline, operating house, biological lake... According to the design, the Na Ri district landfill project will process more than 10 tons of waste/day with an incinerator with a processing capacity of 500kg/hour, qualified to process waste from communes in the central area of Na Ri district such as: Kim Lu, Luong Ha, Lam Son and Yen Lac town, contributing to limiting the situation of widespread waste and heavy environmental pollution at the district's temporary waste dump as it is now. Workers collect waste at the garbage collection sites, the waste is transported by truck to the landfill and processed according to the process.

Difficulties in the collection and treatment of waste in Na Ri district:

- The DSW management still has many shortcomings such as lack of human resources and equipment for collection and labor protection; many localities do not have DSW collection points and have not yet implemented environmental protection fees for DSW.
- The authorities of some communes have not given strong direction, inspection and supervision work is still limited, so waste treatment at the incinerator has not followed the correct process;
- The amount of waste is large, the area for drying waste is narrow, the waste storage deck after treatment is small, not enough to meet the amount of waste generated daily that needs to be treated;

- Domestic solid waste has not been classified at the source, so it is very difficult to classify and treat at the incinerator; The funding to support the waste collection and treatment working group is still low;
- The collection and treatment of domestic solid waste is currently only carried out in areas near the district center. Some commune cluster centers with markets such as Cu Le, Xuan Duong, Lang San, Quang Phong... do not have a waste collection and treatment site.
- In addition, the environmental protection awareness of a part of the population is still limited, they are not proactive in collecting and classifying household waste, and in some places, waste is still thrown indiscriminately in public places;

3.2. Solutions to improve the efficiency of domestic solid waste classification at source in Na Ri district, Bac Kan province, Vietnam

a. *Raise awareness of the community*

One of the most important solutions to improve DSW management in Na Ri district, Bac Kan province, Vietnam is to raise awareness of the community on how to identify types of waste and the importance of sorting DSW at source.

Sorting DSW at the source will contribute to reducing the amount of solid waste to be transported and treated, improving the efficiency of waste treatment processes, and at the same time reducing the amount of waste released into the environment. Therefore, it will contribute to reduce the risk of environmental pollution; reduce the cost of collection, transportation and treatment of solid waste. In addition, sorting waste at the source also helps to improve the efficiency of waste treatment; increase reuse of organic waste, thereby creating a source of clean fertilizer for crops, reducing costs in agricultural production, and minimizing risks of pollution and diseases arising from waste; recover and recycle useful components in waste (paper, metal…). Vietnam's Law on Environmental Protection 2020, which took effect from January 1, 2022, has many new points that specify more clearly and specifically the responsibilities of each organization, each household and individual on the issue of increasing responsibility for environmental protection. Therefore, localities need to step up propaganda to raise awareness for the community on how to identify types of waste or provide each household with a poster with a list and illustrations of waste types (inorganic wastes, organic wastes and recyclable wastes). Posters should be posted on the wall near trash cans and garbage collection points in public places so that people of all ages can easily identify and conduct waste separation at source. In addition, it is necessary to promote education to raise awareness for the community about the importance of waste segregation at source. This will contribute to improving the efficiency of waste separation at source.

b. Implementation of solutions for effectively and thoroughly DSW classification at source

One of the weaknesses in the DSW management in Bac Kan province in particular and the country in general is the waste classification at source. Waste will become a recycling resource to serve human life if the process of sorting - collecting - transporting and disposing of waste is done scientifically and thoroughly. An important step in this process is waste sorting at source. Domestic solid wastes can be classified into three main categories: organic wastes, inorganic wastes and recyclable wastes. Inside:

Organic waste: is easily decomposable and recyclable waste. They can be used for composting fertilizing crops and making food for animals. It is origined from uneaten or spoiled foods that cannot be used by human. For example: Damaged vegetables, tubers, fruits; Uneaten food, expired foods; Grass, leaves, plants, flowers, straw; Fruit peels and seeds; Tea residues, coffee residues; Animal carcasses...

Inorganic waste: is the type of garbage cannot be used anymore, is less recycled and often carried to landfill. For example: crockery, bricks, coal slag, nylon...

Recyclable waste: is waste such as newspaper, plastic, metal ... They will be transferred to facilities for recycling into new products.

In order for the classification of domestic solid waste at source to be effective, it is necessary to apply the following measures:

+ Require households to use three-compartment dustbins or three separate dustbins to store three types of different waste (inorganic, organic and recyclable waste). The nylon bags using for containing DSW inside each separate compartment/dustbin must be the same color with the compartment/dustbin to be convenient for the collection of different types of waste anywhere. Besides, it must be necessary to have pictures/letters to symbolize the types of waste in each compartment / dustbin so the waste classification at source will be easier and more effective.

+ The color of the bag / compartment / dustbin, and the pictures for each type of waste that need to be synchronized in all management areas are extremely important. Therefore, everywhere we will not be confused when implementing waste classification solutions at source.

+ There must be a handling and discipline for organizations and individuals that do not classify wastes at source.

The sorting of domestic solid waste helps to recover the types of waste that can be recycled and reused (heavy metals, plastics, paper ...); reduce the amount of waste generated in households. Therefore, it will reduce the

amount of remained waste in localities that do not have incinerators or centralized waste treatment plants; reduce transportation costs and improve the operational efficiency of incinerators and waste treatment plants in the area.

IV. Conclusion

Na Ri is a mountainous district in the Northeast of Bac Kan province, with complex terrain, mainly hills with many limestone mountains, narrow valleys, steep slopes, and many ethnic groups living there such as Tay, Nung, Dao, Kinh, Mong... (the largest of which are Tay and Nung ethnic groups), with a slow urbanization rate and undeveloped industrial activities. The economic life of the people is still difficult and the intellectual level is low. Na Ri district has a population of 42,513 people. The average amount of domestic solid waste generated is 0.5 kg/person/day. The total amount of domestic solid waste generated in the area is about 7,800 tons/year, of which the amount of urban DSW is about 4,380 tons and the amount of rural DSW is about 3,420 tons. The composition of DSW includes organic matter (71.38%), inorganic matter (28.38%) and hazardous waste (0.24%). The main methods of treating DSW in the study area is burial or burning. In Na Ri district, there are currently 03 incinerators (located in Yen Lac town, Con Minh commune, Tran Phu commune). Although local Party committees and authorities have focused on raising awareness of environmental protection among the people; providing partial financial support for households to build garbage pits and household waste treatment points; movements to prevent plastic waste; self-managed youth roads; self-managed women have been widely deployed... But local people are still not aware of waste classification. The rate of collected and treated domestic solid waste is 5,402 tons/year, reaching 69.25%. The DSW management still has many shortcomings such as lack of human resources and equipment for collection and labor protection; many localities do not have DSW collection points and have not yet implemented environmental protection fees for DSW. The authorities of some communes have not given strong direction, inspection and supervision work is still limited, so waste treatment at the incinerator has not followed the correct process; Domestic solid waste has not been classified at the source, so it is very difficult to classify and treat at the incinerator; Funding for garbage collection and treatment teams is still low...

To improve the effectiveness of classifying domestic solid waste at source, it is necessary to promote propaganda to raise public awareness about how to recognize types of waste and the importance of classifying waste at source; Implement effective and thorough solutions to classify domestic solid waste at source: Domestic solid waste can be classified into three main types: organic waste, inorganic waste and recyclable waste; Require households to use three-compartment trash cans or three separate trash cans to store three different types of waste (inorganic waste, organic waste and recyclable waste). In addition, there must be images/letters representing the types of waste in each compartment/trash can to make waste classification at source easier and more effective; The color of bags/compartments/trash cans, images for each type of waste need to be synchronized in all management areas, which is extremely important; There must be sanctions and discipline for organizations and individuals who do not classify waste at source...

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