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HANOI ARCHITECTURAL UNIVERSITY

URBAN DOMESTIC SOLID WASTE MANAGEMENT IN FIRST CLASS CITIES OF NORTHERN MIDLAND AND MOUTAINOUS REGION, TAKING THAI NGUYEN CITY AS EXPERIMENTAL AREA

PH.D. THESIS

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INTRODUCTION

1. SIGNIFICANCE OF THE STUDY

Rapid urbanization and city growth of city residents have made urban domestic solid waste management local authorities' critical concern, which requires strategic supervision. Urban domestic solid waste management is one of the five public services in the field of Public Utilities stipulated in Decree No: 31/2005/NĐ-CP by the Prime Minister.

Northern midland and mountainous region comprises of 160 urban areas, included Thai Nguyen City and Viet Tri City, which are first class cities. By 2030, there will be two more first class city, which are Lao Cai City and Lang Son City, making the region's number of municipal first class cities become four. Similar to other cities, in these urban areas, domestic solid waste management is becoming more complicated as the amount of domestic solid waste is increasingly rising while the main processing method is burial, which leaves serious consequences for the living habitats. Therefore, the study of "Urban domestic solid waste management in first class cities of Northern midland and mountainous region, taking Thai Nguyen City as experimental area" is extremely essential, scientifically significant and practical.

2. PURPOSE OF THE STUDY

The study of "Urban domestic solid waste management in first class cities of Northern midland and mountainous region is aimed at guaranteeing an improvement in the living standard of the citizens.

3. OBJECTIVES OF THE STUDY

1. Conducting a comprehensive study about the state of urban domestic solid waste management in specific countries in the world to comprehend the global trend of the managing tasks at the present.

2. Assessing the state of urban domestic solid waste management in first class cities in the country and in Northern midland and mountainous region.

3. Studying the scientific basis of urban domestic solid waste management in first class cities in Northern midland and mountainous region.

4. Proposing particular measures to innovate the model of urban domestic solid waste management and applying to Thai Nguyen City.

4. OBJECTS AND AREA OF THE STUDY

* Study object: urban domestic solid waste management.

* Study area: first class cities in Northern midland and mountainous region.

* Study period: 2030 (Pursuant to Decision No: 980/QĐ-TTgdatedJune21st2013by Prime Minister on approval of Planning and construction in Northern midland and mountainous region oriented towards 2030).

5. STUDY METHOD

The study accomplish these following research methods: Systematizing and inheriting; Investigating and examining; Meta-analysis; Inviting expert's opinions; Comparing and Collating; Attesting and Applying.

6. SCIENTIFIC AND PRACTICAL VALUES OF THE STUDY

* Scientific values

- Systematizing the thesis of urban domestic solid waste management in first class cities in Northern midland and mountainous region; new tendencyin global management.

- Providing basic content of urban domestic solid waste management, applying to first class cities in Northern midland and mountainous region as well as other cities during urbanization progress.

- References for teaching and research in the field of urban management.

* Practical values

- Assessing the execution of state management documents on urban domestic solid waste management in first class cities in Northern midland and mountainous region.

- Indicating the causes and suitable solutions to managing problems in Northern midland and mountainous region.

- Applying the study's results to Thai Nguyen City.

7. INNOVATIVE CONTRIBUTIONS OF THE STUDY

- The study proposes the division into three areas of urban domestic solid waste management in first class cities in Northern midland and mountainous region.

- The study proposes four models of urban domestic solid waste management and processing technology of the three areas.

- Proposing solutions to private garbage collecting bases in first class cities in Northern midland and mountainous region.

- Proposing the "3R" solutions to urban domestic solid waste management in first class cities in Northern midland and mountainous region.

- Proposing solutions to mechanism and policy in urban domestic solid waste management, which include:adjusting garbage collecting cost, sanction in waste sorting, encouraging processing urban domestic solid waste in modern methods that apply advanced technology.

8. EXPLANATION OF ACADEMIC TERMS USED

9. STRUCTURE AND CONTENT OF THE DISSERTATION

Apart from the introduction and conclusion, proposal, list of results publishments, the dissertation includes: Chapter I: Overview of urban domestic solid waste managementin Vietnam and in the world; Chapter II: Scientific basis of urban domestic solid waste management in first class cities in Northern midland and mountainous region; Chapter III: Solutions to urban domestic solid waste management in first class cities in Northern midland and mountainous region. The dissertation comprises of 17 tables; 51 images and 24 charts.

CHAPTER I: OVERVIEW OF URBAN DOMESTIC SOLID WASTE MANAGEMENT IN VIETNAM AND IN THE WORLD

1.1. URBAN DOMESTIC SOLID WASTE MANAGEMENT IN BIG CITIES IN THE WORLD

1.1.1. Urban domestic solid waste management in developed countries

According to World Bank, 34 countries of Organization for Economic Co-operation and Development (OECD) are creating 572 ton of solid waste per year. Solid waste per capita are about 1.1-3.7 kilograms per day, average is 2.2 kilograms per person per day. Solid waste is becoming one of the resources that bring about many benefits such as energy, micro-organic fertilizer, construction material and so on.

a. Stockholm – Sweden

b. Copenhagen and Horsholm – Denmark

1.1.2. Urban domestic solid waste management in developing countries

The amount of solid waste in developing countries is about 0.4-1.1 kilograms per person per day. The first priority is to collect waste rather than process them. The collecting proportion is about 10%-41%-85%-100% depending on each country and their economies. Recycling is mainly informal and inaccurate statistics.

a. Pune – India

b. Bogor and Surabaya – Indonesia

c. Nonthaburi – Thailand

1.2. OVERVIEW OF SOLID WASTE MANAGEMENT IN SPECIFIC CITIES IN VIETNAM

1.2.1. Municipal first class cities:

There are different urban domestic solid waste management between different cities due to population and regional features. Nonetheless, in most of the local, the management model is basically similar. Socialization in environment protection is urged in most cities.

1.2.2. Provincial first class cities:

Vietnam has 15 provincial first class cities, where burial is the main processing method while recycle has just been applied in recent years. Harmful solid waste are still mixed with urban domestic solid waste, which is out of control.

1.3. URBAN DOMESTIC SOLID WASTE MANAGEMENT IN NORTHERN MIDLAND AND MOUTAINOUS REGION

1.3.1. About the Northern midland and mountainous region

a. Natural conditions:

Northern midland and mountainous region includes 14 provinces of Lang Son, Cao Bang, Ha Giang, Lao Cai, Lai Chau, Dien Bien, Son La, BacGiang, Thai Nguyen, BacKan, tuyenquang, PhuTho, Yen Bai, HoaBinh . The total area is 95,264.8 square kilometers and a population of 2014 people is 11667.5. The region has mountainous and complex topography.

b. Economic and social conditions:

The region has 6/10 mountainous area, 7/9 mountainous provinces of the country. Ethnic minorities account for 13.8% of the population with highest poverty rate 21.14% among the country.

c. Basic characteristics of first class cities in Northern midland and mountainous region: the region has two first class cities, in 2030, there will be four first class cities, including: Thai Nguyen City, Viet Tri City, Lao Cai City and Lang Son City. The process of urbanization in Northern midland and mountainous region prospered since the country entered a period of renewal. Almost all cities are sorted as class third. Although there are a lot of urban areas, but the rate of urban population is low.

1.3.2. Overview of urban domestic solid waste management in first class cities in Northern midland and mountainous region

a. Arised situation: The amount of incurred domestic waste rated3rd among the country per capita. Viet Tri City and Thai Nguyen City account for most of domestic solid waste in the region. Indicator per capita arising from high to low relatively: Viet Tri City, Lao Cai City, Lang Son City, Thai Nguyen City. The amount of solid waste is expected to increase by 5 times by 2030.

b. Urban domestic solid waste components: The highest proportion is organic matter, from 50% to 75%; the other components are inorganic substances and other substances. Plastic bags are emerging concerns. Other information about the components of domestic solid waste are inaccurate as a result of unrealized waste sorting.

c. Collect situation:

- Collection: waste from household is collected with their streets. Public areas are collected by hand, other bases which are not households and business bases are collected and shipped under contracts. Average collecting rate in the urban areas in the region average is 85%, the lowest is in the Son La City (60%), the highest belonging to Lang Son City, Viet Tri City, Thai Nguyen City.

- Recycling: The recycling rate is low, collected waste is mixed with many components and be buried, spray pollution reduce chemicals. Collecting urban domestic solid waste for recyclingis only performed by informal organizations.

d. Planning situation:

In the region, the planning of urban domestic solid waste management was conducted by local authorities, until 2015, there are 12 out of 14 cities that has been planned. The plans aim to build a modern management system with advanced processing technology and restrict burial. However, in planning contents revealed the following shortcomings:

- Planning contents focuses on collection and transport systems, calculate the size and distribution, layout processing zones;

- Set high collecting targets (95%), processing (85%) without a specific solution;

- Not mention about planning, management of landfills. Currently most of the landfills in the area were closed and the overloaded landfills is heavily polluting, which has not been solved.

e. Process situation

* Burial: Currently, urban domestic solid waste process isvery primitive and cannot meet environmental standards due to the following reasons:

- Insufficient concentration spraying

- Some regional landfills were no longer receiving waste, but also untreatedly closed is causing environmental pollution (landfill Khuoi Mat- Bac Can City, landfill KhuoiKep- Cao Bang City).

- Some operating landfills are heavily polluting the environmentdue to overloaded waste for many years (landfill NoongBua (Dien Bien City); landfill Doc Bung (HoaBinh City).

- Some landfills located in high terrain is causing water pollution (Lai Chau City landfill).

* Process organic waste by means of composting: The entire area has five factories (one factoryprocesswasteintomicro-organism fertilizers in Viet Tri City and three new factories under construction in the city of Son La, Yen Bai, Lao Cai, Lang Son).

* Process waste bymeans of technology: Currently 5 cities have invested in advanced global technology:

- waste processing factory in Viet Tri City, waste treatment plant in Lao Cai City, solid waste treatment plant of ChiengNgan, (Son La City), waste treatment and organic microbiology fertilizer production factory of Yen Bai City, waste treatment plant of Thai Nguyen.

- Landfills are mainly processed by disinfectant spraying with microbial products EM (Effective Micro-organisms), the cities that have waste treatment plant still combine

burial, despite the big amount of waste landfills, which has not tend to recover in the future. Only one city have a landfill assessed hygienic (Yen Bai City).

- There was no waste treatment project on regional scale; no mechanisms and policies to encourage investment to develop this type of projects.

g. Urban domestic solid waste management model in first class cities in the region

* There are 3 management models:

- Urban environmental sanitation company under People's Committee of the following provinces(Son La, Dien Bien, BacKan, Lai Chau, HoaBinh, Ha Giang, TuyenQuang, Cao Bang, Lao Cai).

- Urban environmental sanitation company under People's Committee of the followingcities (BacGiang, Thai Nguyen, Viet Tri).

- Entirely socialized models (Lang Son City, Yen Bai City).

* In terms of professional management: there are two management models in the region:

- Under Construction Department: (Thai Nguyen, Vietnam Tri, Lao Cai, TuyenQuang, Ha Giang, Dien Bien, Cao Bang, Son La, BacGiang, BacKan).

- Natural Resources and Environment Department: (Yen Bai, Lai Chau, HoaBinh, Lang Son).

* Management models under Environmental Sanitation Company: Each locality has different models: joint stock companies, limitedliabilitycompanies, companies of public services or public utility services, companies of non-public services. Operation of these companies are under administration of local authorities.

h. Socialization work in urban domestic solid waste management in cities of the region: Following the general trend of limited liability companies, management will equitize. Apart from URENCO, the other units such as limited companies, joint stock companies, cooperatives ... will socialize the management under the project "Hygiene residential areas".

i. About environmental sanitation service fee. The promulgation of documents on environmental sanitation fee under the jurisdiction of provincial people's councils, municipal citiesbased on the proposals of local Finance Department. Budget for collecting and processing urban domestic solid waste will be paid by the government. Environmental fees only partially addressed for collection services. Costs for URENCO to collect and process waste will base on class of the cities.

1.4. DOMESTIC SOLID WASTE MANAGEMENT IN THAI NGUYEN CITY

1.4.1. Overview of Thai Nguyen City

Thai Nguyen City is the political, economic, cultural and social center of Thai Nguyen province and Northern midland and mountainous region, its natural area is 17,069.76 hectares in 2014) with the population of 306 842, comprises of 27 administrative units including 19 wards, 8 towns. Thai Nguyen City located in Midland area with ethnic groups.

1.4.2. Overview of domestic solid waste management in Thai Nguyen City

a. Incurred situation and components

The amount of solid waste in 2012 was 0.4 (kg / person / day); in 2013 was 0.46 (kg / person / day); in 2014 is 0.5 (kg / person / day), much lower in comparison with other first class cities in the country.

b. urban domestic solid waste components: Thai Nguyen has not conduct waste sorting so statistical surveys are conductedin landfill Da Mai and the result was estimated. Organic solid waste accounts for 89.3%, while other components account for more than 10%.

c. Collecting situation: In 2013, collecting is applied 24 towns / wards, In May 2014, collecting is applied 26 towns/wards, in 2015 made collecting is performed in all 8 towns and 19 wards.

Waste in downtown area is collected according to daily process of URENCO and flexibly in the suburban area. In eight towns, there are five remote towns (PhucTriu, Tan Cuong, PhucXuan, Phuc Ha, ThinhDuc), due tolow population density, URENCO

company will collect garbage at central hamlets. In other hamlets, where are no concrete roads, street lighting, the amount of waste generated is less, collection is conducted every 5-7 days at a shared junkyard of 2 or 3 hamlets. The whole city has 99 shared junkyard. The average amount of waste is about 133 tons / day (47 880 tons / year), accounting for about 95% of household waste generated in the city.

d. Process situation: process with burial method in Da Mai landfill (Tan Cuong), with an area of 25 hectares, the city is investing in building incineration factories to reduce burial amount and save land, but has not aimed to turn into energy yet.

e. Management situation: For Provinces: Natural Resources and Environment Department of Thai Nguyen performs state management functions of resources and the environment. Construction Department performs state management of the construction industry, including technical infrastructure of urban solid waste.

- For Thai Nguyen City

+ Urban Management Division: a division that in charge of environmental management

+ Natural Resources and Environment Division of the city: state management of natural resources and environment.

+ Thai Nguyen urban works and environmental joint stock company: collection, transport, handling of solid waste disposal in the city.

h. Socialization works: Before August 2014, environmental sanitation teams of wards/towns were established pursuant to Decision No.808/QĐ-UBND dated 08/15/2001 by People's Committee of Thai Nguyen City. There are 22 environmental sanitation teams with 276 collectors from households → transport to the garbage dumps → urban works and environmental joint stock company will transport to Da Mai junkyard. After 10 years of operation, environmental sanitation teams of wards/towns shows many shortcomings so People's Committee of Thai Nguyen City has assigned environmental sanitation teams to URENCO instead of wards/towns as in Decision 808/QĐ-UBND dated 15/8/2001byPeople's Committee of the city.

g. Policy in urban domestic solid waste management in Thai Nguyen City. People's Committee of province issued "Environment protection scheme in the locality from 2011 to 2015". People's Committee of the city issued Decision No.808/QĐ-UBNDwhichregulates on construction order management, pavement management, hygiene and wastewater management, waste management in the city.

1.5. COMMENT ON URBAN DOMESTIC SOLID WASTE MANAGEMENT IN FIRST CLASS CITIES IN NORTHERN MIDLAND AND MOUNTAINOUS REGION AND IN VIETNAM.

1. Population growth in big cities (including first class cities) will inevitably increase the amount of urban domestic solid waste.

2.The composition of waste is predicted to change according to the development of economy and modern living standard, organic components will decrease while waste packaging, paper and plastic will increase.

3. Burial is the main waste management method in urban areas.

4. Waste statistics are inaccurate due to the unrealized waste sorting. The thesis is based on the amount of urban domestic solid waste that is collected during the day and the number of citizens served, the average amount of waste is about 0.88 kg / person / day, which is equivalent to the figures reported by Construction Department in 2015.

5. The management content has not kept up with new trends in the world.

6. There is no urban domestic solid waste planning for the whole region. Although 12 out of 14 cities have planning, there is no specific solution for waste management in planning. There is no classification of urban domestic solid waste components; Collection rates are not high; The management model is basically a public utility company; The new sanitation fee is used for compensation for the collection and transportation of wastes, which is entirely financed by the budget;

1.6. OVERVIEW OF RESEARCH IN THE COUNTRY AND ABROAD

1.6.1. Overview of abroad research: Post-graduates have studied a number of works of scientists and international organizations of the United Nations, World Bank, ADB Bank, Habitat such as integrated solid waste management,…

1.6.2. Overview of research in the country: Post-graduates have studied a number of scientific works including ministerial theses, PhD theses and related theses.

CHAPTER II

SCIENTIFIC BASE OF URBAN DOMESTIC SOLID WASTE MANAGEMENT IN FIRST CLASS CITIES OF NORTHERN MIDLAND AND MOUTAINOUS REGION

2.1. BASIC THEORY OF URBAN DOMESTIC SOLID WASTE MANAGEMENT SYSTEM.

2.1.1. Urban domestic solid waste management system: a professional management system of: waste → storage → collection → sorting → transportation → processing / transformation /disposal reasonably based on the basic principles of public health, economics, engineering, conservation, landscape, environmental issues, community attitudes.

2.1.2. Urban domestic solid waste management organizing and responsibilities assigning system.

a. The municipal organizational system consists of five ministries that are directly responsible for solid waste management: Ministry ofNatural Resources and Environment, Ministry ofConstruction, Ministry ofIndustry and Trade, Ministry of Health and Ministry of Agriculture and Rural Development.

b. Local organizational system: Department of Construction; Department of Natural Resource and Environment; Urban Environmental Company (URENCO).

2.2. INTEGRATEDMANAGEMENT OF SOLID WASTES - NEW TRENDS IN ENVIRONMENTAL PROTECTION

Solid waste integrated management: A coherent management chain system in that includes: minimization, sorting, reuse, collection, transport, recycling, process and disposal. Therefore, the trend of integrated management in which the concentration is minimizing the amount of waste including these following steps: reduce, reuse, recycle, recover, resources protection. This is the view of 3R-4R - 5R

2.2.1. Concept of solid waste integrated management

a. Waste management at the end of production

b. Waste management throughout the production process

c. Waste management that emphasizes consumption

d. Waste integrated management

Waste management is a progressive approach adopted by the United Nations Environment Program (UNEP) and guided countries to implement. In Vietnam, waste integratedmanagement is addressed in the "National Strategy for IntegratedManagement of Solid Waste to 2025 with a view to 2050"

2.2.2. 3R Technique - sorting garbage at source: Reduce, Reuse, and Recycle are abbreviated as 3R.

2.2.3. 4R Technology – Integrated Waste Management (IWM): Based on 3R + 1: Reduce, Reuse, Recycle and Recover.

2.2.4. 5R - Integrated Solid Waste Management and Resource Management (Urban Solid Waste Integrated Management). The 5R includes Reduce, Rethink, Reuse, Recycle and Refuse.

2.2.5. Compare the development steps of 3R, 4R, 5R

3R: "Reduction - Reuse - Recycle" emphasize on the people who litter.

4R: 3R + 1 associated with breakthrough technology development.

5R: to be implemented when the economy develops, the living quality of people is stable, technology for each stage in the waste stream are invested advanced, modern and

synchronous. The prospect where the amount of waste is “zero” must stuck in people’s minds.

2.3. REQUIREMENTS IN URBAN DOMESTIC SOLID WASTE MANAGEMENT

2.3.1. Requirements in collection and transportation

a. Collection: Collection process for low-rise housing; Medium and high-rise housing; Bulk collection; Roadside collection with designed roads.

b. Planning and managing transportation routes

2.3.2. Requirements in urban domestic solid waste process

a. Burial method: Sanitary burial; Unprofitable burial; Criteria for selection of location of landfills.

b. Burning method

c. Biological method: discharge of waste to recover biogas; processing of micro-biological fertilizer; select urban domestic solid waste processing technology.

2.3.3. Requirements policy for urban domestic solid waste management

a. Expense for collection, transport and process of urban domestic solid waste

b. Charge for Solid Waste Management

c. Requirements of cost reduction and control

2.3.4. Requirements of scientific and technological development:

a. Technical requirements for solid waste management: Investment in technical systems must be synchronized from collection → transport → recycling → process → burial → energy recovery from landfill gas. Guidance, technical methods for selecting equipment can be provided. Maintain the operation and maintenance capacity of urban domestic solid waste management system.

b. Application of GIS technology in garbage collection: GIS application will rearrange the waste collection system to help assess the current status of the collection

system and provide high efficiency when mapping, especially when quick, accurate results requested.

2.4. URBAN DOMESTIC SOLID WASTE MANAGEMENT ORGANIZING SYSTEM

2.4.1. Urban domestic solid waste management system

2.4.2. Urban domestic solid waste management organizing and responsibilities assigning system.

a. Municipal

b. Local

2.5. ROLE OF RELATED PARTIES IN URBAN DOMESTIC SOLID WASTE MANAGEMENT

2.5.1. Community participation in urban domestic solid waste management

a. The role of community

b. The role of informal collectors

2.5.2. The role of local authorities

2.5.3. The role and involvement of the private sector

2.5.4. The role of non-governmental organizations and external support organizations

2.6. LEGAL BASESOF URBAN DOMESTIC SOLID WASTE MANAGEMENT IN FIRST CLASS CITIES OF NORTHERN MIDLAND AND MOUTAINOUS REGION.

2.6.1. State documents on urban domestic solid waste management.

2.6.2. Specific regulations on urban domestic solid waste management of Northern midland and mountainous region .

- Planning the construction of Northern midland and mountainous region by 2030

- Decision No: 2211- QĐ-TTg dated 14/11/2013 on the Solid Waste Management Plan for Cau River area towards 2020.

2.7. EXPERIENCES OF A NUMBER OF FOREIGN AND DOMESTIC URBAN AREAS ON SOLID WASTE MANAGEMENT

2.7.1. Experience of Yokkaite City - Japan.

2.7.2. Experience of QuyNhon City in solid waste sorting at source.

2.7.3. Synthesize domestic and foreign experiences in urban solid waste management

CHAPTER III

PROPOSING MODELS AND SOLUTIONS FOR URBAN DOMESTIC SOLID WASTE MANAGEMENT IN FIRST CLASS CITIES OF NORTHERN MIDLAND AND MOUTAINOUS REGION (APPLICABLE TO THAI NGUYEN CITY)

3.1. POINTS OF VIEW, TARGETS, PRINCIPLES

3.1.1. Points of view

- Classification of solid waste at source is the main key.

- Reducing the amount of waste, protecting the environment is a responsibility of the whole society.

- Unclosed managementbyadministrative boundaries.

- Ensure economic, technical optimization; Social and environmental security.

- Attach to the master plan for socio-economic development of cities and provinces in the region.

- Urban domestic solid waste management towards the "no waste" criteria, establishes a "shared responsibility" environment and follows the principle of "polluters pay."

3.1.2. Targets

- Specifying the urban domestic solid waste management in Northern midland and mountainous region.

- Management according to Integrated Solid Waste Management Strategy.

- Build synchronous solid waste classification at source system.

- To build and complete a system of mechanisms and policies on urban domestic solid waste management.

- Building suitable management models and investing in appropriate technologies for urban areas. Minimize the amount of buried waste, recognizing the role of unofficial waste collectors.

3.1.3. Principles

- Limiting the negative impact on the living environment.

- Compliance with the Law on Environmental Protection and other relating legal documents.

- Management tools must be developed based on the real situation of Northern midland and mountainous region.

- All organizations, individuals and households are responsible for implementation of regulations on the environmental sanitation.

- People's Committees encourage the socialization of the collection, sorting, transportation and disposal of solid waste.

3.2. PROPOSING THE URBAN DOMESTIC SOLID WASTE MANAGEMENT MODEL IN FIRST CLASS CITIES OF NORTHERN MIDLAND AND MOUTAINOUS REGION.

3.2.1. Divide the area for management.

a. Base of the division of management areas: Based on the differences between areas within a city including society, economy, climate, space, urban development, technology, waste characteristics.

b. Principles on the division of management areas.

- Division based on the subject who litter.

- Division based on geographic location, land-use model.

- Division based on technical infrastructure condition of the areas.

- Division based on cultural characteristics, economic conditions and lifestyle.

c. Proposing 3 management areas

- Area 1: Downtown area.

- Area 2: The area around the city center.

- Area 3: New suburban residential areas.

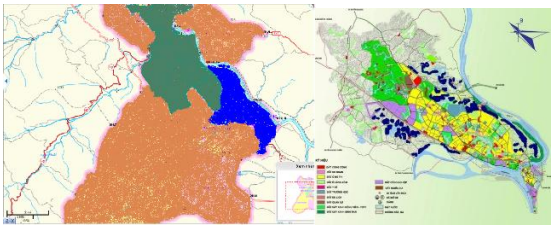

Image: 3 areas of Lao Cai City and Viet Tri City

c. Collection by areas:

Area 1, the most appropriate waste collection and transportation must be planned.

Area 2, depending on the distance of transportation, the size and density of the population to build large or small gathering yards. The means of collection also vary according to the slope.

Area 3, each village build waste gathering yards, environmental sanitation teams will collect by trolley or specialized vehicles to junkyards then the environmental sanitation unit transport to waste processing places by specialized vehicles.

3.2.2. Urban domesticsolid waste management model in first class cities ofNorthern midland and mountainous region.

a. Area 1, proposing2 models

Model 1: Urban environmental company co-operate with People's Committee of Ward (where there are no waste gathering yards)

Model 2: Public-private partnership

b. Area 2, proposing model 3

Model 3: Environmental companies co-operate with wards/towns (where is sparsely populated with waste gathering yards).

c. Area 3, proposing model 4

Model 4: complete socialization

3.3. PROPOSING URBAN DOMESTIC SOLID WASTE MANAGEMENT SOLUTIONS TO FIRST CLASS CITIES OF NORTHERN MIDLAND AND MOUTAINOUS REGION.

3.3.1. Organize new and unite private collecting groups.

a. Complete efficient private waste collectinggroups.

b. Establish a new waste collecting group, set up a working mechanism.

3.3.2. Proposing 3R solution in urban domestic solid waste management

a. Waste sorting according to regional and time conditions.

b. Waste sorting at waste gathering yards and processing areas.

c. Prevention, minimization, recycling, reuse of urban domestic solid waste.

d. Building a model of co-operatives for recycling.

e. Establish organization and work rules for garbage collecting "army".

g. Establish waste paths in waste sorting in correspondence to investment in local processing technology.

h. Establish sanctions in waste sorting.

3.3.3. Proposingsuitablesolutionsto urban domestic solid waste management in first class cities of Northern midland and mountainous region.

a. Area 1, invest in a factory to process waste into micro-organisms fertilizer.

b. Area 2, investing in solid waste processing technology combining large-scale agricultural waste such as microbial fertilizer processing factories, electric and thermal power plants.

- Build small-scale garbage incinerators.

c. Solutions to urban domestic solid waste management in Area 3, increasing the process of organic waste into micro-organismsfertilizerin agricultural areas.

Garbage process into micro-organisms fertilizer in area 3

Small incinerator in area 2

3.4. PROPOSING SOLUTIONS ON POLICY MECHANISMS IN URBAN DOMESTIC SOLID WASTE MANAGEMENT OF NORTHERN MIDLAND AND MOUTAINOUS REGION.

3.4.1 Improve waste collection service fees

- Assign the initiative to the local authorities to calculate collection fees.

- The collection feesshould be differentiated between areas, households in area 1 are charged according to the general regulations, then area 2 shall be reduced to 0.8, area 3 is 0.7. For waste gathering yards, fees will based on volume or weight.

3.4.2. Sanction policy in waste sorting

a. It is necessary to standardize and synchronize waste sorting program

b. Encourage the private sector to participate in urban domestic solid waste management.

3.4.3. Policies that encourage the process of solid waste with modern method

3.4.4. Intraregional urban domestic solid waste management policies.

Cities should agree on indicators and require commitment to reduce the amount of waste. Some cities work together to build toxic waste treatment plants.

3.5. PROPOSING SOLUTIONS TO URBAN DOMESTIC SOLID WASTE MANAGEMENT IN THAI NGUYEN CITY.

3.5.1. Divide the area for management

Area 1: 19 wards in the center of the city

Area 2: 8 suburban towns

Area 3 (the urban area will be developed until 2035), including Son Cam Town(PhucLuong); Chua Hang Town, Linh Son Town, HuongThuong Town (Dong Hy) ;Dong Lien Town (PhuBinh).

3.5.2. Proposing collection and transportation model

a. Collection by the model of socialization: It is possible to carry out each stage of collection, transportation.

b. Area 1: transportation, collection, transportation and management based on GIS technology for optimal transport.

+ For traffic routes, regional roads, neighborhood streets, branch roads, pick up waste two opposite houses and in turn through pairs of houses along the route. Use trolley along the route and transport all trolleys to the waste gathering yards.

+ Collection in concentrated residential areas: the collecting vehicles are also transport vehicles.

+ Collection at waste gathering yards: local authorities coordinate with People's Committees of wards / communes in the area to select collection methods.

- Area 2: each town has a collecting team that will use trolleys to collect inorganic waste to the waste gathering yard. The organic waste will be transferred to the micro-organisms factory.

- Area 3: Expanded townswill be applied according to the model of area 1 - the center of the city, for the following reasons:

- Transportation is connected to the central area due to the short distance (3 - 6km).

- These are adjacent towns with fast urbanization, social and urban infrastructure developed according to the adjusted plan.

- The transportation and process devices of the city up to 2035 will be more modern.

c. Proposing Technology for domestic solid waste process in Thai Nguyen city towards 2020: recycle 10-15%; processing of micro-biological fertilizer: 60-70%; Burning, burial 20-25%.

d. Proposing waste sorting solutions for Thai Nguyen City.

① Management task under the 3R model

② Reduce the amount of waste from the habit of living and consumption. Support for recycling packaging, established the "Association of non-waste enterprises"

③Solutions of reusing, establish a donation area for others to continue to use.

④Recycling Solutions, Organize of Recycling Initiatives Competition; Create an information website; Advertising campaigns, guidance for people; Build a team of volunteer propagandize recycling.

⑤Stages of 3R implementation: stage 1: from 2014 to 2016, launch, propagandize and implement initial steps with residential clusters, streets, markets, restaurants, hotels, hospitals, agencies, schools.

Stage 2: From 2017 to 2020, drastically execute to go into order, forming habits and awareness in every citizen.

⑥About equipment: URENCO can place sample boxes at places where people litter

⑦ Promulgated the text of the city in implementing 3R

e. Proposing sustainable financing solution for urban solid waste management for Thai Nguyen City. After 2020, it is necessary to exploit funds from recycling and modern processing.

3.5.3. Proposing the structure of urban domestic solid waste management

a. Promote the socialization of public services to reduce the financial burden of the state

b. Build a synchronized state management apparatus to avoid overlapping.

c. Enhance the participation of relating sectors.

d. Give more power to local authorities.

3.6. DISCUSS THE RESULTS

3.6.1. Discuss the area divisionfor urban domestic solid waste management of first class cities.

3.6.2. Discuss the model of domestic solid waste management in first class cities of Northern midland and mountainous region.

3.6.3. Discuss suitable solutions for domestic solid waste process in first class cities of Northern midland and mountainous region.

3.6.4. Discuss the model and sanction policies in classification of solid waste at source.

3.6.5. Discuss the possibility of applying the urban domestic solid waste management model for Thai Nguyen City.

CONCLUSION AND PROPOSALS

1. CONCLUSION

1. The thesis “Urban domestic solid waste management in first class cities of Northern midland and mountainous region, taking Thai Nguyen City as experimental area”has been studied. This is a complex and sensitive area because there are many stakeholders in the management of urban domestic solid waste. First class cities in Northern midland and mountainous region have their own characteristics that require different solutions compared to other regions of the country.

2. The dissertation has proposed solutions for Northern midland and mountainous region approaching the general management trend, firstly implement waste sorting, investment in processing technology in correspondencewith the sustainable management strategy.

3. From the analysis of the scientific basis of Northern midland and mountainous region, the path to success of urban domestic solid waste management in a sustainable manner must be started from waste sorting.

4. Due to the particular characteristics of Northern midland and mountainous region, it is appropriate to classify the management areas according to the conditions of each urban area in the management and development of urban areas.

5. The work of urban domestic solid waste management in Northern midland and mountainous region should be renovated to manage and develop services associated with creating a market economy.

6. The investment in the construction of technical infrastructure, means of transport and transportation, construction of processing areas with appropriate technology are being actively implemented by localities and seeking for public-private partners. Socialization is a popular trend in first class cities ofNorthern midland and mountainous region.

7. Urban domestic solid waste management in the area cannot be reproduced to turn garbage into input material. Inter-regional and inter-urban relationships in the field of urban domestic solid waste management.

8. Due to the different characteristics of the areas within the same city, the collection and process is divided into three areas with different topographic economic conditions, the charges between different areas should be reduced from the center to the perimeter of the city.

9. The work of domestic solid waste sorting is extremely important, the government should have sanctions and incentives people to participate in waste sorting.

10. The content applicable to Thai NguyenCitycan also be studied further to suit other cities.

2. PROPOSALS

This is a new thesis related to urban domestic solid waste management for first class cities of Northern midland and mountainous region, the thesis has some proposal as follows:

1. Cities should be divided into 3 management areas with specific conditions of each urban in the area.

2. The government should make the waste sorting at source into Ordinance, which will mobilize the entire society into a responsible implementation.

3. The collecting fees also needs to be divided into three levels corresponding to three different areas in the implementation of services. For households in area 1, charges according to the general regulations, area 2 reduced to 0.8; area 3 is 0.7.

4. The State should have policies to encourage solid waste process by modern methods and manage in accordance with inter-regional cooperation.

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