SURVEY REPORT ON THE ENVIRONMENTAL CONDITIONS AND UTILIZATION OF THE RIVERINE SPACE ALONG THE RED RIVER IN PHUC TAN AND CHUONG DUONG WARDS, HOAN KIEM DISTRICT, HA NOI

Faculty of Architecture and Planning, Hanoi University of Civil Engineering

and the Livable Hanoi Network

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FOREWORD

Implementing the Plan No. 179/KH-UBND dated August 2nd, 2023 by the Hoan Kiem District People's Committee, the Livable Hanoi Network, represented by ECUE, has supported the Hoan Kiem District's Department of Natural Resources and Environment in conducting surveys on the current situation of waste, wastewater, social conditions, space usage, and the needs of the residents in the riverside areas of Chuong Duong and Phuc Tan Wards. This survey report aims to propose community-based environmental rehabilitation, the construction of forest parks, and the long-term management of the ecological environment in the areas.

The survey was conducted from October 2023 to January 2024. The survey team included Dr. Arch. Truong Ngoc Lan, Vice Dean of the Faculty of Architecture and Planning (Hanoi University of Civil Engineering); Dr. Arch. Pham Anh Tuan, Head of the Landscape Architecture Department, Chairman of the Vietnam Landscape Architects Association; MS. Dao Hai Nam from the Planning Department, Faculty of Architecture and Planning; MS. Nguyen Thi Thuc Anh, GIS and Remote Sensing Specialist; MS. Le Quang Binh, coordinator of the Livable Hanoi; MS. Nguyen Minh Huyen, researcher at ECUE; BA. Le Quang Minh, research staff at ECUE; and MS. Ha Ngan Ha, project manager at GreenHub. The research team received support and contributions from the staff of the Hoan Kiem District's Department of Natural Resources and Environment, leaders and officials of the People's Committees, and residents living along the riverbanks in Phuc Tan and Chuong Duong Wards. Additionally, the survey was assisted by 23 students from the Faculty of Architecture and Planning, Hanoi University of Civil Engineering.

The research team hopes that this report will serve as a valuable source of information for the People's Committee of Hoan Kiem District, the Department of Natural Resources and Environment, the People's Committees of Phuc Tan and Chuong Duong Wards, as well as relevant agencies for reference in environmental and urban management work. In addition to proposing specific solutions for waste and wastewater management in the short term, the report also suggests long-term, sustainable directions that contribute to improving the living conditions of the residents, especially women, children, and people with disabilities. The proposed solutions also consider the legal framework related to the riverside area in accordance with Decision No. 257/QĐ-TTg dated February 18th, 2016 by the Prime Minister on approving the Plan for Flood Prevention and Dyke System in the Red River and Thai Binh River; and the Red River development plan according to Decision No. 1045/QĐ-UBND on approving the Urban Planning of the Red River with the 1:5000 scale (from Hong Ha Bridge to Me So).

We also hope that the results of this report will serve as a basis for Hoan Kiem District to guide public investments as well as mobilize social resources for environmental and ecological rehabilitation in the riverside area, thereby improving the quality of life for the residents.

The survey team would like to express gratitude for the support from all stakeholders, including the technical support from the United Nations Development Programme (UNDP) in Viet Nam with funding from the Australian Department of Foreign Affairs and Trade (DFAT) for this study. All opinions expressed in this report are those of the research team with the aim to provide a source of reference the Hoan Kiem District's Department of Natural Resources and Environment and do not necessarily represent the views of UNDP in Viet Nam or any other agency.

The Research Team

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SECTION I. INTRODUCTION TO THE RESEARCH

I. OVERVIEW OF THE RESEARCH AREA

The banks of the Red River, which border the flow of the river itself, serve as a protective dike corridor safeguarding the heart of Hanoi. The riverside area within the scope of this study falls within the Chuong Duong and Phuc Tan wards of Hoan Kiem District. This zone, nestled between the bustling residential areas on one side and the Red River on the other, essentially forms a link connecting the river with its human counterparts. Spanning a total length of 3.8km, the area covers an estimated 47 hectares.

As an area designated for flood discharge and prevention of encroachment, most of the riverside zones are currently "abandoned," with wild vegetation growing unchecked. Many areas along the riverbanks, close to residential zones, have become dumping grounds for household waste, plastic bags, construction debris, and broken furniture, gradually turning into environmental hotspots over time. Furthermore, there are about 26 exposed drainage outlets of various sizes, discharging domestic wastewater directly into the Red River[1]. The situation with waste and wastewater in some areas along the riverbanks is causing severe sanitation and environmental pollution issues, adversely affecting the local people's health.

In reality, in some areas, residents have transformed spaces into vegetable gardens, fruit tree plantations, livestock areas, and cooking sites for personal benefit. Some spaces are utilized for community activities such as exercising, sports, bird singing contests, or cultural and spiritual events. While these riverbanks play a crucial role as a bridge between the river and the people and possess great potential to become public and ecological spaces within the city, the current state of pollution and the lack of comprehensive rehabilitation solutions mean that the Red River banks have yet to unleash their potential and contribute to the local economic, social, cultural, and environmental development.

II. OBJECTIVES OF THE RESEARCH

The research was conducted with the following objectives:

- Evaluate the current situation of solid waste, domestic wastewater, sources of pollution, the status of solid waste collection/management, and the land use and vegetation cover in the riverside areas of Chuong Duong and Phuc Tan wards of Hoan Kiem District, Ha Noi City;
- Collect and understand the needs, opinions, and aspirations of local residents regarding environmental management in the area and the future use of the Red River's riverside spaces;
- Propose recommendations and suggestions for the Hoan Kiem District's People's Committee and Ha Noi Department of Natural Resources and Environment on (i) community-based environmental treatment and management; (ii) spatial use orientation to improve the sustainable ecological environment; (iii) selecting a suitable location to support environmental rehabilitation that addresses environmental issues while increasing public space for local residents.

[1] According to the survey report by SHD Infrastructure Consulting Joint Stock Company

III. RESEARCH METHODOLOGY

This study involved both observation and assessment of 10 concentrated waste sites and 7 wastewater drainage outlets distributed along the riverbank as shown in Photo 1. The research team also conducted a sociological survey of 308 households living along the riverbank (see Appendix 1 for the questionnaire) via online questionnaire on KoboToolbox application. Additionally, the research team conducted in-depth interviews with 15 local residents and public officials. During the survey, the research team also conducted field trips to study vegetation coverage, human activities, and the current environmental status along the riverbank. Secondary data, including information collected from Google Earth on the historical changes in water levels and vegetation cover over time, were also utilized by the research team.

The ten survey points along the riverbank in Phuc Tan and Chuong Duong wards were selected based on satellite imagery from Google Earth, preliminary field surveys, inputs from local authorities, and feedback from the residents. These ten points were chosen as representative locations along the Red River banks, where the pollution of waste and wastewater is severe. They are easily accessible and have the potential for vegetation coverage, making them suitable candidates for transformation into public spaces for the community.

The on-site survey results were analyzed by a multidisciplinary team of experts in social sciences, environmental studies, planning, and landscape architecture to draw feasible and comprehensive conclusions and solutions.

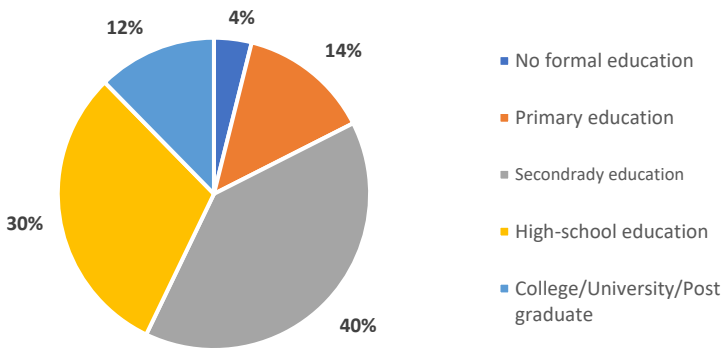
Photo 1: The field study site

SECTION II. RESEARCH RESULTS

I. DESCRIPTION OF THE POPULATION IN THE RESEARCH

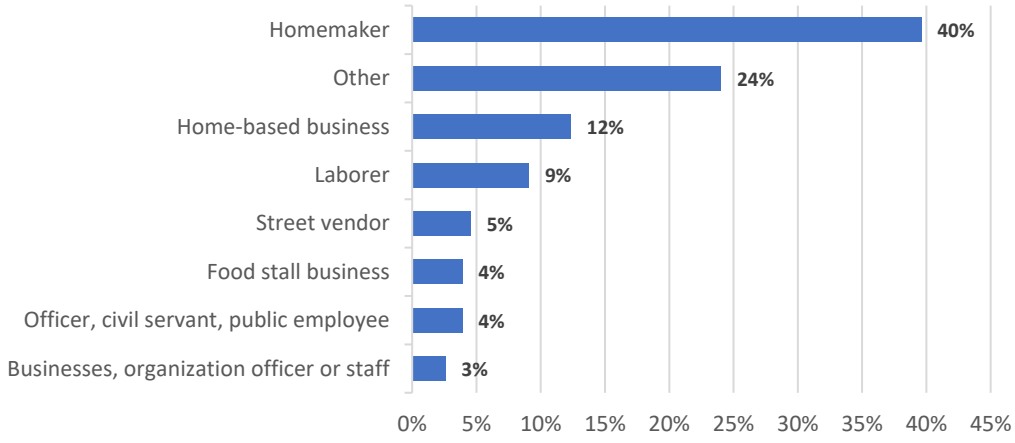
In the two wards of Chuong Duong and Phuc Tan, there were a total of 308 participants in the environmental and sociological survey, with 40% from Chuong Duong ward and 60% from Phuc Tan ward. In term of gender, females accounted for 70% and males accounted for nearly 30%. In terms of education, 70% of the survey participants had graduated from secondary or high school; 12% had completed college/university or postgraduate education; and 4% not receiving any formal education, with the majority being female (10 out of 12 individuals, accounting for 83%). Information about the educational background of survey participants is illustrated in Figure 1 below.

Figure 1. Education Level of Survey Participants



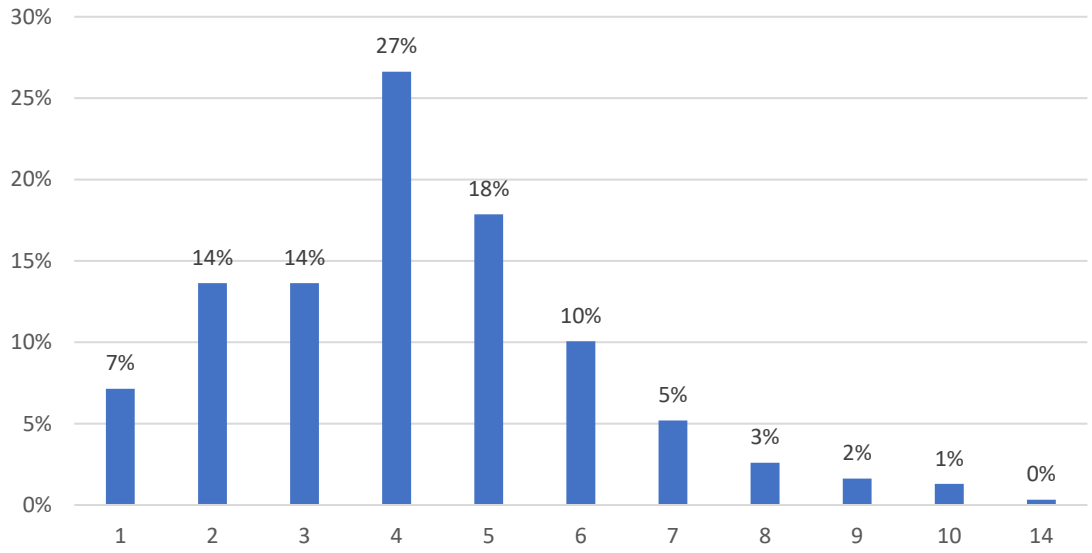
The occupations of the research participants are quite diverse, with the majority being homemakers (40%) and home-based business (12%). A significant proportion of the participants are also laborers (9%) and street vendors (5%). This reflects the characteristics of the riverside area, where many migrant workers from other provinces come to Ha Noi and rent houses due to the affordable rent prices and proximity to the city center, making it easier to find jobs. Specific information regarding the occupations of the survey participants is presented in Figure 2 below.

Figure 2. Occupation of the survey participants



Households participating in the study have varying numbers of members, ranging from 1 to 14, with the majority being single or two-generation families with member counts ranging from 2 to 6 individuals (see Figure 3). Notably, 56% of respondent households have at least one child under 16 years old. Additionally, 29% of households have at least one elderly person over the age of 70. This is a vulnerable group susceptible to environmental pollution, and they also have a need for physical activity to maintain health and cognitive development.

Figure 3. Number of members in households participating in the survey



Therefore, most of the population in the riverside area are laborers, homemakers, small business owners, workers, or street vendors. The educational background is fairly typical, with most having completed at least secondary or high school education. Many households have children and elderly members, who are vulnerable to environmental pollution.

II. THE ENVIRONMENTAL SITUATION

The environmental situation is one of the most significant concerns for residents along the riverbank. According to the survey results from 308 residents, 59% reported being affected by pollution from waste, 21% mentioned pollution from wastewater, and 25% cited air pollution. This indicates that environmental issues along the riverbank directly impact the lives of most residents and require improvement solutions.

1. Current Status of Solid Waste

The research team conducted a survey on the current situation of solid waste at 10 research points within the study sample. The survey focused on plastic, metal, glass, rubber, wood, fabric, and construction waste.

The results show that all these types of waste are present at the survey points to varying degrees, as detailed in Appendix 3. Through the assessment, the three most common types of waste are wood, construction, and plastic waste.

Regarding wood waste, the most common type of waste is industrial wood pieces and household wooden furniture (Photo 2).

Photo 2. Industrial wood pieces and household wooden furniture

According to interviewed residents, wood waste is often bulky and accumulates over time because currently the Hanoi Urban Environment Company Limited (URENCO), a trash company, only collects household waste, and there is not yet a mechanism for collecting bulky waste. The results are presented in Table 1 below on a scale of 0 for nonexistent and 5 for most common.

Table 1. Assessing the prevalence of wood waste.

Wood waste	**Level of prevalence (on a 5-point scale)**
Industrial wood pieces	3.51
Household wooden furniture	2.88
Cardboard	1.69

Regarding construction waste, various materials such as bricks, cement, lime, gypsum, or pipes are found at most survey points (see Photo 3).

Photo 3. Construction waste

From the views of the interviewed residents (Table 2), this is the consequence of unconscious discharge of waste, illegal dumping, and accumulation over time for many years.

Table 2. Assessing the prevalence level of construction waste

Construction waste	Prevalence level (on a scale of 5)
Cement	3.95
Lime	3.50
Bricks	3.46
Wood, plywood	1.94
Water pipes	1.28
Gypsum	1.14

For plastic waste, the survey focused on various types such as coconut bags, nylon bags, single-use plastics (cups, spoons, plates, straws...), plastic ropes, foam boxes, household plastics (pots, racks, baskets, toys...), cigarette filters, plastic sandals, beverage bottles (bottles of mineral water, soft drinks...), other containers (shampoo, shower gel...), medical masks, personal care bottles/jars (cosmetics, toothpaste tubes...), lighters. The on-site survey results show that the most common type of plastic waste is sacks and plastic bags (Photo 4).

Photo 4. Plastic bag

Specifically, the prevalence of plastic waste is illustrated in Table 3 below.

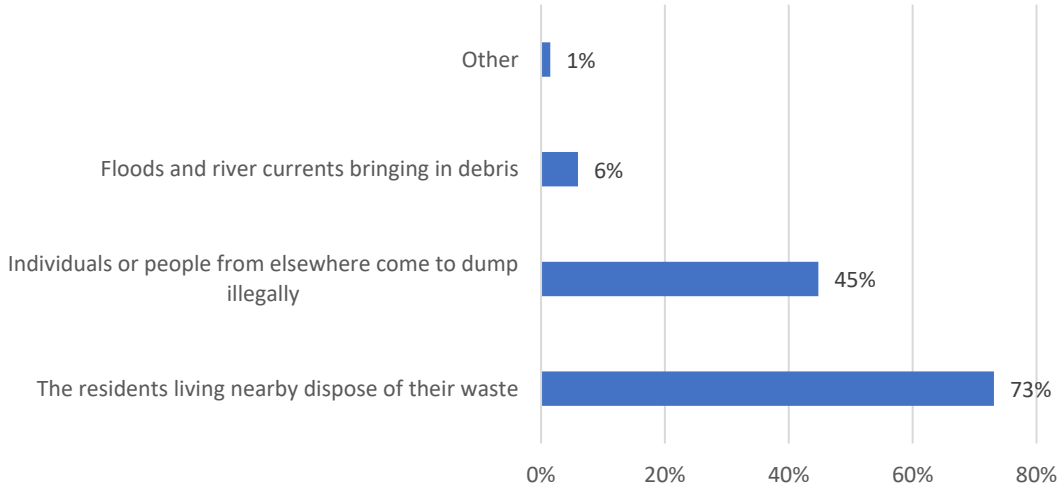
Table 3. Assessing the prevalence level of plastic waste.

Plastic waste	Prevalence level (on a scale of 5)
Sacks	4.19
Nylon bags	3.82

Plastic waste	Prevalence level (on a scale of 5)
Foam boxes	2.70
Beverage bottles (mineral water bottles, soft drink bottles...)	2.23
Single-use plastic items (cups, spoons, plates, single-use straws...)	2.02
Plastic strings	1.84
Other containers (shampoo bottles, shower gel bottles...)	1.49
Plastic household items (basins, shelves, baskets, toys...)	1.35
Cigarette filter tips	0.95
Plastic sandals	0.79
Medical face masks	0.79
Personal care containers (cosmetic containers, toothpaste tubes...)	0.38
Lighters (Hazardous waste)	0.26

The survey results from 308 residents show that most waste is either dumped by the people living in the riverside area or by outsiders. Since there are no government agencies or manufacturing plants in this area, waste management mainly involves household waste.

Figure 4. Source of waste



Therefore, most types of household waste exist in the riverside areas. The accumulated waste has been building up over time. Currently, the main solid waste from households consists of organic waste, food waste collected by URENCO, and recyclable waste, such as bottles and cans. This indicates that if the current volume of waste at these leftover points is processed and the collection system is strengthened, the issue can be effectively resolved. This matter will be discussed further in Section III of the report.

2. Current Status of Wastewater

Alongside solid waste, wastewater is a pressing environmental issue for residents. To assess the current situation, the survey selected 7 points considered to be significantly affecting the environment and people's health.

According to the evaluation results, these 7 discharge points are all open drains emitting a particularly foul odor, especially the drains in CD3 - 407 Bach Dang area, the drains near Chuong Duong Bridge, and the drains near the playground of block 16 of Phuc Tan ward. As they are open drains, most of them have accumulated waste, causing blockages. Some drains are surrounded by livestock farming activities, exacerbating the pollution problem. The evaluation results and images are presented in Table 4.

The on-site survey revealed that all drains lack proper covers, resulting in overflow onto the ground. Many drains create muddy puddles less than 20 meters away from residential areas, posing an air pollution source and spreading diseases. This issue will be discussed in detail in Section III of the report.

Table 4. Assessing Sewage Outfalls

#	Surveyed area	Suveyed time	Assessment of Odor	Assessment of Dirtiness	Stagnant garbage	Photo
1	**THE DRAIN AT THE CD3 AREA - 407 BACH DANG**	28/10/2023	5	5	Plenty	
2	**THE DRAIN AT THE CD4 AREA - ALLEY 533 BACH DANG**	22/10/2023	1	3	Some	
3	**THE DRAIN AT THE CD5 AREA - ALLEY 695 BACH DANG**	22/10/2023	3	4	Some	

#	Surveyed area	Suveyed time	Assessment of Odor	Assessment of Dirtiness	Stagnant garbage	Photo
4	**THE DRAIN AT THE PT01 AREA - LONG BIEN BRIDGE**	14/10/2023	4	4	Plenty	
5	**THE DRAIN AT THE PT02 AREA - ALLEY 62 BAO LINH**	21/10/2023	5	4	Some	
6	**THE DRAIN AT THE PT03 AREA - CHUONG DUONG BRIDGE**	21/10/2023	5	5	None	
7	**THE DRAIN AT THE PT04 AREA - PLAYGROUND OF BLOCK 16**	28/10/2023	5	5	Plenty	

III. THE CURRENT USAGE OF SPACE

The riverside area, despite being polluted, hosts various activities. Broadly, these activities can be categorized into two types: community-based and individual, livelihood activities. These activities are often spontaneous but serve as important indicators of the residents' needs. Therefore, they can serve as valuable inputs for environmental and spatial improvement solutions in the riverside area.

Public and community activities are diverse and revolve around cultural, sports, and spiritual activities. The most common activities include sports such as badminton, shuttlecock kicking, double jump rope, and gym workouts, as well as walking and cycling (especially among children). In the Phúc Tân area, there are also community cultural activities, such as bird singing competitions. Additionally, there are larger-scale cultural activities like sightseeing, tourism, or fashion shows related to the Phuc Tan artistic street. Spiritual activities are mainly associated with the Son Hai temple in Chuong Duong ward. Furthermore, spiritual activities such as 'merit releasing' are regularly organized on Friday mornings, attracting both residents and visitors from the city center to participate in the Phuc Tan artistic street area. Some photos of these public activities are shown in Table 5 below.

Table 5. Public/Community Activities

Physical Exercise, Sports: Shuttlecock Kicking	
Physical Exercise, Sports: Gym in front of households	
Spiritual Activity - Releasing living creatures	

Spiritual Activity: Releasing Carps on the Kitchen Gods' Day (ECUE documentary photo)	
Spiritual Activity: Gold Paper Horses	
Cultural Activity: Bird Singing Competition	
Cultural Activity: Recreational Fishing	
Cultural Activity: Fashion Show on Phuc Tan Art Street (Photo from Thanh Nien Newspaper)	
Exploration and Nature Connection Activity (Photo from Dream & Do)	

The household and community activities are diverse and varied, including cooking, farming, gardening, running beverage stalls, and providing car parking services. Among these, gardening, animal husbandry, and natural fruit and vegetable harvesting are the most common. Specifically, among the 308 residents surveyed, 15% reported engaging in gardening activities, 2% in animal husbandry, and 2% in fruit and vegetable harvesting in the riverside area. In recent years, many households have cleared waste to create small vegetable gardens and seasonal crops with the aim of self-sufficiency. Some households grow fruit trees such as papaya, jackfruit, starfruit, and bananas. Regarding animal husbandry, households mainly raise chickens, ducks, dogs, and cats for family consumption, with some engaging in small-scale sales. Generally, gardens and animal pens are makeshift because residents do not want to invest in more permanent structures and because they are located in flood-prone areas. In the survey, households confirmed that their gardening or animal husbandry activities are temporary because the land belongs to the state, and they are willing to return it when requested. Some households with gardens or animal pens also expressed a desire to continue their activities if there are designated areas for gardening or animal husbandry in government plans.

Table 6. Individual/Livelihood Activities

Boiling corn, sweet potatoes, and cassava to serve for street vending	
Cooking for family	
Running a beverage stall	

Car parking lot	
Gardening for growing vegetables	
Gardening for growing fruit trees	
Growing ornamental plants and flowers	

Livestock farming in confined spaces	
Free-range livestock farming	
Bird trapping in the riverside area	
Burning scrap waste to retrieve copper/aluminum wires for sale	
Renting houseboats	

The public and livelihood activities mentioned above typically occur in residential areas or nearby. However, some activities have also been observed in the riverbank areas along the Red River, far from residential areas. Specifically, there is wild bird trapping activity to serve the ritual of releasing birds as part of religious practices. This activity is carried out by community members (through cage trapping) or by outsiders (using nets) as a livelihood for their families. A local engaged in bird trapping for release shared that each released bird is sold for 5-10k VND, with an average of 10-15 birds caught per day. According to this individual, due to poor health and a lack of alternative livelihood options, he has to resort to bird trapping as a means of making a living. Some households also often harvest various types of naturally grown vegetables along the riverbank for household use or medicinal purposes. In several survey occasions, the expert team also encountered some locals using the riverbank as a place to burn electrical wires to collect copper for sale. This activity is often carried out away from residential areas but still contributes to air pollution and fire hazards. Moreover, there are also activities of renting accommodation on boats along the river, especially in the border area between Phuc Tan and Chuong Duong wards. This activity mainly serves migrant workers, street vendors, informal scarp collectors, or small-scale traders. Because the riverbank area is adjacent to the old quarter and the Long Bien Bridge/Phuc Tan artistic street, occasionally tourists still come for walking and exploration.

In summary, civic and community activities in the riverside area are quite diverse, reflecting the needs of the local people. Some activities related to culture, community, or ecology also demonstrate the potential of the riverside area to serve community-based economic activities. This reality needs to be considered when devising solutions for environmental management and space utilization in the riverside area. Specifically, some activities related to people's livelihoods (such as women selling boiled corn/potato/cassava, releasing birds for luck, selling water, and engaging in livestock farming and gardening) are not numerous but should also be considered in the redevelopment of the riverside area. The next part of the report will focus on the results of a social survey involving 308 residents in the riverside region to effectively propose environmental and spatial management solutions.

IV. PUBLIC OPINION ON ENVIRONMENTAL AND SPATIAL MANAGEMENT

To explore the perspectives and practices of the residents regarding environmental issues, survey interviews with 308 residents from the Chương Dương and Phúc Tân wards were conducted. Additionally, the expert team conducted in-depth interviews and group discussions with 15 residents to further explore their analyses of environmental conditions as well as their desires for environmental improvement and spatial management in the riverside area.

1. Waste and Wastewater Management

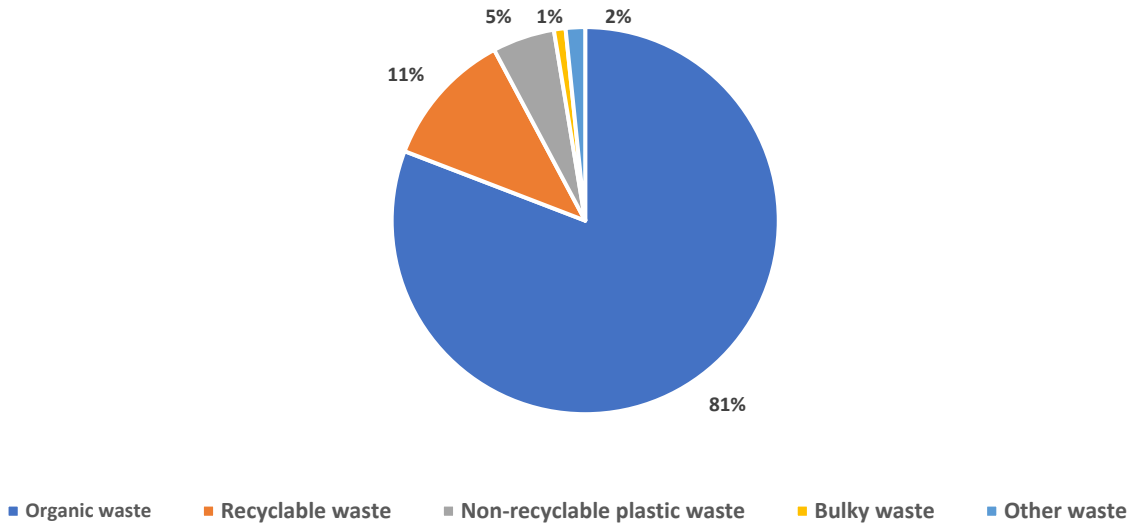
Waste management is a critical issue in urban areas worldwide, and the riverside region is of no exception. According to survey results, nearly half of the residents (47%) indicated that waste and wastewater issues are affecting their health.

In in-depth interviews, the residents frequently mentioned respiratory illnesses, including tuberculosis. One resident from Group 2 in Phúc Tân ward shared that he lives close to a waste discharge pipe with his wife, two young children (ages 8 and 11), and his 73-year-old mother-in-law. He is deeply concerned about his family's health due to their proximity to the discharge pipe. As a result, he has invested several million dong to cover the sewer, paid a neighbor to move their livestock

farm further from residential areas, and renovated their yard to improve living conditions. However, he noted that while pollution has decreased, the problem has not been completely resolved. He also shared that many locals have suffered from persistent illnesses due to the waste discharge, and he mentioned a neighbor, Mrs. H, who recently returned from the hospital with tuberculosis.

The survey results show that 81% of the respondents indicated that organic waste constitutes the largest portion of total household waste, followed by recyclable waste and materials sold for recycling, which account for 11% of the surveyed households. The distribution of household waste types is illustrated in Figure 5.

Figure 5. The type of waste that occupies the most weight in the total household waste



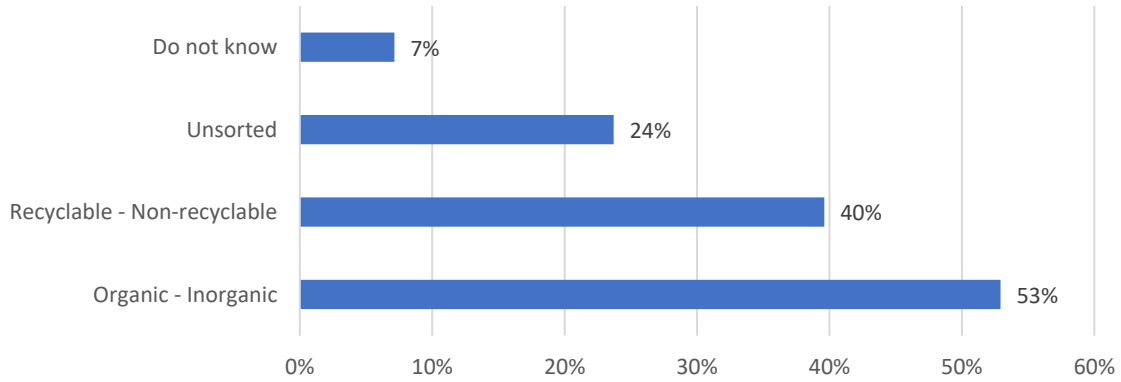
Most households (83%) reported having a waste collection system, and their garbage is regularly collected daily by URENCO. However, still 17% believed that their area lacks a collection system. According to an environmental management official in the ward, the coverage of the collection system is quite good, with 90-95% of the daily waste being collected, and the remainder being left overnight. Currently, a ward has only about 10 workers who collect garbage from 200 different alleys while many of the alleys are narrow and deep, so not all households could bring out garbage at the correct time and to the right points. The main method of garbage collection involves ringing a bell to remind households to bring their waste to the moving collection vehicle at fixed times in the morning and/or evening. The distance residents need to carry their waste to disposal points is quite convenient, with 87% stating they only have to walk less than 100 meters to dispose of their trash. According to the survey results, 93% of residents find this mobile, timed collection reasonable. If a family is not home during the collection time, they can bring their waste to fixed collection points, such as at gates. Some households find the collection times inconvenient for them (early in the morning when they are not yet awake or in the evening before they return from work). These households will have to leave their waste at fixed collection points or along the roadside, which causes visual pollution and contamination. The current environmental fee is 72,000 VND per person per year. When asked about the current fee level, 96% of the residents find it reasonable, only 3% find it too high, and 1% find it too low. With this fee, 93% of residents said they were willing to pay for waste collection services.

However, in-depth interviews revealed that the issue of littering or illegal dumping still persists in the embankment area. The most cited reasons are the lack of awareness among households and the inconvenient garbage collection system. The fact that URENCO only collects household waste also leads some residents to illegally dump bulky waste instead of cutting it into smaller pieces for collection. Some people mentioned that in the embankment area, many are laborers, street vendors, or motorbike taxi drivers, so they are often not at home when the garbage truck comes to collect. Therefore, they tend to illegally dump their trash on the embankments at night. Many are frustrated with this dumping but cannot catch the perpetrators red-handed, making it difficult to control. Some people mentioned that even though they know others are dumping trash, it is hard to address because administrative penalties are not being enforced, so people are not afraid.

In discussions with environmental management officials at the district and ward levels, there is a legal framework for administratively fining those who dump trash in public places. The fines vary and can be as high as 2 million VND. In practice, one ward official mentioned that he often imposes a fine of 1.5 million VND per bag of trash. However, fining households for dumping trash in public places still faces many challenges, mainly due to a lack of evidence or insufficient personnel to monitor and enforce penalties. According to the ward official, community involvement in monitoring is necessary, such as self-management teams or households affected by dumping near their homes, as they are motivated to collect evidence and report. Currently, there is a Zalo group in the ward, and sometimes neighborhood leaders also send information about conflicts caused by dumping for the ward to resolve, although this practice is not yet widespread.

One of the challenges in household waste management is separation at source. According to survey results, 31% of the respondents either do not know or their families do not sort waste. However, 40% of the respondents said they are sorting waste into recyclable and non-recyclable categories, and 53% are sorting waste into organic and inorganic categories (see Figure 6).

Figure 6. How households sort waste in the surveyed area

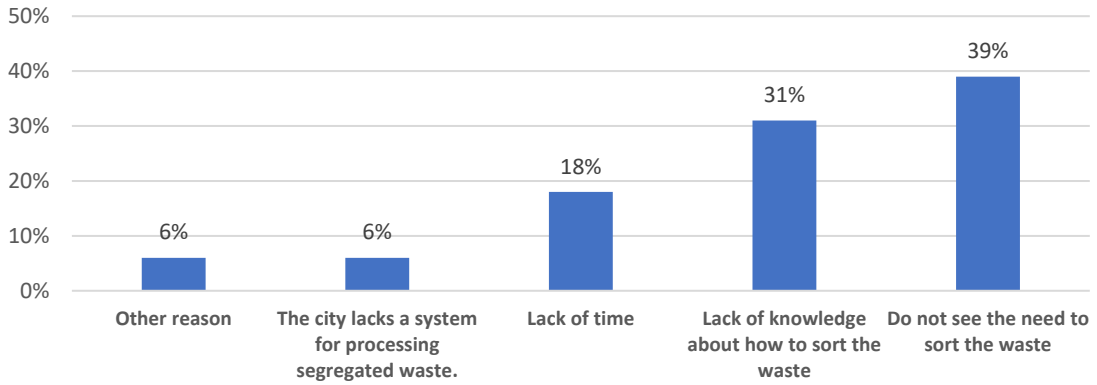


When asked in-depth about their reasons for sorting waste, residents mentioned that they do so because they want to sell or give recyclable items to collectors to avoid waste. Common recyclable items include plastic bottles, nylon bags, cardboard, and newspapers. Many residents also collect old clothes to donate to charity for the poor. Sorting organic and inorganic waste is mainly for using leftover food for animal feed by the collectors. As shared by a resident in Block 2 of Phuc Tan ward, she personally raises dogs, chickens, and cats, so she often receives leftover food from the surrounding residents. She mentioned that many households put leftover rice and food in bags hanging on trees

or electric poles for collectors from outside to take for animal feed. Therefore, people will sort waste if they have a clear purpose and their sorting activities are beneficial, either for themselves or others. Thus, communication activities regarding waste sorting at households should have clear purposes and specific benefits to change people's behaviors more effectively.

Among those who do not sort waste, the main reasons are that they do not see the need to sort (39%), lack of time (18%), or the city does not have a waste sorting system (6%). Additionally, 31% mentioned that they do not sort because they do not know how to, as presented in the Figure 7.

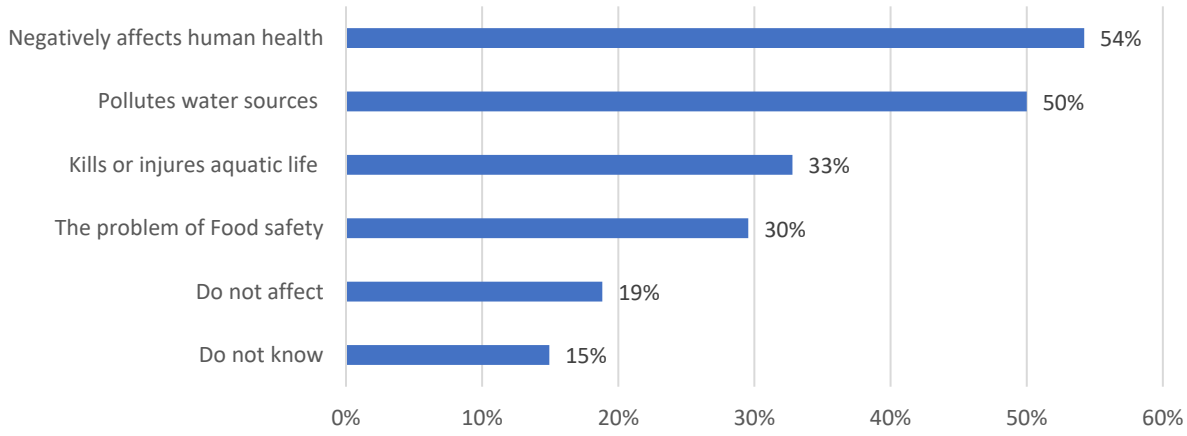
Figure 7. Reasons for not sorting waste



In-depth interviews revealed that overall, people had a good understanding of waste issues. Their lack of waste sorting, bundling all types of waste into one bag for disposal, is mainly due to the absence of a waste sorting movement. For them, initial support, such as providing bins or bags for different types of waste and guidance on how waste should be sorted, is needed. To initiate the movement, besides environmental management agencies, the participation of neighborhood leaders and women's unions is essential. Many suggested starting from households because both men and women dispose of waste and take out the trash.

Among the types of waste, plastic waste is the one that requires attention because of its long decomposition time and long-term impact on human health, organisms, and the environment. Survey results show that people have a fairly good understanding of the consequences of plastic waste on health and nature, as illustrated in the Figure 8.

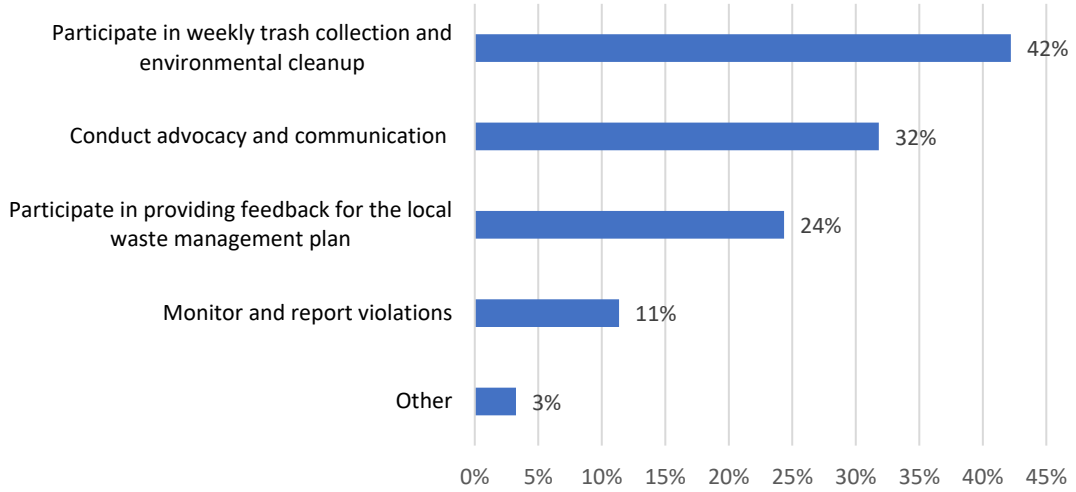
Figure 8. The impact of plastic waste on humans and wildlife



While aware of the harms of plastic waste, the residents' current habit of minimizing plastic use is not significant. A large proportion of residents (47%) did not know how to handle it, and there are other reasons identified by residents such as the lack of a waste sorting system (24%), synchronized collection and processing (11%), the habit of using plastic products (14%), and the difficulty in finding alternative products (14%).

It can be said that waste, wastewater, and environmental issues are prominent problems that need resolution. According to the survey results, **76% of residents were concerned and ready to participate in various environmental sanitation activities**, from weekly environmental clean-ups, involvement in communications, to even monitoring and reporting violations, as shown in Figure 9.

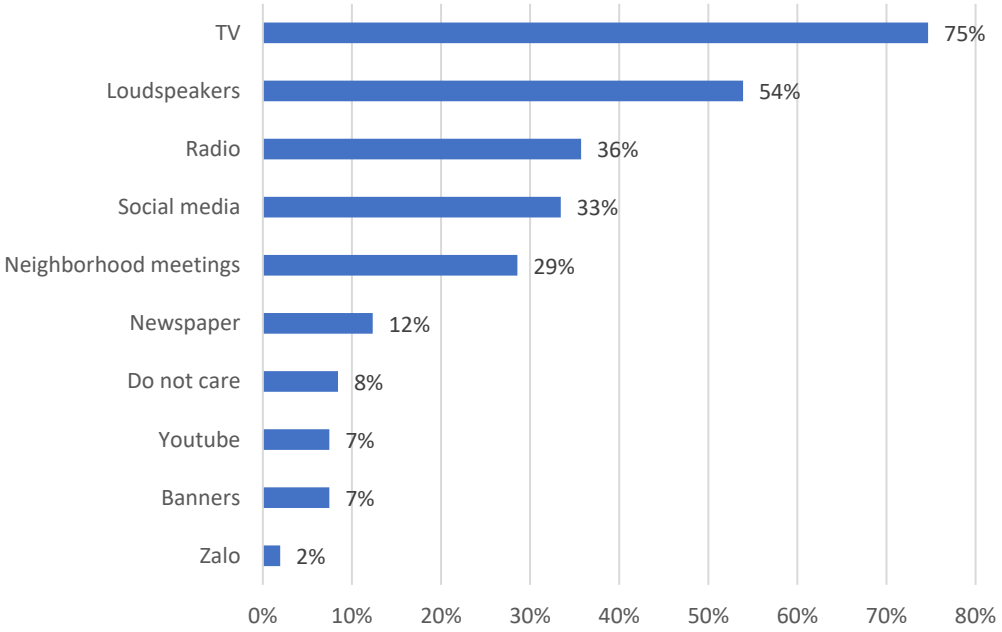
Figure 9. Environmental activities that residents are interested in and want to participate in



During in-depth interviews, residents also emphasized their willingness to participate in environmental management if the waterfront area is renovated. A group of women from Phúc Tân ward in their discussion confirmed that if the environment is cleaned, people will naturally become more conscious of protecting it. They pointed out areas that have been cleaned by the community, cemented, and swept daily. For them, the only days they do not clean are during storms because everyone wants to maintain a clean environment in their living area.

Therefore, the current pollution situation, along with the promotional and advocacy activities by environmental management agencies, has led to a high level of environmental concern among the residents of the waterfront area. According to the survey results (see Figure 10), television and loudspeakers remain the main channels through which people receive environmental information. Additionally, social media and radio are also significant channels for the residents to access environmental information.

Figure 10. Channels through which residents commonly receive information about the environment and waste



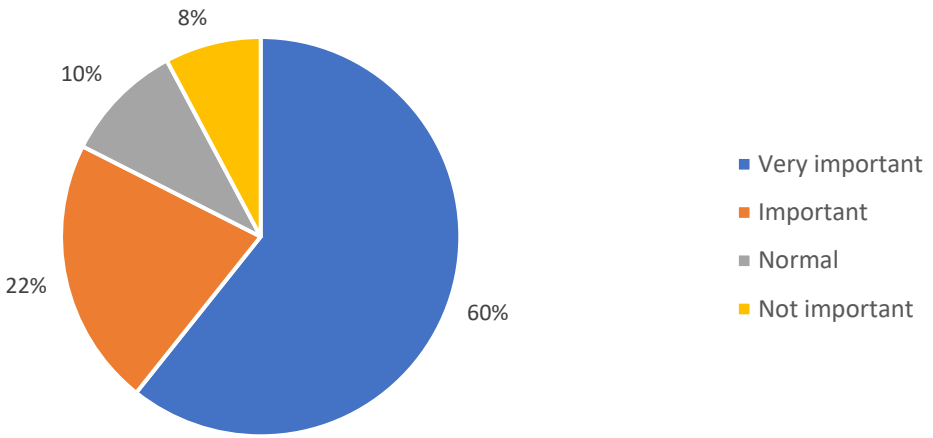
In reality, many households are implementing various solutions to improve the environmental conditions where they live. **The most common solution is usually waste collection for landfilling or burning.** Additionally, many households invest in cementing the area in front of their homes, cleaning regularly, and covering drains to reduce odors. Some residents also mentioned that they regularly clean the drains to prevent blockages that cause sewage overflow and severe pollution. However, these solutions are not sustainable and are only temporary.

Upon observation, the areas with the least waste are typically those where residents clean, garden, and plant fruit trees, ornamental trees, or flowers. Additionally, public spaces such as badminton courts and the Phúc Tân art street are cleaner because they are regularly used and maintained by the community. It is evident that spaces used by residents tend to be cleaner, and when there are issues with waste, residents proactively address them instead of waiting for environmental sanitation authorities to intervene.

2. Space management

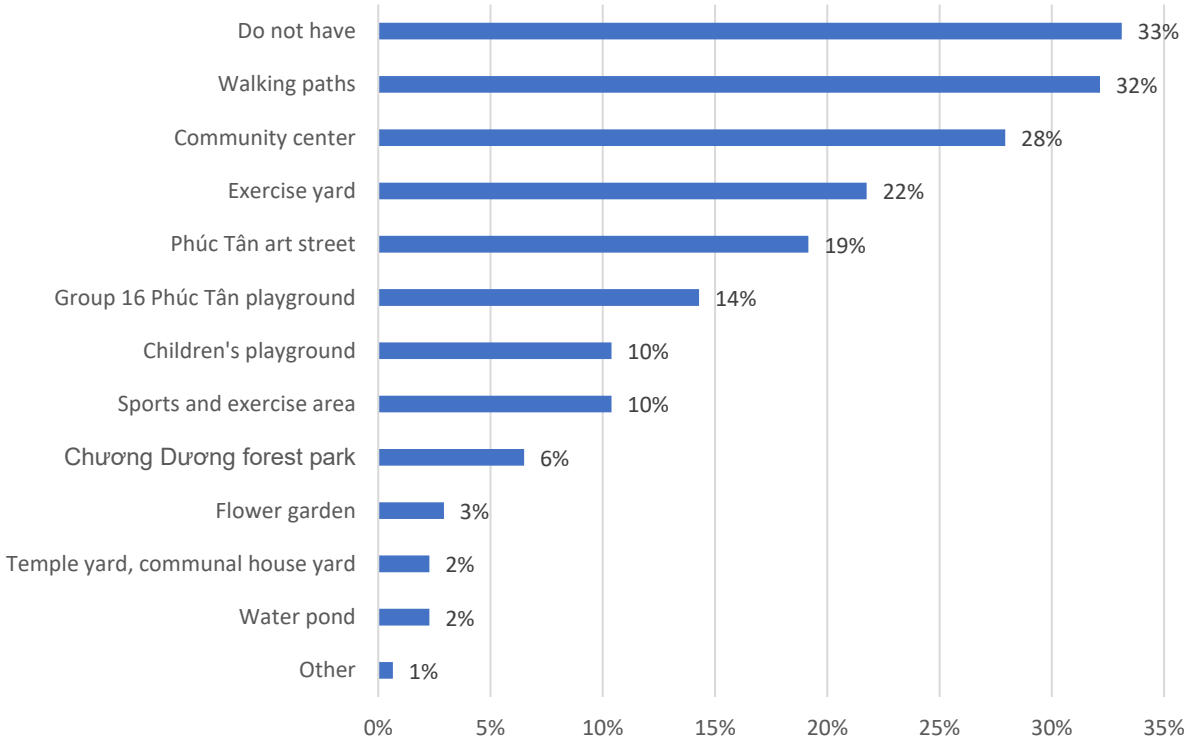
Public spaces are considered important or very important for the lives of 82% of residents (see Figure 11). This result is quite similar to surveys conducted in 2020 by the People's Participation Working Group (PPWG), where 92% of Hanoi residents stated that public spaces were important to their lifestyles. When looking at the data by gender, the percentage of women who consider public spaces very important is 14% higher than that of men (81% vs. 67%).

Figure 11. The role of public spaces in personal and family life



According to the survey results, 33% of the residents said that there are no public spaces near their homes (within a 5-minute walk). When analyzed by district, the proportion of people without any nearby public spaces is higher in Chương Dương ward than in Phúc Tân ward, with 48% and 23% respectively. The availability of public spaces influences residents' usage patterns. Specifically, in Chương Dương ward, 48% of residents did not use public spaces in the past month due to distance or difficulty in access, while this figure in Phúc Tân is 31%. This is because Phúc Tân has the Phúc Tân art street, the Group 16 playground, and the exercise yard, which are easily accessible to residents. The public spaces mentioned by residents are presented in Figure 12 below.

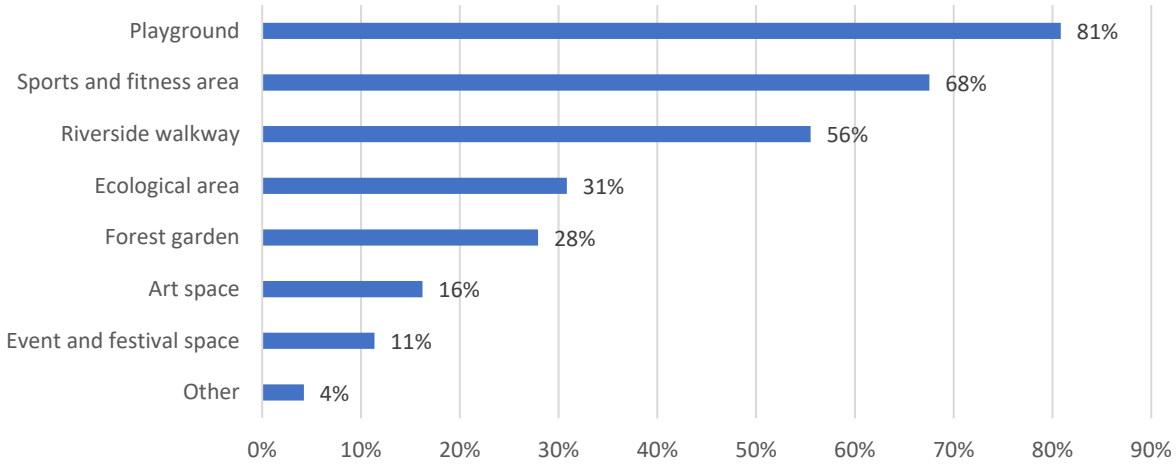
Figure 12. What public spaces are there within a 5-minute walk from your house?



According to the results of in-depth interviews, many residents mentioned that they have to walk to Hoan Kiem Lake to exercise. However, elderly people, those who are ill, have weak health, or children also find it difficult to exercise because pedestrian spaces, even exercise areas, are located along roads with motorbike traffic, posing risks to them. Therefore, despite being near the waterfront area, they lack public spaces. According to the survey results, 53% of respondents stated that they did not use any public spaces in the past month.

When asked about their desires for renovating the riverine zone, the majority of residents expressed a desire for playgrounds, sports and exercise areas, riverside walkways, ecological areas, or forest gardens.

Figure 13. What public space do you hope to turn the riverine zone into?

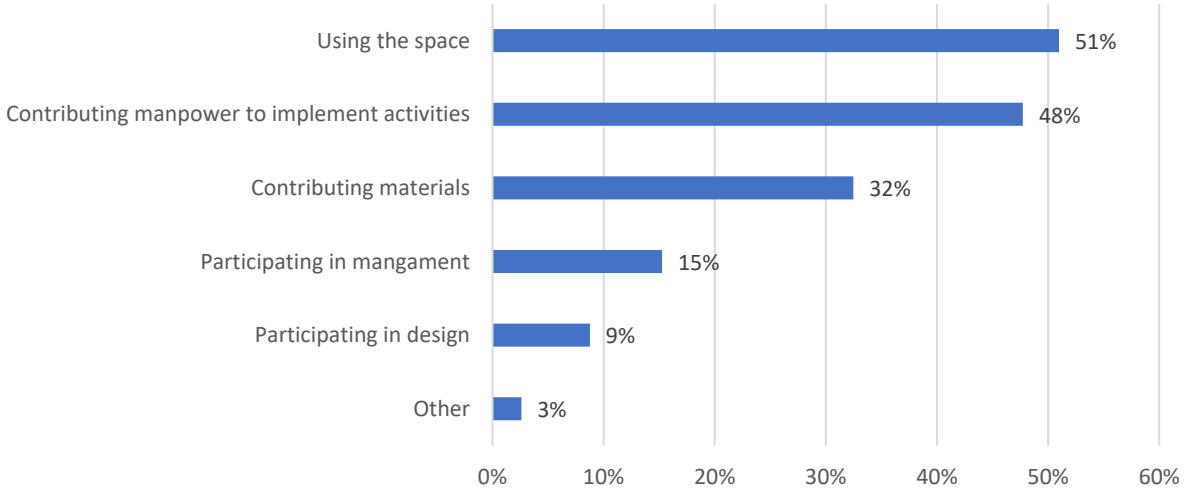


During in-depth interviews, residents consistently emphasized the value of the riverine zone as a natural habitat, including vegetation, birds, and squirrels. Many emphasized the need to prioritize conservation efforts because this is not only the valuable asset of the riverine zone but also of the city. They believe that there is no need to plant more trees because the existing ones grow rapidly, and they simply need to be left undisturbed as they will regenerate naturally. Some suggested that if supplementary planting is necessary, fruit-bearing trees such as guava and star fruit should be planted because they provide food for birds, have multiple uses including medicinal properties, and are especially resilient to flooding during floods.

Regarding public facilities, many residents emphasized the importance of tree-lined walking paths along the river, alongside exercise and sports facilities catering to different age groups and health conditions. The walking paths were frequently mentioned because there is a significant demand for walking among residents, especially the elderly and children. Many of them currently have to go to the lakefront to exercise, which is far and dangerous due to high traffic density. Many people with poor health want to exercise, but the waterfront area lacks suitable conditions. A woman from Group 2 in Phúc Tân ward mentioned that right next to her house, there is a woman born in 1973 who became disabled from the age of 15 and can only sit at the door because the road is rough and there is a lot of traffic. Therefore, according to her, suitable equipment for the sick, stroke patients, or disabled people to participate in exercise and functional recovery is a necessity that should be met. Playgrounds for children and teenagers were also frequently mentioned because residents see that children currently have nowhere to play or have to compete for space and exercise equipment.

When asked about their role in the renovation of the riverine zone, in addition to the roles of usage and enjoyment, 48% of the residents said they were willing to contribute labor, and 32% willing to contribute materials to implement activities. This indicates the desire of residents to participate in the renovation of the riverine zone.

Figure 14. The role of the local community in renovating the riverine zone



In group discussions and in-depth interviews, people often mentioned post-renovation management. Many believed that without a specific management entity, renovated areas can easily degrade and become polluted again. Various suggestions for management were proposed. Some suggested having a separate management team for the waterfront; however, this requires funding for the team's operations. They proposed a small fee of 5-10k per person for individuals or activities from organizations and individuals who come to play and explore the natural waterfront. However, many opinions suggest that community participation in management is also feasible. According to them, if the community uses the renovated space continuously and is frequently present, the dumping of trash or vandalism would be minimized. The community could even contribute labor to plant and care for trees, and participate in renovating small, manageable projects that fit their capabilities and resources. Additionally, some believe it is necessary to enhance public awareness about waste management and environmental care, especially after renovation. They even suggest implementing administrative penalties, as there are already regulations punishing littering in public places.

Using public spaces is a significant need for the residents in the riverine zone. Currently, residents are making use of limited spaces such as the streets in front of their houses, the Phúc Tân art street, the playground at Group 16, or the Chương Dương forest garden playground for exercising or organizing community activities. There is a desire and demand among the residents to renovate the waterfront area to increase the availability of playgrounds, walking paths, and ecological areas to enhance health, community connections, and improve the quality of life for themselves and their families.

PART III. DISCUSSION AND RECOMMENDATION

I. SOLID WASTE MANAGEMENT

The result of the on-site survey on social environment indicates that solid waste and wastewater are two prominent issues negatively impacting the health and lives of the residents. There are two major issues related to solid waste: (i) the accumulation of long-standing landfills along the riverine and (ii) the daily household waste collection.

Regarding the accumulated landfills along the riverine zone in both Chuong Duong and Phuc Tan wards, there are dozens of large and small sites with various types of waste such as glass, metal, wood, fabric, construction waste, and plastic waste. Among these components, wood waste, construction waste, and plastic waste are the most common. This quantity of waste has accumulated over many years, mainly from residents living along the riverine, people from elsewhere dumping illegally, and a small amount drifting in with the river currents. Currently, URENCO does not have a plan to address the accumulated landfills due to their large volume and difficult accessibility.

Regarding daily household waste, according to the survey, organic waste accounts for the highest proportion, followed by recyclable waste and glass bottles. For now, URENCO has been relatively effective in collecting daily household waste through mobile collection at a fixed hour. Some residents reckoned that the timing of waste collection is not suitable for them (too early in the morning before they wake up or in the afternoon before they return from work). URENCO only collects daily household waste, while bulky waste has been left untouched. From the interviews, 17% of the respondents stated that their neighborhoods still lack a waste collection system. Through in-depth interviews, some households admitted to littering waste in the riverine zone due to poor awareness, inappropriate waste collection hours, or lack of law enforcement.

In general, residents had a good understanding of environmental and waste issues, including plastic waste, compared to several years ago. However, waste sorting is not common and systematic. A significant proportion of residents sort their waste based on organic/inorganic (53%) or recyclable/non-recyclable (40%), but mostly spontaneously, interruptedly, primarily for selling/giving to informal waste collectors or animal husbandry. According to residents, the reasons for not recycling are “they do not see the need to sort” (39%), “lack of time” (18%), or “the city lacks a waste sorting system” (6%).

Therefore, to comprehensively address the waste issue in the riverine zone, the research team proposes the following recommendations.

***First*, to enhance communication on waste issues, including content to promote waste reduction (both general waste and plastic waste specifically), 100% waste collection, and sorting, reusing, and recycling of waste by households or junkyards.** Although residents have relatively good knowledge about waste pollution issues, continuous communication and reminders are necessary. Content on waste sorting at source should promote the expansion of the current waste sorting models (sorting for giving away/selling to junkyards and animal husbandry), rather than making general appeals while the city's waste collection system has not yet dealt with sorted waste until the final stage. In terms of communication channels and methods, direct and highly interactive approaches should be employed to change people's behaviors. Media channels such as TV, radio, or social media often provide information and raise awareness, but to change behaviors, there should be direct and interactive

communication activities involving group/community participation to create pressure/motivation for change (e.g., prize-winning competitions, collective waste cleanup activities). This can be done in collaboration with residential groups and civil society organizations such as Women's Union, Youth Union, and Veterans' Association.

Second, **to develop efficient models for household solid waste sorting** in accordance with the Environmental Protection Law 2020 and the project of Ha Noi People's Committee, following the pilot of Hoan Kiem District, referring to the guideline provided by Hanoi People's Committee below. These models should incorporate economic factors to sustainably maintain them, potentially linking with livelihoods/supplementary incomes of some residents to serve as examples/inspiration for expansion.

Table 7. Summary of Principles for Classification, Collection, Transportation and Treatment

<table>
<tr><th>Type of Waste</th><th>Before classification</th><th>Classification</th><th>Collection & Transportation</th><th>Treatment</th></tr>
<tr><td rowspan="3">(1) Reusable, recycleable waste</td><td rowspan="3">- Encourage reduction and reuse.
- Keep dry, clean, and compact in available packaging.</td><td>Bring to centralized collection points (by residential areas, schools, shopping centers, supermarkets, etc.)</td><td rowspan="3">Collection unit collects on schedule</td><td rowspan="3">Recycling facilities</td></tr>
<tr><td>Transfer to the designated collection unit on a fixed schedule.</td></tr>
<tr><td>Sell to informal waste collectors.</td></tr>
<tr><td rowspan="3">2) Food and organic waste</td><td rowspan="3">- Keep dry.
- Trim and shred large-sized tree branches and garden waste.</td><td>Process organic waste into compost or animal feed at home.</td><td rowspan="3">Collection unit collects on schedule</td><td>Centralized organic waste treatment.</td></tr>
<tr><td>If the local area applies centralized organic waste treatment technology: Store separately in green packaging/bags.</td><td>Process according to existing technology.</td></tr>
<tr><td>If the local area does not have centralized organic waste treatment: Store together in the remaining waste bags.*</td><td></td></tr>
<tr><td>(3) Hazardous waste</td><td>Separate with other types of waste.</td><td>Bring to the designated collection points (as regulated by the local People's Committee at all levels).</td><td>Functional collection and transportation unit</td><td>Process according to regulations.</td></tr>
</table>

Type of Waste	Before classification	Classification	Collection & Transportation	Treatment
		Transfer to the designated hazardous waste collection unit on a fixed schedule.		
(4) Bulky waste	Compact, reduce in size to sort in to 3 categories: recycleable, reusable, and other household solid waste	Self-transport or hire a unit with the function to transport to the designated collection point or to the processing facility (regulated by the local People's Committee).*	Functional units	Process according to current technology.
(5) Other waste		Store separately in packaging*	Collection unit collects on schedule	Process according to current technology
(Note: *Waste must be priced for services based on weight or volume)				

Third, to establish community self-management teams for monitoring environmental quality/waste management and for community-serving models is also needed. For example, organic food waste can be processed into enzyme cleaning solution or fertilizer for forest gardens, reducing pressure on the waste collecting system and preventing littering after play areas are cleaned.

Fourth, to communicate regarding administrative law enforcement and the implementation of administrative penalties for littering in public places needs to be strengthened in the riverine zone. The government has issued Decree No. 45/2022/ND-CP dated July 7, 2022 on administrative penalties for violations in the environmental protection sector, including littering in public places. According to Article 25 (2) of the decree, littering, dumping, or disposing of waste on sidewalks, roadsides, or into urban drainage systems shall be fined from 1,000,000 VND to 2,000,000 VND. However, according to environmental management officials in the district and wards, the biggest difficulty currently is obtaining evidence for state agencies to impose penalties, partly due to the very limited environmental management staff. Therefore, it is necessary to develop a system for receiving reports and images from the community about violations. This system should be based on **community self-management teams** and connected with environmental management officers of the wards. The administrative penalties will help change people's littering behaviors and address the shortage of human resources in the environmental management team.

To enforce administrative penalties and monitor the environment, support activities for the Environmental Protection Department and environmental management officers in the wards are needed. Firstly, digital infrastructure should be established to receive reports and process environmental information based on the Zalo platform. This system is based on 5 steps: citizens send reports - the system automatically processes – reports transferred to relevant units - relevant units handle the reports - display processing results to citizens. Secondly, organizational capacity should be based on community self-management teams. To establish discipline, capacity, and credibility, the

community monitoring system should be built through interactive and direct communication activities as mentioned above. In other words, environmental officers and community teams are the ones implementing direct and interactive communication activities with the community.

Fifth, to clean up long-standing landfills along the riverine is a prerequisite to decisively address the waste issue and improve the quality of living environment quality. There are two methods to tackle this problem. Firstly, URENCO collects and transports the waste to the city's landfill. This method will be costly as it involves collecting and transporting large amounts of waste and there are many difficult-to-access points. Essentially, it merely relocates waste from the riverine zone to the landfill, thus being inefficient. The second method is to organize sanitary landfilling of solid waste at the site. This method is less costly and more feasible because the riverine area does not have hazardous chemical waste and has a sufficiently large land area to carry out waste collecting and landfilling using machinery. On-site landfilling should be done in conjunction with spatial transformation solutions as in the Chuong Duong playground – forest garden project for optimal effectiveness. This solution will be thoroughly discussed in Section 4, Part III of the report. After cleaning up, there needs to be a monitoring mechanism with community participation to maintain and preserve the results as recreational destinations for residents.

II. WASTEWATER

According to the survey results from 7 sewers in Phuc Tan and Chuong Duong wards, all sewers are open, emitting foul odor which affects the nearby households. They often contain waste that causes blockages. Many residents say that wastewater is severely deteriorating their health. Several households have made efforts to reduce pollution by installing sewer covers and unblocking the sewers, but the impact is unsignificant.

Addressing wastewater issue is the prerequisite to effectively solve environmental problems in the riverine zone. Currently, Project No. 14-DA/QU on Improving Urban Environmental Quality in Hoan Kiem District includes planning for wastewater management, constructing drainage systems, and treating wastewater in Chuong Duong and Phuc Tan wards. According to the plan, Hoan Kiem District will have a sewage collection system from 26 identified sewers along the riverine of Chuong Duong and Phuc Tan wards[2], which will be gathered for treatment at a planned wastewater treatment plant at the end of Chuong Duong ward. Once this wastewater treatment system is completed, it will certainly reduce air pollution, improve health, and enhance the quality of life for residents.

A temporary solution which has been implemented in the Chuong Duong forest garden and Phuc Tan playground is moving open sewers underground. While this solution does not address the issue of wastewater flowing into the Red River, it helps reduce air pollution and significantly decreases the risk of disease transmission for residents. Additionally, moving sewage system underground creates an area of land free from overflowing wastewater or foul odors, which can be repurposed for other public uses, as will be discussed in Section 4, Part III of the report.

[2] According to the survey conducted by SHD Infrastructure Construction Consultants Joint Stock Company, there are 26 sewage drains scattered throughout the area. Based on the construction experience in Chuong Duong forest garden and Phuc Tan playground, there are many small sewers hidden under trees, bushes, and garbage. They are only discovered during cleaning process. Therefore, the actual number of sewers may be higher than the reported figure of 26.

Despite the success of undergrounding sewage systems or wastewater treatment plant projects, there remains a significant source of pollution along a stagnant part of the river starting from the foot of the Long Bien Bridge (next to Phuc Xa Ward, Ba Dinh District) to the ferry terminal in Chuong Duong Ward. This stagnant part receives domestic wastewater from the upstream of Ba Dinh District. Hence, without a comprehensive solution for this part of the river, water pollution and odors will persist. According to some experts, this issue can be addressed by diverting the flow to turn the stagnant part of the river into a flowing stream, especially during low-flow periods. Another feasible solution is to collect all domestic wastewater at source (Ba Dinh District). In this case, the stagnant river would become clean water reservoirs as they would no longer contain domestic wastewater. Consequently, the scenery of the Hoan Kiem District's riverine zone would become more vibrant, and the ecosystem would become more diverse.

III. SPACE

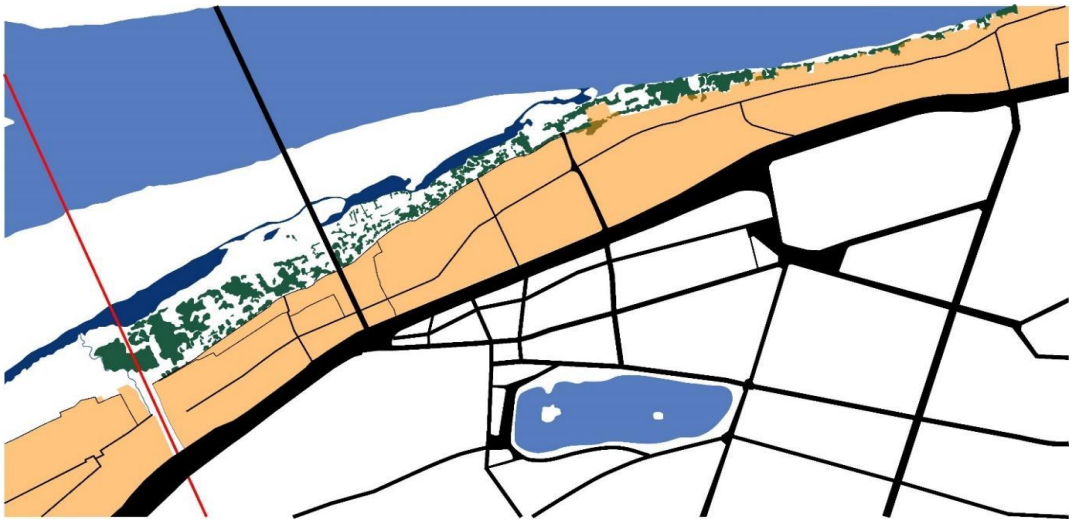
Space conversion is an environmental solution (plus), or alternatively, it can be referred to as integrated environmental spatial development, adapting to practical and flexible factors in all natural circumstances. Not only does space conversion effectively address wastewater issues, but also it adds many ecological, economic and cultural values to the locality. To convert the space, the following factors and experiences will be incorporated into the solution.

1. Practical factors

1.1 Ecological factors and biodiversity

The research area features distinctive vegetation of the seasonal flooding region, combined with crops cultivated by the local community. According to a survey conducted by Mr. Nguyen Hoang Hao, the riverine zone has approximately 166 plant species. Although diverse in species composition, the predominant ones are cultivated crops, specifically: 43 species of ornamental plants, 43 species of leafy greens, 23 fruit-bearing trees, 18 urban green space plants, and only 39 species of wild plants. Among them, certain wild plants such as Paper mulberry *(Dướng)*, Plantago *(Mã đề)*, Solanum procumbens *(Cà gai leo)*, and Passion flower *(Lạc tiên)* are valued for their use in traditional medicine. Due to the characteristics of seasonal flooding, the area exhibits a diversity of habitats. However, these which unfortunately being under the form of regeneration and impoverished ones.

Photo 5. Shade tree coverage (mostly Paper mulberry trees) has created a distinctive canopy structure in the research area



Additionally, according to previous studies, the research area is home to approximately 146 animal species. At the time of the survey, the research team recorded 24 out of 146 species belonging to 44 families, including pest species such as stink bugs. A study conducted by scientists at the Center for Nature Conservation and Development (CCD) in the 2021-2022 period documented the presence of at least 192 migratory bird species and 40 local bird species, including extremely endangered ones, in this specific area. According to interviewed residents, both plants and animals were regarded as valuable assets of the riverine zone. They hoped that regardless of the redevelopment approach, efforts should be made to preserve the plants and animals along the riverine. The diversity of flora and fauna in an area adjacent to the capital city is an invaluable ecological asset that needs to be preserved to ensure the sustainable development of Hanoi.

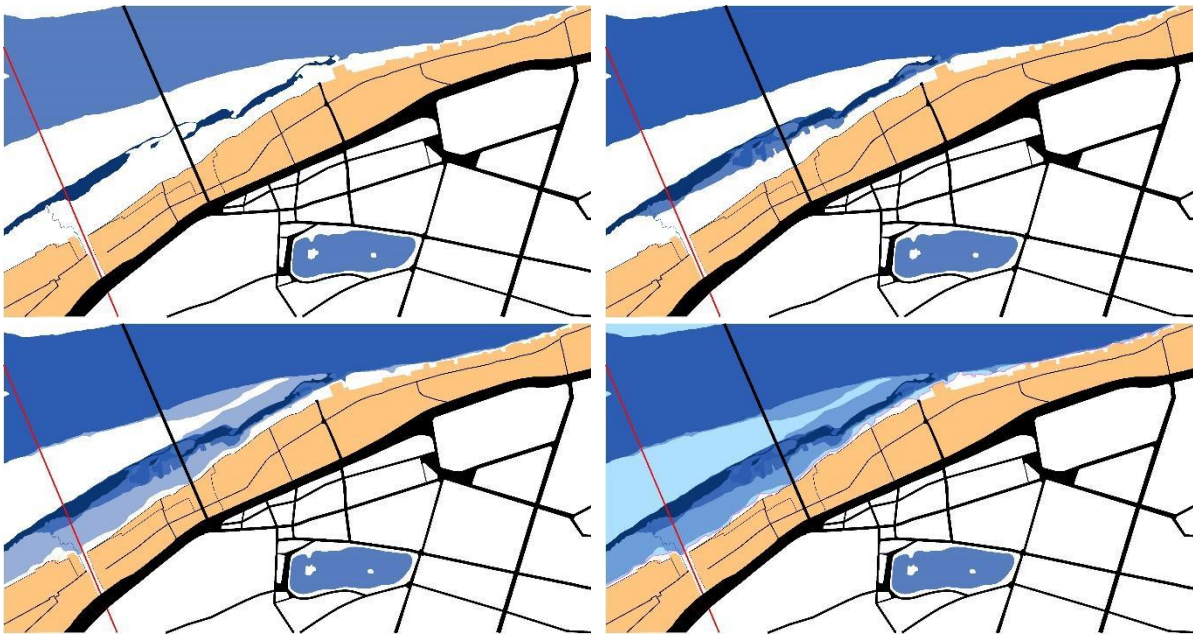
Photo 6. Some habitats and characteristics of the vegetation system in the riverine zone

1.2 Hydrological regime and air quality

The hydrological regime of the Red River, flowing through the center of Hanoi, belongs to the lower basin of the Red River – Thai Binh Province. This area receives water supply mainly from the upper basin rivers, namely the Da River, Thao River, and Lo – Gam River. The Son Tay Hydrological Station on the Red River serves as the confluence point of these upper basin rivers, and the flow rate at this area represents the hydrological regime in the lower basin. Flowing through the Son Tay basin, the Red River bifurcates into the Thai Binh River, with its main flow passing through the Duong River. At this point, there is a hydrological station called Thuong Cat. Following the Red River – Duong River bifurcation is the Hanoi Hydrological Station.

Water shortages mainly occur in February and March each year on both the Red River and the Duong River, with March being the month experiencing the most severe water shortages. During the calculated period on the Red River at the Son Tay station, 46 out of 55 years experienced water shortages in March. At the Hanoi station, the month with the highest frequency of water shortages is February, occurring in 48 out of 55 years, but March is the month with the most severe water shortages. On the Duong River, both February and March have the same number of occurrences of water shortages, which is 33 out of 55 years, 15 years less than at the Hanoi station. The total water shortage in March from 1961-2018 at Son Tay is 2215.13 billion m3, at Hanoi is 1630.69 billion m3, and at Thuong Cat is 480.75 billion m3.

Photo 7. The water level undergoes complex changes between dry and rainy season and is isolated from the upstream source of the Red River, resulting in adverse pollution in the research area. Many seasonal flooding areas also appeared.



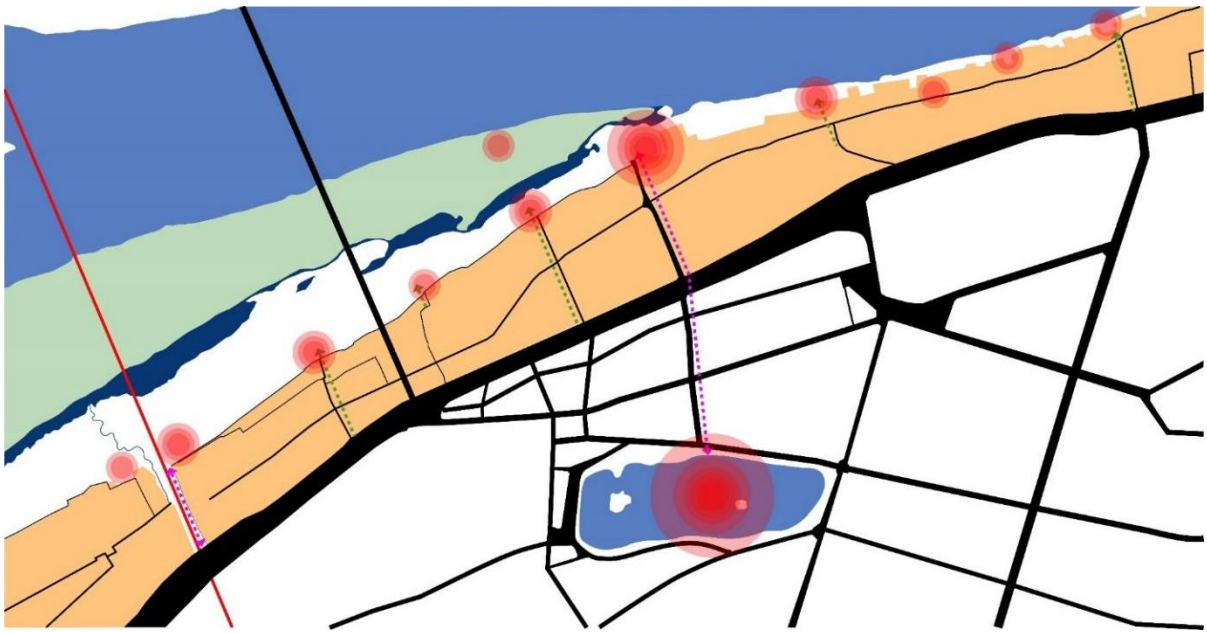
The research area is currently heavily impacted by wastewater discharge activities and is also cut off from the flow of the Red River from the upstream, exacerbating the severity of water quality in the region. Additionally, this diversion from the main river flow significantly alters the hydrological regime in the area, with frequent fluctuations in water levels. Coupled with the abrupt terrain features near the residential areas, this has had a significant impact on the environmental quality of the region. It has led to serious pollution not only of the water source but also of the air, creating a paradox for the riverine landscape environment.

1.3 Connectivity with neighboring economic and cultural regions

Meanwhile, the research area has significant potential to reconnect with the urban center, especially the connecting axis to Long Bien Bridge and Chuong Duong Do Road, which links to Hoan Kiem Lake. Thus, this area creates numerous opportunities for spatial reconnection and restores the role of the landscape from the city center to the riverine zone – a linear ecological structure contributing a great value in the central urban ecosystem.

Photo 8. The potential spatial connecting axes offer opportunities to restore the fragmented ecosystem of the central urban area

Photo 9. The natural and socio-cultural conditions of the riverine zone suggest significant potential for developing a network of public spaces linked to the riverbank landscape, Long Bien Bridge, Hoan Kiem Lake, and the central area of Hanoi. This public space structure contributes to promoting the diverse forms and structures of ecological landscape based on the characterized features of each area, connecting the local community activities with a chain of socio-cultural activities in the Hoan Kiem Lake area and the historic city central.



1.4 Current environmental status, land use, and community needs

The current environmental pollution is one of the main reasons why the large green spaces near the city center have not contributed to local development. Therefore, environmental improvement efforts will help "liberate" tens of hectares of land in the riverine zone and create opportunities for economic, social, and ecological development for the local. Practical experiences in Phuc Tan playground and Chuong Duong forest garden show that poor waste disposal practice decreases when landfills are repurposed as communal playgrounds, which are used and managed by the residents. This is because community awareness increases, and the space/environment is better managed (e.g., whoever litters in the playground will be promptly reminded). Additionally, previous studies show that people have the tendency to dispose of garbage in dirty places and refrain/cease/unable to dump waste in clean spaces. Therefore, transforming spaces into playgrounds, forests, or ecological areas is the most effective solution to address environmental issues (waste and wastewater).

According to the survey results, residents engage in various household activities in the riverine zone. These activities include cooking, gardening (vegetables, fruit trees, flowers, ornamental plants), and raising livestock. The residents are aware that the land in this area belongs to the state, thus they are willing to return it to the government when required. However, some household activities in this area serve as livelihoods for certain individuals/families, such as street vendors (selling boiled corns/potatoes/yams), migrant workers or impoverished people who live by gardening, raising livestock, catching wild birds. Therefore, integrated solutions or support are needed to assist the locals with spaces transitioning.

Community activities are relatively diverse, reflecting the residents' need for public spaces. Through field survey and sociological studies, it is evident that all residents – including the elderly, children, people with disabilities - desire communal spaces for exercise, playing sports, walking and strolling. Moreover, recreational activities like fishing, bird keeping, tourism, nature exploration, or spiritual activity are also in high demand. Therefore, space design should take these needs into account, even adjusting if activities require changes (such as bird keeping, fishing, or livestock raising).

1.5 The Hoan Kiem District government's plans for Red River embankment renovation

In recent years, Hoan Kiem District has made significant and continuous efforts to collaborate with various organizations, including the partnership with the Livable Hanoi Network and its member organizations, to improve the environment and living conditions for residents in the riverine zone. Specifically, Hoan Kiem District has:

- Directive of the Standing Committee of the District Party Committee in Announcement No. 191-TB/QU dated November 4, 2021, regarding the implementation of Community-based Environmental Management Project in Lane 43/32 Bach Dang Street, Chuong Duong Ward.
- Plan No. 235/KH-UBND dated November 10, 2021, on the Implementation of the Environmental Management Project in Lane 43/32 Bach Dang Street, Chuong Duong Ward.
- Plan No. 170/KH-UBND dated July 5, 2022, issued by the People's Committee of Hoan Kiem district.
- Announcement No. 77/TB-UBND dated March 28, 2023, regarding the Conclusion of Nguyen Anh Quan - Standing Vice Chairman of the People's Committee at the conference on addressing

existing difficulties and obstacles in maintaining and ensuring environmental sanitation and urban order in Hoan Kiem district.

- Plan No. 179/KH-UBND dated August 2, 2023, on conducting environmental and social conditions survey in the riverine zone of two wards: Chuong Duong and Phuc Tan and implementing the Community-based Environmental Management Project in Phuc Tan Ward.

These efforts represent the commendable endeavors of Hoan Kiem District in socializing community-based environmental management experiments. Therefore, this survey serves as a continuation to support Hoan Kiem District with additional information to guide public investments as well as social resources towards the improvement of the environment and ecosystem of the riverine zone, thereby enhancing the quality of life for its residents.

2. International experiences

2.1 The Red Ribbon model: Tanghe River Park

The Tanghe Riverside Park project is located in Qingdao City, Hebei Province, China. The Tanghe River shares similar hydrological characteristics and environmental pollution conditions with the research area. Originally, most of this site was used as a landfill, comprised of abandoned slums and hydraulic structures. This area was rugged and inaccessible, hence largely abandoned.

Photo 10. (Left) The riverbank has been canalized to reduce erosion, but this process has destroyed the riverside ecosystem; (Right) The riverside landscape not only creates an attractive environment for community activities but also restores a sustainable native ecosystem.

(Source: https://www.asla.org, https://www.world-architects.com)

The red ribbon running through the Tanghe River Park can be seen on the backdrop of natural terrain and vegetation, spanning 500 meters and integrating functions such as lighting, seating, environmental interpretation, and navigation. While preserving as many natural river corridors as possible, this project demonstrates how a minimalist design approach can significantly enhance the landscape.

Native vegetation, including local switchgrass, is present throughout the park. The plants were strategically planted within the ribbon structure running along the riverbank. The park also serves an educational purpose. Each pavilion is named after a local plant.

Photo 11. Yu Kongjian's (Turenscape) planning solution focused on preserving as many natural river corridors as possible, as well as leveraging diverse and lush natural vegetation. Instead of paving the riverbank with rigid sidewalks and ornamental flower beds, the design utilized a 500-meters steel structure called "red ribbon". The idea was to provide access to activities such as jogging, fishing, and swimming with minimal intervention in the landscape.

(Source: https://www.archdaily.com)

Cyclists can access the area previously inaccessible, which has significantly encouraged community participation. Serving as urban, modern, and accessible, the Red Ribbon River Park stands out while preserving the natural ecosystem of the riverbank.

Photo 12. Each pavilion is named after a local plant. This is a way to educate people about the local biodiversity, fostering a love for nature and an understanding of biodiversity within the residents' living environment.

(Source: https://www.archdaily.com)

2.2 Shanghai Houtan Park model

Houtan Park is built on the abandoned land of a former industrial area, creating a rejuvenated landscape along the Huangpu River in Shanghai. The park's constructed wetland manages ecological flooding, while industrial structures and materials, as well as urban agriculture, are essential components of the overall restoration design strategy to address river pollution and aesthetically revive degraded riverbank.

The park's design objective was to create a Green Expo, accommodating a large influx of visitors during the exhibition period from May to October 2010, showcasing green technologies and transforming a unique space to turn the Expo into an unforgettable event and subsequently convert it into a public riverside park.

Stairs and terraces are utilized to oxidize nutrient-rich water, removing and retaining nutrients while reducing suspended sediment accumulation, thereby creating pleasant water characteristics. Various wetland plants have been selected and designed to absorb different pollutants from the water. On-site experiments have shown that 2,400 cubic meters of water per day can be treated from Level V to Level III. The treated water can be safely used throughout the Expo for non-drinkable purposes and saves half a million US dollars compared to conventional water treatment.

Photo 13. This site is a narrow strip of land (14 hectares), situated along the Huangphu River in Shanghai, China. It was previously owned by a steel plant and shipyard, with only remnants of industrial structure remaining. Much of the area was used as landfill and industrial material storage.

(Source: https://www.archdaily.com)

Photo 14. Design strategies for regeneration were employed to transform the site into a living system providing comprehensive ecological services including food production, flood control, water treatment, and habitat creation combined with educational and aesthetic elements. This site is intended to serve as a creative showcase of ecological culture for the 2010 Expo.

(Source: https://www.archdaily.com)

Photo 15. Through the center of the park, a linear constructed wetland which is 1,7 kilometers long and 5-30 meters wide was designed to create a revitalized riverbank. This design acts as a "living machine" to treat polluted water from the Huangpu River.

(Source: https://www.archdaily.com)

Photo 16. The wetland area also serves as flood buffer zones between levees with a lifespan of 20 and 1000 years. The meandering valley along the wetland creates a series of thresholds that provide visual interest and refuge in the bustling exhibition world with entertainment, educational, and research opportunities. The design of the highest part of the wetland reduces the height difference between the city and the river, connecting people safely to the water's edge. Additionally, the existing concrete flood barriers have been replaced with environmentally friendly stone, allowing native species to thrive along the riverbank while protecting the coastline from erosion.

(Source: https://www.archdaily.com)

Inspired by the fields in China's agricultural landscape, the terraces were created to break the 3-5 meters elevation change from the water's edge to the road and to slow the flow towards the stream in the constructed wetland. These terraced fields reminiscent of Shanghai's agricultural heritage before industrial development in the mid-20th century. The selected crops and wetland plants create an urban farm allowing people to witness seasonal changes: golden flowers in spring, vibrant sunflowers in summer, ripe wheat in autumn, and green clover in winter. It provides an educational opportunity for people to learn about agriculture and gardening in the city.

Photo 17. Nested within the matrix of ecological regeneration landscape are layers of the area's agricultural and industrial past and the future of post-industrial ecological civilization.

(Source: https://www.archdaily.com)

Photo 18. Houtan Park demonstrates a living system where ecological infrastructure can provide multiple services for both society and nature as well as new eco-water treatment methods and flood control. The post-industrial design embodies a productive landscape evoking memories of the past and future of ecological civilization, expressing reverence for a new aesthetic landscape based on low maintenance and high performance.

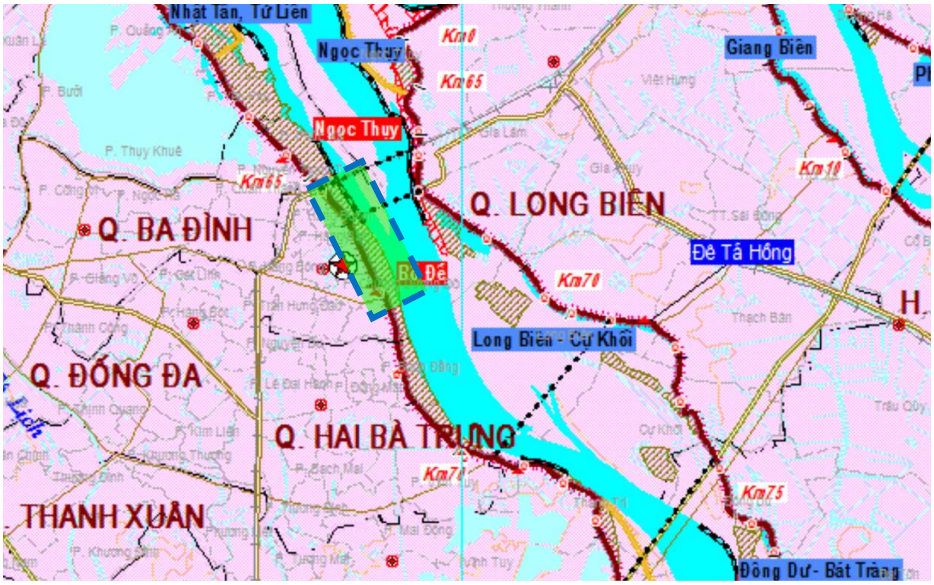
(Source: https://www.archdaily.com)

3. General principles in developing spatial solutions

Based on the current environmental, economic, social, and legal conditions of the riverine zone, as well as national and international experiences, the research group suggests some spatial-related solutions according to the following general principles.

Adherence to legal regulations: There are two important legal frameworks that must be followed to implement spatial renovation solutions. The first legal framework is Decision No. 257/QĐ-TTg dated February 18, 2016, by the Prime Minister approving the Flood Prevention Planning and the dyke system regulation planning of the Red River and Thai Binh River. As illustrated in Figure 19 below, the entire riverine zone falls within the flood discharge corridor according to this Decision.

Photo 19. Flood discharge corridor passing through the center of Hanoi according to Decision No. 257/QĐ-TTg



The second legal framework is the Red River development plan under Decision No. 1045/QĐ-UBND approving the Red River urban planning at a scale of 1/5000 (from Hong Ha Bridge to Me So). According to the plan, as depicted in Figure 20, there are multiple transportation infrastructure facilities that could be developed in the future, so environmental and spatial solutions need to take this factor into account.

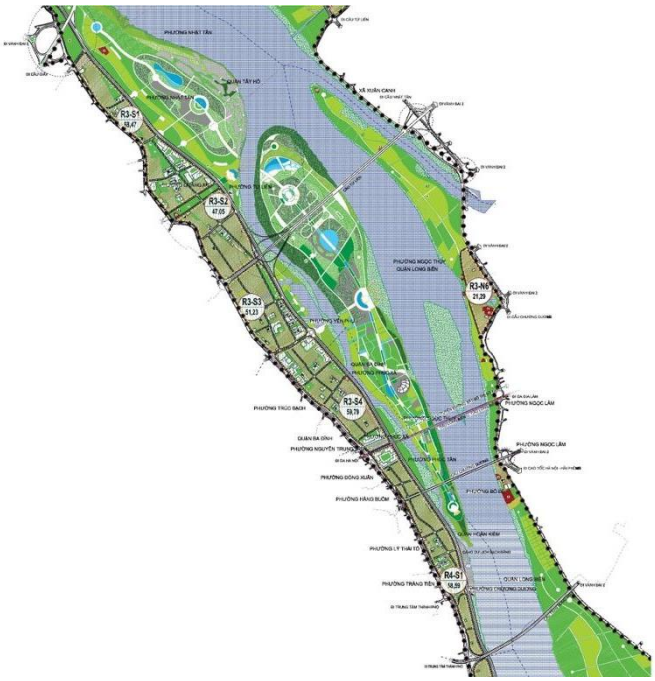


Photo 20. Red River urban planning according to Decision No. 1045/QĐ-UBND

Preserving and enriching the plant and animal ecosystem in the riverine zone: Due to its unique characteristics, riverine zone has valuable vegetation, especially for urban areas like Hanoi. Additionally, the riverine zone is part of the ecological system of the Red River's banana island, serving as an important stopover for nearly 200 species of migratory birds from Russia, Mongolia, and Japan. Therefore, the solutions need to protect this riverine ecosystem, considering it a common asset not only of the Hoan Kiem District but also of Hanoi, Vietnam, and the world.

Accommodating public needs: The riverine zone has a dense population but limited public space. Therefore, the solutions need to create public spaces such as playground, forest garden, and pedestrian path to meet the needs of the people. These public amenities must consider the specific needs of children, the elderly, people with disabilities, and adolescents. This area can be considered as a buffer zone between densely populated residential areas and the ecological area of the Red River riverine.

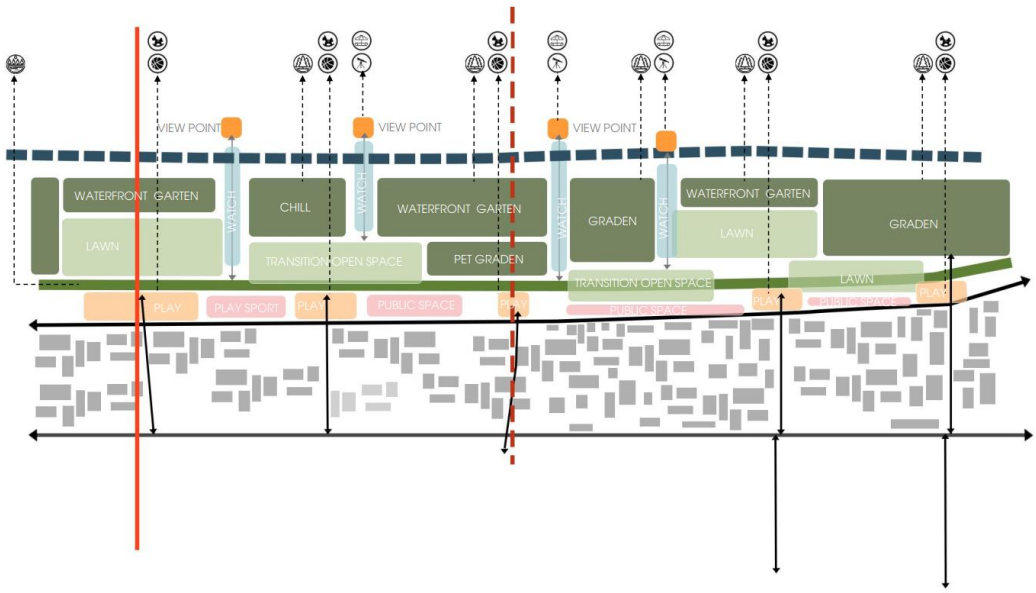
Photo 21. Playground and forest gardern in Chuong Duong Ward

Connecting the riverine zone with night-time economy areas (e.g., the walking street and Long Bien Bridge) to create an economic, cultural, ecological, and tourism ecosystem: Once treated, the riverine zone can become a significant attraction for Hoan Kiem district. This area can serve as an ecological site, providing experience in nature and connecting with the Red River, which is essential to Hoan Kiem district in specific and Hanoi in general. Therefore, the riverine zone should be linked to the walking street surrounding Hoan Kiem lake as well as the Long Bien market – Long Bien bridge. In the future, this connection can even extend to the Red River's banana island. This approach will add in more cultural, tourism, and exploration activities for the residents and tourists, and create more jobs for the locals, including street vendors.

4. Spatial solutions for the riverine zone

The Red River's riverine zone in Hoan Kiem District covers approximately 30,8 hectares, stretching from the Northwest to the Southeast. This area is divided in to layers as depicted in the diagram below:

Photo 22. The cross section of layers in the riverine zone



The first layer is the riverine road next to the residential area, serving as a multifunctional and multi-activity space, primarily functioning as a transportation link for vehicles and communal space for inhabitants. The unique feature of this spatial axis lies in the intersection of various activities of the people with the natural environment. The planning idea for constructing the first layer is maintaining appropriate activities, especially the social activities of residents such as social interaction, sports activities, recreational activities, agricultural activities, or household livelihoods; strictly controlling harmful practices to the environment such as inappropriate waste disposal and unreasonable construction. In addition to its function as a motor vehicle transportation route, the riverine landscape corridor will include a mix of cultural and community activities, including:

- Playgrounds and sport fields are arranged approximately 400-500 meters apart from each other, ensuring residents' accessibility. The selection criteria for playgrounds are determined based on the consensus of the local authority and community.
- Besides the playgrounds, livelihood activities of the residents such as growing vegetables and raising livestock should also be maintained.
- A parking system plan should also be included.

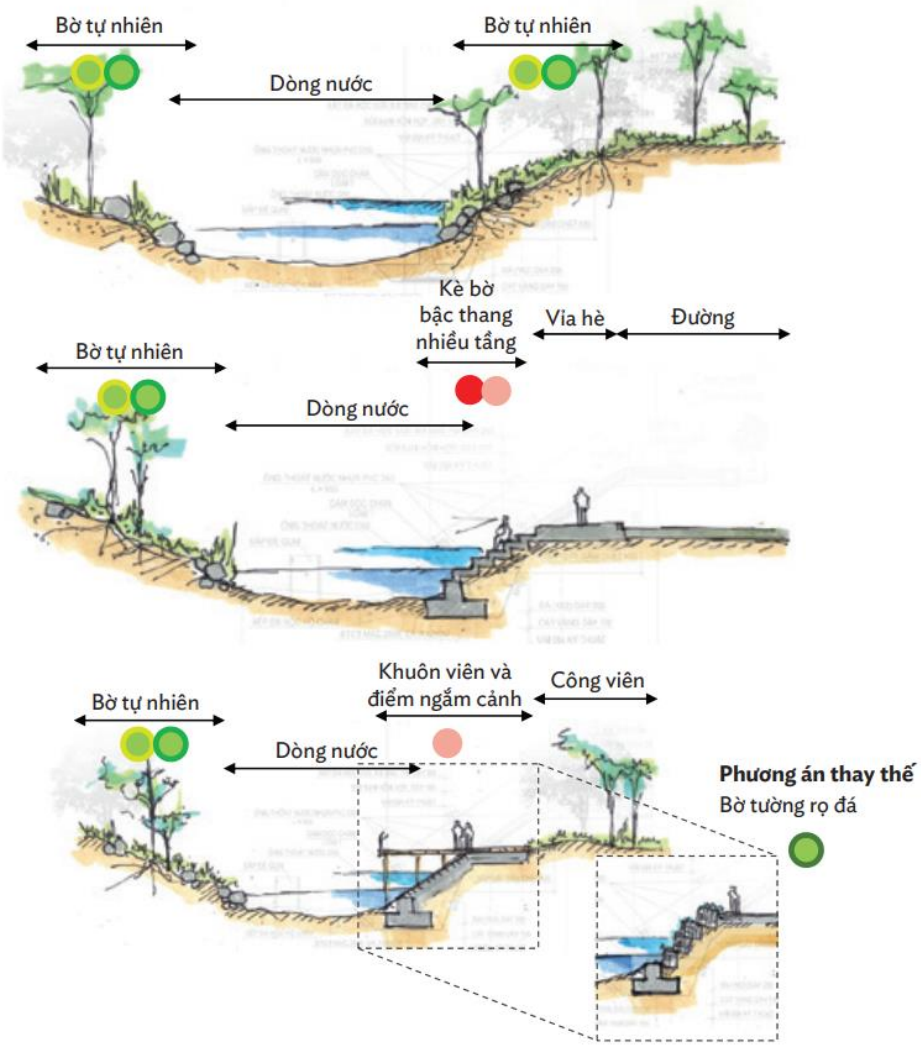
The second layer includes the entire landscape and wetland ecosystem. With the goal of respecting the natural ecosystem and enhancing landscape values through Nature-Based Approach (NBA) and Water Sensitive Urban Design (WSUD) methods, the planning scheme identifies and delineates viable locations and proposes interventions based on nature to enhance space value, make use of the sites' potentials to bring people closer to nature, and raise awareness of the importance of conserving the riverine zone and Banana Island of the Red River. The second space layer is suitable for organizing two types of activities. Firstly, small and medium-sized community activities by utilizing vacant areas and less valuable shrubs. It could be organized as art exhibitions, outdoor performance venues, seating areas, scenic areas, and walking trails. Secondly, nature exploration activities (e.g., trekking and walking) can be held in high canopy areas, forming a connected route throughout the area.

The third layer is the landscape corridor in contact with the waterfront and the Banana Island of the Red River. It identifies and determines special locations for organizing scenic areas, unique viewpoints towards Long Bien Bridge, the Banana Island of the Red River, waterfront landscapes, and Chuong Duong Bridge. It forms horizontal connections leading from these important viewpoints to the riverbank road, creating an attractive landscape axis that links the three layers of space. These horizontal connection axes play a role in spatial recognition, opening entrances to guide people's activities to the Red River riverine zone.

Photo 23. Landscape axis in contact with waterfront and the Banana Island

The interventions in the riverine zone draw from international experiences in addressing two fundamental issues: improving water environment and utilizing space through the Nature-Based Approach (NBA) and Water-Sensitive Urban Design (WSUD). These solutions aim to integrate water cycle management with civil engineering environment through urban planning and design. They incorporate various aspects of the urban water cycle, including water storage, reuse, treatment, retention, and surface water infiltration, as valuable urban resources. Water-Sensitive Urban Design is a part of nature-based solutions, utilizing natural environments (such as soil, water, and vegetation) to address diverse challenges related to the environment, economy, society, and climate. This design approach is nature-based, utilizing water to create healthier and more livable urban environments. WSUD offers diverse solutions, including bio-retention basins, eco-drainage channels, eco-filter strips or detention ponds, permeable surfaces (such as roads, sidewalks, etc.), infiltration wells, and circular eco-filter systems. These solutions can supplement or replace concrete infrastructure depending on specific purposes and local contexts.

Photo 24. Nature-based Approach (NBA) and Water-sensitive Urban Design (WSUD)



The concept and tools of WSUD are flexible enough to be applied to various types of urban development. Among these, parks and public spaces are ideal locations to integrate WSUD. By drawing people closer to water and nature, WSUD helps cities transform their spaces into vibrant community hubs.

IV. CONCLUSIONS

The survey results reflect the current environmental and social conditions, and the public space usage needs of the residents in the Red River embankment area. The environmental situation along the embankment is quite severe, with a significant accumulation of solid waste piling up over the years, along with numerous untreated and odor-emitting open sewage drains. This pollution is greatly affecting the lives of the majority of residents and requires solutions for improvement. The reasons for this situation stem from both the residents' awareness and the ineffective waste collection system in the area. Some areas are less polluted thanks to the residents' initiatives to clean up, refurbish spaces for gardening, plant trees, and organize public activities. However, the environmental improvement measures taken by the residents are mostly temporary, lacking synchronization and sustainability. The current state of environmental pollution is one of the main reasons why the large green areas near the city center have not contributed to local development.

Most residents in the embankment area are laborers, housekeepers, small businesses, employees, or street vendors, with a relatively typical educational background; most have completed secondary or high school, and many families include children and elderly, who are vulnerable groups. The residents use the embankment space for a rich variety of public and community activities. Cultural, fitness, and sports activities are the most frequent and popular. The residents understand and are conscious of preserving the ecological value of the embankment, and they are willing to put effort into planting more trees and contributing to ecological conservation because it directly affects their quality of life. The demand for public space is immense, yet the number of public facilities in the area is very limited, small, and inaccessible, especially for the elderly, disabled, and those in poor health.

Based on the current environmental, economic, and social conditions at the Red River embankment, the research team proposes several recommendations for the Hoan Kiem District People's Committee and the Department of Natural Resources and Environment, as detailed in Part III of the report. Regarding environmental management, these recommendations suggest focusing on quickly addressing the pollution from solid waste and sewage to improve residents' lives. Short-term solutions such as communication, household waste collection, final treatment of existing garbage dumps, sewage treatment, and underground sewage systems are necessary and can be implemented immediately. Regarding public space, transforming the space as an environmental management solution is reasonable and effective. In the long term, it not only resolves the discharge problem but also creates new values in ecology, economy, culture, and society for Hoan Kiem specifically and Hanoi in general. The proposed renovation solutions should consider the unique factors of the embankment area, as well as the legal corridors and development strategies for the Red River.

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

Name of Interviewer:

Interview group:

Personal information of the respondent:

1.1 Ward

- Chuong Duong
- Phuc Tan

1.2 Residential Group

2. The coordinateco-ordinate of household

- latitude (x.y)
- longitude (x.y)
- altitude(m)
- accuracy(m)

3. Name of the respondent?

4. Sex/Gender:

- Male
- Female
- Others

5. Phone number:

6. How old are you?

7. Do you have a permanent residence registration or a temporary one?

- Permanent
- Temporary

8. Do you have your own house or rent one?

- Own house
- Rented house

9. How many people are there in your family?

10. How many children under age 16 are in your family?

11. How many old people over age 70 are in your family?

12. Does your family have people with disability?

- Yes
- No

12.1. If yes, please share the type of disability that your family member has (Selected multiple answers)

- Physical impairment
- Visual impairment
- Hearing and speech impairment
- Neurological or mental disability
- Intellectual disability
- Other

13. What is your highest level of education?

- Not attending school
- Primary school
- Secondary school
- High school
- University, postgraduate education

14. What is your current occupation?

- Officer, civil servant, public employee
- Employee and/or worker for other businesses and organisations
- Home-base businesses
- Street vendor
- Operating a food business
- Laborer (work for Grab...)
- Homemaker
- Other

15. If you are doing home-based business, what kind of merchandise are you selling?

- Vegetable
- Refreshment
- Grocery store
- Souvenir
- Fresh food (meat, fish)
- Other (Clearly indicate)

Status and practices of waste treatment

16. Which type of waste accounts for the largest amount in your household waste?

- Organic waste
- Recycle waste
- Plastic waste
- Bulky waste
- Other waste

17. How does your family treat household waste? (Selected multiple answers)

- Disposing of waste at collection points
- Sorting and selling for informal waste collectors
- Composing for fertilizer
- Landfilling
- Waste burning
- Direct waste disposal (riverbanks, drains, streets)

18. Where do you leave waste for waste collectors? (Selected multiple answers)

- Inside the house when the garbage truck arrives
- In front of house doors
- Collection points of residential groups or ward
- Public trash cans
- At random
- Other (Clearly indicate)

19. How far are the nearest waste collection points from your home?

- Door-to-door collection
- <100m
- 100 - 200m
- 200 - 500m
- >500m

20. How does your family sort waste?

- Organic - Inorganic
- Recyclable - non-recyclable
- Not sorting
- Don not know

21. If not, what is the reason?

- Do not have time
- Unnecessary
- Do not know how to sort
- Your city lacks a waste sorting and processing system
- Other (Please elaborate)

22. According to you, if your neighborhood has sorting bins, are you willing to put the waste in the correct one?

- Yes
- Maybe
- No

Knowledge and awareness about household solid waste management

23. Does your residential group have a waste collection system?

- Yes
- No
- Do not know

24. How often does this system collect waste?

- More than once per day
- Once a day
- Once every two days
- Once a week
- Other (Please elaborate)

25. Do you think the waste collection schedule is convenient for your family?

- Yes
- No

26. Does your family pay for the waste collection service?

- Yes
- No
- Do not know

26. Do you think the cost for waste collection service is reasonable?

- Too cheap
- Reasonable
- Too expensive

27. If waste is not collected, would you be willing to pay for household waste collection?

- Yes
- No

28. According to you, is your health affected by the current waste pollution?

- Yes
- No
- Do not know

29. What are the sources of pollution in your residential area?

- Waste
- Wastewater
- Odor
- Other (Please elaborate)

30. Do you know where household wastewater (excluding toilet wastewater) of your home is discharged to?

- Into the city's wastewater treatment system
- Discharged through open drains to the bank of the Red River
- Do not know

31. What communication channels do you use to receive information about the environment and waste?

- Radio
- Television
- Loudspeaker
- Neighborhood Meeting
- Newspaper
- Internet: online news, social media
- Banners, signposts
- Tiktok, YouTube
- Zalo groups

- Not interested

32. Are you interested and willing to participate in environmental cleaning practices?

- Yes
- No

32.1. If yes, how do you want to participate in?

- Communication
- Participate in contributing to local waste management schedule
- Supervise and report violations
- Participate in waste collection and environmental cleaning weekly
- Other

32.2. If no, why?

- Not being invited to participate
- Not interested in waste management issue
- This should be the responsibility of the specialized management agencies
- Other (Please elaborate)

33. Are there areas where you live that are at risk of waste pollution?

- Yes
- No
- Do not know

33.1. If yes, please list the areas which are at risk of waste pollution:

34. In your opinion, where does this waste originate from? (Selected multiple answers)

- Residents living nearby
- Individuals and outsiders come to dump illegally
- Floods and rivers bring it in
- Other (Please elaborate)

Knowledge and awareness of plastic waste

35. How does plastic waste pollution affect humans and organisms? (Selected multiple answers)

- Killing and injuring aquatic organisms
- Polluting water sources and habitat
- Negative impact on human health
- Food safety violation
- Other (Please elaborate)
- No effect
- Do not know

36. What challenges do you face when you implement activities of plastic waste reduction? (Selected multiple answers)

- Sorting waste
- The habit of using plastic products
- The difficulties in finding plastic alternatives

- Lack of specific knowledge and guidance about plastic waste reduction
- Lack of instruction from the government
- Lack of regulations on using and disposing of plastic products
- Lack of coordinator from sorting to collecting and handling
- Do not know
- Current status and needs of using public spaces of residents

Public spaces are areas used for public purposes such as playgrounds, cultural zones...

37. Which of the following public spaces are located near your house (within 500 meters or about 5 minutes walk)? (Selected multiple answers)

- Phuc Tan street art
- A playground in the residential group no.16, Phuc Tan ward
- Chuong Duong forest garden
- Walking trails
- Public ground
- Lake
- Community center
- Garden
- Sport facility
- Temple
- Kids playground
- Do not have
- Other (Please elaborate)

38. Have you used any public spaces in the past month?

- Yes
- No

39. Which of the following public spaces have you used? (Selected multiple answers)

- Phuc Tan street art
- A playground in the residential group no.16, Phuc Tan ward
- Chuong Duong forest garden
- Walking trails
- Public ground
- Lake
- Community center
- Garden
- Sport facility
- Temple
- Kids playground
- Do not have
- Other (Please elaborate)

40. Why don’t you use public spaces?

- Too busy, no time
- Too far
- Too crowded

- Dirty
- Too cramped
- Difficult to access
- No facilities for people with disability
- No need to use
- Not safe (narrow, uneven path, prone to accidents)
- No security (lack of street lights, prone to harassment)
- Other (Please elaborate)

41. How do you evaluate the importance of public spaces in your family's life/lifestyle?

- Very important
- Important
- Normal
- Unimportant
- Very unimportant

42. Are you using public areas for activities related to utilizing green spaces? (Selected multiple answers)

- Cultivation
- Livestock raising
- Harvesting natural leaves and fruits
- Hunting, trapping, and catching wild animals (rodents, birds, snakes, fish...)
- Do not use

43. What public spaces do you expect to be implemented on the riverine of Red River?

- Forest park
- Playground
- Ecological zone
- Artspace
- Sport facility
- Walking trails
- Space for events, celebrations
- Other (Please elaborate)

44. What role should the local community play in the renovation of the riverine zone? (Selected multiple answers)

- Participating in the design process
- Contributing human resources for implementation activities
- Contributing materials (benches, trees..)
- Participating in management
- Using space
- Other (Please elaborate)

APPENDIX 2: COORDINATES OF SURVEY POINTS

Phuc Tan Wards:

- PT1: Long Bien Bridge’s footing (The end of alley 195 Hong Ha) (Coordinate: 21°02'23.4"N 105°51'14.8"E)
- PT2: Alley 62 Bao Linh (Coordinate: 21°02'17.3"N 105°51'20.0"E)
- PT3: Chuong Duong Bridge’s footing (Coordinate: 21°02'11.2"N 105°51'24.6"E)
- PT4: Phuc Tan playground (Coordinate: 21°02'00.9"N 105°51'31.5"E)
- PT5: Mr. Binh’s parking lot (Coordinate: 21°01'58.3"N 105°51'34.1"E)

Chuong Duong Wards

- CD1: Ship pier 46 Chuong Duong Do (Coordinate: 21°01'50.1"N 105°51'41.8"E)
- CD2: Hoang Kim garage (Coordinate: 21°01'39.6"N 105°51'42.2"E)
- CD3: Alley 407 Bach Dang (Coordinate: 21°01'32.9"N 105°51'44.4"E)
- CD4: Alley 533 Bach Dang (Coordinate: 21°01'22.8"N 105°51'47.3"E)
- CD5: Alley 695 Bach Dang (Coordinate: 21°01'11.4"N 105°51'50.6"E)

APPENDIX 3: COMMON TYPES OF WASTE IN THE RESEARCH AREA

(FROM 0 - VERY UNCOMMON TO 5 – VERY COMMON)

	PT1 – LONG BIEN BRIDGE'S FOOTING	PT2 – ALLEY 62 BAO LINH	PT3 – CHUONG DUONG BRIDGE'S FOOTING	PT4 – PHUC TAN PLAYGROUND	PT5 – MR. BINH PARKING LOT	CD1 – CHUONG DUONG SHIP PIER	CD2 – HOANG KIM GARAGE	CD3 – 407 BACH DANG	CD4 – ALLEY 533 BACH DANG	CD5 – ALLEY 695 BACH DANG
Plastic waste										
Jute sack	5	3	4.3	5	5	2.8	4.5	5	4	3.3
Nylon bag	3.6	3	3	5	3.8	3.8	4	5	4	3
Disposable plastic items (disposable cup, spoon, fork, straw...)	2.8	2.3	1.7	3	1.8	1.3	1.5		4	1.8
Plastic string/rope	2.4	1.5	0.7	3	2.5	1	2.5		3	1.8
Foam box	1.8	1.8	1.3	4	4.8	3	4.5		4	1.8
Household plastic items (bowl, basket, colander, toys...)	1	1.5	0.7	2	1.5	1	1		4	0.8
Cigarette butt	1.6	1.3	1.3	0	2.3	1			0	2
Plastic slippers	1	0.3	0.3	1	0.8	1			3	0.5
Beverage bottle (water bottle, soft drink bottle...)	1.8	2	2	2	3	1.7	3	1	4	1.8
Other types of bottle (shampoo, body wash...)	1	1	2.3	1	1	1.3	0.5	3	3	0.8

	PT1 – LONG BIEN BRIDGE'S FOOTING	PT2 – ALLEY 62 BAO LINH	PT3 – CHUONG DUONG BRIDGE'S FOOTING	PT4 – PHUC TAN PLAYGROUND	PT5 – MR. BINH PARKING LOT	CD1 – CHUONG DUONG SHIP PIER	CD2 – HOANG KIM GARAGE	CD3 – 407 BACH DANG	CD4 – ALLEY 533 BACH DANG	CD5 – ALLEY 695 BACH DANG
Medical face mask	1.2	1.3	0.3	0	1.8	0.5			2	0.8
Personal care products (cosmetic, toothpaste…)	0.6	1	0.7	0	0.5	0.5			0	0.5
Lighter		1.3	0.3	0		0.2			0	0.8
Metal waste										
Metal pieces	2	2	0.3	1	3.3	0.7	2.5	2	5	1.8
Beverage cans (beer, condensed milk, soft drinks…)	0.8	2	1	2	2.5	1.2	2.5		5	0.5
Spray bottle		0.8	0.3	0	0.3	0.5			0	
Glass waste										
Glass pieces	4	1.5	1	1	3	0.8	3		5	3
Glass bottle	1.4	1.8		1	1.5	0.2	1		0	0.8
Rubber waste										
Rubber slippers	1	0.8	0.3	0	0.8	1.7			3	0.3
Tires	0.4	1		1	0.3	0.3			0	1
Rubber gloves		1	0.8	0	0.3	1.3	1.7		0	0.3
Wood waste										

	PT1 – LONG BIEN BRIDGE'S FOOTING	PT2 – ALLEY 62 BAO LINH	PT3 – CHUONG DUONG BRIDGE'S FOOTING	PT4 – PHUC TAN PLAYGROUND	PT5 – MR. BINH PARKING LOT	CD1 – CHUONG DUONG SHIP PIER	CD2 – HOANG KIM GARAGE	CD3 – 407 BACH DANG	CD4 – ALLEY 533 BACH DANG	CD5 – ALLEY 695 BACH DANG
Household wooden furniture	2	3	1	0	4	0.8	5	4	5	4
Industrial wood chip	2.8	3.5	1.3	5	4	0.5	5	4	5	4
Cardboard	0.4	2	1.7	0	4	0.8			5	3
Fabric waste										
Gloves, shoes	1.2	1.3	0.3	0	1.5	0.3	1.5		2	1.3
Blanket	0.4	1	0.3	0	2.3	0.2		1	5	0.3
Fabric pieces	1.4	1.3		0	3.5	1	3.5	3	0	2.5
Clothes	1.2	1.3	0.3	0	1.5	0.5			3	1.3
Handkerchief, towel	0.4	0.3		0	1.3	0.2			0	1
Construction waste										
Bricks	4.8	2	3	0	4.3	0.5	5	5	5	5
Cement	4.8	3	3.7	5	3		5	5	5	5
Lime mortar	4.8	2	2	5	2.5	0.2	5	5	4	4.5
Wood, formwork	0.6	1.8	0.7	5	2.3	0.5	5		0	3.5
Plaster	0.4	0.8		0	0.5	0.2	2.5	5	0	2
Water pipe		0.8	0.3	2	2	0.2		2	4	1.5