REPORT ON MACROPLASTIC SURVEY

SOURCE IDENTIFICATION IN THE LOWER MEKONG RIVER BASIN

Developed by

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This is a deliverable of **Activity 2-I**, conduct a macroplastic analysis with a focus on major plastic constituents as identified in CM1 in the lower Mekong in two seasons and produce a report on the findings, under the Contract No. UNEP/PCA/Asia and Pacific Office/2021/3202 between the United Nations Environment Programme and Asian Institute of Technology.

Counter MEASURE FOR PLASTIC FREE RIVERS

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1. Introduction

River systems are particularly vulnerable to pollution by varied range of plastics. These plastics are introduced by direct disposal or runoff and have adverse effects on the organisms living in and around the system (Emmerik & Schwarz, 2019). Those living in the system or using it for resource gatherings like fish and birds face life-threatening difficulties following ingesting plastic waste or becoming entangled in it. The general population living in the surrounding urban areas is exposed to flood increases due to plastic waste impeding drainage devices during storm events, leading to property damage and loss of life. Hence, there is a need to investigate the pathways in which macroplastic waste enters river systems.

Regarding lessons learned from Phase I, the Phase II macroplastic data collection survey aims to identify the dominant plastic waste varieties at three different types (artificial barriers, uncontrolled dumpsites, and littering spots) of sampling sites from the cities involved in the study. Furthermore, Covid-19 related plastic waste implied the additional consideration to gain insight into the global pandemic's effect on macroplastic riverine pollution. According to the survey results, 1580 sample sites were surveyed using the mobile app from January 2021 until February 2022. It covered two main seasons (dry and wet) in the target areas along the Lower Mekong River. In addition to the survey's objective, the results are also used to collect in-situ data at survey sites in six Lower Mekong River Basin cities to verify GIS overlay analysis results and uncover plastic leakage pathways.

This macroplastic survey report is developed with the primary goals are (i) to identify the dominant plastic waste types, including its volume; (ii) to analyze the changes in plastic waste in two different seasons; and (iii) to consider Covid-19 related plastic waste to gain insight into the global pandemic effect on macroplastic riverine pollution.

In addition to this report, the content divided into three main sections:

- Data collection in six cities
- Discussion on the survey results
- Conclusion and recommendation

2. Data Collection

Phase II investigated macroplastic waste in six Lower Mekong River Basin cities. Five cities visited in Phase I, including Ubon Ratchathani, Thailand; Chiang Rai, Thailand; Phnom Penh, Cambodia; Vientiane, Lao PDR; and Can To, Vietnam. Tonle Sap, Cambodia was added for Phase II. The macroplastic survey which conducted in the lower Mekong River basin incorporated with five universities respectively in each cities (Figure 2.1).

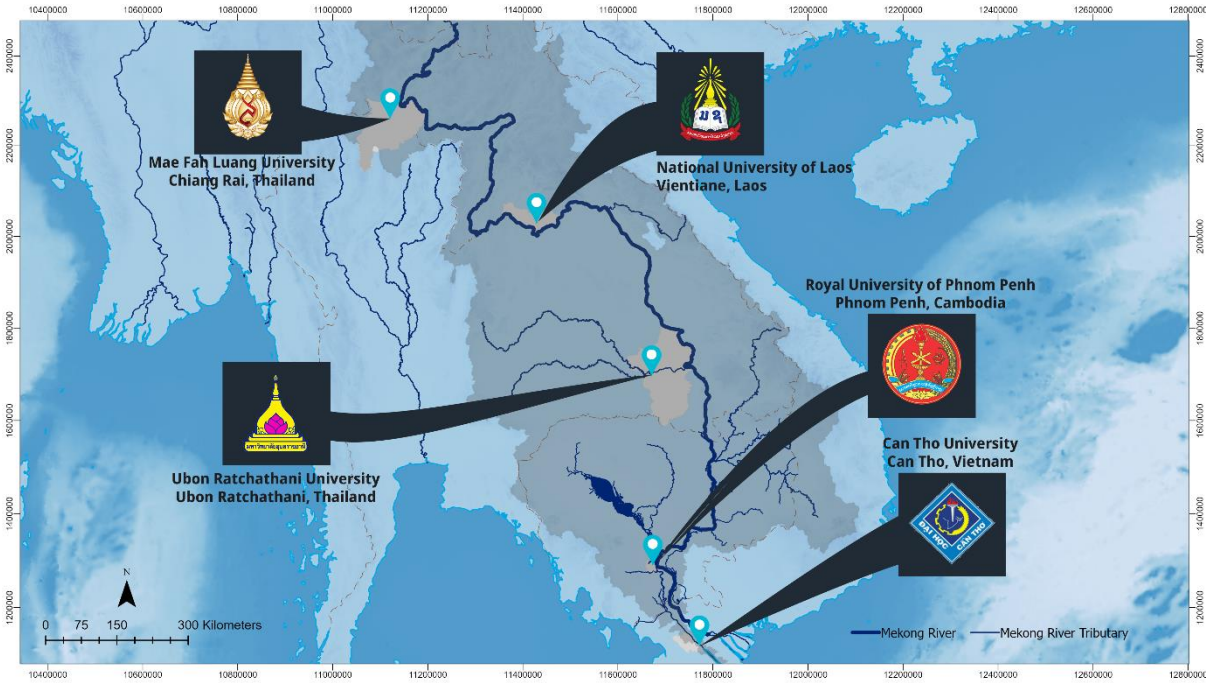


Figure 2.1 Project Partners included in the Macroplastic Survey

In addition to the data collection, the study was conducted during the dry and wet seasons in four mainland Southeast Asian countries. While the beginning and end of the dry or wet season vary from country to country, the period between December to May (low rainfall) or June to November (monsoon season, heavy rain) was considered inclusive for all countries involved in the study, respectively. Due to the lockdown and restriction under the Covid-19 situation in each city and countryside along the lower Mekong River, project partners conducted the survey based on the actual condition in their cities. Therefore, from now onward, the survey results in the dry and the wet season are called the first survey and second survey.

Cooler		Hot/Dry			Wet					Cooler	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
NE monsoon		Transition			SW monsoon					NE monsoon	

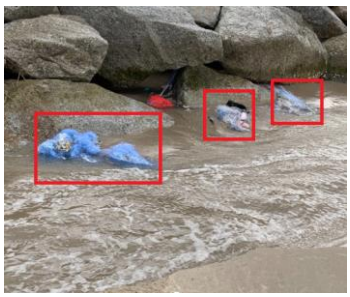
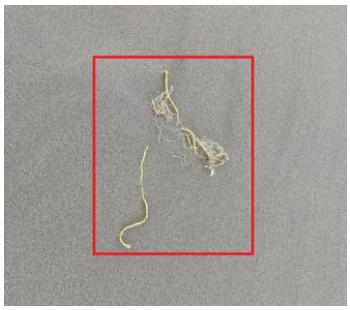
Figure 2.2. The climate of the Mekong River basin. The Lower Mekong River basin weather is considered a tropical monsoonal.
[Source: Mekong River Commission https://www.mrcmekong.org/about/mekong-basin/, accessed on Feb 2nd, 2022]

During Phase II, field teams visited three types of survey sites in these cities: littering spots, artificial barriers, and piers (both sampled in Phase I), and uncontrolled dumpsites (new for Phase II). Field teams recorded the types and amount of plastic waste present at each site and took digital images of the site using a smart device-based data collection

application. The data collection application used during Phase II was an improved design of the one used in Phase I, with improvements made to the user experience. The main improvement features of the mobile app in Phase II are: (i) to identify the most common type of plastic waste at different types of survey sites in six cities. Table 2.1 shows an overview of the waste types discovered across all sites (including single-use plastics [food wrapper and sachet, take away container, cup and plate, etc.], plastic bottles, textiles and clothes, etc.), and (ii) to estimate the amount ofthe cleaning frequency of accumulated wastes at different types of survey sites.

Table 2.1. Examples of different types of plastic waste

Name		Description	Sample
Dominant plastic waste type	Food wrapper and sachet	These are food wrapper and sachet including: candy, chips, tobacco, ketchup	
	Take out/away container	These are typically food containers such as take out/away boxes, cups, etc.	
	Cup and plate	These are plastic cups or plates in any size, any color	
	Cutleries	These are cutleries that are in different form such as straws, stirrers, forks, knives, spoons, chopsticks	
	Beverage bottle	These are plastic beverage plastic bottles that originally contained some type of liquid such as tea, water, etc.	

Name		Description	Sample
	Other plastic bottles	These are plastic bottles that contained some special type of liquid such as shampoo, detergents, oil, bleach, etc.	
	Grocery bag	These are plastic grocery bags which can be whole bags and/or small piece of plastic (broken-down from plastic bag)	
	Other plastic bags and sheets	These are plastic bags or sheets (excluding grocery bags) which can be whole bags/sheets and/or small piece of plastic (broken-down from plastic bag)	
	Fishing gear	These are fishing gear products such as fishing net, line, lures, etc.	
	Rope	Rope in different size, length, and color	

Name		Description	Sample
	Diaper	Diaper in different size, and color	
	Textile/clothes	These are textile/clothes in different size, shape, and color	
	Others	All other plastic litter items that do not fit into the above categories such as bottle caps, pieces of bottle, or fragments of plastic objects of any type, etc.	
Trash bin		Receptacle for garbage/waste	
Litter pile		An accumulation of litter occurring in the environment	

Name		Description	Sample
Covid-19 related waste	Face mask	Disposable face mask used to prevent the spread of disease	
	Hand glove	Disposable hand glove used to prevent the spread of disease	
	Protective gears	Disposable protective gears used to prevent the spread of disease	
	Others		

3. Results and Discussion

Per February 2nd, 2022, project partner field teams collected data at 1576 sampling sites in the target cities (Table 3.1). Table 3.1 shows that there are 842 sampling points already surveyed in the first season, while there are 734 sampling points observed in the second season. Overall, all field teams contributed actively in conducting the survey, even under a hard time of lockdown and restriction of Covid-19. As the results of the study (both seasons), the Vientiane field team collected 412 sampling points (26.08% of the total sampling points in the lower Mekong River basin), followed by the Phnom Penh team (395 sampling points, 25.00%), Tonle Sap team (295 sampling points, 18.67%), and Can Tho team (216 sampling points, 13.67%). In comparison, Chiang Rai and Ubon Ratchathani teams conducted more than 110 sampling points, particularly 141 sampling points (8.92%) and 117 sampling points (7.41%) (Figure 3.1).

Table 3.1. Macroplastic survey results in the dry season

No. of survey		City Name					
		Chiang Rai	Vientiane	Ubon Ratchathani	Phnom Penh	Tonle Sap	Can Tho
First survey	Start Date	2-Jun-21	21-Apr-21	9-May-21	1-Jul-21	16-Jul-21	15-Apr-21
	End Date	5-Jul-21	12-Jun-21	27-Jun-21	22-Jul-21	21-Jul-21	29-Apr-21
	No. of sample sites	3	220	104	269	142	104
Second survey	Start Date	20-Aug-21	20-Nov-21	3-Sep-21	13-Nov-21	2-Jan-22	19-Jan-22
	End Date	21-Dec-21	30-Nov-21	24-Oct-21	19-Nov-21	6-Jan-22	23-Jan-22
	No. of sample sites	138	192	13	126	153	112
Total sample sites		**141**	**412**	**117**	**395**	**295**	**216**

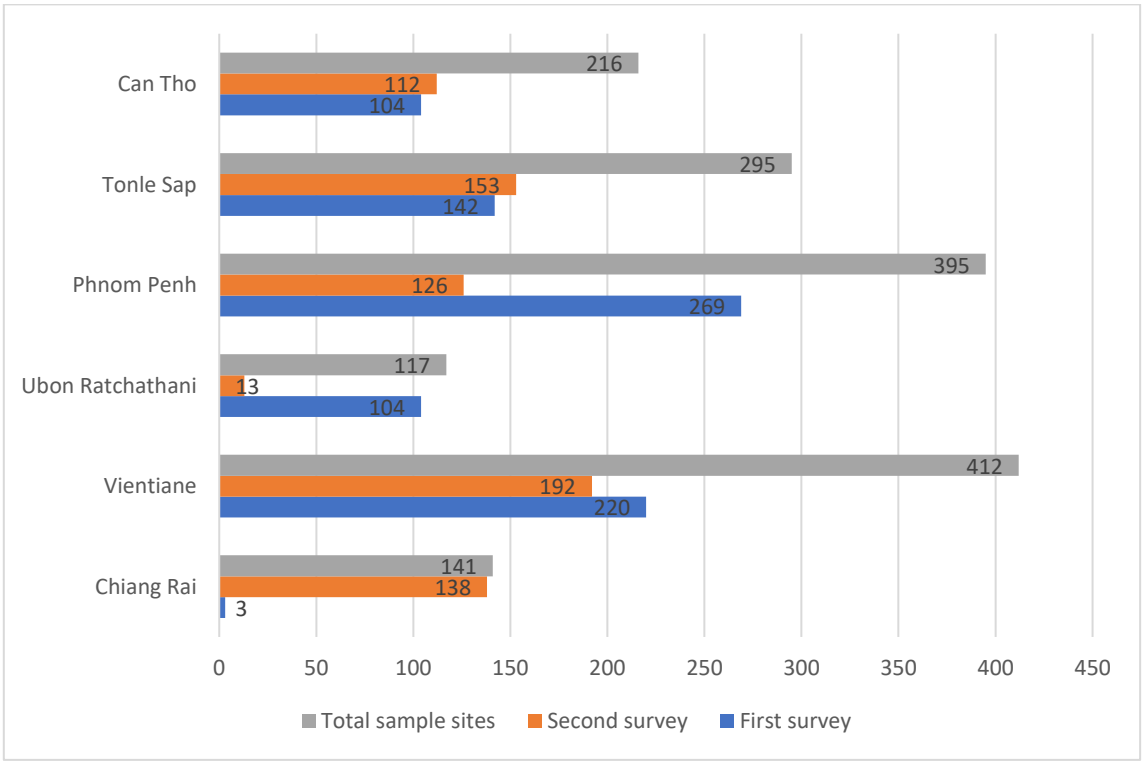


Figure 3.1. Number of sampling points in six cities in two surveys

Some teams started collecting data in the first season in April 2021, while others have not yet begun due to Covid-19 pandemic-related restrictions. Statistics results show that the data collection started on Apr 15, 2021, with three sampling points, and ended on Jul 22, 2021, with 38 sampling points. The most active data collection date was Jul 3, 2021, with 98 sampling points.

In the second season, the field teams collected a sample on Aug 20, 2021 and ended the survey on Jan 23, 2022. Seven hundred thirty-four sampling points were collected in the second survey (46.57% of total sampling points), while eight hundred forty-two were collected in the first season (53.43%) (Figure 3.2).

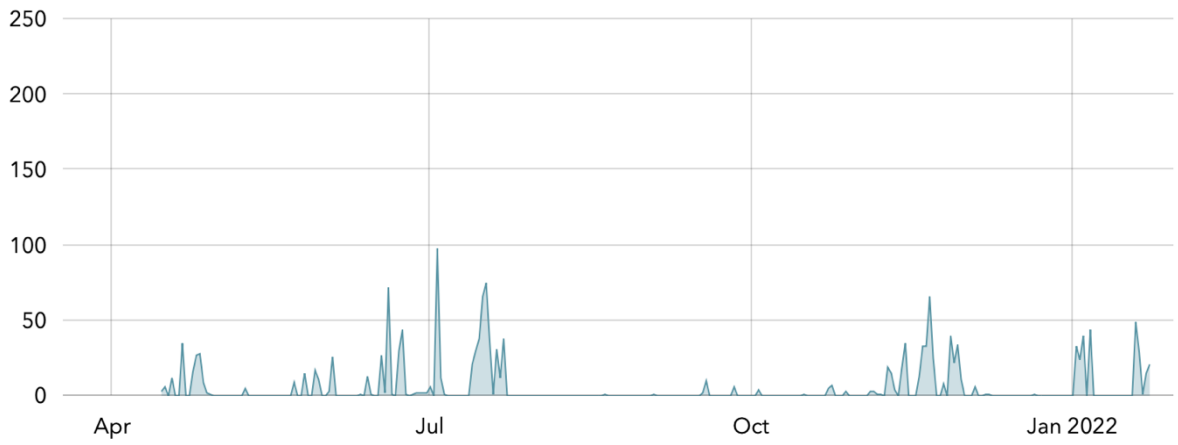


Figure 3.2. Date and time of the data collection. The vertical line presents number of sampling poins and the horizontal line shows the time of two survey (April-July and August-Jan).

Statistics information and spatial distribution of locations of the macroplastic survey are shown in Figure 3.3.

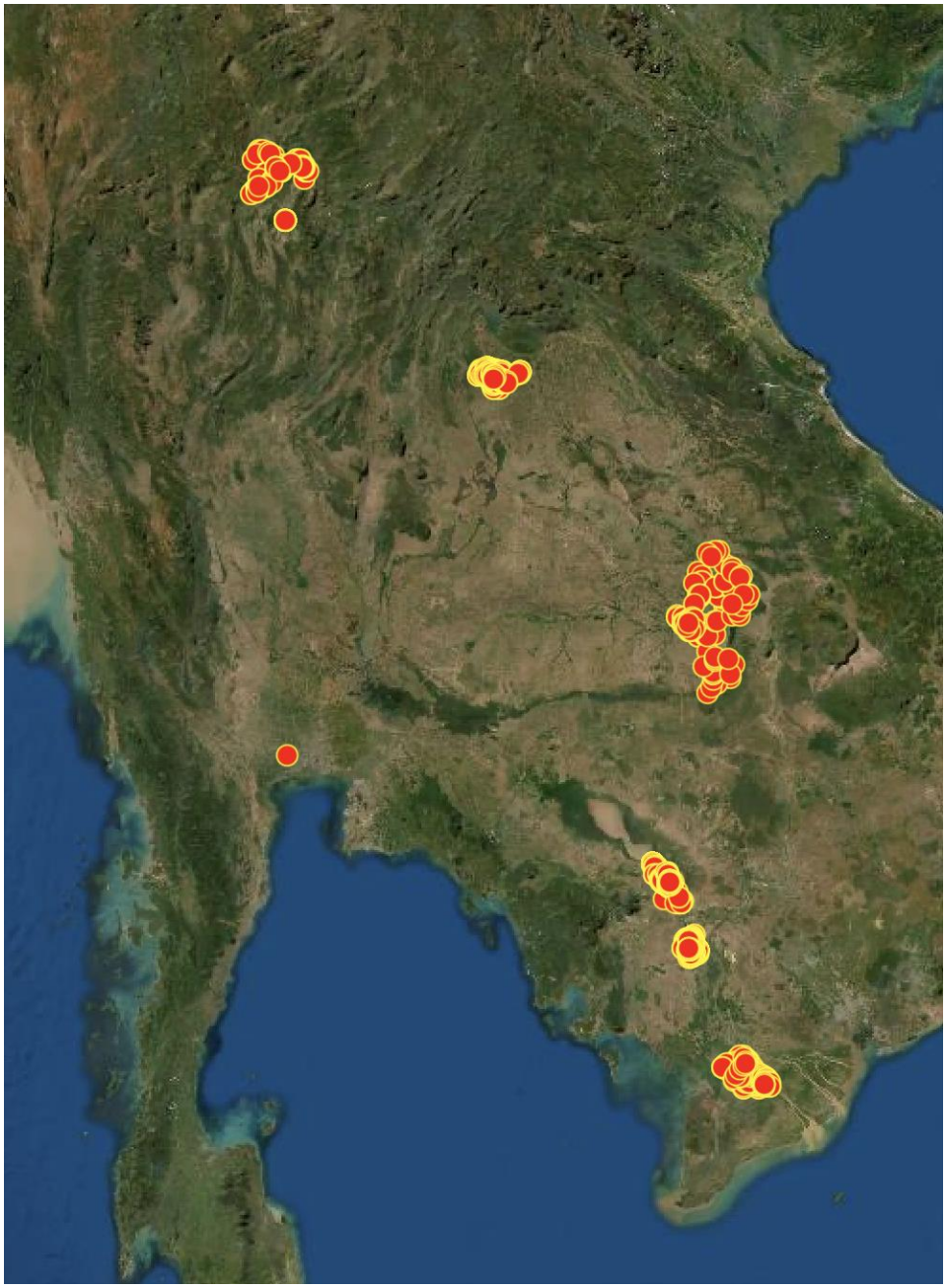


Figure 3.3. Spatial distribution of macroplastic survey locations in lower Mekong River basin. In total, 1576 sampling points collected during the dry and wet season survey.
[Source: https://arcg.is/1iH1Pz, accessed on on Feb 2nd, 2022]

Three types of sampling points were visited, including (1) artificial barriers, (2) littering spots, and (3) uncontrolled dumpsites. The survey results indicate that littering spots contained the highest amount of waste accumulated out of the three location types. Figure 3.4 gives a breakdown of the plastic waste found at the 1574 sampling

points1. There were 993 sampling points at littering spots (63.09% of the total sampling points), 456 sampling points at artificial barriers (28.97% of the total sampling points), and 126 sampling points uncontrolled dumpsites (7.94% of the total sampling points). In addition to the results, sampling points in uncontrolled dumpsites increased about 1.3 times (50 sampling points in the first survey) compared with the other two types of sampling (less than one time).

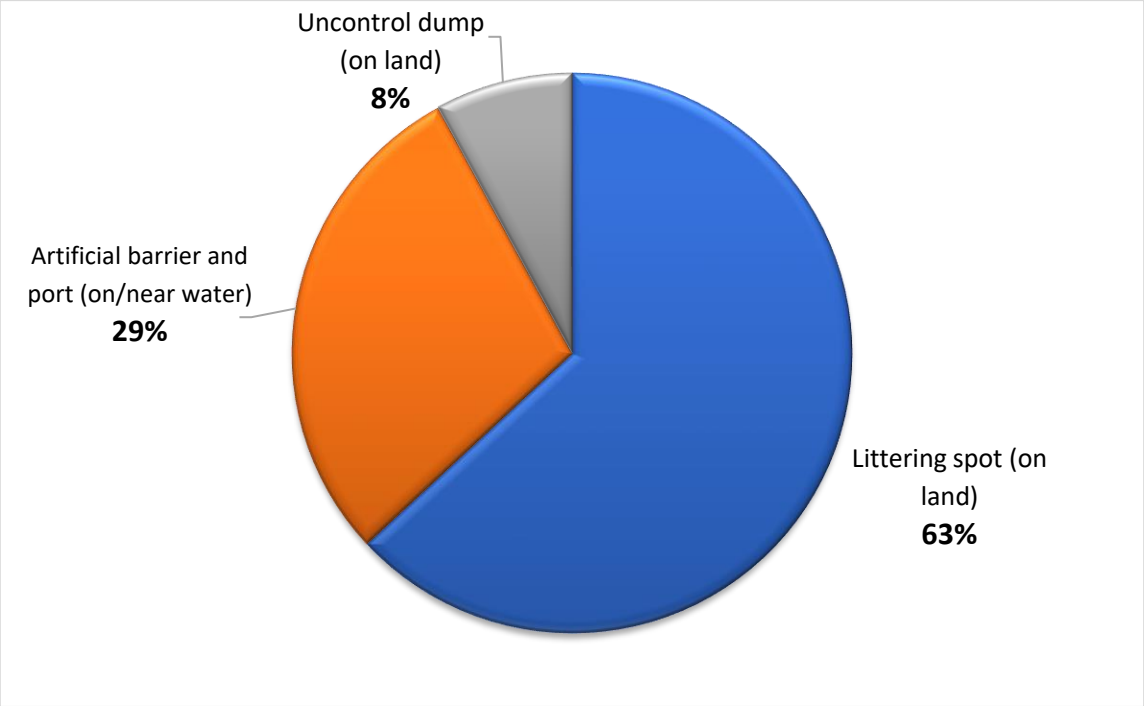


Figure 3.4. Percentage of different types of data collection: Artificial barriers and ports, Littering spots, and Uncontrolled dumpsites in six cities.

Table 3.2. Macroplastic survey in six cities in both seasons

City/Area	Type of data collection						Total	
	Artificial barriers		Littering spots		Uncontrolled dumps			
	Point	%	Point	%	Point	%	Point	%
Can Tho	40	8.77	157	15.81	19	15.20	216	13.72
Chiang Rai	17	3.73	95	9.57	27	21.60	139	8.83

1 The total number of samplings is changed from 1576 to 1574 due to missing three sampling points's attribute (not added by surveyor[s])

City/Area	Type of data collection						Total	
	Artificial barriers		Littering spots		Uncontrolled dumps			
	Point	%	Point	%	Point	%	Point	%
Phnom Penh	131	28.73	193	19.44	71	56.80	395	25.10
Tonle Sap	151	33.11	143	14.40	1	0.80	295	18.74
Ubon Ratchathani	40	8.77	70	7.05	7	5.60	117	7.43
Vientiane	77	16.89	335	33.74	0	0.00	412	26.18
Total	456	100	993	100	125	100	1574	100

A comparison of results (Table 3.2) show that more data was collected in Vientiane and Phnom Penh than in other cities (26.18% and 25.10% of total sampling points, respectively), followed by Tonle Sap, Can Tho, and Chiang Rai that accounted for 18.74%, 13.72%, and 8.83% of total sampling points, respectively. Data collected in Ubon Ratchathani accounted for 7.43% of total sampling points.

Besides, the below Figures show the gallery of different types of plastic waste in the six cities. They included food wrapper and sachet, take out/away container, cup and plate, cutleries, beverage bottle, other plastic bottles, grocery bag, other plastic bags and sheets, fishing gear, rope, diaper, textile/ clothes, and other types of plastic waste.

Figure 3.5. Sample of images of other plastic bottles in the lower Mekong River collected in the survey.

Figure 3.6. Sample of images of grocery bags in the lower Mekong River collected in the survey.

Figure 3.7. Sample of images of other plastic bags and sheets in the lower Mekong River collected in the survey.

Figure 3.8. Sample of images of fishing gear in the lower Mekong River collected in the survey.

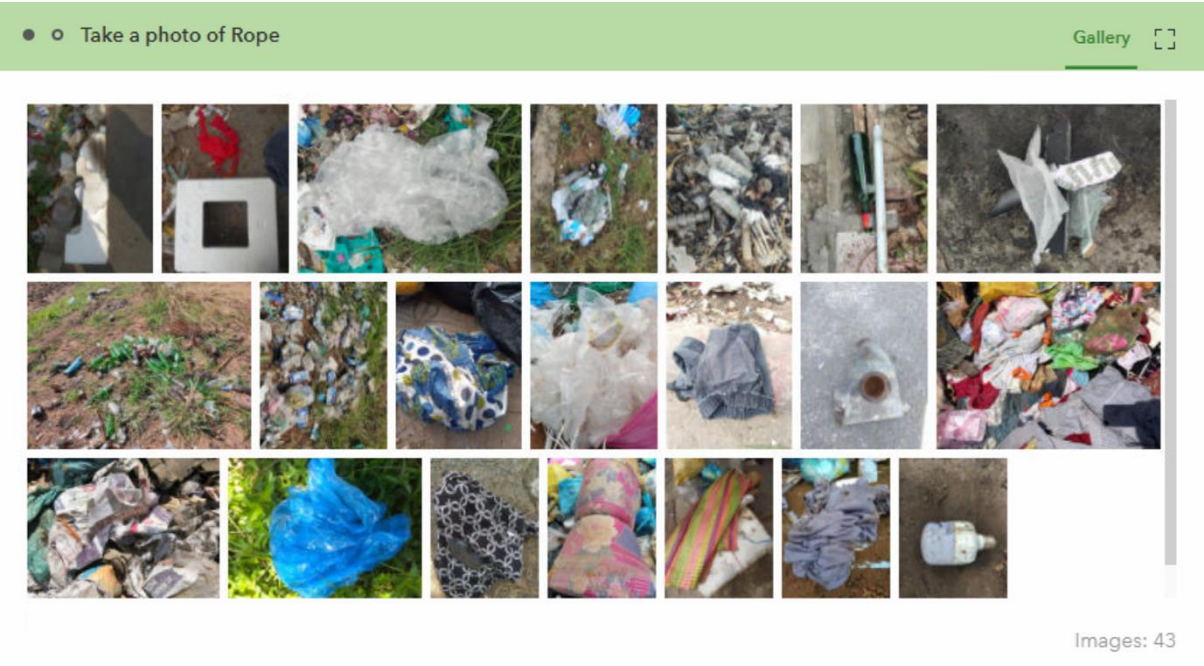


Figure 3.9. Sample of images of rope in the lower Mekong River collected in the survey.

Figure 3.10. Sample of images of diaper in the lower Mekong River collected in the survey.

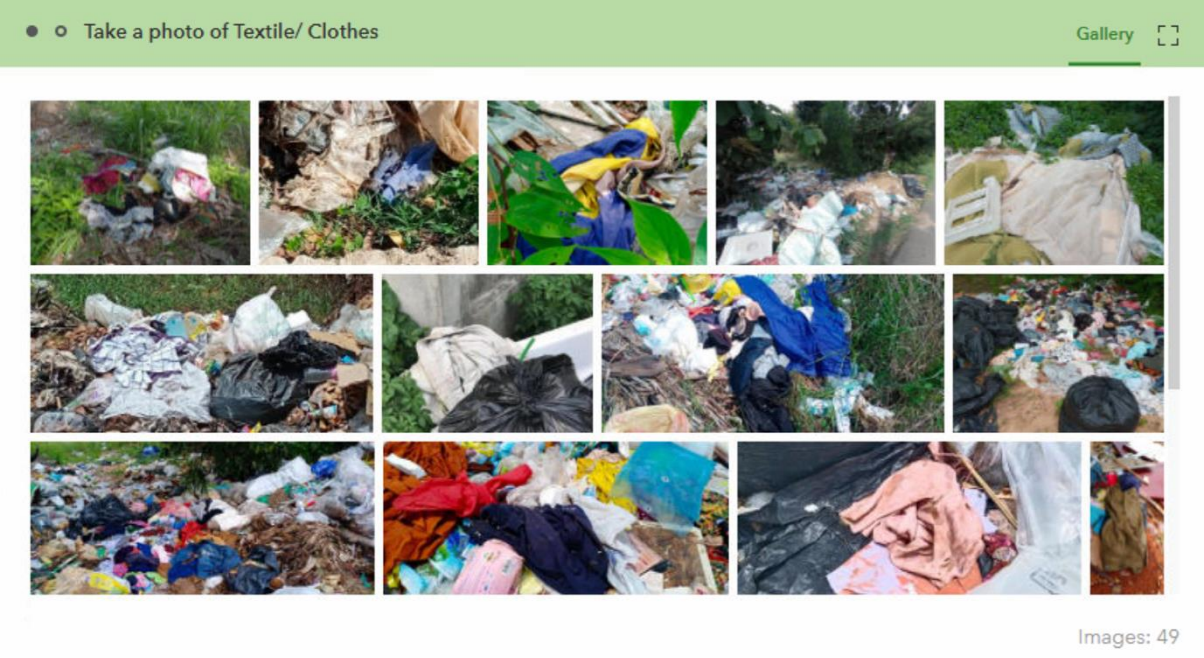


Figure 3.11. Sample of images of textile/clothes in the lower Mekong River collected in the survey.

Figure 3.12. Sample of images of other types of plastic in the lower Mekong River collected in the survey.

Figure 3.13. Sample of images of beverage bottle in the lower Mekong River collected in the survey.

Figure 3.14. Sample of images of cutleries in the lower Mekong River collected in the survey.

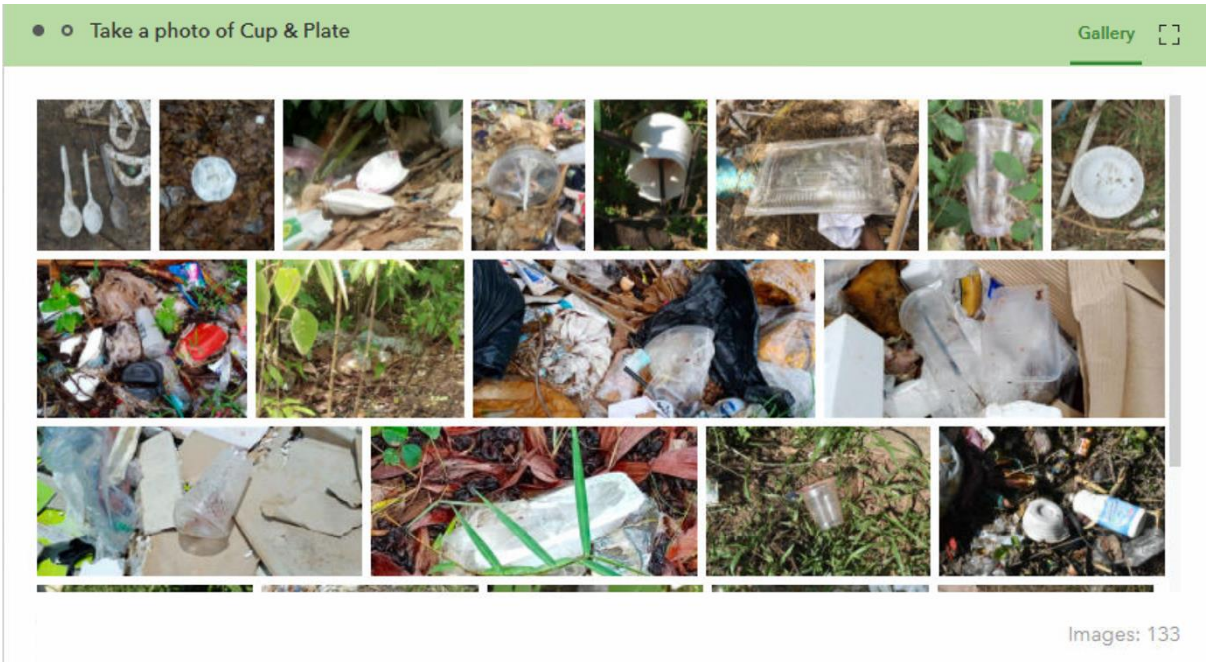


Figure 3.15. Sample of images of cup and plate in the lower Mekong River collected in the survey.

Figure 3.16. Sample of images of take out/away container in the lower Mekong River collected in the survey.

Figure 3.17. Sample of images of food wrapper and sachet in the lower Mekong River collected in the survey.

4. Data Collection Analysis Results

4.1. Chiang Rai

4.1.1. Introduction

Chiang Rai is the second-largest city in the northern region of Thailand. Covering both highland and lowland, the Regional Environment Office reported that waste generated from this province was 430,828.2 ton, with only 24.40% properly disposed of. Only 20.8 % of wastes are re-utilized, and 43.2 % of wastes are inappropriately managed. Considering the characteristic of the topology (high-slope areas), narrow roads, and limited disposal sites, the province's highland areas still face more difficulty in waste separation, transportation, and disposal.

4.1.2. Data collection

The field team from Chiang Rai started macroplastic data collection for the project from June 2 to December 21, 2021. The team collected 141 sampling points, made up of 17 artificial barrier and ports (accounted for 12.06% of total sampling points), 95 littering spots (67.38%), and 27 uncontrolled dumpsites (19.15%). Figure 4.1. displays the team's spatial distribution of collected data, along with detailed images of the plastic litter collected in the field from each location. Due to Covid-19 restrictions in the province, the field team conducted only one survey in one season. However, the analysis results told us a full figure in Chiang Rai about the dominant plastic waste there.

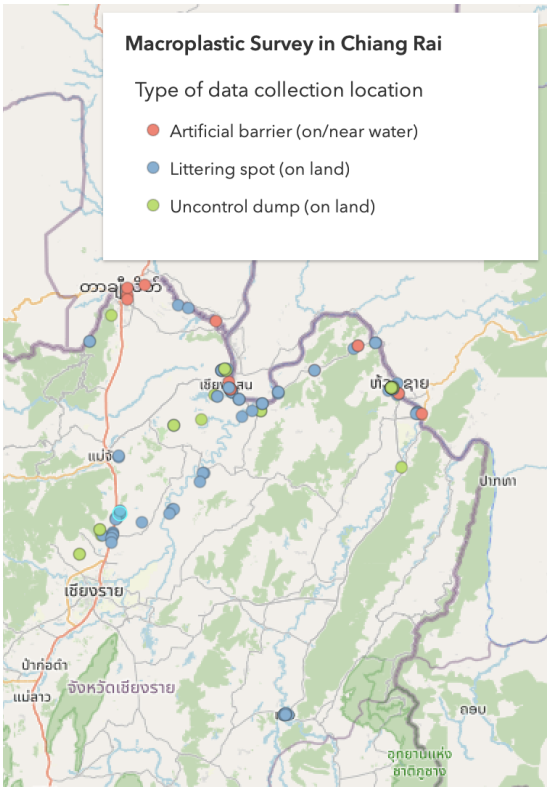


Figure 4.1. Macroplastic survey locations in Chiang Rai, Thailand.
[Source: https://arcg.is/1iH1Pz, accessed on February 10, 2022]

4.1.3 Results and Discussion

According to the survey results, the average volume of waste accumulation of 17 artificial barriers and ports was 711.28 L (estimated volume in a unit of 20L plastic bottle), the average volume of the waste accumulation of 95 littering spots was 5.96 m^3, and the average volume of the waste accumulation of 27 uncontrolled dumpsites were 5,430.56 m^3. In addition to the survey on artificial barriers and ports, the team found that only 12 sampling points (out of 27 sampling points) had cleaned the accumulated wastes once a year or a half-year. The local government did cleanup at nine sampling points while others did at three sampling points.

Regarding the dominant plastic waste, Figure 4.2. contains 13 types of plastic waste found at 141 sampling points in Chiang Rai. There were five dominant plastic wastes, including other types of plastic waste, other plastic bags and sheets, beverage bottles, grocery bags, and textile/clothes. The most abundant plastic waste type found at 72 sampling points, followed by other plastic bags and sheets (57 sampling points), beverage bottles (54 sampling points), grocery bags (30 sampling points), and textile/clothes (26 sampling points). In addition, other beverage bottles and take away/out containers also contributed to plastic waste in the city (21 and 13 sampling points, respectively).

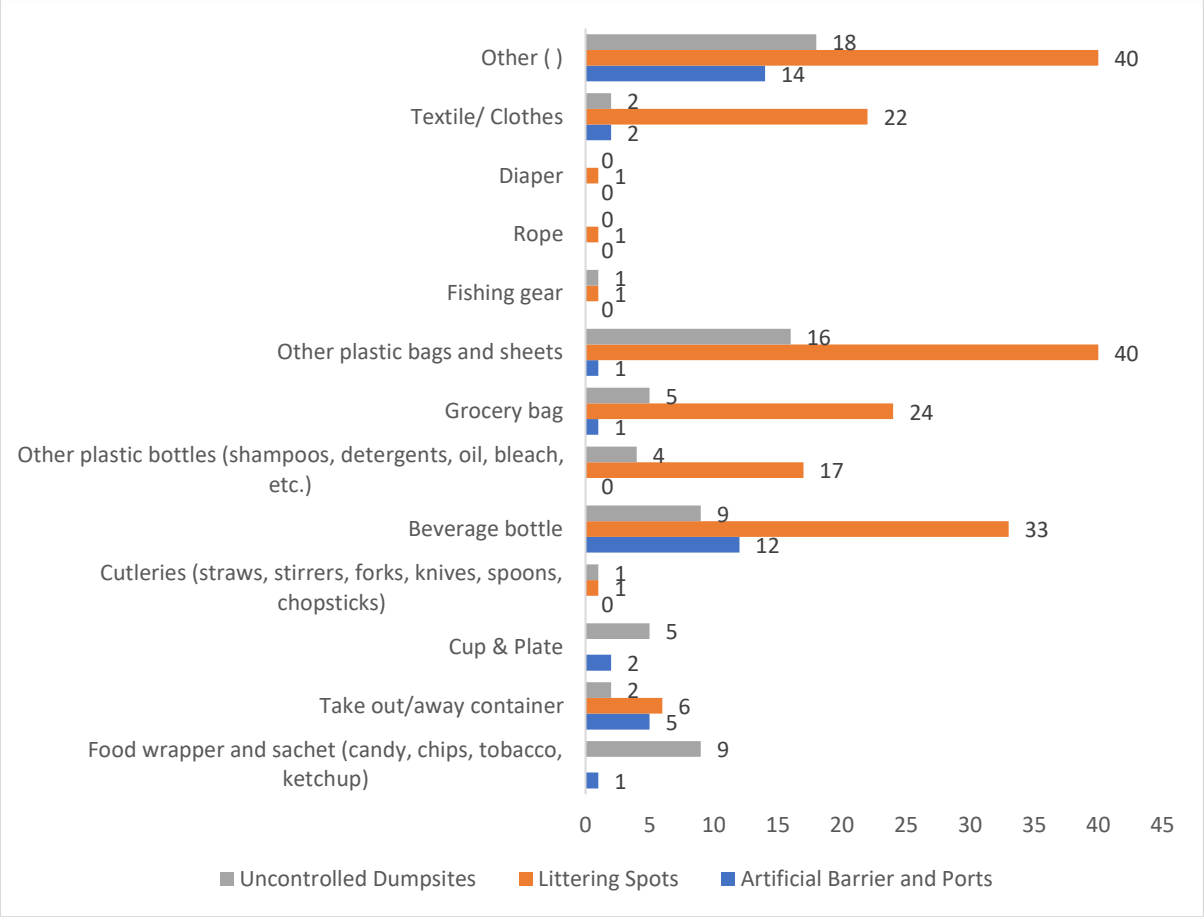


Figure 4.2. Dominant plastic waste found in Chiang Rai

In addition to three different sampling locations, plastic waste was highly found at littering spots at 141 sampling points, followed by uncontrolled dumpsite and artificial barriers and ports. There was interesting that other types of plastic and beverage bottles were dominant plastic waste at artificial barriers and ports. Considering the condition

Face masks were the most frequent COVID-19 related waste found during the survey at 24 sampling points, while gloves were found at one sampling point in the study area.

4.2. Vientiane

4.2.1. Introduction

Vientiane Capital City's per capita waste generation is 300.76 kg/year, while the total waste generation is 285.3 x 10^3 ton/year (948,477 peoples x 300.76 kg) or about 760 ton per day (VCOMS, 2021). The total population in Vientiane Capital is increasing by 1.41% to 1.58%from 2015 to recent year, but waste collection service in the service area is superficially estimated to cover around 400,000 of the population. Vientiane Capital is a middle-income city that generates about 0.824kg/person/year solid waste (VCOMS, 2021). The major factors affecting the amount of MSW are:

- Population.
- The standard of living.
- Social energy resource's structure.
- People's diet habits.

The coverage of the waste collection service in Vientiane Capital is slowly developed, including nine districts. Despite landfills in Vientiane, collection services are limited to accessible areas and profitable target groups such as markets and medium and high-income households. The average collection ratio from household to the collectiong companies accounted 31.32% (VCOMS, 2020) which formally collected and disposed of by stakeholders.. The reasons for not using the collection services are the lack of awareness about the impacts of wastes on their health and the environment; and that the collection fee is high for some low-income families. As such the majority of people still get rid of wastes in old fashion–by burning and dumping inappropriately (VCOMS, 2021). The collection coverage now is about 60%, and types of waste collected and disposed of are household, healthcare, nonhazardous industrial, and sludge from septic tanks (MPWT, 2015). The waste segregation at the source does not occur, and no separation bins are provided for households or on the street. The waste is segregated during the collection or after at the landfill site.

4.2.2. Data collection

As the survey results in two seasons, the team collected 412 sampling points, consisting 77 artificial barrier and ports (accounted for 18.69% of total sampling points), and 335 littering spots (81.31%). Figure 4.3. displays the team's spatial distribution of collected data, along with detailed images of the plastic litter collected in the field from each location.

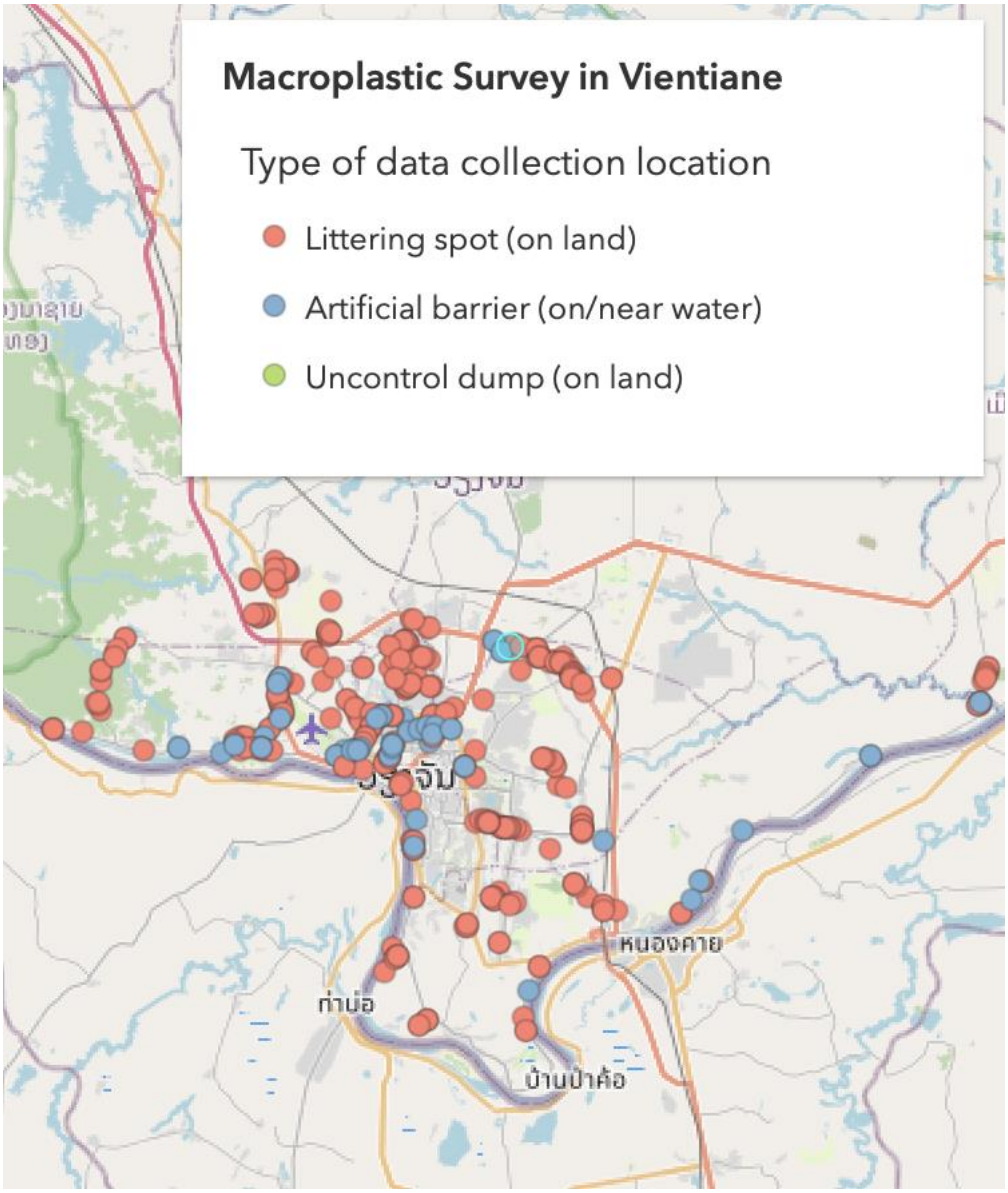


Figure 4.3. Macroplastic survey locations in Vientiane, Laos.
[Source: https://arcg.is/1iH1Pz, accessed on February 10, 2022]

4.2.3 Results and Discussion

Figure 4.4 contains 13 types of plastic waste found in Vientiane regarding the dominant plastic waste. There were five dominant plastic wastes, including grocery bags (found at 339 sampling points), other types of plastic waste (273 sampling points), beverage bottles (154 sampling points), other plastic bags and sheets (144 sampling points), and food wrapper and sachets (79 sampling points). In addition, diapers; cups and plates; and take away/out containers also contributed to plastic waste in the city (61, 51 and 49 sampling points, respectively).

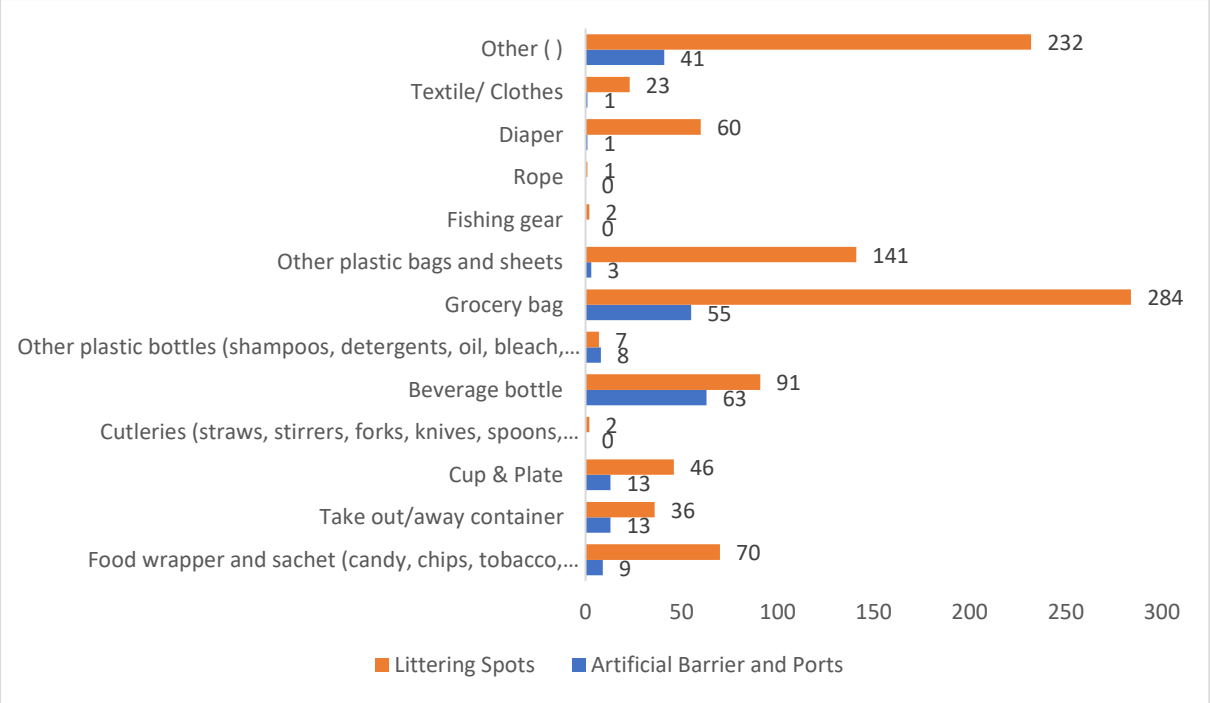


Figure 4.4. Dominant plastic waste found in Vientiane

According to the survey results, the average volume of waste accumulation of 17 artificial barriers and ports was 35.79 L (estimated volume in a unit of 20 L plastic bottle), and the average volume of the waste accumulation of 335 littering spots was 2.68 m^3. In addition to the survey on artificial barriers and ports, the team found that only 17 sampling points (out of 77 sampling points of artificial barriers) had cleaned the accumulated wastes once a year or a half-year. The villagers and local government did cleanup at 15 sampling points while others did at twosampling points.

Figure 4.5 presents that most of the dominant plastic wastes in Vientiane were reduced in the second survey (September to November 2021) at artificial barrier and ports. However, only beverage bottles and other plastic bottles were increased by 9 and 1 sampling points, respectively.

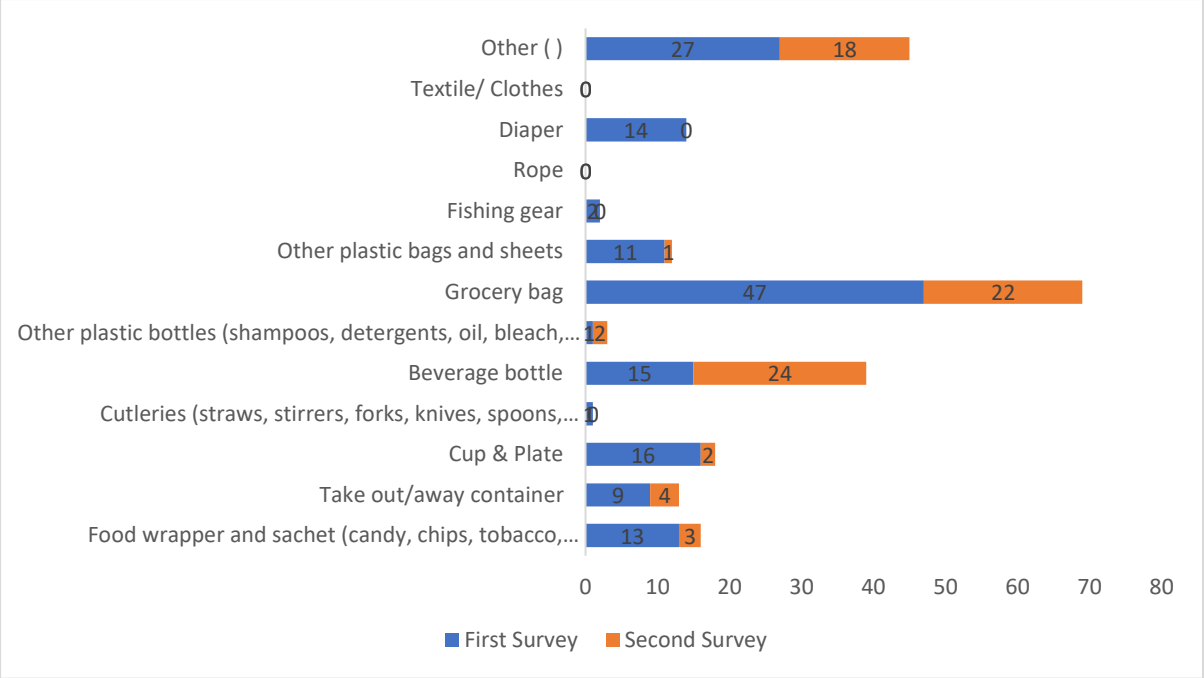


Figure 4.5. Comparison of dominant plastic waste of survey results between two seasons at artificial barriers and ports.

In contrast with analysis results at artificial barriers and ports, Figure 4.6 shows that almost dominant plastic waste was dramatically increased in the second survey at littering spots, especially grocery bags, other types of plastic waste, and other plastic bags and sheets.

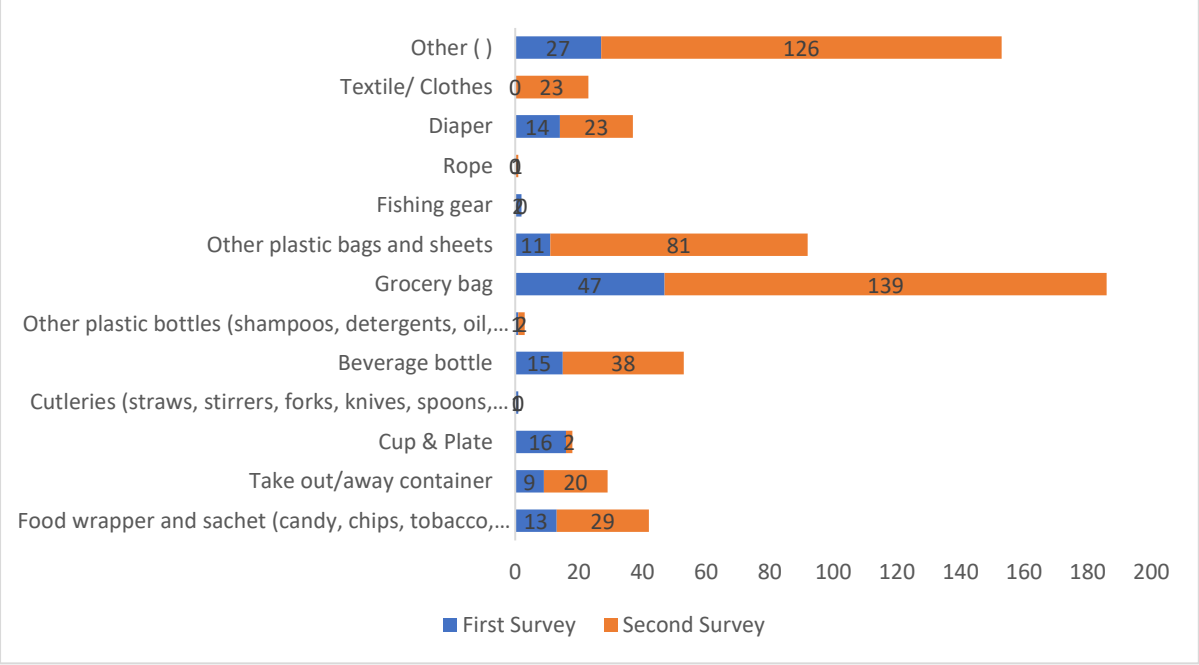


Figure 4.6. Comparison of dominant plastic waste of survey results between two seasons at littering spots.

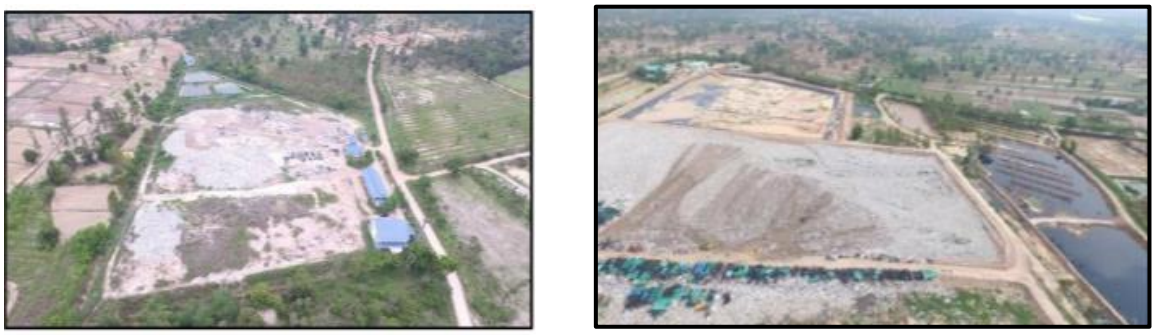
Face mask were the most frequently found type of COVID-19 related waste. Face masks were found at 170 sampling points, followed by hand gloves (2 sampling points).

4.3. Ubon Ratchathani

4.3.1. Introduction

The amount of solid waste generated in 2020 found that Ubon Ratchathani province generated 1,611.20 ton per day, with approximately 838.60 ton/day being reused and recycled (50.2%), properly disposed of about 366 ton/day (21.9%), uncontrol dump 406.60 ton/day (24.3%), with 60 ton/day of residual waste (3.6%). The proper waste disposal sites were 12 sites, divided into 2 sanitary landfills, 10 controlled dumps (<50 ton/day), 28 dumping sites (PCD, 2022).

In Ubon Ratchathani, two sanitary landfills are located in Warinchamrab and Phibun Mangsahan district. Both sanitary landfills are operated and served by the Local Administration Organization (Warinchamrap Town Municipality and Phibun Mangsaha Town Municipality).



(a) At Phibun Mangsahan district (b) At Warinchamrab district

Figure 4.7. Sanitary Landfill site in Ubon Ratchathani province

4.3.2. Data Collection

The study was conducted during both seasons. While the beginning and end of the dry season were between May to June 2021 and in September to October 2021 for wet season. As of October 24th, 2021, Ubon teams collected data at 117 sampling sites in total as shown in Table 1. It comprised 40 artificial barriers, 70 littering spots, and 7 uncontrolled dumps. The location of each site is shown in Figure 4. At the each site, our teams recorded the types and amount of plastic waste present and took digital images of the site using a smart device-based data collection application. An overview of the waste types discovered in the area order by most common found is in Table 4.1.

Table 4.1. Macroplastic survey results in the dry and wet season

Season	# Point	%
Dry season	103	88.03 %
Wet season	14	11.97 %
Total	117	100 %

The average volume of waste accumulation at 40 artificial barriers was 0.28 L (estimated volume in a unit of 20 L plastic bottle), the average volume of waste accumulation at 70 littering spots was 3.33 m^3, and the average volume of waste accumulation at 7 uncontrolled dumpsites was 2,645 m^3. For uncontrolled dumpsites, there is a big uncontrolled dump that the municipality use for disposal waste in Khong Chiam Sub-District at 15,000 m^3. This raises the total mean of all areas to 2,645 m^3. The photo of this uncontrolled dumpsite is shown in Figure 4.8.

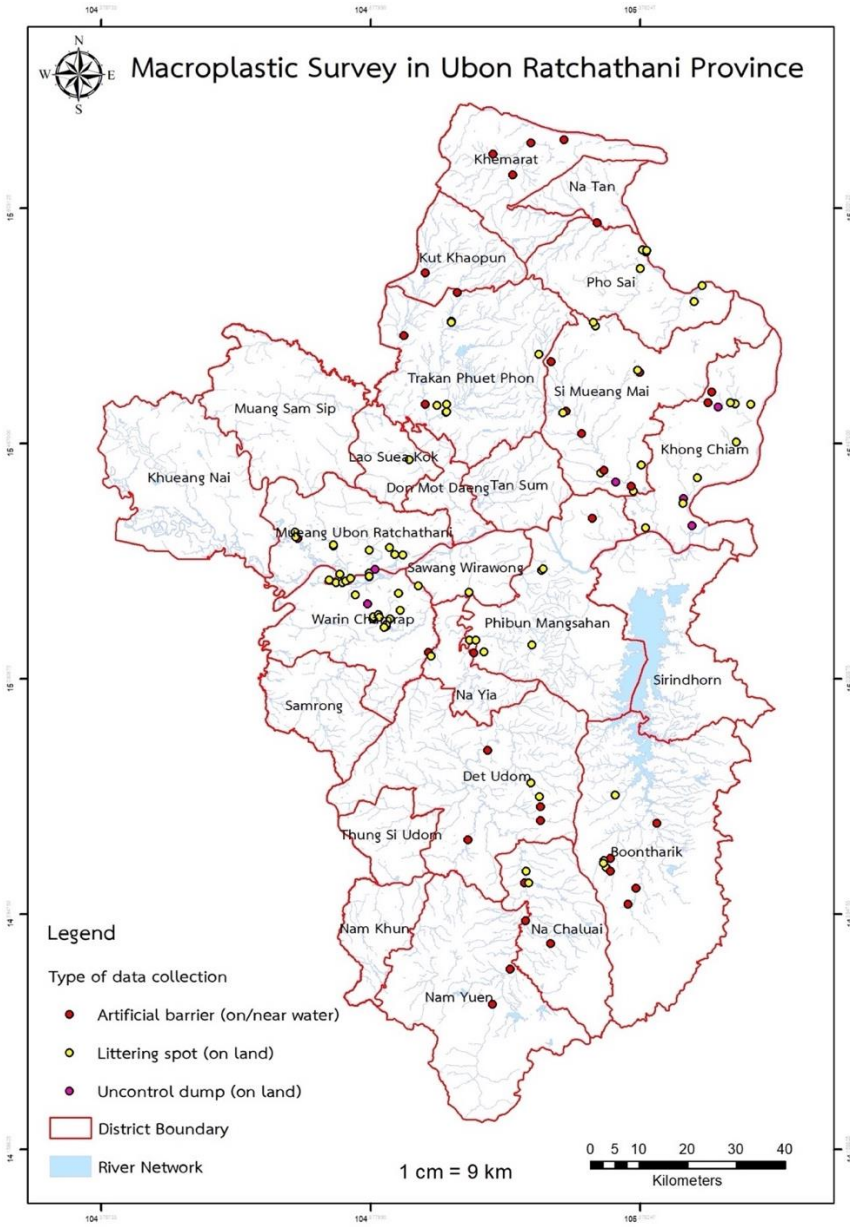


Figure 4.8. Location of macroplastic sampling sites

Table 4.2 represents the types of plastic waste accumulated at 117 sampling points in Ubon Ratchathani. The survey results show grocery bags, beverage bottles, and food wrapper and sachet as the three most dominant plastic waste type found. Grocery bags were most frequently found at sampling points (66 sampling points), followed by beverage bottles (54 sampling points), food wrappers and sachet (51 sampling points).

Face masks were the most frequently found type of COVID-19 related, occurring at 22 sampling points. Face masks were found at littering spots more than artificial barriers or uncontrolled dumpsites.

Table 4.2. Types of plastic waste in Ubon Ratchathani province, Thailand (Unit: # sampling points)

Type of plastic waste	Artificial barrier		Littering spot		Uncontrolled dump		Total	
	Points	%	Points	%	Points	%	Points	%
Grocery bag	17	25.8	44	66.7	5	7.6	66	18.8
Beverage bottle	32	59.3	22	40.7	-	0.0	54	15.3
Food wrapper and sachet (candy, chips, tobacco, ketchup)	22	43.1	27	52.9	2	3.9	51	14.5
Other plastic bags and sheets	12	24.5	35	71.4	2	4.1	49	13.9
Textile/ Clothes	3	15.0	16	80.0	1	5.0	20	5.7
Other plastic bottles (shampoos, detergents, oil, bleach, etc.)	7	46.7	8	53.3	-	0.0	15	4.3
Take out/away container	1	9.1	8	72.7	2	18.2	11	3.1
Cup & Plate	3	30.0	7	70.0	-	0.0	10	2.8
Diaper	-	0.0	7	87.5	1	12.5	8	2.3
Cutleries (straws, stirrers, forks, knives, spoons, chopsticks)	2	100.0	-	0.0	-	0.0	2	0.6
Fishing gear	1	100.0	-	0.0	-	0.0	1	0.3
Other (Milk box, plastic sheet)	15	34.9	25	58.1	3	7.0	43	12.2
COVID-19 waste (Face mask)	5	22.7	16	72.7	1	4.5	22	6.3
Total							**352**	**100**

4.3.3. Results and Discussion

Collection, 117 sampling points were surveyed in the Ubon Ratchathani province. Three types of sampling points were visited, including (1) artificial barriers; (2) littering spots; and (3) uncontrolled dump sites. Results of the survey indicate that littering spots contained the most litter out of the three location types. Data found in Table 4.3 give a breakdown of the plastic waste found at the 117 sampling points. There were 70 sampling points at littering spots (59.8% of the total sampling points), 40 sampling points at artificial barriers (34.2% of the total sampling points), and 7 sampling points uncontrolled dump (6.0% of the total sampling points).

Table 4.3. Macroplastic survey result

City/Area	Type of macroplastic survey method							
	Artificial barriers		**Littering spots**		**Uncontrolled dump**		**Total**	
	Points	%	Points	%	Points	%	Points	%
Ubon Ratchathani	40	34.2	70	59.8	7	6.0	117	100

Survey results show that the top three dominant plastic waste types found at artificial barriers were beverage bottles (32 sampling points), food wrapper and sachet (22 sampling points) and grocery bags (17 sampling points). Regarding Covid-19 related waste, survey results showed that face masks were found in 5 sampling points, accounting for 12.5% of the total sampling points at artificial barriers. The reason why these types of plastic were found was probably due to activity on land. Because most weirs have a beautiful view, it becomes a place where most people often come to relax and do fishing activity. Thus, causing the plastic waste from the activities of eating and drinking in that area.

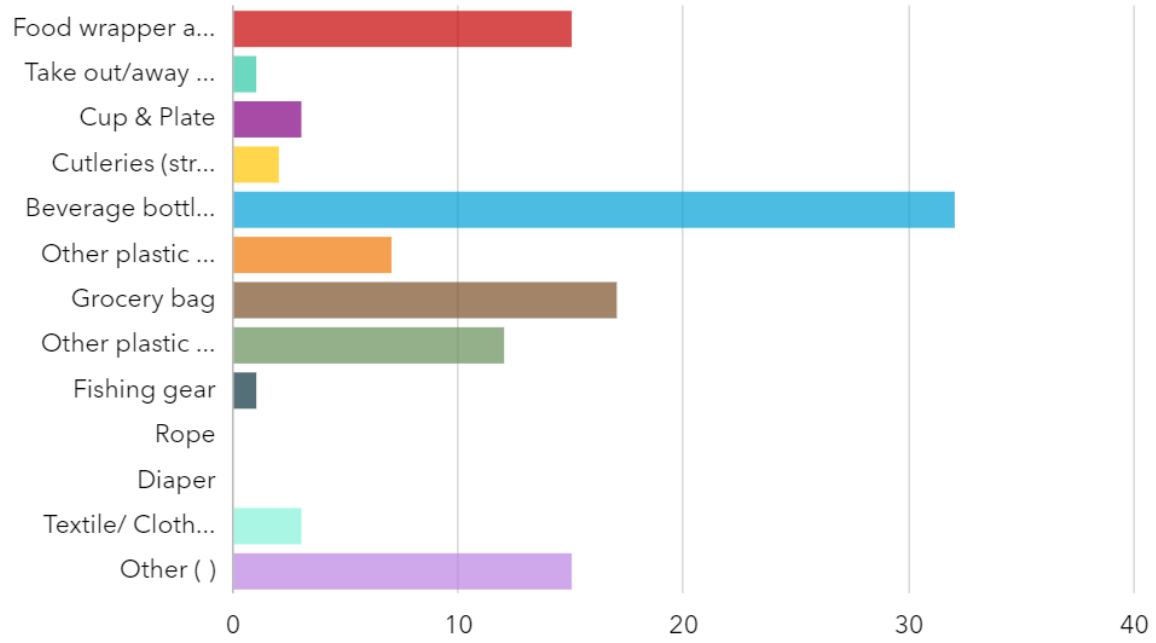


Figure 4.9. Type of plastic waste which found at artificial barriers

Table 4.4 shows cleaned up at artificial barriers in 7 sampling points of the total 40 sampling points (accounted for 17.5% of the total sampling points). In addition to the cleanup activities at artificial barriers, the stakeholders/organizations responsible for cleanup were identified, including local governments, other. Local governments conducted the cleanup waste on 6 sampling points (or accounted for 15% of the total sampling points which were done by cleanup). Most of the waste at artificial barriers did not get clean up in Ubon Ratchathani due to the low amount of residual waste. Besides, most of the garbage in the rainy season will float with the stream to the downstream, thus there is less residual waste at the artificial barriers.

Table 4.4. Waste cleaning responsibility and frequency of cleaning at artificial barriers

Waste cleaning responsibility (stakeholders)	**Points**	**Percentage**	**Frequency of cleaning**	**Points**	**Percentage**
Local governments	6	15.0%	Once a month	0	-
Village	-	-	Once a half-year	0	-
Port authority	-	-	Once a year	1	2.5%
NGOs	-	-	No clean-up	1	2.5%

Waste cleaning responsibility (stakeholders)	Points	Percentage	Frequency of cleaning	Points	Percentage
Other	1	2.0%	Unknow	38	95.0%
No one clean-up	33	82.5%	-	-	-
Total	**40**		**Total**	**40**	

Furthermore, in table 4.4 the frequency of cleanup activities is divided into six-time frequencies: once a month, once a half-year, once a year, no cleanup, unknown, and not specified. As a result of the macroplastic survey, there were 38 sampling points in which an unknown cleaning frequency (95.0%); one sampling points had once a year frequency (2.5%); and one sampling point in which no cleanup activities previously occurred (2.5 %). The reason for this is because the amount of waste left at the weir is not large. From asking villagers who live nearby, we received an answer that most of the garbage that got stuck at the weirs were aquatic plants, which when water flows, it will carry over the weir along the stream. So, it's not need to be cleaned. If there is a cleaning activity, it will be infrequently, not determining when to do it. Most of the weirs that were surveyed did not find a caretaker because most of the weirs were built by the irrigation authorities for villagers and then handed over to the local municipalities in the area to take care of them. In Table 6, it shows the estimate the total volume of accumulated waste by length, width and height of littering spot and uncontrol dump (Unit=meter)

Table 4.5. Estimate the total volume of accumulated waste by length, width and height of littering spot and uncontrol dump (Unit=meter)

Location:	Littering spot			Uncontrol dump		
	Length (m.)	Width (m.)	Height (m.)	Length (m.)	Width (m.)	Height (m.)
Min.	0.2	0.1	0.1	10	3	0.8
Max.	8	6	1.5	100	50	3
Avg.	2.22	1.46	0.36	28.57	18.93	1.58

The dominant types of plastic waste found at littering spots (Figure 4.10) included grocery bags, plastic sheet, beverage bottles, cloth, diapers, food wrappers, other, take out away containers and cups plates. Face masks were found in 16/70 sampling points,

accounting for 22.9% of total littering spot sampling points. Grocery bags were found the most because people would put their trash in these bags and throw them away in the littering spot. Most of them came from grocery stores or fresh market. Normally they are often thin, easily contaminated, so people do not clean them for reuse. Therefore, most people tend to dispose of them more easily than other types of plastic. The area in Ubon Ratchathani, where there is no solid waste collection service, it is found that there are quite a lot of waste masks being discarded at various points. Currently, the relevant agencies are looking for a solution to this problem. Most of the face masks were probably from people who weren't infected. However, it should be collected for proper disposal.

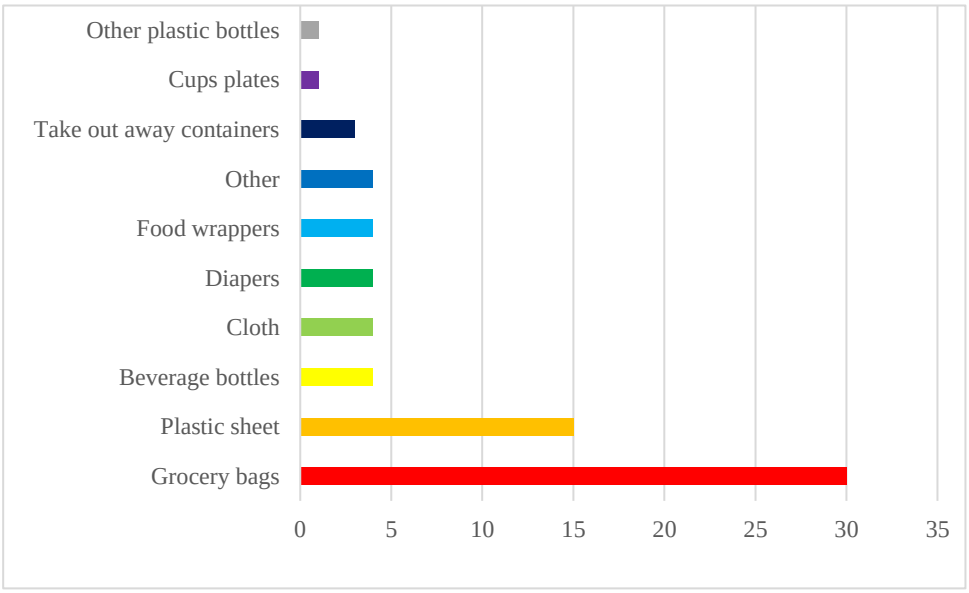


Figure 4.10. Type of plastic waste found on littering spots

The results also found that the dominant types of plastic waste at the uncontrolled dump sites (Figure 4.10) were grocery bags, plastic sheet and food wrapper. Covid-19 related waste was found at 1 sampling points of uncontrolled dumpsites (7 sampling points). These group of wastes are not commonly sorted for recycling. Therefore, there is no incentive to segregate at source. Most villagers use the grocery bags to collect all the trash and dispose of them in uncontrolled dump area.

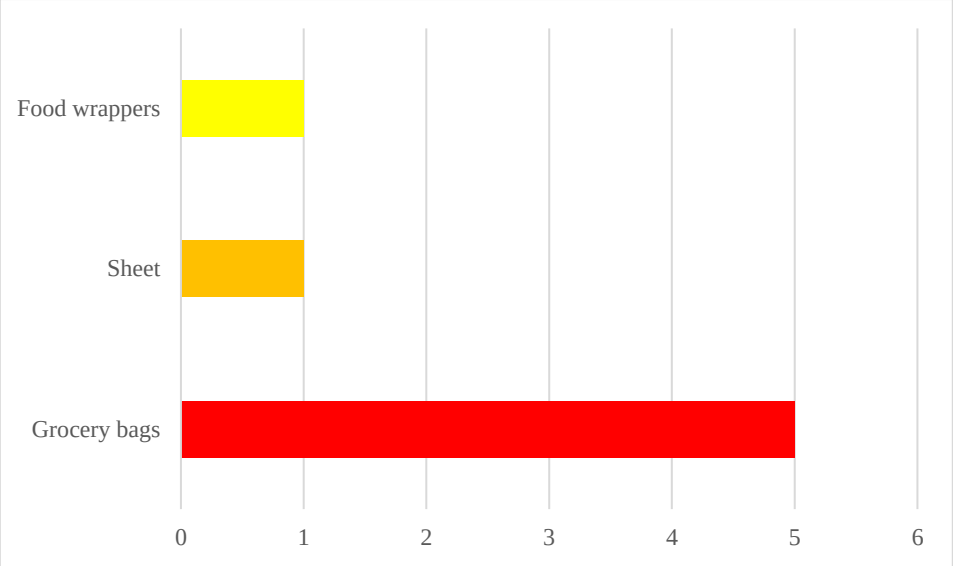


Figure 4.11. Type of plastic waste found on uncontrolled dump

4.4 Phnom Penh

4.4.1 Introduction

Cambodia produced approximately 4,090 thousand ton of solid waste in 2015, and the management service collected only about 64.76%. Phnom Penh is the capital of Cambodia, with a total population of more than 2.1 million people. The population density is 3,136 persons/km^2 over 679 km^2 (Ministry of Planning, 2019). A large quantity of plastic is used throughout the nation as part of daily consumption. As estimated in 2015, the capital needed approximately 10 million pieces of plastic bags (Fondazione ACRA, 2015), and two-thirds of 143 thousand ton of the total disposed plastic were plastic shopping bags (Seng et al., 2018). Plastic waste was found about 18% of the household waste in the city, and plastic bags remained a significant item for daily use as they shared more than half of the total plastic residues (Seng, 2019). This high demand leads to a problem of plastic waste management while public concerns are raised.

4.4.2 Data Collection

Phnom Penh is the study location of the CounterMEASURE Project-Phase I implemented by the United Nations Environment Programme (UNEP) in 2020. Using the mobile application, up to 227 sampling points of artificial barriers and littering spots were observed during the microplastic survey. In 2021, this city has also become the CounterMEASURE Project-Phase II study location. As of the survey results, 395 sampling points are surveyed from July to November 2021. The expected outcomes of this project will be crucial inputs to tackle plastic leakage in the city.

Before starting the data collection in the city, the mobile app training is conducted for surveyors who will visit the field to collect the macroplastic waste. The below table shows more details about the plan of the data collection.

Table 4.6. Macroplastic Survey Schedule

No.	Activities	Date	Number of Survey Points
1	Training to enumerators on data collection	30-June-21	-
2	Testing of mobile application	1-July-21	5
3	Discussion with enumerators about testing results	2-July-21	-
4	Macro-plastic survey in rainy season and observation of waste management at ports/piers	3-July-21	98
		4-July-21	12
		13-July-21	21
		14-July-21	30
		15-July-21	38
		16-July-21	28
		17-July-21	37
		22-July-21	38
5	Macro-plastic survey in dry season and observation of waste management at ports/piers	13-Nov-21	18
		14-Nov-21	35
		18-Nov-21	13
		19-Nov-21	21
Total Number of Surveyed Points			**395**

The field team conducted the microplastic survey in two phases: 1) in the rainy season in July 2021 and 2) in the dry season in November 2021. The team could not survey between March to June 2021 due to the unfortunate situation of the Covid-19 Pandemic. Spatial distribution of the survey locations shown in the Figure 4.12.

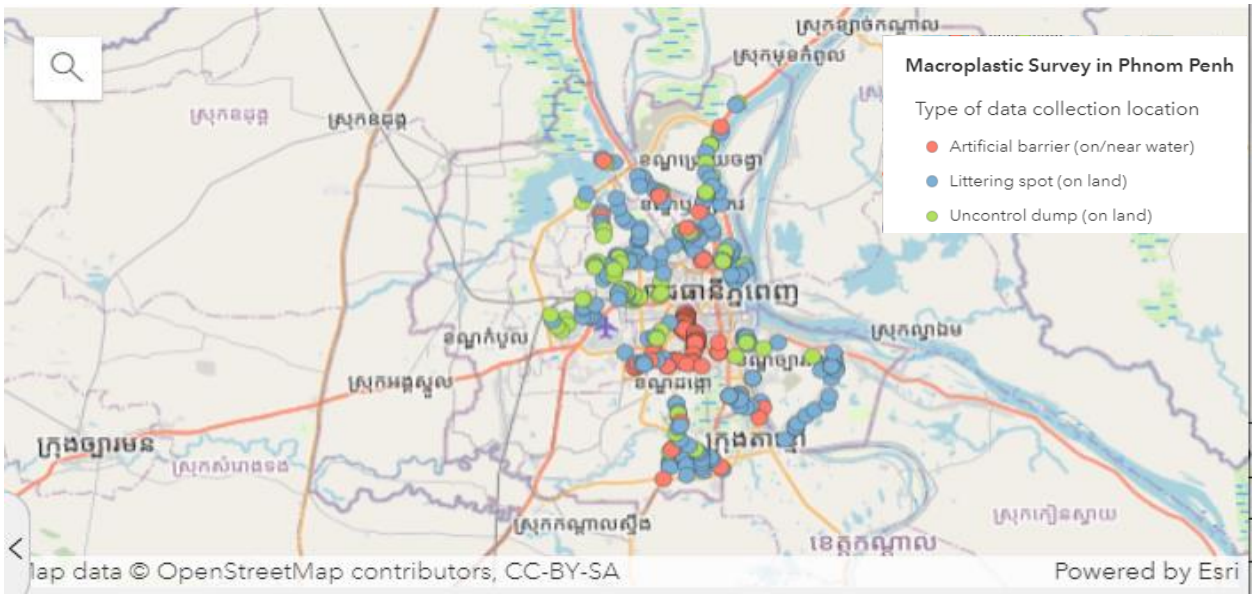


Figure 4.12. Location of Macroplastic Survey in Phnom Penh

4.4.3 Results and Discussion

Solid Waste Management in Phnom Penh

Phnom Penh has 14 administrative districts (Khans) and 105 communes (Sangkats). In 2021, approximately 2,744 ton of municipal solid waste could be collected per day, with coverage of over 105 communes (MoE, 2021). The generation rate in this capital is estimated at 0.8 kg/capita/day (RGC, 2021). Before July 1st, 2021, CINTRI (Cambodia) LTD operated the waste collection service. Later on, the Phnom Penh City Administration has divided the city into three zones and contracted three different companies to run the municipal waste collection service (Phnom Penh City Administration, 2021).

- 800 Super/Global Action for Environment Awareness Public Limited: cover the waste collection in 5 districts, including Toul Kork, Russey Keo, Sen Sok, Chrouy Changvar, and Praek Phnov.
- Mizuda Group Co., Ltd.: to cover the waste collection in 5 districts including Daun Penh, 7 Makara, Dangkor, Puthisenchey, and Kamboul.
- CINTRI (Cambodia)/Everbright (China): cover the collection in 4 districts, including Chamkarmorn, Boeng Keng Kang, Mean Chey, and Chbar Ompov.

Table 4.7. Waste collection company, waste amount, and collection coverage in Phnom Penh in 2021 (Source: MoE, 2021)

District (Khan)	No. of Commune (Sangkhat)	Waste Collection Company	Waste Amount (ton/day)	No. of Commune with Collection
Boeng Keng Kang	7	CINTRI (Cambodia)/ Everbright (China)	130	7
Chamkamorn	5		180	5
Chbar Ampov	8		335	8
Mean Chey	7		308	7
7 Makara	8	Mizuda Group	105	8
Dangkor	12		167	12
Daun Penh	11		186	11
Kamboul	7		75	7
Puthisenchey	7		428	7
Chrouy Chongvar	5	800 SUPER/ GAEA	21	5
Praek Phnov	5		166	5
Russey Keo	7		161	7
Sen Sok	6		240	6
Tuol Kouk	10		242	10
Total	**105**		**2,744**	**105**

The city has a plastic recycling depot that recycles plastic bags, plastic sacks, and Styrofoam into a plastic pellet. Another place is Gomi Recycling 1001, which collects waste in the Phnom Penh Special Economic Zone (Zone) and sells recyclables to junk buyers.

Table 4.8. Waste recycling companies in Phnom Penh

No.	Name	Recycling Business	Location	
			Latitude	Longitude

1	Plastic recycling depot	Recycle plastic bag, sack and Styrofoam into plastic pellet	11.456869	104.893058
2	Gomi Recycling 1001	Collect waste in the Phnom Penh SEZ and sell the recyclables to junk buyers	Phnom Penh Special Economic Zone (SEZ)	

Results of macroplastic survey

The team had conducted a macroplastic survey in both the rainy and dry seasons in Cambodia. 395 sampling points were observed to estimate the volume of waste and identify the types of plastic disposed of at each observation point. There were the points of artificial barriers (131 sampling points), littering spots (192 sampling points), and uncontrol dump (72 sampling points), whose results are presented below.

Artificial Barriers

The team surveyed 131 points along the city's sewage systems and open streams. The estimated volume of waste at the observed locations was 386,775 liter or 386.775 m^3. Waste was accumulated due to illegal dumping and poor management, especially in poor communities lacking management service. Various sites were also usually cleaned up by the government and local authorities.

Table 4.9. Summary results of artificial barriers observation

No.	Statistics	Volume
1	Est. minimum (L)	40
2	Est. maximum (L)	37,500
3	Est. average (L)	2,952
4	Est. sum (L)	386,775
5	Est. sum (m^3)	386.775

Table 4.10. Who clean up the artificial barrier

No.	Who clean up	Frequency	Percentage
1	No one clean-up	76	19.24

No.	Who clean up	Frequency	Percentage
2	Local government	52	13.16
3	Village	1	0.25
4	Other	2	0.51

It could be said that plastic waste was accumulated at the observed artificial barriers. There are 50.55% of other plastic bags and sheets, 24.43% of other plastic bottles (shampoos, detergents, oil, bleach, etc.), 11% of take out/away containers, 9.08% of cup and plates, 2.84% of beverage bottle, 0.58% of food wrapper and sachet, 0.58% of textile and clothes, and others. Besides these plastic waste, there were also medical masks. Though, it should be noticed that the team could not conduct waste segregation to analyze the physical components. The team estimated from what could be seen and information received from the interviewed people near the locations.

Table 4.11. Types of plastic found at artificial barriers

No.	Types of Plastic in Artificial Barriers	Percentage
1	Other plastic bags and sheets	50.55
2	Other plastic bottles (shampoos, detergents, oil, bleach, etc.)	24.43
3	Take out/away container	11.35
4	Cup & Plate	9.08
5	Beverage bottle	2.84
6	Food wrapper and sachet (candy, chips, tobacco, ketchup)	0.58
7	Textile/ Clothes	0.58
8	Others	0.58

Littering spot

Littering was a big issue in Phnom Penh, especially in July 2021 when the city changed the waste collection company. Waste was scattered along the roads as the new contracted operators were unprepared to run the services. This became the leading cause of many littering spots in July 2021. Though, the situation was much better after a

couple of months of operation. In total, it was estimated that the total volume of the littered waste could be up to 659.849 m^3.

From observation, the team could see that other plastic bags and sheets were the major plastic waste components up to 37.50% followed by 23.64% of take out/away containers, 20.45% of cups and plates, 5.68% of food wrappers and sachets, 3.86% of other plastic bottles, 2.50% of textiles and clothes, etc. It should be noticed that the survey was conducted during the Covid-19 pandemic so that the take out and away containers was the second largest plastic components as people usually had the cdelivered and takeaway food instead of eating at the restaurants due to the resctriction. Subsequently, medical masks were also found as the highest material generated.

Table 4.12. Types of waste found at survey littering spots

No.	Plastic Items	Count	Percentage
1	Other plastic bags and sheets	165	37.50
2	Take out/away container	104	23.64
3	Cup & Plate	90	20.45
4	Food wrapper and sachet (candy, chips, tobacco, ketchup)	25	5.68
5	Beverage bottle	17	3.86
6	Other plastic bottles (shampoos, detergents, oil, bleach, etc.)	14	3.18
7	Textile/Clothes	11	2.50
8	Diaper	3	0.68
9	Rope	2	0.45
10	Grocery bag	1	0.23
11	Others	8	1.82
Total		**440**	**100**

Estimated total amount of accumulated wastes in uncontrol dump

During the transition of the waste collection operators in the city, uncontrolled dumps of waste was also found. The team surveyed the total of 72 uncontrolled dumped which was totaled up to 4,291.31 m^3 in volume. The number of uncontrolled dump was less

than the number of littering spots, the estimated volume of the uncontrolled dumps was larger as it had a large pile of waste.

From observation, we found that there were about 31.88% of other plastic bags and sheets, 29.38% of take out and away containers, 24.38% of cups and plates, 3.75% of other plastic bottles (shampoos, detergents, oil, bleach, etc.), 2.40% of textiles and clothes, 1.87% of food wrappers and sachets, 1.87% of beverage bottles, 1.25% of ropes, and 1.25% of diapers, and 1.87% of others. We could also saw some medical masks were mixed in the waste piles as well. Same to previous section, the take out and away containers was the second largest plastic component. This type of plastic waste seemed remarkably increase as people tended to stay home during the Covid-19 Pandemic and had delivered meals rather than having meals at restaurants.

Table 4.13. Types of plastic found at surveyed uncontrol dump

No.	Plastic Items	Count	Percentage
1	Other plastic bags and sheets	51	31.88
2	Take out/away container	47	29.38
3	Cup & Plate	39	24.38
4	Other plastic bottles (shampoos, detergents, oil, bleach, etc.)	6	3.75
5	Textile/ Clothes	4	2.40
6	Food wrapper and sachet (candy, chips, tobacco, ketchup)	3	1.87
7	Beverage bottle	3	1.87
8	Rope	2	1.25
9	Diaper	2	1.25
10	Others	3	1.87
Total		**160**	**100**

In sum, the total estimated volume of waste found by microplastic survey was up to 5,337.934 m^3.

Table 4.14. Summary results of microplastic survey in Phnom Penh in 2021

No.	Surveyed Points	Number of Surveyed Points	Est. volume (m^3)
1	Waste at artificial barrier	131	386.775
2	Waste at littering Spot	192	659.849
3	Waste at uncontrolled Dump	72	4,291.310
Total		**395**	**5,337.934**

Waste Accumulation at Ports/Piers

The team also conducted the observation at 11 ports/piers in Phnom Penh to understand plastic waste accumulation and management. The observation was carried out 3 times during microplastic survey and microplastic sampling. The observed locations and observation results are shown in below figure and table. The types of plastic waste found in each location were not different from one another. In usually, there are plastic bag, straw, PET bottle, plastic cup, straw, food containers, and food sachets. To be noticed, 4 of the observed ports did not use the waste collection service yet usually burn their waste. These 4 ports are small in size and operated as a family business. Besides, plastic waste was also found in the rivers as a result of illegal dumping on the bank on the sites and from the upstream. Though, none of the observed sites collected the accumulated plastic from the river. It is usually washed away by the seasonal flow of the Mekong River.

Challenges of plastic waste management at the observed Ports/Piers are:

- Limited knowledge of staffs/workers at the sites,
- Limited knowledge of passengers,
- Road access to the port,
- Unwilling to pay for the collection service,
- Lack of law enforcement.

Therefore, there should be following actions to tackle the challenges:

- Provide capacity building to the staffs/workers about waste management approach,
- Raise the awareness of the passengers,
- Develop waste collection system where collection is not available,
- Control waste littering of the passengers,
- Enforce the solid waste management.

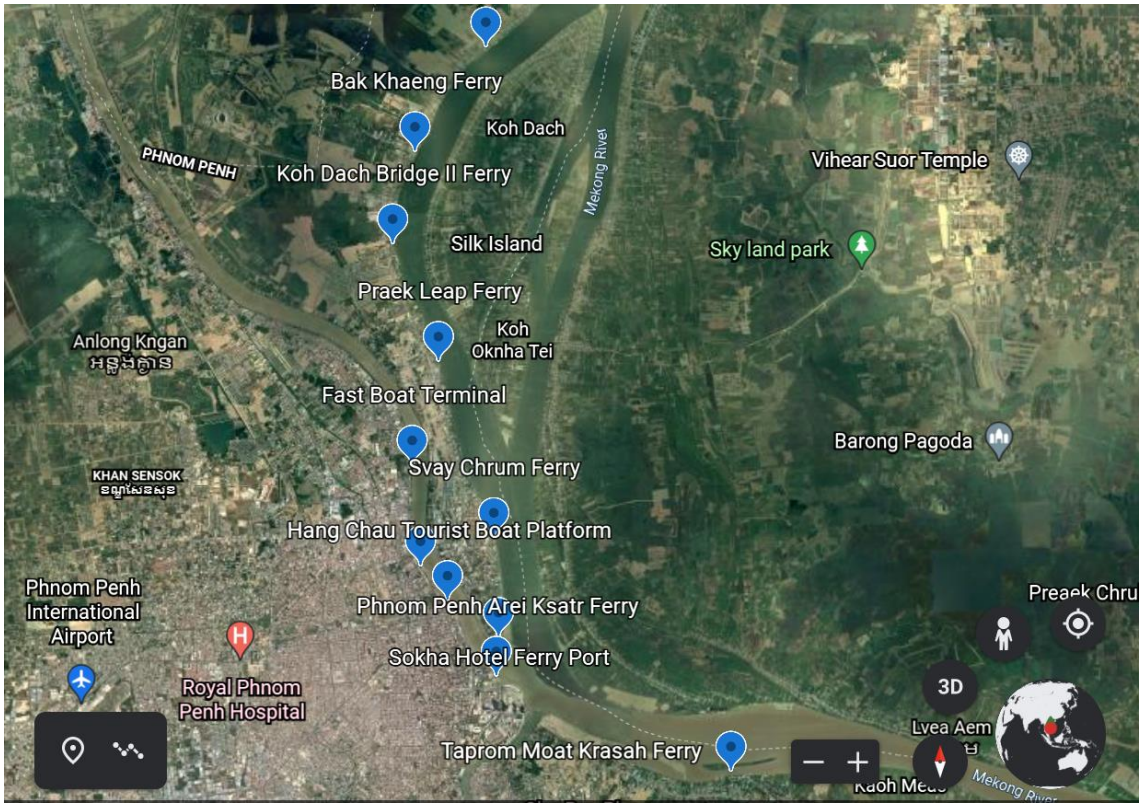


Figure 4.13. Location of Waste Observation at Ports/Piers

Table 4.15. Results of observation at ports/piers

No.	Ports/Piers	Waste Generation		Estimated Plastic Accumulation (kg)			
		Est. Amount (kg/day)	Mag't Situation	On 4-5 Sept	On 18-19 Sept	On 20-21 Nov	Mag't Situation
1	Phnom Penh Autonomous Port	None *	-	None	None	None	-
2	Hang Chau Tourist Boat platform	None *	-	1.5	1.5	None	Uncollected
3	Phnom Penh Areiy Ksatr Ferry	30	Collected	0.5	0.5	0.2	Uncollected
4	Svay Chrom Ferry	15	Collected	0.5	0.5	0.5	Uncollected
5	Fast Boat Terminal	None *	-	None	None	None	-
6	Preak Leap Ferry	15	Collected	None	0.2	0.2	Uncollected
7	Koh Dach Bridge II Ferry	10	Burnt	None	None	None	-
8	Bak Khaeng Ferry	5	Burnt	0.5	0.5	None	Uncollected
9	Kdei Chas Ferry	10	Burnt	None	None	None	-

No.	Ports/Piers	Waste Generation		Estimated Plastic Accumulation (kg)			
		Est. Amount (kg/day)	Mag't Situation	On 4-5 Sept	On 18-19 Sept	On 20-21 Nov	Mag't Situation
10	Taprom Moat Krasah Ferry	10	Burnt	2	2	1	Uncollected
11	Sokha Hotel Ferry Port	2	Collected	1	1	0.5	Uncollected

Note: * The ports were temporarily closed due to the widespread Covid-19 Pandemic.

4.5 Tonle Sap

4.5.1. Introduction

Tonle Sap is one of the great lake and water reservoir in Cambodia. Located in the Northwestern from Phnom Penh Capital, Tonle Sap water flows to the tributaries Srêng and Sên rivers, which also flowing to Bassac River and connecting to Mekong River in Phnom Penh area. Town's tributaries located in Kâmpóng Thum (Kompong Thom). Commonly in floating population in the floating village, Tonle Sap acquired with the floating waste generated in its tributaries.

4.5.2. Data collection

As the survey results in two seasons, the team collected 295 sampling points, made up of 151 artificial barrier and ports (accounted for 51.19% of total sampling points), 143 littering spots (48.47%), and 1 uncontrolled dumpsite (0.34%). Figure 4.14 displays the team's spatial distribution of collected data, along with detailed images of the plastic litter collected in the field from each location.

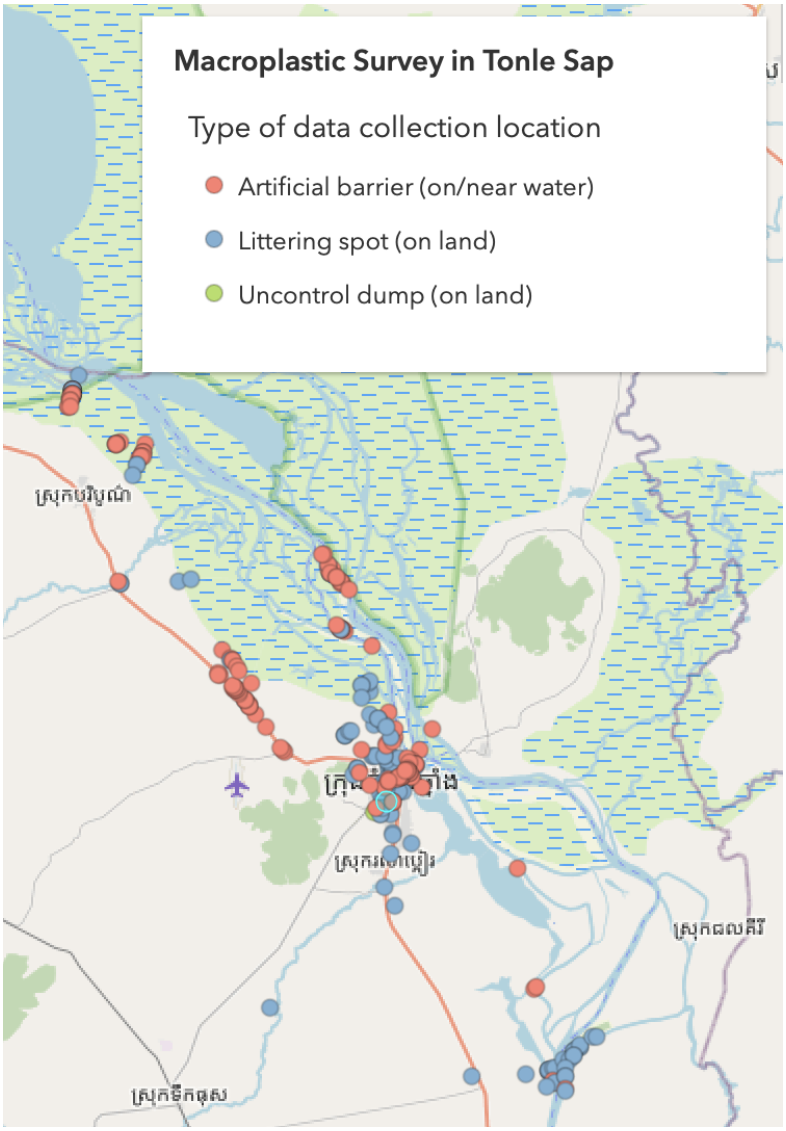


Figure 4.14. Macroplastic survey locations in Tonle Sap, Cambodia. [Source: https://arcg.is/1iH1Pz, accessed on February 10, 2022]

4.5.3 Results and Discussion

Regarding the dominant plastic waste, Figure 4.15 contains 13 types of plastic waste found in Tonle Sap. There were three dominant plastic wastes, including other plastic bags and sheets (found at 158 sampling points), followed by other plastic bottles (found at 94 sampling points), and take out/away containers (83 sampling points). In addition, food wrapper and sachet, cup and plate, and diaper also contributed to plastic waste in the city (46, 40 and 38 sampling points, respectively).

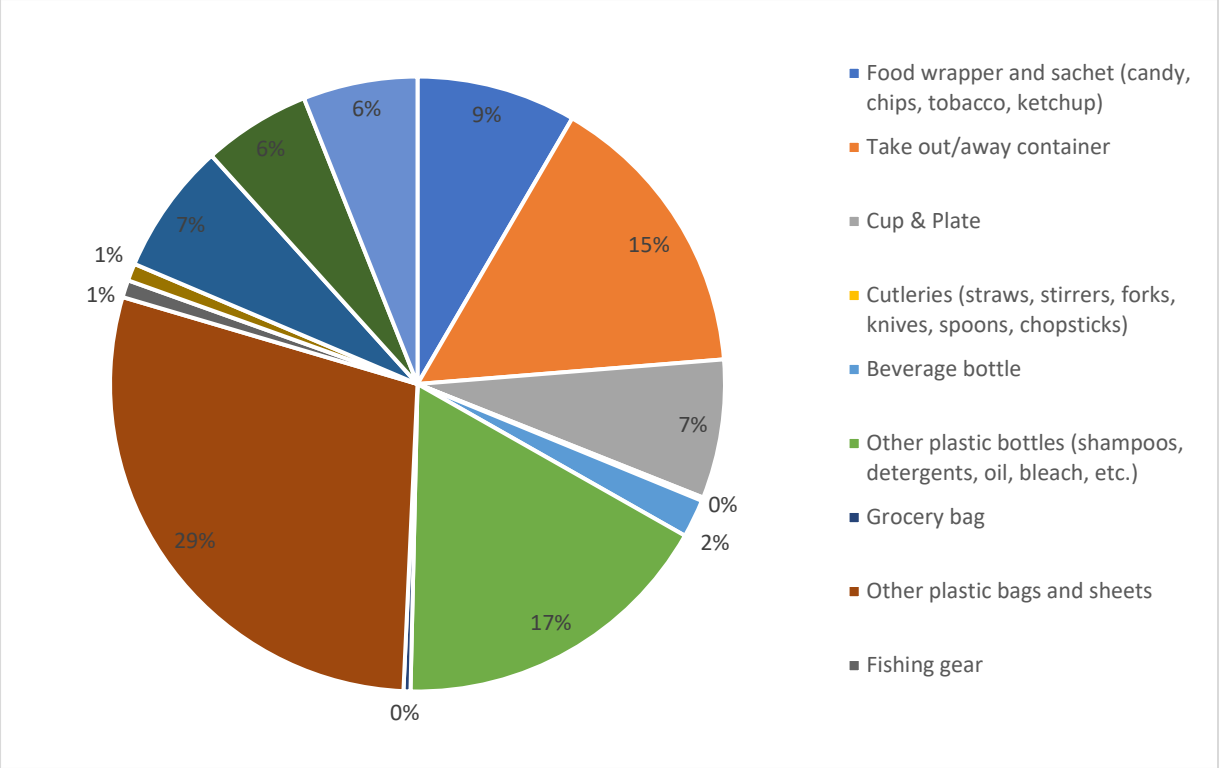


Figure 4.15. Dominant plastic waste found in Tonle Sap

According to the survey results, the average volume of waste accumulation of 151 artificial barriers and ports was 116.43 L (estimated volume in a unit of 20 L plastic bottle), and the average volume of the waste accumulation of 143 littering spots was 0.72 m^3. In addition to the survey on artificial barriers and ports, the team found that there was no cleanup at the accumulated wastes on artificial barrier and ports.

Figure 4.16 presents that most of the dominant plastic wastes in Tonle Sap were reduced in the second survey at artificial barrier and port. However, only other types of plastic waste increased by 3 sampling points.

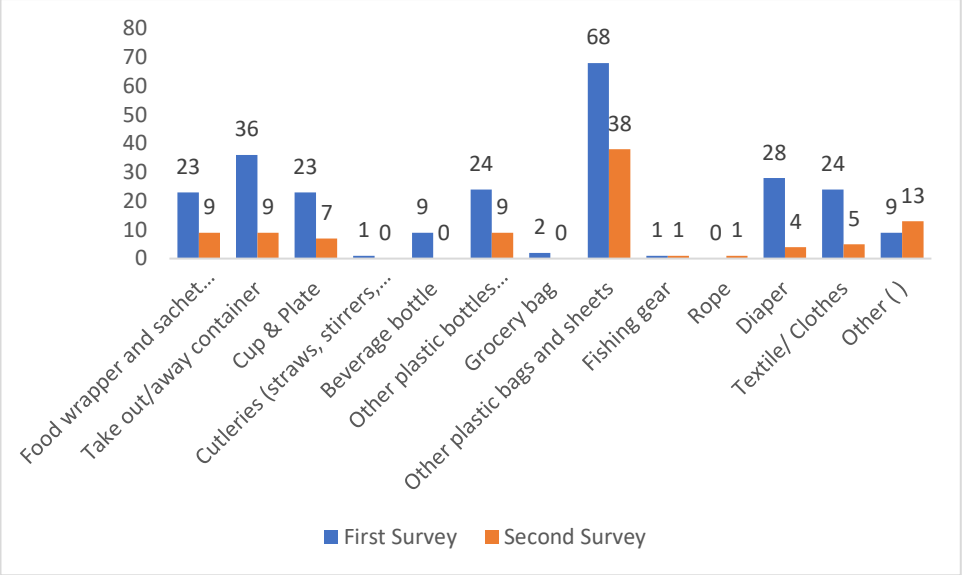


Figure 4.16. Comparison of dominant plastic waste of survey results between two seasons at artificial barriers and ports.

In contrast with analysis results at artificial barriers and ports, Figure 4.6 shows that almost dominant plastic waste, such as other plastic bags and sheets increased in the second survey while other plastic bottles is reduced at littering spots. Other types of plastic waste were slightly changed in both surveys.

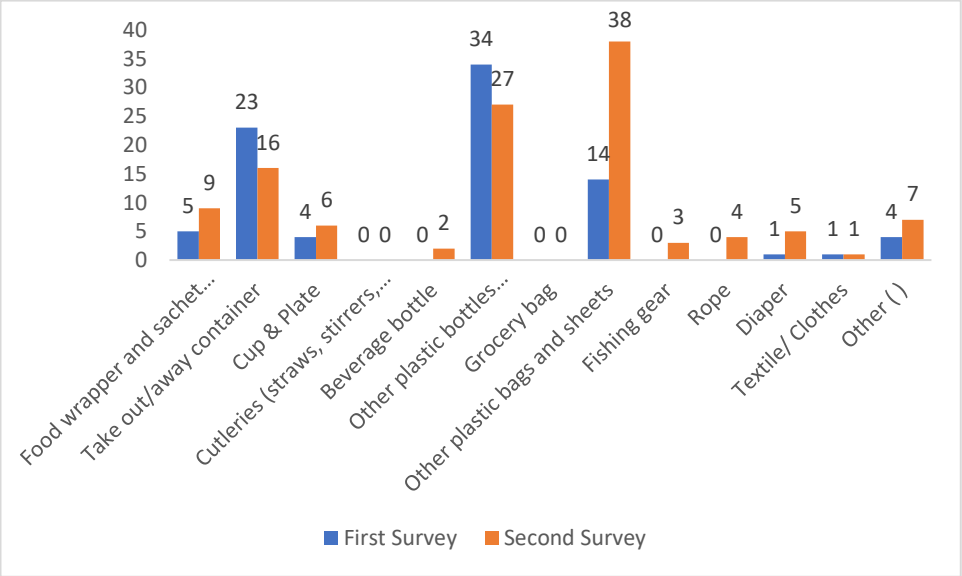


Figure 4.17. Comparison of dominant plastic waste of survey results between two seasons at littering spots.

Face mask were the most frequently found type of COVID-19 related waste. Face masks were found at 35 sampling points at two surveys, artificial barrier and ports (7 sampling points), and littering spots (28 sampling points)

4.6 Can Tho

4.6.1. Introduction

Can Tho is the largest city in the Mekong Delta region of the Mekong River, which also the waterfront of famous floating community's activities. This city is accrossed by Hau River which also Bassac River disembogues from Phnom Penh, Cambodia. Occupying 861,274 population in 2019 along the urban area across the city, Can Tho potents to annual flooding from the Mekong River. Deliberating with its intense activity along the river, Can Tho is providing the service on municipal waste management including the disposal sites and 26 transfer stations.

4.6.2. Data Collection

The team from Can Tho was the first to start macroplastic data collection for the project during Phase 2. In total, the Can Tho team collected 216 sampling points, made up of 40 artificial barriers (accounted for 18.52% of total sampling points), 157 littering spots (72.69%), and 19 uncontrolled dumps (8.80%). Figure 4.18 displays the data collected by the Can Tho team.

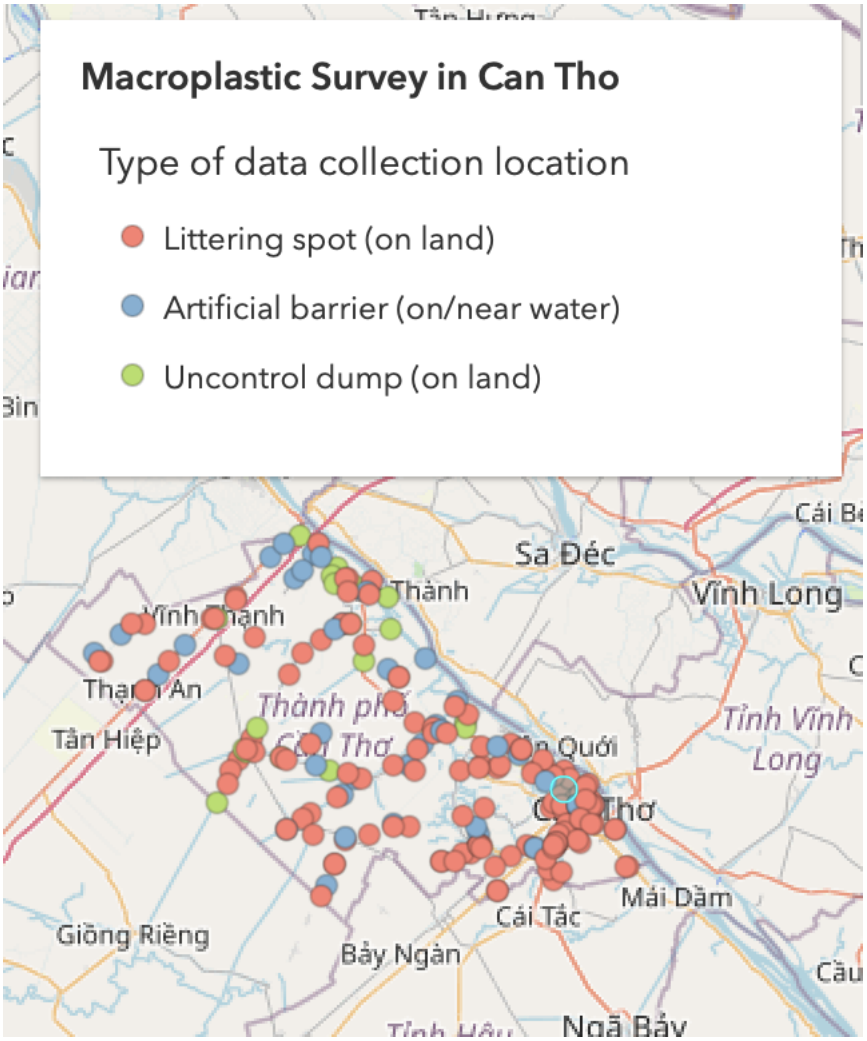


Figure 4.18. Macroplastic survey locations in Cantho, Vietnam [Source: https://arcg.is/1iH1Pz, accessed on February 10, 2022]

4.6.3. Results and Discussion

According to the survey results, the average volume of waste accumulation of 40 artificial barriers was 400.25 L (estimated volume in a unit of 20 L plastic bottle), the average volume of the waste accumulation of 157 littering spots was 0.39 m^3, and the average volume of the waste accumulation of 19 uncontrolled dumpsites were 1698.47 m^3.

Figure 4.19 presents that most of the dominant plastic wastes in Can Tho were reduced in the second survey at artificial barrier and port. However, only take out/away containers, cutleries, cup and plate, and other plastic bags and sheets waste increased by three sampling points. In addition to the trend of plasic waste types, the dominant plastic waste at uncontrolled dumpsites is similar to artificial barriers and ports; all plastic types were reduced at the second survey (Figure 4.20).

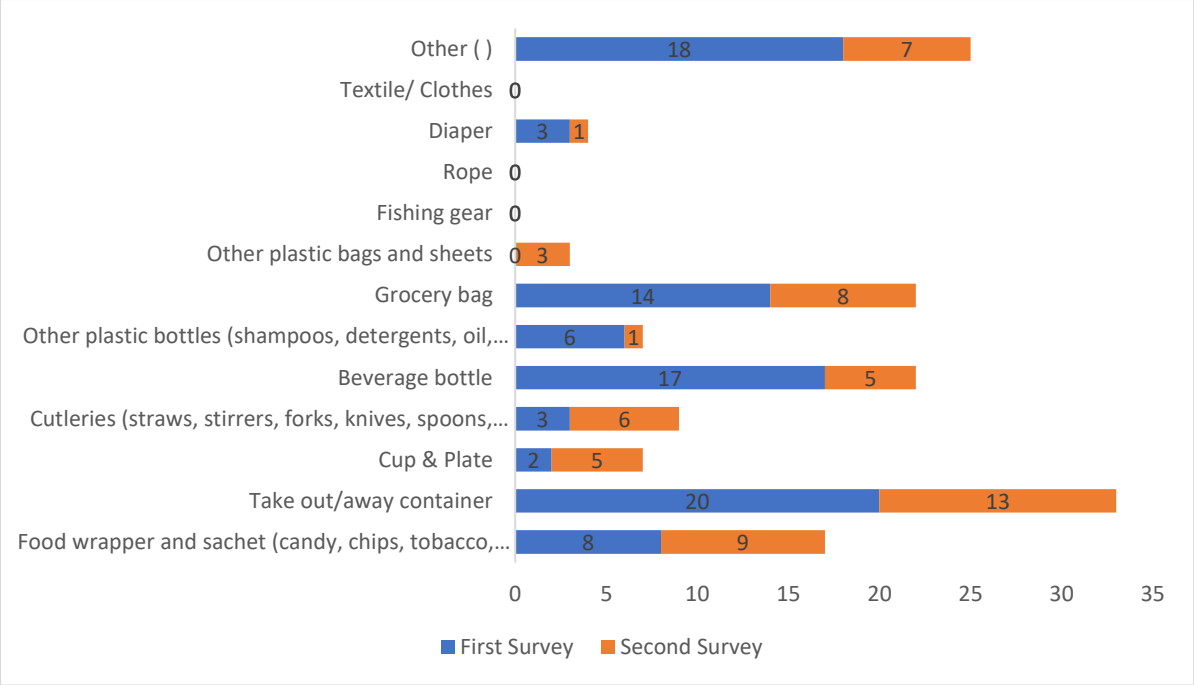


Figure 4.19. Comparison of dominant plastic waste of survey results between two seasons at artificial barriers and ports.

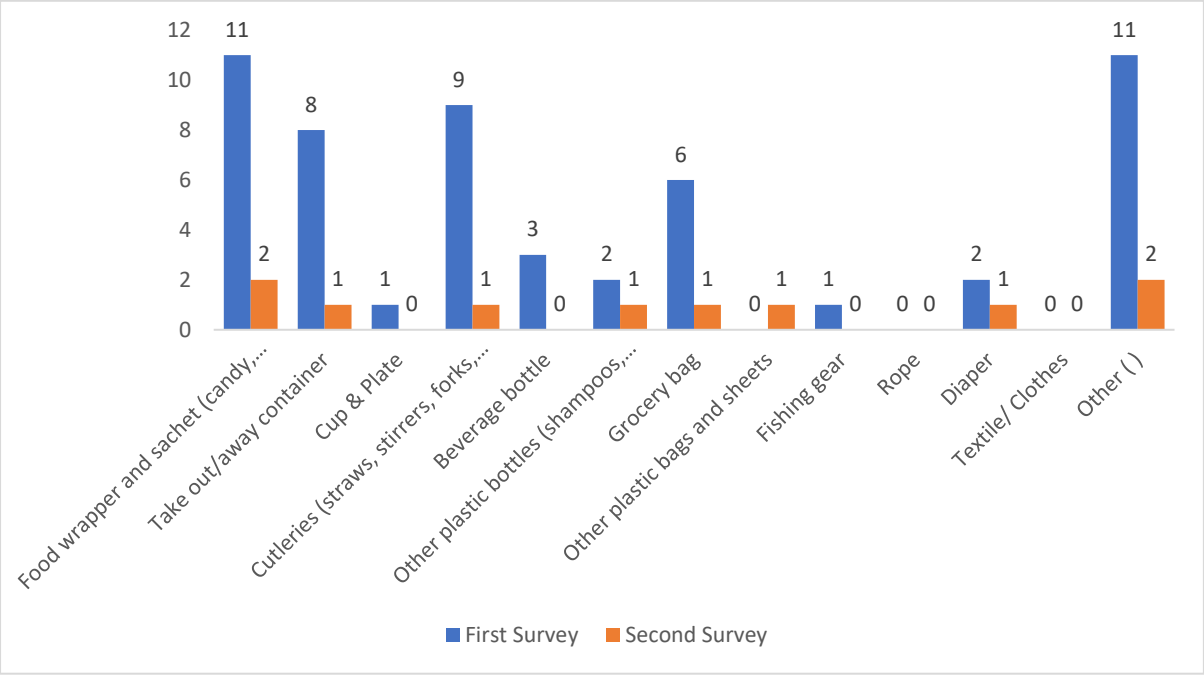


Figure 4.20. Comparison of dominant plastic waste of survey results between two seasons at uncontrolled dumpsites.

In contrast with analysis results at artificial barriers and ports, Figure 4.21 shows that all dominant plastic waste increased in the second survey.

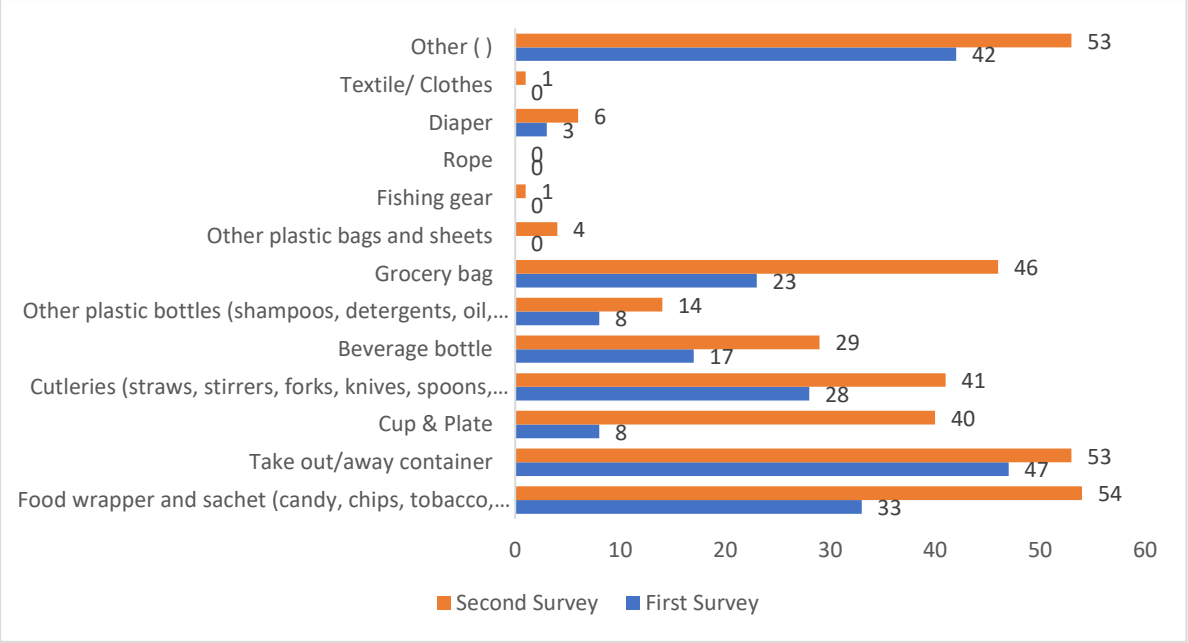


Figure 4.21. Comparison of dominant plastic waste of survey results between two seasons at littering spots.

Face masks were the most frequently found type of COVID-19 related waste. Face masks were found at 93 sampling points at two surveys, artificial barrier and ports (17 sampling points), littering spots (75 sampling points), and one sampling point at uncontrolled dumpsites. In addition to covid-19 related wastes, hand gloves and other types of covid-19 waste found at littering spots, 3 and 3 sampling points, respectively.

5. General Discussion and Conclusion

Based on the types of survey, the overall analysis of three types of locations (artificial barrier and port, littering spot, and uncontrolled dumpsite) will be analyzed and discussed in the following sessions. The main aim is to identify the dominance of plastic waste in the lower Mekong River. Comparison results between the two seasons are also added in the sessions below.

5.1. Artificial Barrier and Port

Survey results show that the dominant plastic waste types found at artificial barriers (Figure 5.1) were other plastic bags and sheets (106 sampling points), followed by beverage bottles (96 sampling points) and other plastic bottles (95 sampling points), grocery bag (65 sampling points), and take-away containers (62 sampling points). Regarding waste associated with Covid-19, survey results showed that face masks were

found in 126 sampling points, accounting for 27.63% of the total sampling points at artificial barriers.

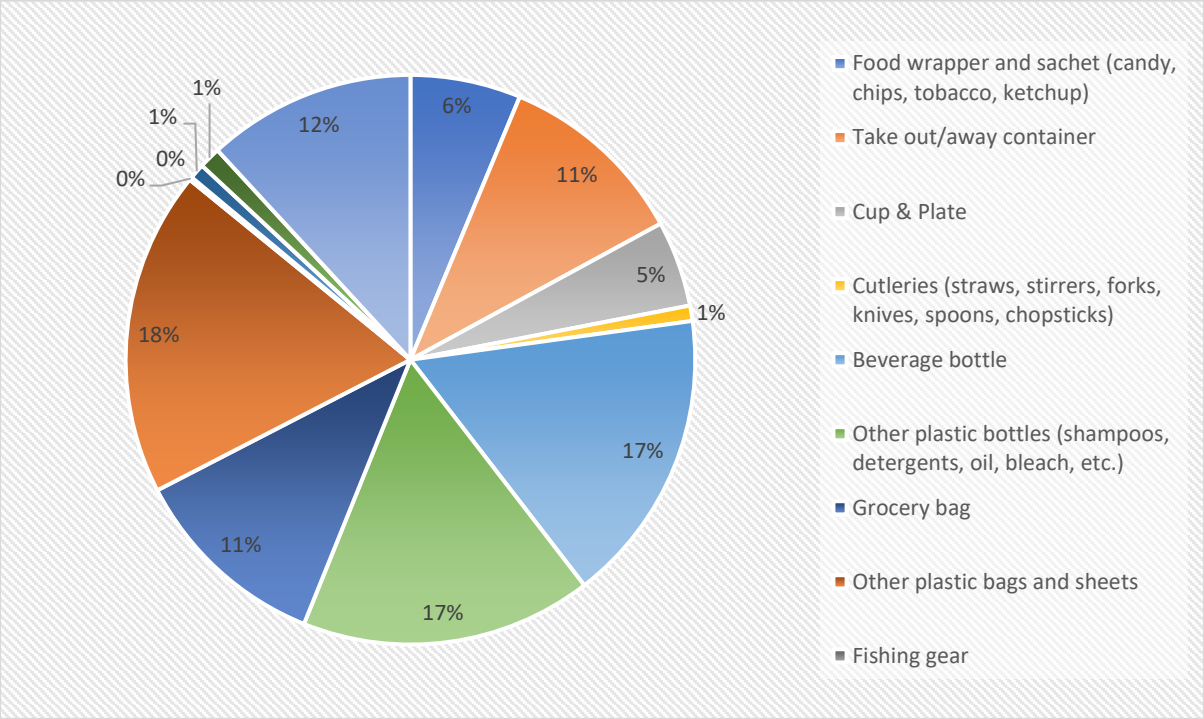


Figure 5.1. Type of plastic wastes which found on artificial barriers in the lower Mekong River

In addition to the dominant plastic waste at the artificial barrier and ports, the dominant plastic waste in both surveys is compared and shown in Figure 5.2. The survey results included plastic bags and sheets, take-away containers, other plastics bottles, beverage bottles, and others. Those are dominant plastic waste in the lower Mekong River in both surveys. In addition, textile, diaper, rope, and fishing gear are less apparent than other types of plastics. However, there is an exciting thing that the dominant plastic wastes in the second survey are reduced, such as other plastic bags and sheets, other plastic bottles, beverage bottles, and grocery bags. Besides, the rope is found at four sampling points, and fishing gear is increased two more sampling points in the second survey (wet season). In addition, shown in Figure 5.2 cutleries also rose slightly in the wet season.

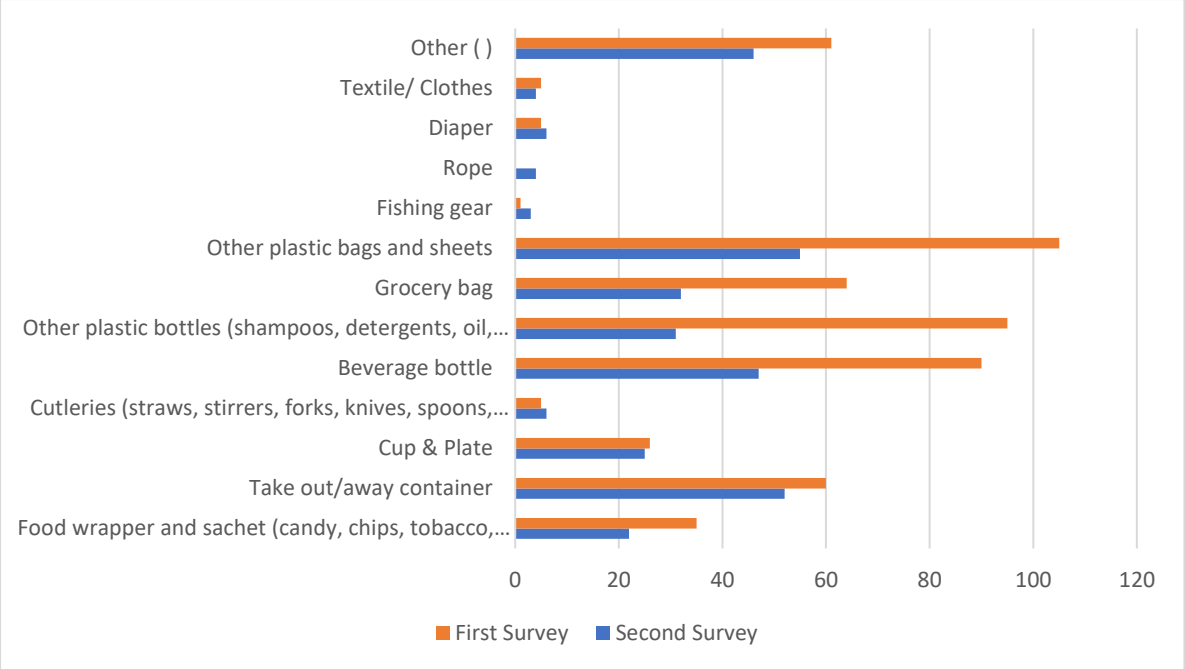


Figure 5.2. Dominant plastic wastes at artificial barrier and ports in two surveys in the lower Mekong River

Regarding accumulated wastes information, as shown in Figures 5.3 and 5.4, most of the accumulation locations are unknown the frequency of cleaning or no cleanup in both surveys. It is made a very scene because no one cleans up the accumulated wastes, except the local governments, villagers, and others. They did cleanup once a month or once a year. Those two figures show that the second survey's cleanup activities were more active than in the first survey due to seasonal changes in the area (monsoon season with high rainfall).

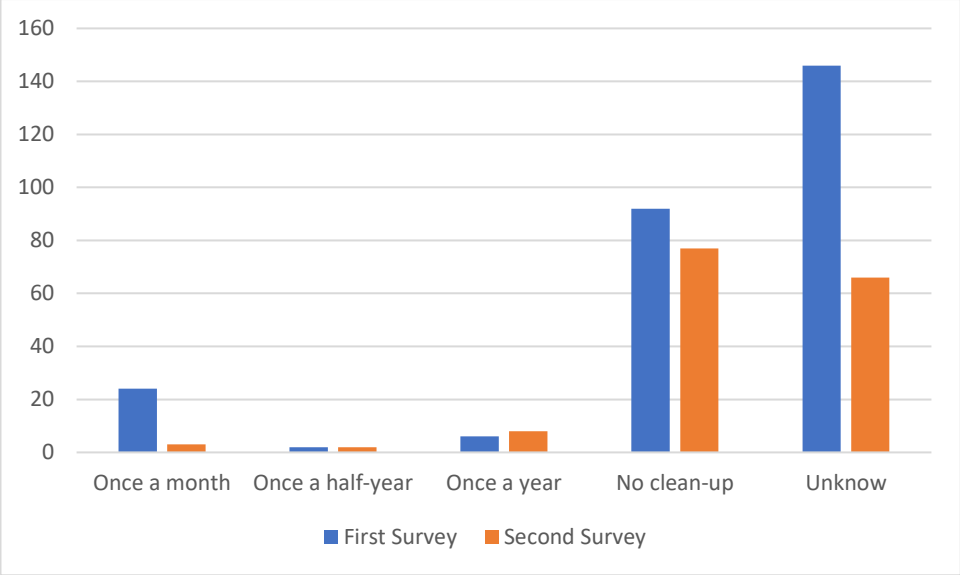


Figure 5.3. Frequency of cleaning of accumulated wastes at the barriers and ports

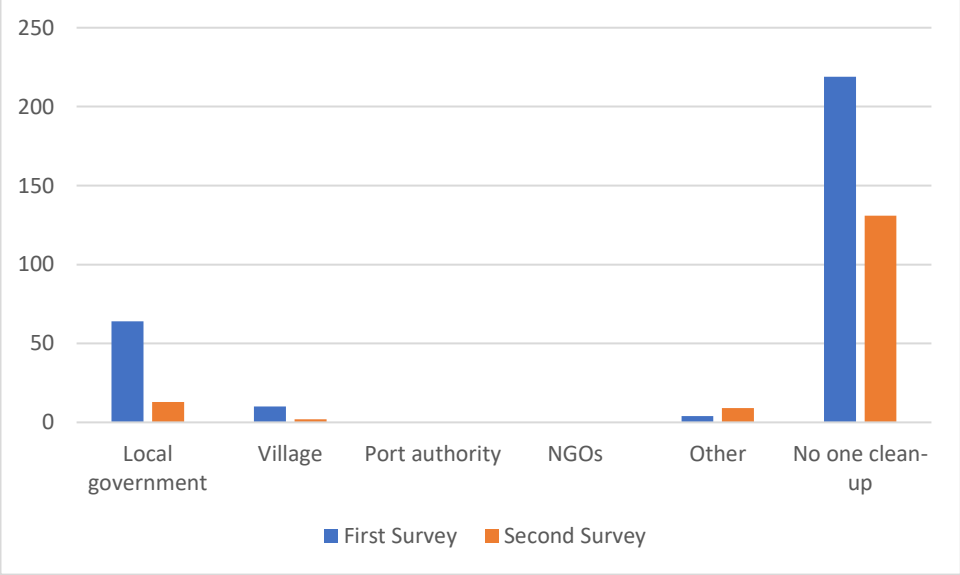


Figure 5.4. Waste cleaning responsibilities of accumulated wastes at the barriers and ports

5.2. Littering Spot

As the analysis results for the littering spots, there were 993 sampling points out of 1574 in total; the study found that the dominant types of plastic waste found at littering spots (Figure 5.5) included other plastic bags and sheets, grocery bags, other types of plastic, food wrappers, take-away containers, and cup and plate, which accounted for 19.66% (315/1602 sampling points), 13.86% (222/1602 sampling points), 12.80% (205/1602 sampling points), 11.61% (186/1602 sampling points), 10.30% (165/1602 sampling

points), and 9.49% (152/1602 sampling points) of total littering spot sampling points which found a different type of plastics waste, respectively. Besides, covid-19 related garbage (face masks) was found in 195 sampling points, accounting for 22.26% of total littering spot sampling points.

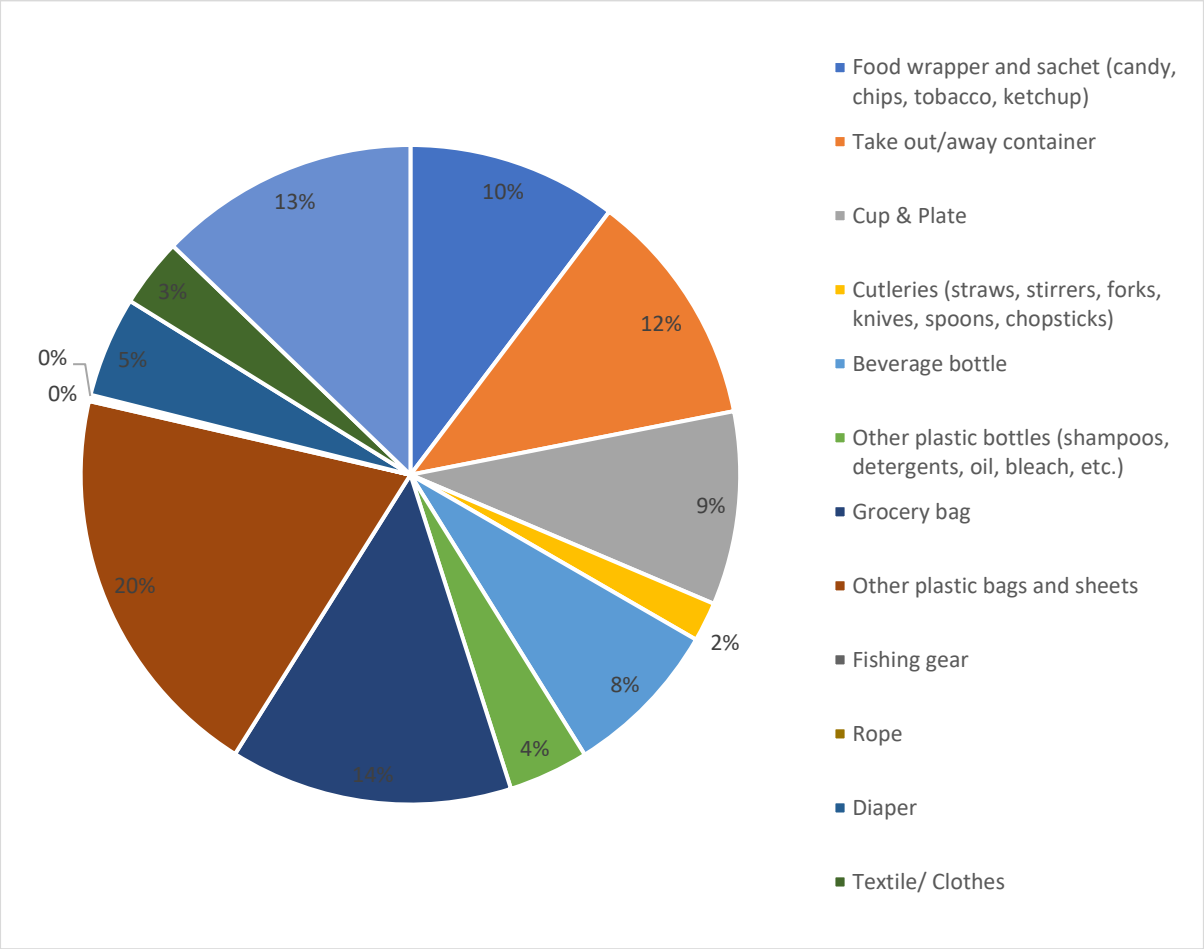


Figure 5.5. Type of plastic wastes which found at littering spots in the lower Mekong River

The statistical results show that dominant plastic wastes at the littering spots slightly changed in both seasons. In the second survey, almost dominant plastic wastes are reduced in six cities. At the same time, few of them are increased, including textile or clothes, other types of plastic waste, grocery bags, and cutleries.

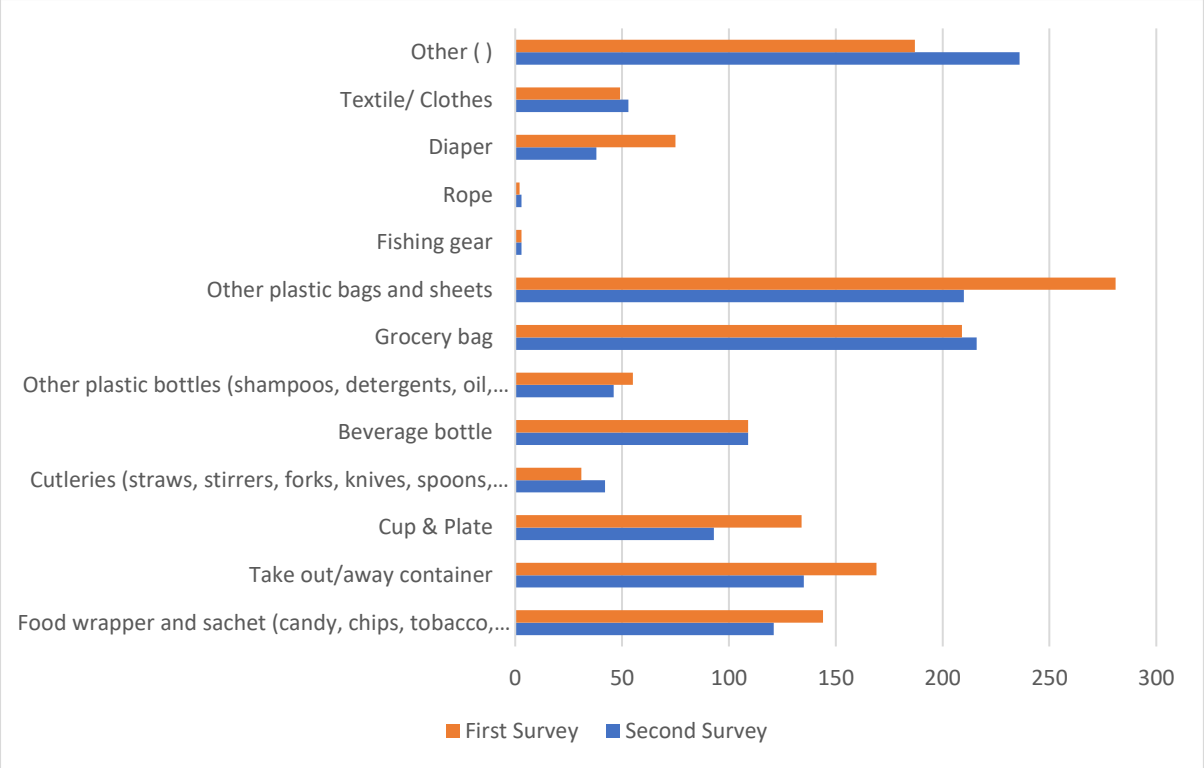


Figure 5.6. Dominant plastic wastes at littering spots in two surveys in the lower Mekong River.

Besides, the study is also estimated the volume of littering spots. The result presents that the average volume of littering sites in all six cities is 2.67 m^3.

5.3 Uncontrolled Dumpsite

The results also found that the dominant types of plastic waste at the uncontrolled dumpsites (Figure 5.7) were other plastic bags and sheets (43 sampling points), take-away containers (41 sampling points), cups and plates (27 sampling points), and food wrappers and sachet (25 sampling points), and other types of plastic (20 sampling points). Covid-19 related waste (facial mask) was found at 37 sampling points of uncontrolled dumpsites in the lower Mekong River.

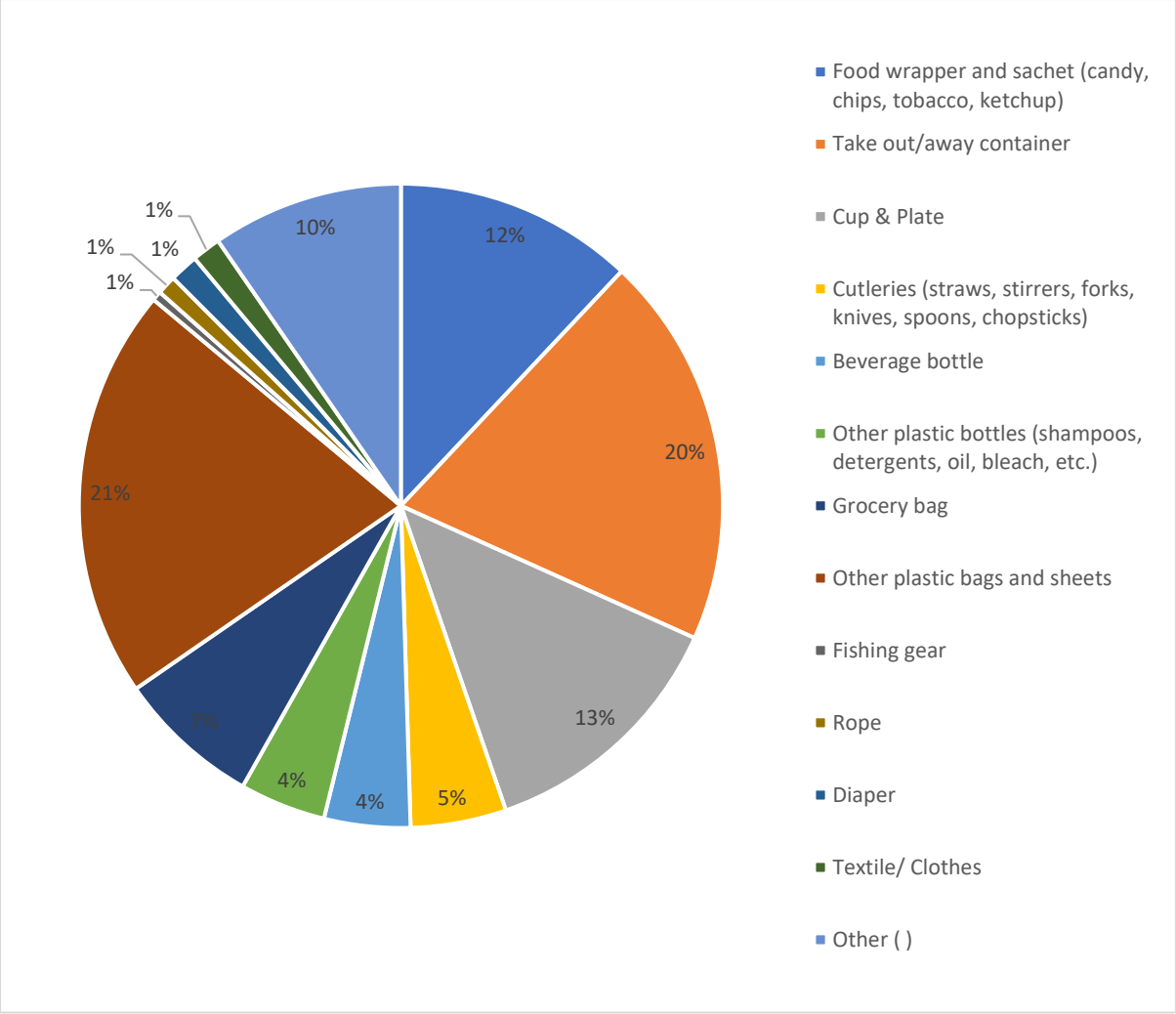


Figure 5.7. Type of plastic wastes found at uncontrolled dumpsites in the lower Mekong River

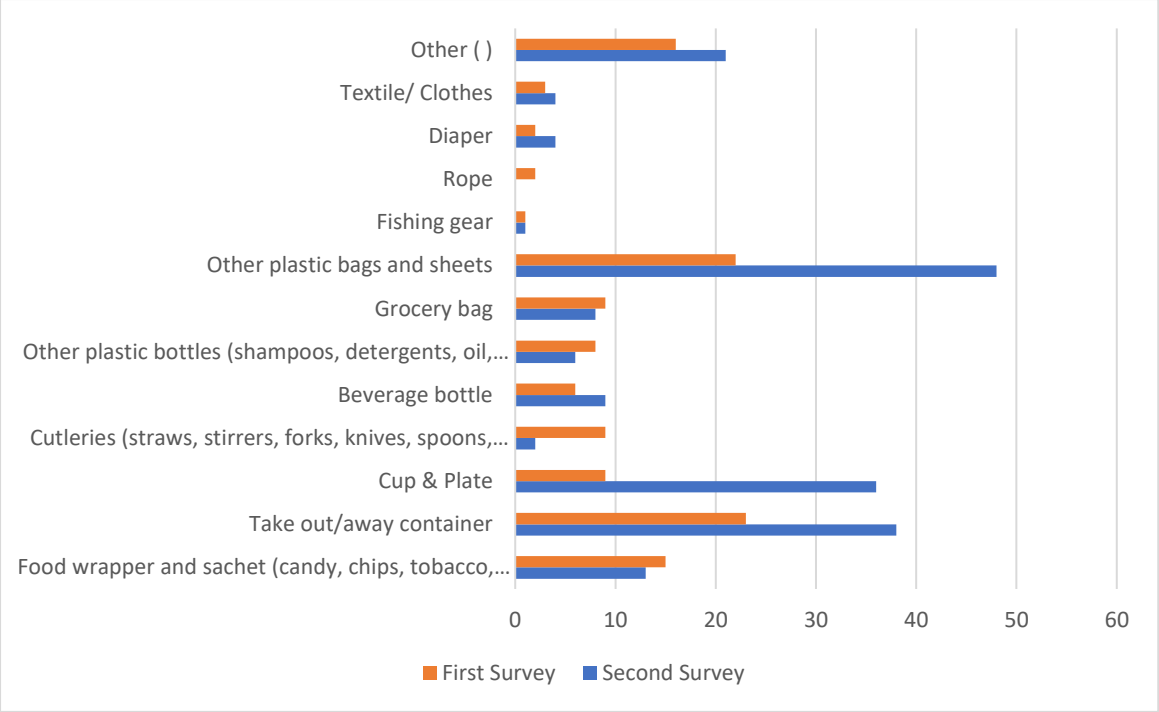


Figure 5.8. Dominant plastic wastes at uncontrolled dumpsites in two surveys in the lower Mekong River.

In addition, the dominant plastic waste in the first and the second survey are compared. Figure 5.8 above shows that the survey results included:

- Other plastic bags and sheets.
- Take-away containers.
- Other plastics bottles.
- Other types of plastic.
- And food wrapper and sachet.

Those are dominant plastic waste in both surveys found at uncontrolled dumpsites in the field survey. In the figure, almost all the dominant plastic waste types are increased in the wet season (the second survey). Especially, cup and plate, other plastic bags and sheets, and take-away containers rose dramatically while rope was not found.

In addition to the type of waste, 37 sampling locations, out of 126 sampling points of the uncontrolled dumpsites, found the covid-19 related waste, all of which were facial masks.

6. Conclusion

The survey revealed that the top three of predominant types of plastic waste occurring in Ubon Ratchathani province are grocery bags, beverage bottles and food wrapper. The littering spot were found both in public area and near by the community. Covid-19

related waste like face masks were found in many sampling points and tend to rising since the Covid-19 case in Ubon Ratchathani is remaining increase. Face masks and food wrappers have been found to occur in nearly every permutation of city and location type, followed by take-away containers and others. Our team found that the area along the river is difficult to find the littering spot comparing to in the city area.

The results of microplastic survey showed that solid waste management in Phnom Penh is still lacking as waste remain found at the artificial barriers, littering on land, and uncontrolled dump. By observation, the lacking management of solid waste is related to: 1) limited knowledge about waste management of the residents, especially at the poor communities, 2) limited access to the waste management service of the poor communities, 3) lacking quality of the management service after the transition of the waste collection operator, and 4) lack of law enforcement. The situation should be improved by awareness raising, capacity building of the waste management operators, collection of waste at poor communities, strengthen the quality of waste management, and law enforcement.

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