

JUNE 2021
WORLD BANK

SUPPORTING LAO PDR IN DEVELOPMENT OF A PLASTIC ACTION PLAN

PLASTIC DIAGNOSTICS



EXECUTIVE SUMMARY

Due to rapid urbanization and economic development in Lao PDR, the amount of solid waste is increasing, and with it the plastic waste fraction. Building on the 8th National Socio-Economic Development Plan (Ministry of Planning and Investment, 2016), that recognizes the challenges to be addressed because of urbanization, the Government of Lao PDR (GoL) approved, in February 2019, a National Green Growth Strategy 2030 (GoL, 2018).

The World Bank is supporting the GoL to generate and convene knowledge that informs the implementation of Lao PDR's green growth transition and help the country build natural and human capital from better management of pollution, waste, and renewable natural resources. The GoL, through the Ministry of Natural Resources and Environment (MoNRE), has asked World Bank for support in addressing the solid and plastic waste problems, including the development of a National Plastics Action Plan (NPAP) and potential investments.

There is a lack of reliable data on the amount and variety of plastic in Lao rivers. A sound understanding of the problem is essential to prepare adequate policies and investments to reduce plastic waste and prevent leakage into the environment. The activities carried out aim to support the GoL in the development of policies and investment measures to reduce, reuse and recycle priority plastics items, and thus contribute to reducing plastic pollution, creating a conducive environment for the tourism industry, mitigating flood risks, and fostering integrated and sustainable economic development in healthy oceans.

Under this framework, this report presents the findings of diagnostical work on the analysis of plastics pollution in the country with particular focus on assessing types, quantities, sources and impacts of plastic wastes that leak into the environment and rivers in Lao PDR.

The plastic diagnostics was carried out in six cities in Lao PDR, although some activities focused on the whole country. Activities included:

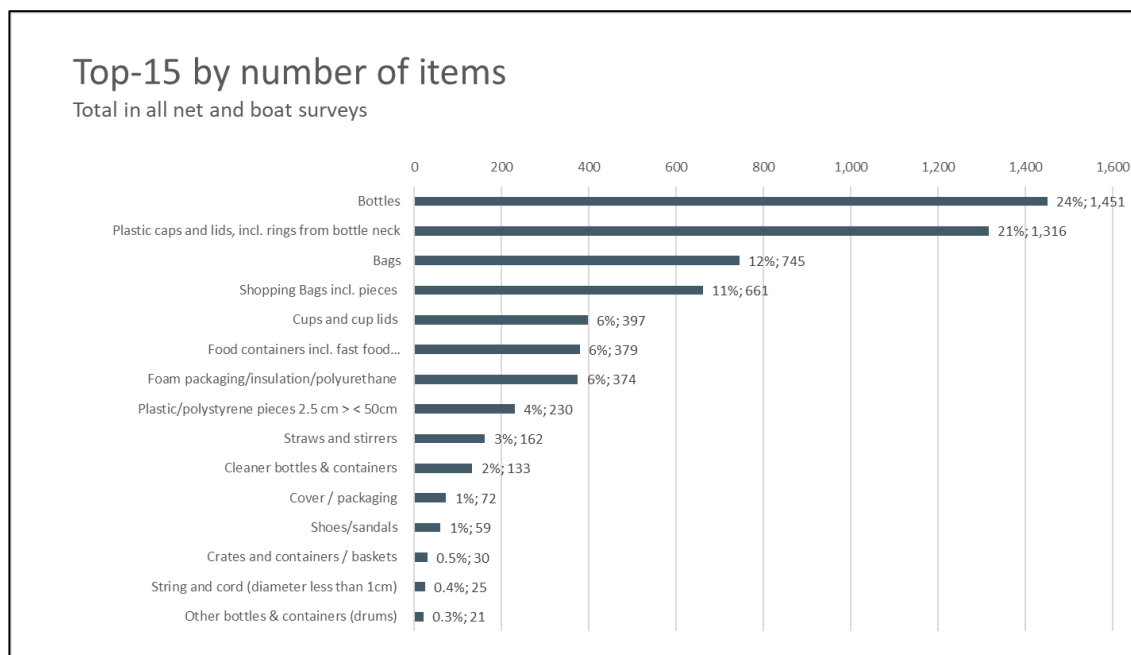
- Determining locations of plastic pollution hotspots along Mekong River and tributaries
- Estimating the quantities of plastic waste leaking into the waterways
- Determining the major types (and possibly brands) of discharged plastic waste
- An assessment of plastic waste imports for priority plastics
- An assessment of the impacts of plastic pollution.

The methodology for the diagnostic work was based on a variety of studies and tools, both land- and riverine-based, to ensure the best possible analysis of plastic pollution in the selected cities. Surveys included the mapping of the plastic waste flow and pathways; identification of local plastic pollution hotspots; modelling of plastic quantities leaking into the river; riverine surveys to identify priority plastic items; data analysis and stakeholder and key informant interviews on multiple aspects regarding plastics pollution, plastics collection and management, recycling, plastics trade, and other aspects as covered by this survey.

Identification of priority plastic items leaking into the environment was a priority under this scope of work to inform potential policies and measures. Effective policies require a thorough understanding of key items that need to be targeted. The riverine surveys in six cities found that the Top 10 plastic items alone are responsible for 95 percent of the pollution. By targeting several of these items with selected feasible and realistic policy measures, the ones which are non-essential or for which good alternatives already exist on the market, overall plastics pollution in Lao PDR can be reduced significantly. The Top 10 plastic items (in percent (%) of number of total plastic items collected) that appeared from the surveys are as follows:

1. Beverage bottles: 24%
2. Plastic caps and lids: 21%
3. Shopping bags: 12%
4. Other bags: 12%
5. Cups and cup lids: 11%
6. Food containers: 6%
7. Foam packaging/insulation: 6%
8. Plastic pieces between 2.5 cm – 50 cm: 4%
9. Straws and stirrers: 3%
10. Cleaner bottles/containers: 2%

ES Figure 1. Top 15 Plastic Items by Number



Improved knowledge about the Top 10 priority plastic items leaking into the environment provides the foundation for the development of effective plastic policies targeting the most polluting plastic items.

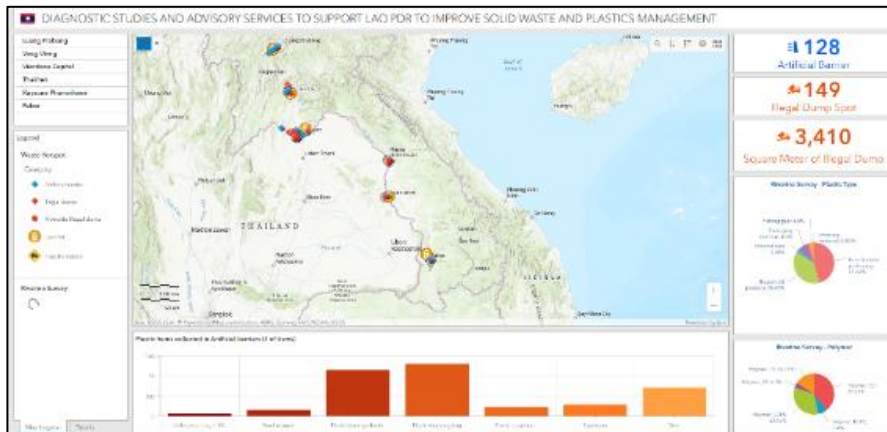
These findings are further enhanced by an assessment of available alternative products which were assessed through a market study. A key finding of this assessment is that for several of the identified single-use plastics exist, the focus of alternatives should generally be on promotion of reusable items for economic reasons, avoidance of negative impacts of other materials, and overall support in

developing a more circular economy in line with the government’s green growth agenda.

Priority pollution hotspots were identified in all six cities and can support local governments to develop measures for specific locations. These sites and other information such plastic waste facilities, informal dumpsites, landfills and transfer stations, and plastics survey results in each city are provided through these interactive online maps:

- The 1st map, also called the **dashboard**, allows the end-user to screen areas and read aggregated information as an indicator of the specific selected location. Weblink: <https://bit.ly/3lgnzmb>
- The 2nd map, also called **WebApp** allows the end-user to explore the data and use simple tools for various uses presented in a GIS environment. Weblink: <https://bit.ly/2SrxboK>

ES Figure 2. Plastics Diagnostic Data Dashboard



The study also revealed a continuous increase of import of plastic waste over the last five years and a drastic 10-fold increase of import of plastic waste to Lao PDR from 2018 (7,800 tons) to 2019 (98,500 tons), with major sources being USA, Thailand, and China, Hong Kong, but also European countries and others. While a small recycling industry exists in the country, it centers largely on pre-treatment and exporting to neighboring countries for further processing. The capacities to cope with such plastic waste amounts and particularly low-value plastics are not present and are likely to further increase river pollution and widespread open burning.

All of these and other findings as presented in the report provided the basis for carrying out an assessment on potential policy measures to target priority items and reduce plastics pollution and promotion of circular economy. This policy assessment is provided in a separate report “Supporting Lao PDR In Development of a Plastic Action Plan. Plastic Policy Assessment”. The findings further support the continued World Bank support to the GoL in improving plastics management and informing a potential “Environmental and Waste Management Project” under preparation.

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ABBREVIATIONS

ADB	Asian Development Bank
EPS	Expanded polystyrene (foam)
GIS	Geographic Information System
GPS	Global Positioning System
GMS	Greater Mekong Subregion
GoL	Government of Lao PDR
HDPE	High Density Polyethylene
HS	Harmonized Standards
JRC	Joint Research Center
LDPE	Low Density Polyethylene
MFA	Material Flow Analysis
MoNRE	Ministry of Natural Resources and Environment
NSEDP-8	8th National Socio-Economic Development Plan
NUoL	National University of Laos
PA	Polyamide, aka. nylon
PET	Polyethylene terephthalate
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
SWM	Solid Waste Management
TA	Technical Assistance
ToR	Terms of Reference
UN	United Nations
XPS	Extruded polystyrene (foam)

1 Introduction

1.1 Context

Due to rapid urbanization and economic development in Lao PDR, the amount of solid waste is increasing, and with it the plastic waste fraction. Building on the 8th National Socio-Economic Development Plan (Ministry of Planning and Investment, 2016), that recognizes the challenges to be addressed because of urbanization, the Government of Lao PDR (GoL) approved, in February 2019, a National Green Growth Strategy 2030 (GoL, 2018).

The Strategy prioritizes policy and investment action on renewable natural resources, pollution and waste management, environmental fiscal instruments and nature-based tourism that can drive or protect economic growth and help create green jobs. The Strategy refers to the need for building the infrastructure for disposal or treatment of waste and improving the waste management system to make it more efficient and effective, especially in large towns. It also mentions that reuse of waste is an opportunity for investment to create jobs and income generating activities for the peoples. However, no clear targets are set, and gaps remain in the analytical underpinnings, advisory services, and government capacity to implement this ambitious reform agenda and this transition requires strong advisory services to continue its momentum.

GoL and the World Bank have worked together for over 50 years and this partnership has contributed towards shaping Lao PDR's impressive economic growth and successes in overcoming poverty. The World Bank is currently supporting the GoL to generate and convene knowledge that informs the development and implementation of policies, plans and investments for Lao PDR's green growth transition and help the country build natural and human capital from better management of pollution, waste, and renewable natural resources.

Under this framework, the GoL, through the Ministry of Natural Resources and Environment (MoNRE), has requested the World Bank for support in addressing the solid and plastic waste problems, including the development of a National Plastics Action Plan (NPAP) and a potential investment operation. The activities done to support the development of a NPAP focused on analytical work and surveys to analyze the types, quantities, sources and impacts of plastic wastes that are entering the rivers in Lao PDR, an assessment of suitable policies and regulations, and the development of a set of recommendations.

1.2 Objective and Scope

The World Bank is implementing and preparing several analytical activities as part of the Green Growth Advisory Program, which will inform the development and implementation of policies, plans, and investments for Lao PDR's green growth transition and help the country build natural and human capital to better manage pollution, waste, and natural resources. One of the activities, captured under this Technical Assistance program, includes the assessment of solid and plastic waste management priorities, investment and policy reform, and sustainable financing options and requirements. The overall objective of this activity is to generate,

convene and disseminate knowledge that informs the development and implementation of policies and investments for enhanced solid and plastic waste management in Lao PDR.

Within this context, the objective of this report is to enhance the understanding of plastics pollution and plastics management in Lao PDR and to identify the priority plastics that contribute the most to environmental pollution. As such, this report serves as a basis for the recommendations for policy and regulatory measures to reduce single-use plastic consumption and pollution (provided in the separate *Plastic Policy Assessment Report*). The report will support the GoL in the identification of suitable measures to reduce plastics pollution by targeting identified priority items and provide the basis for the development of an NPAP. The activities under this assessment include:

- Determining locations of plastic pollution hotspots along Mekong River and tributaries
- Determining the priority plastic items leaking into rivers
- Assessing alternative products through a market study
- An assessment of plastics and plastics waste imports and exports
- An assessment of plastics production and recycling
- An assessment of the impacts of plastic pollution
- An estimate of quantities of plastic waste leaking into the waterways.

1.3 Description of the Study Area

Six larger cities were selected as focus areas for the diagnostic work¹:

- Vientiane (capital city)
- Kaysone Phomvihane (formerly known as Savannakhet)
- Pakse
- Luang Prabang
- Thakhek
- Vang Vieng.

In addition, Pathoumphone, a smaller town just south of Pakse, was added to the list. For this town no riverine surveys were performed, but data was collected along artificial barriers and hotspots.

¹ Refer to the Inception Report (June 2020) for a justification of the selected cities.

Figure 1 Geographical Location of the Study Area (Six Selected Cities)



The location of the selected cities is shown in Figure 1 above. The Table below shows the basic facts about the selected cities with respect to land area, number of districts, villages, and households, as well as population data.

Table 1 Basic Facts about the Six Selected Cities and One Small Town

City	Vientiane ¹	Pakse ²	Pathoumphone	Luang Prabang ³	Thakhek ⁴	Kaysone Phomvihane ⁵	Vang Vieng ⁶
Province	Vientiane Prefecture	Champasak	Champasak	Luang Prabang	Khammuan	Savannakhet	Vientiane
Districts in province ⁷	9	10	10	12	10	15	11
Land area (km ²) of city	3,920	125	N/A	788	1,002	779	1,680
Villages in city	481	41	1	115	91	67	62

City	Vientiane ¹	Pakse ²	Pathoumphone Luang Prabang ³	Thakhek ⁴	Kaysone Phomvihane ⁵	Vang Vieng ⁶	
Households in city	173,840	14,722	N/A	16,418	18,448	13,717	10,979
Population of city	927,730	88,332	N/A	91,382	97,108	136,528	60,026
Tourism	**	**	*	***	**	**	***
Agriculture	***	***	***	**	***	***	**
Fishery	*	*	**	*	*	*	*

1) 2019 data (VCOM, 2020); 2) 2018 data (Pakse Urban Development Administration Authority, 2020); 3) (Vang Vieng Town Office, 2020); 4) (Thakhek City Office, 2020); 5) (Urban development Administration Authority of Kaysone Phomvihane City, 2020); 6) (Vang Vieng Town Office, 2020), 7) (Ministry of education and sports, 2020).

*** *Most influential*; ** *Influential*; * *Less influential*.

2 Methodology for Plastic Waste Assessments

The methodology for the diagnostic surveys was based on a variety of studies and tools, both land- and riverine-based, to ensure the best possible analysis of plastic pollution in the selected cities. The land-based surveys include the mapping of the plastic waste flow and identification of local plastic pollution hot-spots as input for modelling of plastic quantities leaking into the river. These estimates were compared with results from field surveys that measured the quantities and composition of the plastic waste in the rivers.

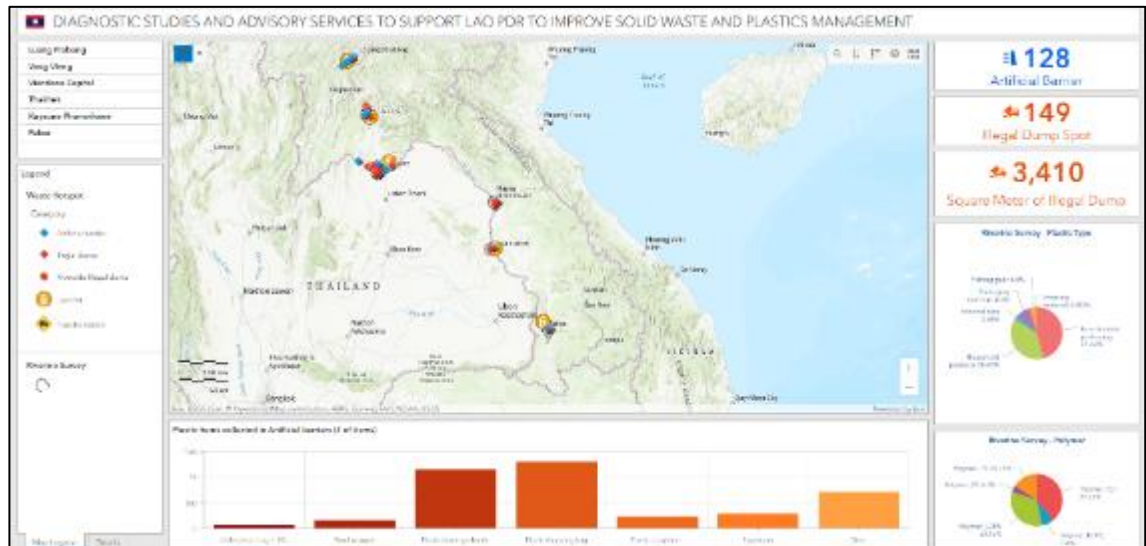
2.1 Global Information System (GIS) Map

Results from the surveys were captured in global information system (GIS) maps. These interactive online maps show all key results of the surveys that were conducted during spring and summer 2020. The following online maps are available:

- The 1st map, also called the **dashboard**, allows the end-user to screen areas and read aggregated information as an indicator of the specific selected location.
 - Weblink: <https://bit.ly/3lqnzmb>
- The 2nd map, also called **WebApp** allows the end-user to explore the data and use simple tools for various uses presented in a GIS environment.
 - Weblink: <https://bit.ly/2SrxvOK>

A guideline to use of GIS maps can be found in Appendix E.

Figure 2 A Screenshot of the GIS Map.



2.2 Land-Based Surveys

The land-based surveys focused on statistical data for import and export of plastic products and plastic waste as well as plastic production in Lao PDR. Furthermore, the survey identifies plastic pollution hotspots in each city. These data were used as input to an Excel-based model (see Section 2.2.5) to estimate the potential riverine plastic pollution from land-based sources for each of the cities.

2.2.1 Production Facilities for Plastic Products

The main objective of this activity was to quantify and describe the plastic packaging production in Lao PDR as part of the yearly mass flow of plastic within the Lao PDR waste system and how this contributes to the plastic pollution of the rivers. The result of this activity was an overview of the largest plastic packaging producers in the country, including the following information for each company, where possible:

- Name and address of the company
- Product description (short description regarding product and use, material, and weight)
- Production capacity (ton per year)
- Market for packaging (domestic or export).

A list of 155 companies registered to produce plastic and rubber goods was obtained from the Ministry of commerce and Industry. Removing companies producing PVC and rubber products left 77 companies. Through individual interviews, details on location, products, production, and markets were obtained for 17 companies. [CC1]

2.2.2 Import of Plastic Packaging and Products

The main objective of this activity was to quantify and describe the imported plastic packaging in Lao PDR as part of the yearly mass flow of plastic packaging into the Lao PDR waste system and its contribution to the plastic pollution of the rivers.

Plastic may be imported for packaging of products produced in Lao PDR or through import of already packed products. For identifying the imported plastic packaging, import and custom statistics from UN Comtrade (United Nations, 2020) were used for the years 2017-2019. It was found that 2019 data was not yet complete, hence 2018 data was used.

For the assessment, products were selected with the following HS codes², which cover most products made from plastic as well as products packaged in plastics:

- 01-05 Animal and Animal Products
- 06-15 Vegetable Products
- 16-24 Foodstuffs
- 39-40 Plastics and Rubbers

Both data concerning the export from neighboring countries (China, Vietnam, and Thailand, which in monetary terms covers 85 percent of the import) and import into Lao PDR were retrieved. This was done because the data reported as imports into the country were not complete (for some items, export from other countries were larger than import). Another challenge was that the items have various quantity units (such as Mix, Pairs, Units). Therefore, we only analyzed items that were recorded in Tons.

Plastic packaging typically constitutes of 1-10 percent of the weight of a product (see Figure 3 below). Furthermore, 53 percent of all goods are packaged in with plastic packaging (Kooijman, 2000). The selected trade categories are already the ones typically wrapped in plastic. Therefore, we applied an estimate of five percent plastic packaging for all selected HS2 codes, but 100 percent for the HS2 codes 39-40 "Plastics/Rubber".

² Harmonized Commodity Description and Coding Systems is a six-digit code system to classify goods.

Figure 3 Examples of Packaging of Different Household Products (Cygnus Group, 1996).

Package Weight to Product Weight Ratios (%)	
1–10%	
1	500 g of pasta in PE bag
	61 g bar of chocolate in plastic wrapper
2.7	1 l milk in paper+PE box
3	1 l soft drink in PET bottle
3.3	1 kg of coffee in brick pack
3.5	1/2 kg of meat on foam tray
4	0.33 l soft drink or beer in aluminium can
	1 l ice-cream in HDPE box
5	fruit juice in aseptic box
	250 g of cold cuts vacuum packed
5.3	2 dl yogurt in plastic cup
5.29	bag of potato chips
6.6	400 g of margarine in plastic tub
	150 g of cold cuts vacuum packed
6.7	1 l ketchup in plastic squeeze-bottle
7.4	10 eggs in pulp tray
9	bar of soap in paper box
9.5	fabric softener in HDPE bottle
11–20%	
11.9	85 g cat food in aluminum pouch
12.4	1/2 l oil in plastic bottle
61–100%	
68	0.5 l salad dressing in glass bottle
74.5	100 tablets in PS bottle and carton box
80	0.5 l oil in glass bottle
>100%	
160	a box of 25 tea bags
588	tablets in blister package and paper box
611	20 g of seasoning in glass bottle
41–60%	
53	0.3 l glass bottle of beer or soft drink
56	deodorant in spray bottle
57	150 g jam in glass jar
61–100%	
68	0.5 l salad dressing in glass bottle
74.5	100 tablets in PS bottle and carton box
80	0.5 l oil in glass bottle
>100%	
160	a box of 25 tea bags
588	tablets in blister package and paper box
611	20 g of seasoning in glass bottle

2.2.3 Import, Export and Domestic Recycling of Plastic Waste

Domestic Recycling Companies

The main objective of this activity was to quantify and describe the local capacity for treating and reprocessing plastic waste into new raw materials. These facilities have the potential to contribute to the plastic pollution of the rivers due to leakage.

The generated overview consists of a list of larger recycling facilities (sorting and reprocessing) in the six cities and includes the following information for each facility:

- Name of the facility
- Description of technology
- Treatment capacity (tons per year) when possible
- Market for output fractions (domestic or export).

The main sources for identifying relevant facilities were the local authorities. The available information was supplemented by data collected from individual stakeholders.

Import and Export of Waste and Secondary Raw Material

The import of plastic and other waste to South-East Asia is rising, especially since China applied a ban on import of plastic waste at the end of 2017. The quality of this imported plastic waste is often low, and the faith of the plastic is therefore uncertain.

The amount of plastic waste imported to and exported from Lao PDR was identified through respectively the Department of Custom at the Ministry of Finance and the Department of import and export at the Ministry of Industry and Commerce as well as UN Comtrade (United Nations, 2020).

The main objective of this activity was to quantify the risk of illegal dumping or other inadequate management of imported plastic waste, that could contribute to the plastic pollution in the rivers. The HS4 code 3915 "Waste, parings and scrap of plastics" was used.

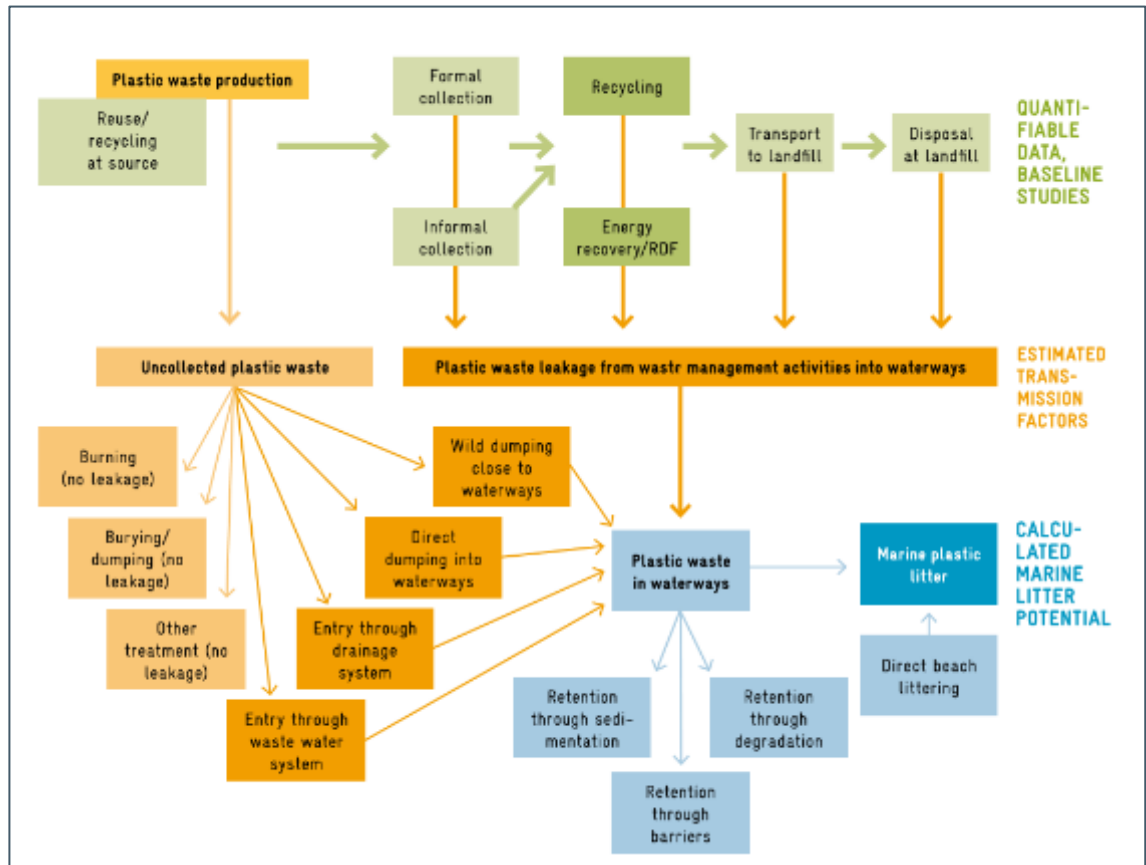
2.2.4 Plastic Waste Pollution Hotspots

The location of illegal dumpsites and other plastic pollution hotspots, such as restaurants, temples, parks or other especially busy areas along the Mekong River or its tributaries, were identified and tagged (GPS location) along with a photograph and a short description including size, types of waste, and history. Interviews with local authorities and citizens, in combination with own field surveys, were used to locate the hotspots.

2.2.5 Simplified Tool for Riverine Plastic Litter Assessment

A quick assessment tool or model, like a simplified Material Flow Analysis (MFA), was used to quantify riverine litter. The model focused mainly on municipal solid waste, and estimated the plastic littered to waterways based on several inputs, following the pathways from human settlements to waterways (see Figure 4). The model did not consider the whole value chain of plastics, but only from the time it became waste. Liquid waste (sewage) was not addressed, as this mainly included micro-plastics, which were not part of the scope of this project. The model also did not consider direct river-based leakage from sources such as the fishing industry.

Figure 4 Plastic Flows Estimated in a Simplified Model (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2018).



Data inputs to the model and justification for estimates are described briefly in Table 2 below and in detail in Appendix A. The model was applied to the six selected cities.

Table 2 Data Inputs and Justifications for Estimates

	Description of data	Data sources and justifications
General waste management information	Population; MSW generation; Plastics content	Literature, see Section 9.
Waste management system	Waste collection coverage and efficiency; Informal plastic sector	Some data on formal sector combined with estimates based on interviews with local authorities and waste companies as well as site visits.
Plastic waste treatment	Reuse and recycling at source and formal	Estimates based on interviews with local authorities and plastic waste companies.
Transmission factors	Uncollected plastic waste with and without leakage into waterways; Leakage from solid waste and plastic management; Retention factors for the river	Rough estimates based on interviews with local authorities, waste companies, artificial barriers survey and the hot-spot survey.
Additional values	Direct beach and riverbank littering	Rough estimate based on major hot spots near river.

It should be noticed that because it was a simplified tool used, the uncertainties of the results are relatively large. The uncertainties on input data regarding waste quantities, composition and collection system are reflected in uncertainties of the resulting plastic waste quantities leaching into the river. Similarly, the underlying model assumptions regarding distribution of the waste flows may not be representative for the specific sites and local conditions. The resulting quantities

(output of the model) therefore indicate a level of magnitude for the plastic pollution more than an exact quantity.

2.3 Riverine Surveys

The plastic pollution of the Mekong River was assessed through different riverine surveys. The surveys were performed for each of the six selected cities to investigate the quantities and composition of the plastic pollution of the river. The surveys were performed in spring and summer 2020. Therefore, variations due to dry and wet season were not investigated. The detailed methodology of the performed surveys is described below.

2.3.1 Net Traps

A trawl (net trap), with 40-meter length and 2-meter height, was used. Two big empty water bottles were put on the top of the net, for every 3-meter length, to function as floating devices. At the bottom of the net, for every 3-meter span, bricks tightened with a 3-meter rope were employed as anchors. The mesh size of the net was 19 millimeters. The net trap was tied to a boat, allowing the trap to stretching out to the middle of the Mekong River.

The area of the net was related to the cross section of the river to estimate how large a fraction of the waste flowing in the river during the five collection days. For example, in Vientiane the net covered half the width of the river (40 out of 80 meters) and covered half the depth (2 out of 4 meters). Hence, one quarter of the river was covered, and it is estimated, that the waste quantities in the river was four times the amount collected during the survey.

Macro-plastics and submerged solid wastes were collected from the trap three times a day during five days during May and June 2020. The collected waste was quantified (items and weight) per collection. Later, the collected waste was sorted and categorized in relation to polymers, product types and (when possible) brands.



Each day, the baseline conditions, including temperature, flow rate, depth of river and weather condition, was recorded, as they might have relation to the amount of waste littered into the river.

Figure 5 The Installed Net Trap in Vientiane



Table 3 Set-up for the Net trap Surveys in the Six Selected Cities

	Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomvihane	Vang Vieng
Net proportions	40 m long 2 m high	40 m long 2 m high	40 m long 2 m high	40 m long 2 m high	40 m long 2 m high	40 m long 2 m high
River width	800	780	650	1,000	1,100	70
River depth (avg. in m)	4.0	3.8	3.1	5.1	2.8	3.3
Current (avg. in m/s)	1.1	0.4	0.9	0.4	0.9	1.6
Duration of survey (days)	5	5	5	5	5	5

The placement of the nets can be observed in the [GIS map](#) by selecting layer list with the following icon  and tick of "Riverine Survey" to see the placement of the net, which has the following symbol .

2.3.2 Collection by Boat

The second approach to riverine waste collection was collection by boat. This approach supplemented the net traps, as the boat could cover the part of the cross section of the river not covered by the net trap. Collection by boat was performed for one hour three times a day for five days during May and June 2020. The collected waste was quantified (items and weight) per collection. Later, the collected waste was sorted and categorized in relation to polymers, product types and (when possible) brands.

Figure 6 Collection by Boat in Vientiane



2.3.3 Artificial Barriers

Artificial barriers in the Mekong River were identified for the six selected cities. Artificial barriers included water pumping stations, water control gates, bridges, and culverts along roads, canals, and creeks connected to the river.

Often, waste accumulated behind artificial barriers since the natural flow of the river was blocked. Therefore, riverine waste was collected from all the identified artificial barriers. The collected waste was counted (items) and categorized with respect to product category.

The results from the surveys at the artificial barriers can be used to supplement the composition-analysis based on the plastic collected from the net-trap-surveys and the boat-collection. However, since the categories used to categorize the waste at the artificial barriers was slightly different than for the other surveys, the data could not be used directly in the analysis.

2.3.4 Visual Observations

For five days, the team registered observed wastes in the river from a defined point (such as a bridge). The observation was performed for one hour twice a day (in the morning and in the afternoon). The observed waste was categorized as plastic or non-plastic items and then further categorized into several sub-fractions. However, not the same categories as used for the net-trap-survey and the boat collection. The observations showed the distribution of the waste items between plastic and other materials.

2.3.5 Quantification of the Plastic Waste

The results of the surveys were used to (roughly) estimate the quantities of plastic in the Mekong River but these estimates come with significant uncertainties. For instance, it is not possible to include uneven distribution of the plastic waste in the water column (vertically) or across the river (horizontally) due to differences in density of the waste and the water currents. Furthermore, the surveys, and thus the

estimated quantities, represent merely a snapshot of the conditions in the river at the time of the survey and do not allow for incorporation of any seasonal variations.

The plastic waste flow was quantified for the number of items as well as the weight of the plastic waste. Both parameters may be useful for different purposes. Often, plastic waste in the aquatic environment is calculated in number of items instead of weight. One reason for this is that the procedure is less complicated and can be carried out in the field without equipment (scale). Another reason is that weight does not always reflect the seriousness of the waste pollution, since smaller pieces of plastic waste very often possess larger risk of hazardousness to aquatic lifeforms, due to ingestion.

2.3.6 Plastic Waste Composition

The waste collected during the net-trap-surveys and the boat collection were used for determining the composition of the plastic waste based on the number of items as well as weight.

Products

The plastic waste was sorted into specific "product items", such as bottles, bags, cups, and cup lids. These were further aggregated into more overall "product types", such as food and drink packaging, household products, and personal care products. The sorting-list was constructed based on a sorting guide for marine litter developed by Joint Research Centre (JRC, 2013). "Face masks" were added because of COVID-19. Some items on the original list were deleted to adjust the list to riverine environment (instead of marine environment) and to simplify the list. The final sorting guide for the surveys contained 86 product items, of which some were present in multiple product types (see Appendix B).

The waste collected from the artificial barriers was categorized in a slightly different way and it was therefore not possible to include these data directly in the analysis of product categories. However, the composition from plastic waste found at the artificial barriers were compared to the results of the composition analysis from the net-trap-survey and the boat collection. The results from the visual observations were used to indicate the relation between plastic waste and other waste items in the river.

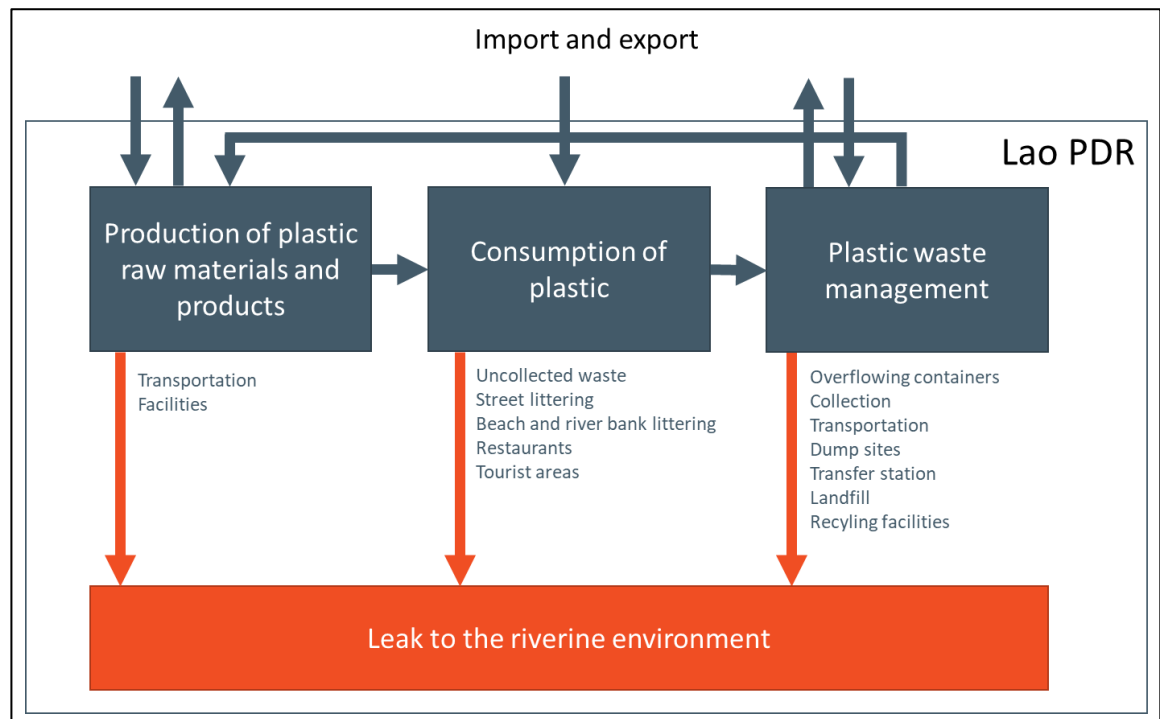
Polymers

Furthermore, the collected plastic waste from the net-trap-surveys and the boat collection was sorted into polymers (HDPE, LDPE, PET, PP, PS, PVC, and others).

3 Plastic Pollution Hotspots

In each city, hotspots of plastic pollution were identified, based on interviews and field investigations. Waste plastics entering the environment are often a result of inadequate waste management systems. These include disposal in dumps or open, uncontrolled landfills but also overflowing waste containers, street and beach littering, and informal sector chain. In addition, there are other sources of pollution, such as leakages at plastic production facilities. All these sources are displayed in the figure below, which represents a simplified materials flow analysis (MFA) of plastics in Lao PDR.

Figure 7 MFA of Plastics in Lao PDR and Leaks to the Riverine Environment



3.1 Hotspots from Production of Plastic

The pollution from the production of plastics in Lao PDR is deemed low. However, with increasing production capacity it will become a priority to reduce impacts here too. The spillage from production facilities are typically small pellets, which are not a part of this study's focus area. These production facilities are however enlisted in Section 4.1.1 Import and Production of Plastic Packaging. They have not been included in the GIS maps.

3.2 Hotspots from Consumption of Plastic

Other hotspots that originate from the consumption and use of plastic at the riverbanks have been mapped. These include restaurants, tourist areas or recreational places. All places have been visited and documented via photos.


- In the [GIS map](#) select layer list with the following icon  and then tick of "Venue hotspots".

Table 4 includes an overview of the different types of hotspots identified along the rivers. It can be observed that many restaurants, bars, and cafés are plastic hotspots. The hotspots vary in size and hence impact, and thus the number of hotspots does not say something about the degree of pollution. The table includes the “major” hotspots in each city, where on average more than 100 pieces of plastic were found. **In Luang Prabang and Vang Vieng there are many hotspots compared to the population, which might indicate a connection to the large level of tourism in the city.** Further details on the hotspots can be observed in the activity reports in Appendix C.

Table 4 Overview of Number of Hotspots from Consumption of Plastic.

	Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomviha ne	Vang Vieng	Total
Restaurants, bars and cafés	144	29	68	19	10	34	304
Hostels, hotels and similar	32	10	45	5	1	50	143
Other service sector; Markets, shops and offices	7	4	4	2	2	0	19
Religious and tourist venues; Temples, monuments	7	7	50	4	4	1	73
Nature, parks, caves and other recreation	0	1	5	3	4	21	34
Public sector; Hospital, schools, universities and bus stations	0	3	8	3	2	0	16
Industry; Factories, fish farms and other industry	2	1	4	1	0	0	8
Total	192	55	184	37	23	106	597
Number of hotspots per 100,000 inhabitants	21	62	201	38	17	177	43

3.2.1 Vientiane

In Vientiane, 192 hotspots were identified along the river from Sangthong district to Hatsayfong district, see Figure 8.


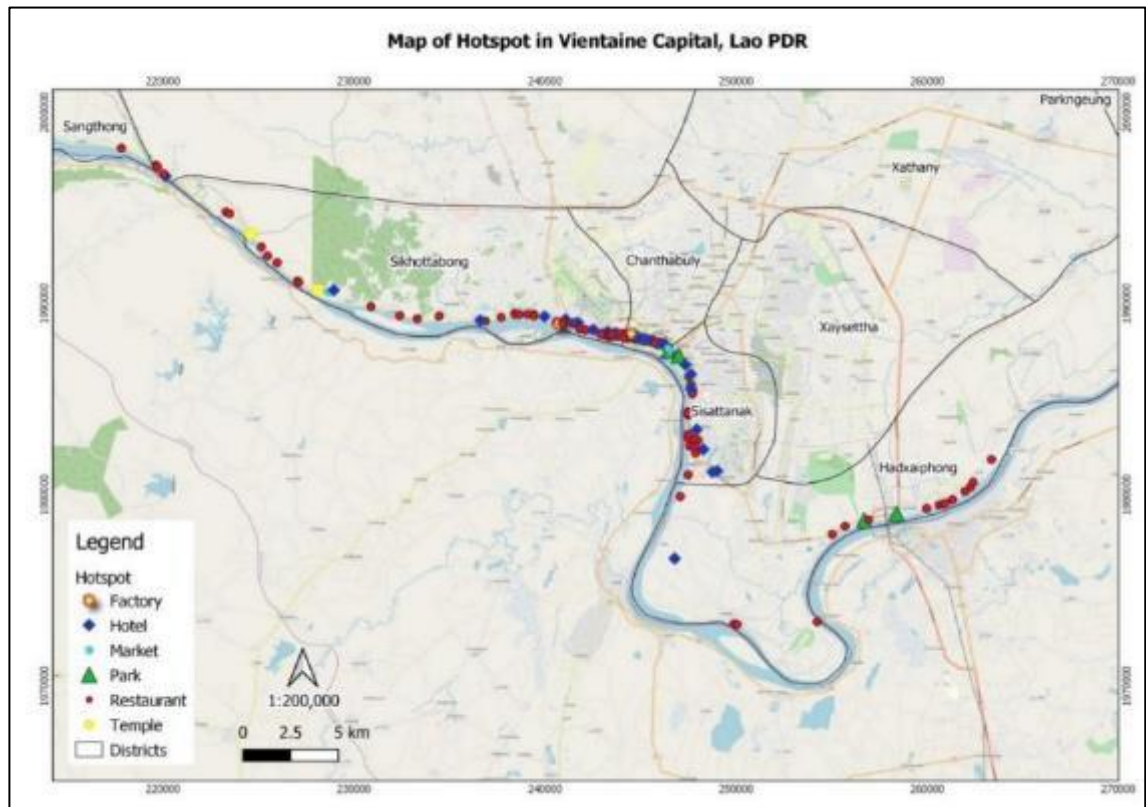
- In the [GIS map](#) select bookmark in the right side and click "Vientiane", then select layer list with the following icon  and tick of "Venue hotspots".

Figure 8 Hotspots from Consumption of Plastic in Vientiane Capital



The major hotspots in Vientiane are assumed to be:

- Restaurants with huts on Landmark Hill at Sangthong District
- Temples on the way to Sangthong District
- Chao Anou Public Park
- Restaurants with huts at Chiempang Village.

Figure 9 Pictures from the Four Major hotspots in Vientiane



3.2.2 Pakse

In Pakse, 52 hotspots were observed along the Mekong River, that can be observed in Figure 10.


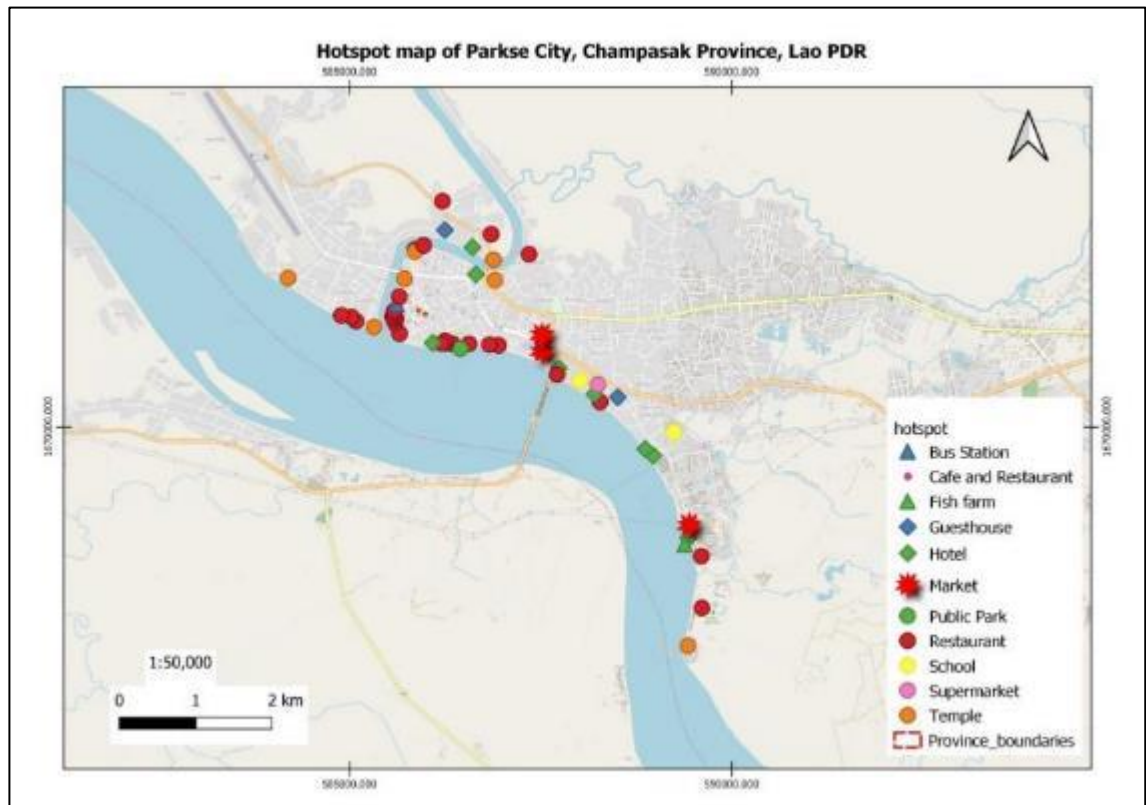
- In the [GIS map](#) select bookmark in the right side and click "Pakse", then select layer list with the following icon  and tick of "Venue hotspots".

Figure 10 Hotspots from Consumption of Plastic in Pakse.



One location stood out as being the major hotspot from consumption of plastic, namely the Wat temple (location No.1). The extent of the pollution can be observed in Figure 11, where 349 pieces of plastic was observed.

Figure 11 Plastic Dumped Close to the Mekong River at Wat temple, Pakse.



3.2.3 Luang Prabang

In Luang Prabang, 184 hotspots from consumption of plastic were observed along the Mekong River and Kan tributary, see Figure 12.


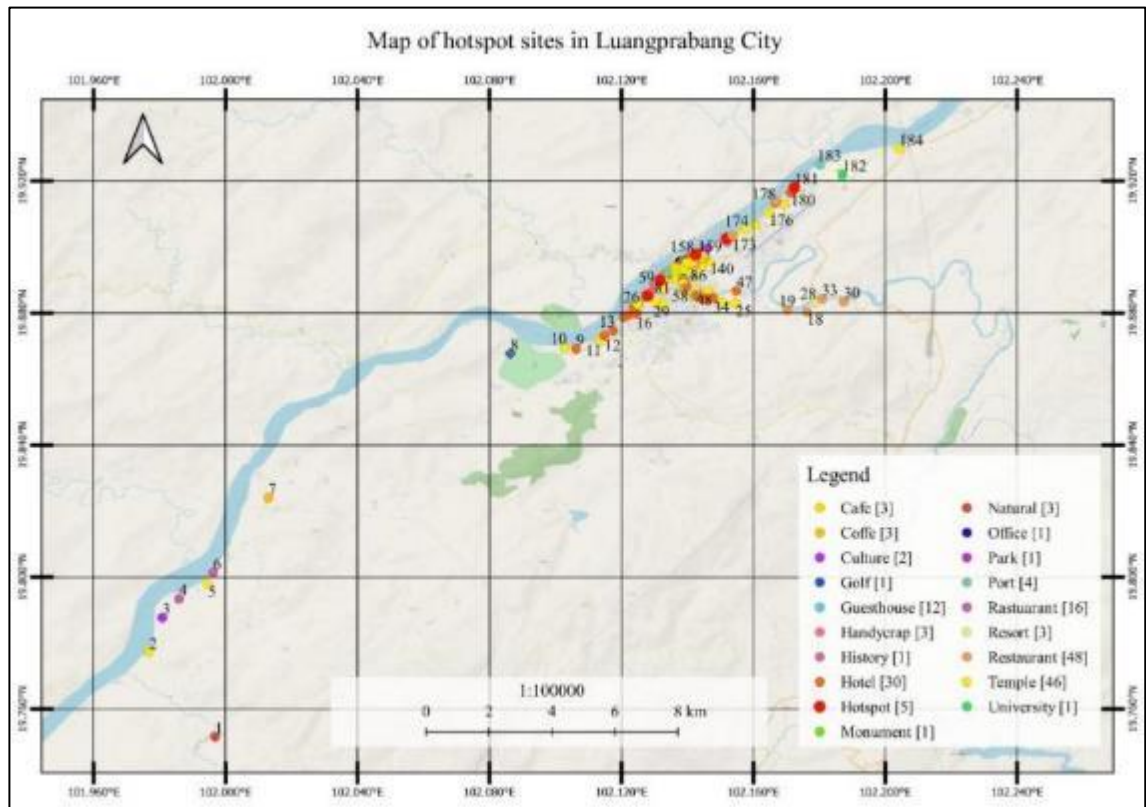
- In the [GIS map](#) select bookmark in the right side and click "Luang Prabang", then select layer list with the following icon  and tick of "Venue hotspots".

Figure 12 Hotspots from Plastic Consumption in Luang Prabang.




There were four major hotspots in Luang Prabang where 36-90 pieces of plastic was scattered around and at the port stacked.

- Khaemkong View restaurant (location No. 117)
- Sao Vang restaurant (location No. 107)
- Choumkong Ferry Port (location No. 105)
- BBQ Buffet Khaemkhong restaurant (location No. 85).

3.2.4 Thakhek

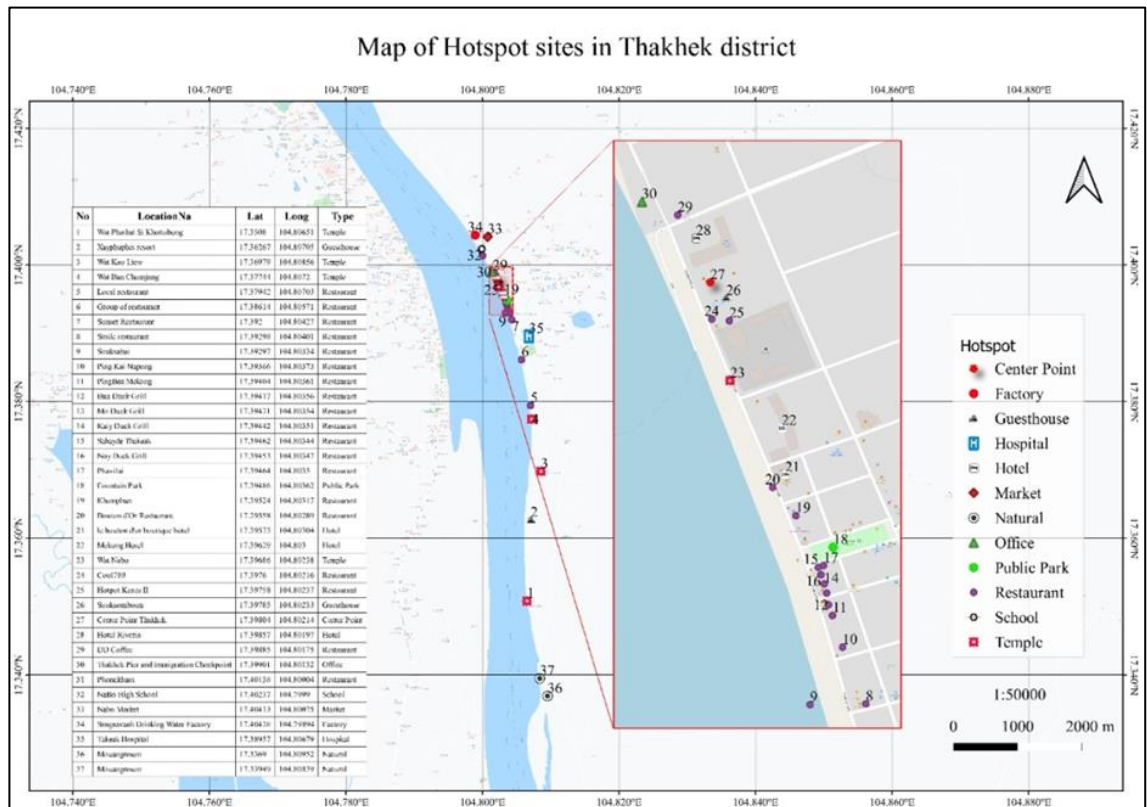
In Thakhek, 37 hotspots were identified along the river, see Figure 13.

- In the [GIS map](#) select bookmark in the right side and click "Thakhek", then in layer list, with the following icon  tick of "Venue hotspots".

The major hotspots in Thakhek are assumed to be:


- The Wat Phathat Si Khottabong temple (location No.1)
- The Had Meuangsoum beach (location No.37).

Figure 13 Location of Other Hotspots in Thakhek



3.2.5 Kaysone Phomvihane

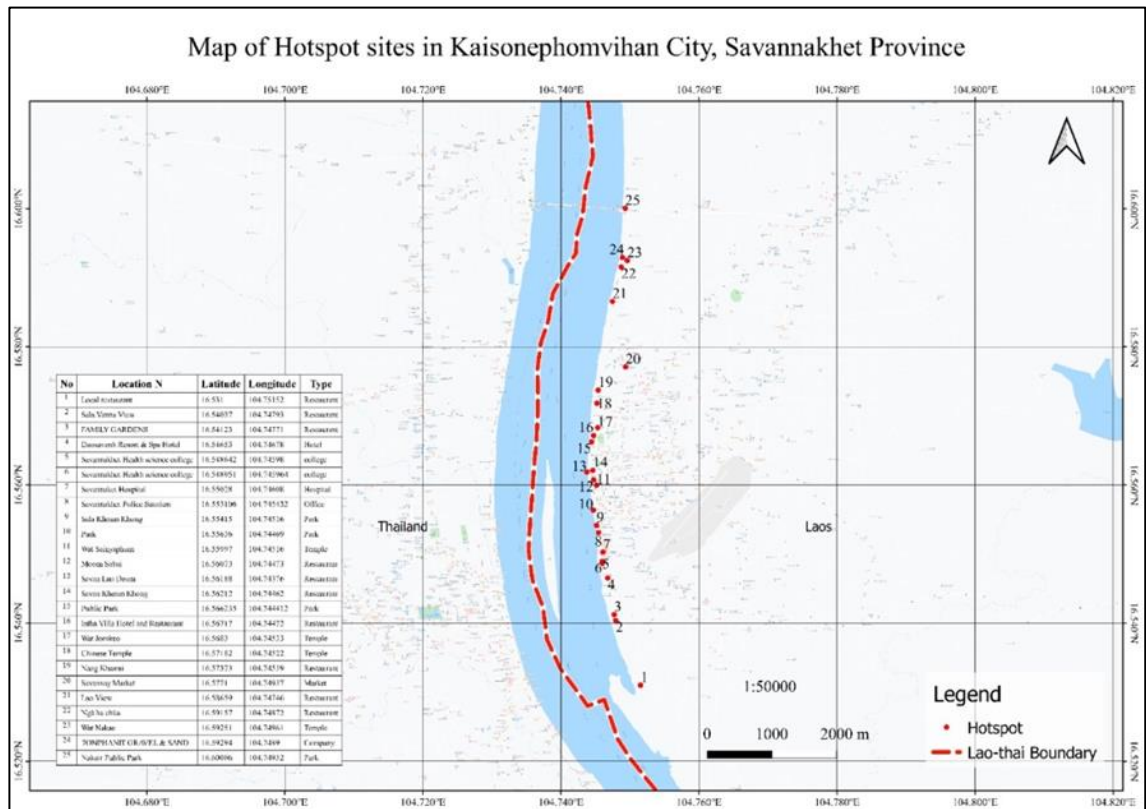
In Kaysone Phomvihane (Savannakhet), 24 hotspots were identified along the river, see Figure 14.

- In the [GIS map](#) select bookmark in the right side and click "Savannakhet", then in layer list, with the following icon  tick of "Venue hotspots".

The major hotspots in Savannakhet are assumed to be:

- Savannakhet Health Science College (location No.5)
- Near location no. 5, local restaurants (location No.6)
- Public Park (location No.15).

Figure 14 Location of Other Hotspots in Savannakhet.



3.2.6 Vang Vieng

In Vang Vieng, 106 hotspots were identified along the river, as observed in Figure 15. None of these was categorized as a major hotspot.


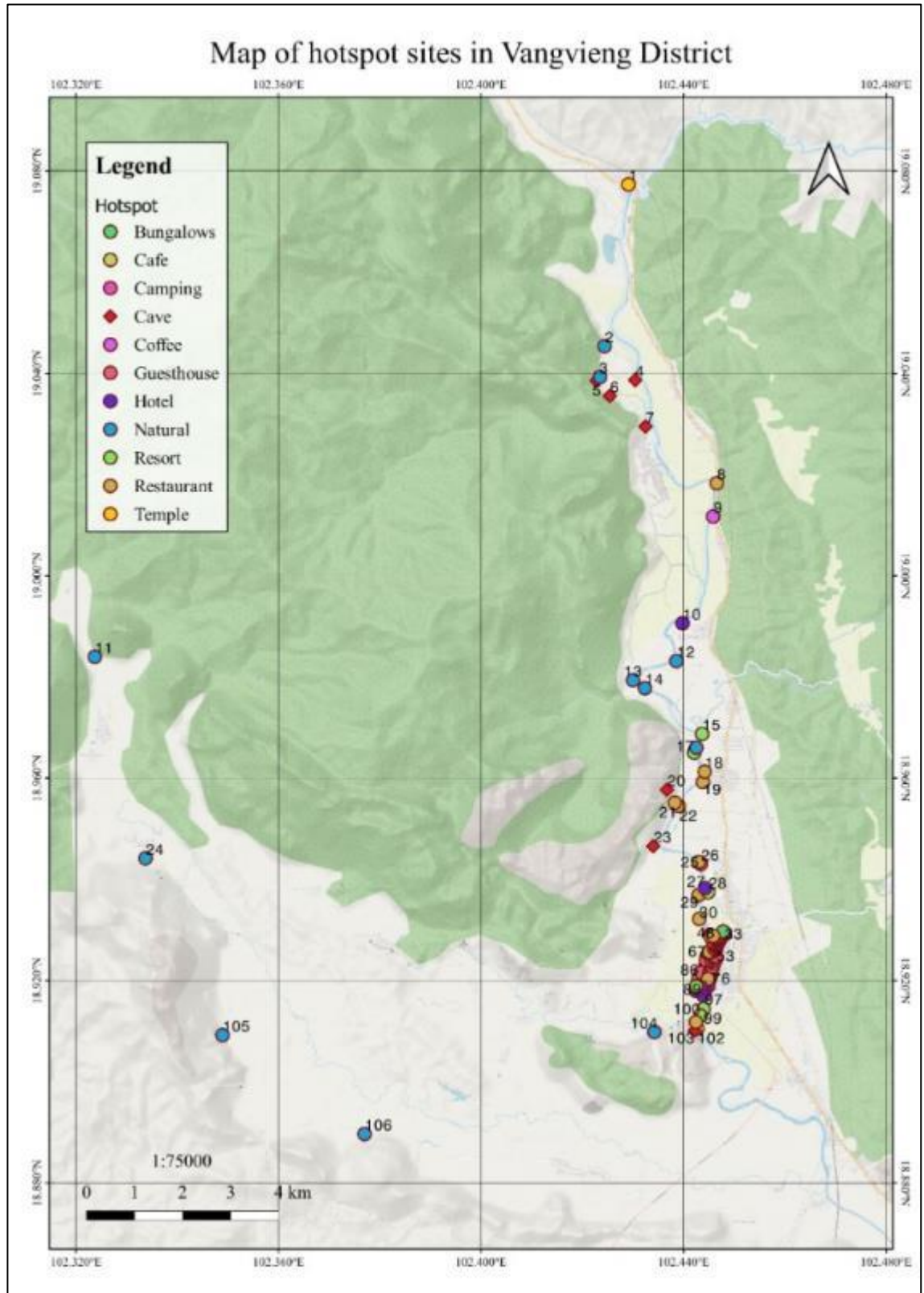
- In the [GIS map](#) select bookmark in the right side and click "Vang Vieng", then select layer list with the following icon  and tick of "Venue hotspots".

Figure 15 Location of Other Hotspots in Vang Vieng.



3.3 Hotspots from Plastic Waste Management

3.3.1 Plastic Waste Facilities

Recycling of plastic waste is a complex process and often requires several steps including several facilities including crushing and compacting, sorting (manual or automatic), extrusion and manufacture of new products. Plastics can be recycled at different stages either as flakes, which is crushed plastics that has not gone through extrusion or pellets and granules, which has been extruded and enhanced properties (by adding additives or mixing with virgin plastics).

The number of plastic waste facilities are summarized in Table 5 below. Plastic waste facilities in Vientiane are more advanced, where plastic is transported to and from the whole country. Details on location can be found in the survey reports under Appendix C. The plastic waste facilities cannot be found in the GIS maps.

Table 5 Number of Plastic Waste Facilities in the Six Selected Cities.

	Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomvihane	Vang Vieng
Retailer/Compacting	2	6	1	1	1	4
Crushing	9	0	0	0	0	0
Compacting and crushing	2	0	0	0	0	0
Automatic NIR Sorting	0	0	0	0	0	0
Recycling (producing pellets/granule)	4	1	0	0	0	0
Source	A	B	C	D	E	F

A: Department of Industry and Commerce of Vientiane Capital and interviews with the factories ; B-F: Interviews at the landfill and with the traders.

Vientiane: Based on the interviews with some plastic crushing and compacting factory owners, most plastics are sold to Thailand (as China banned the imports of compacted plastics and plastic flakes). For plastic granules, some are sold domestically, while most are exported to Thailand and China. Only one of the companies is close to the riverbank.

Pakse: There are six retailers of waste in Pakse that buy plastic bottles and other plastic for redistribution. The plastic bottles are typically transported to Vientiane for recycling, while the other plastic is sold to a Chinese factory in town.

Luang Prabang: There is only one retailer in Luang Prabang (see Figure 16) that transports the collected waste to Vientiane. It was noted that due to COVID-19 the demand for waste products have decreased.

Figure 16 Waste Retailer in Luang Prabang



Thakhek: There is one waste retailer located at the landfill in Thakhek. The plastic waste is primarily transported to Vientiane.

Kaysone Phomvihane: There is one waste retailer located at the landfill in Kaysone Phomvihane. The recovered wastes are sold to waste recycling factories in Vientiane Capital, Vietnam, or Thailand. Recently, Wongpanit Lao, a major waste recovery company in Vientiane, took over the waste recovery operation in the landfill, which was previously owned by the local collection company.




Figure 17 The Waste Retailer at the Landfill in Kaysone Phomvihane with a Rotary Drum Screen



Vang Vieng: There are three smaller waste retailers and one larger one in Vang Vieng. Waste is sold to recyclers in Vientiane. Some of the waste pickers sell directly to a Vietnamese recycling facility.

3.3.2 Illegal Dumpsites

Some of the illegal dumps are placed at the riverbanks, while others are placed inland. The dumpsites in Table 6 were all surveyed by the Consultant. **In total 149 dumpsites were observed across the six cities.** The size of the dumpsites varied from less than one cubic meter to 150 cubic meters, averaging seven cubic meters. **More than 40 percent of the dumpsites was located near rivers, but in volume only 21 percent are located here.**

- In the [GIS map](#) select layer list with the following icon  and tick of "Waste hotspots" to see waste management related hotspots. Illegal dumpsites have an orange diamond label () for dumps inland and red circles () for dumps near the river.

During the surveys, people living near the illegal dumpsites were interviewed. Waste at dumpsites on land is not collected and occasionally burned. Waste on dumpsites near rivers is sometimes burned or simply left and washed away into the river when it rains.

Table 6 Details on the Illegal Dumpsites in the Six Cities

		Dumpsites near rivers	Dumpsites inland	Total, all dumpsites
Vientiane	No. of sites	7	30	37
	Approximate m ³	32	286	318
	Estimated tons	2	20	22
Pakse	No. of sites	6	11	17
	Approximate m ³	107	198	305
	Estimated tons	7	14	21
Luang Prabang	No. of sites	16	10	26
	Approximate m ³	20	24	44
	Estimated tons	1	2	3
Thakhek	No. of sites	13	23	36
	Approximate m ³	34	146	180
	Estimated tons	2	10	13
Kaysone Phomvihane	No. of sites	7	11	18
	Approximate m ³	12	177	189
	Estimated tons	1	12	13
Vang Vieng	No. of sites	12	3	15
	Approximate m ³	19	12	31
	Estimated tons	1	1	2
Total no. of sites		61	88	149
Total m³		224	843	1,067
Total tons		16	59	75

Notes: Dumpsites near rivers have been estimated visually on the GIS map with a distance less than 200 m from the riverbank. Density used to estimate weight: 70 kg/m³.

Figure 18 shows the location of the illegal dumps in Vientiane and in Figure 19 some photos are included. Maps and pictures of the illegal dumps in the other cities can be found in the Activity Reports under Appendix C.

Figure 18 Map of Illegal Dumpsites in Vientiane Capital

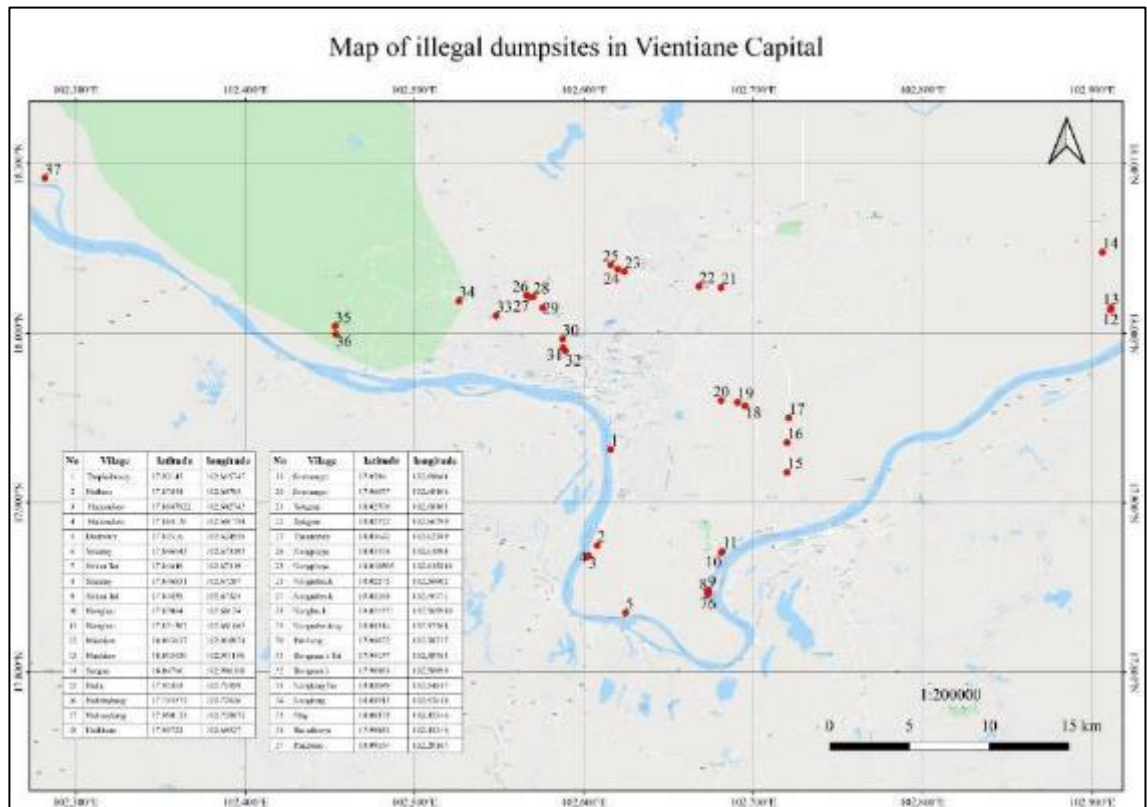


Figure 19 Illegal Dumpsites in Vientiane



3.3.3 Landfills and Transfer Stations

Landfills and transfer stations can potentially be major hotspots for plastic waste pollution. **However, none of the landfills in the six cities are situated near a river.** Table 7 includes an overview of the existing landfills and transfer stations in the six cities.




- In the [GIS map](#) select layer list with the following icon  and tick of "Waste hotspots" to see waste management related hotspots. Transfer stations have a small truck label () and landfills a container label (). See the different cities by clicking the bookmarks in the right side.

Table 7 Overview of Landfills and Transfer Stations.

		Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomvihane	Vang Vieng
Landfills	No.	1	2	1	1	1	1
	Size (ha)	100	14/10	21	9.6	16	9
	In operation from	2009	1998/not in operation yet	1999	1999	1998	N/A
	Remaining capacity	30 ha, 7-10 years	Almost full/10 ha	11 ha	Almost full	12 ha	N/A
	Proximity to river	No	No/No	No	No	No	No
	Management	***	**	**	**	**	*
Transfer stations	Number	1	0	0	0	0	0
	Proximity to river	No					

The level of management is indicated, where *** represents a well-managed or sanitary landfill, while * is managed as an open dump.

Most waste collection companies deliver waste directly to the landfill in **Vientiane** (located at 32 kilometers from Vientiane city center). Waste collected by "Waste Collecting Service Unit" are brought to the transfer station, which is located 16 kilometers from Vientiane city center.

The landfills in **Pakse**, **Luang Prabang** and **Kaysone Phomvihane** were all designed as sanitary landfills, but are now mismanaged with incorrect placement of incoming wastes and no daily covering.

Figure 20 The Landfill in Vientiane (left) and Luang Prabang (right).



In **Pakse** a new landfill has been established but is not yet in operation. In **Luang Prabang** there is land available to extend the capacity of the existing landfill, but this has not been developed yet due to the area being mountainous. A new landfill will be

constructed in **Thakhek** under the Fourth Greater Mekong Subregion Corridor Town Development Project. The new landfill will have three cells, with a capacity of 294,295 cubic meters. The landfill in **Kaysone Phomvihane** is currently being upgraded, including better management and leachate treatment. In **Vang Vieng** the landfill is practically an open dump, but Asian Development Bank (ADB) is assisting in planning to upgrade it to a sanitary landfill.

As part of the *Solid Waste Assessment* (provided as separate report) the status of existing and planned landfills and other waste infrastructure is updated and verified.

4 Quantification of Plastic and Plastic Waste

The purpose of this assessment was to get an overview of the mass flow of plastic in Lao PDR. Most of the plastic waste is plastic packaging, since these products have a limited lifetime and are used for a wide range of products, including food products. Under this activity, the following sources of plastic in the waste system have been investigated:

- Import and production of plastic packaging for domestic use and export
- Import, domestic recycling, and export of plastic waste
- Quantitative estimate of riverine plastic litter based on the land-based hotspot analysis
- Quantitative estimate of riverine plastic litter based on the riverine surveys.

Quantification of plastics and plastic waste is of great interest for the development of policy measures as they point to focus areas. The results from the quantification will be utilized in the *Plastic Policy Assessment* (separate report) to recommend which policy measures should be adopted.

4.1 Land-Based Surveys

4.1.1 Import and Production of Plastic Packaging

In 2018, at least 173 kilotons of plastic packaging and plastic products were imported to Lao PDR. There is an uncertainty in the data, as described in the methodology. **Products with plastic packaging and plastic products are mainly imported from Thailand, China, and Vietnam.** During the 2014-2018 period, 85-92 percent of the import of these products were imported from these three countries (calculated by monetary value). Looking at only plastic products the picture is the same, however with a decreasing percentage over the years giving room for Japan and the European markets.

Table 8 Import of Plastic Packaging and Plastic Products to Lao PDR

Product category	Plastic content estimate	Estimate of import in 2018 (tons)
Animal & Animal Products	5%	4,270
Vegetable Products	5%	9,447
Foodstuffs	5%	31,462
Plastics / Rubbers	100%	127,590
Total		172,769

The above estimate is validated by the registered import in Table 9, which states a large share of rubber products is imported. The export from Lao PDR is smaller than the import and the main categories are pellets (for production) and plastic bags.

Table 9 Import and Export of Products of Rubber and Plastic in 2018 with Specification of the Two Largest Categories³

Product category	Export	Import
Plastic pellets (granules)	18,302	11,672
Plastic bags	18,409	-

³ Source: Raw data from Department of Custom at Ministry of Finance. Data summarised by department of import and export at Ministry of Industry and Commerce.

Product category	Export	Import
Rubber products	-	153,827
Other products (e.g. PVC tubes, construction material)	89,660	4,764
Total	126,372	170,263

There are at least 17 production facilities in Lao LPR with a production capacity of approximately 51,000 tons based on interviews which is listed in Table 10. The capacity is likely larger comparing to the amounts of export and as it was not possible to get hold of all 77 registered facilities. The full list of registered production facilities can be found in Appendix D. The list is registered companies, hence also includes companies that never started production, new companies who have not begun production, and companies which are closed. The Ministry of Commerce and Industry state that updating and improving the existing list is ongoing.

Table 10 Production of Plastic Packaging in Lao PDR

Business name	Address	Product Description	Capacity (t/yr)	Market
Keophila Drinking Water and Ice	Pure Saythani District, Vientiane Capital Tel: 020 55555789	Plastic (drinking water) bottles	30-50	Domestic
LLC Plastic Lao Sole Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 23666636	Plastic pellets (PP, PE, PS, ABS, PAG)	1,500	Domestic & Export
Lao Development Plastic Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 58326789	Bags	10	Domestic
Green Environment Factory	Saythani District, Vientiane Capital Tel: 020 55111086	Import plastic waste for recycling	1,200-2,000	Domestic & Export
Yommanee Factory	Plastic Naxaythong District, Vientiane Capital Tel: 020 96663435	Plastic pellets (granule)	100	Domestic & Export
Sack Factory	Oudomxay Homsay District, Oudomxay Province Tel: 020 55787550	Plastic sack	1200	Domestic
Lao Jing Investment Development Co.,Ltd	Jiang Sam Neua District, Huaphanh Province Tel: 020 99516666	Bags, chopsticks, chairs, baskets	60-120	Domestic & Export
Lomankham Drinking Water & Ice Factory	Kaysone District, Savannakhet Province Tel: 041 212181	Bottles	120	Domestic
Sokmixay Export Sole Co.,Ltd	Import- Kayson District, Savannakhet Province Tel: 020 54151444	Plastic pellets (granules)	5,225	Domestic
Lao You Suan and Rubber Factory	Plastic Kayson District, Savannakhet Province Tel: 02097347597	Import plastic waste for recycling	628	Export
Ketsana Factory	bottle Songkhon District, Savannakhet Province Tel: 020 99147059	Bottles	1	Domestic
Waanchai Co.,Ltd	Plastic Vapi District, Salavan Province Tel: 020 2792266	Bags, straws, ropes, cups, bottles & caps and other plastic products	50	Domestic
Jampadeng Export Sole Co.,Ltd	Import- Khongxedon District, Salavan Province Tel: 020 95551777	All plastic products	21,900	Domestic & Export
S&S Manufacturing and Production Metal Co.,Ltd	Vapi District, Salavan Province Tel: 020 99125777	Plastic pellets (granules)	4,500	Export

Business name	Address	Product Description	Capacity (t/yr)	Market
Champa Factory	Plastics Bajieng District, Champasack Province Tel: 020 55631888	Plastic sack	14,400	Domestic & Export
Phoufa Drinking Water Co.,Ltd	Pure Pakse District, Champasack Province Sole Tel: 020 97844471	Bottles	1	Domestic
IRIS Ice and Plastic Factory Individual	Pure Drinking Pathoumphone District, Champasack Province Tel: 020 97973838	Bottles	2	Domestic

Source: Department of Enterprise Registration and Management & Department of Industry and Handicraft, MOIC, Lao PDR, 2020

4.1.2 Import and Export of Plastic Waste and Secondary Raw Materials

Table 11 shows an overview of import of plastic waste over the last five years. As can be seen, there is a **clear increase of import of plastic waste to Lao PDR - almost 10 times increase from 2018 to 2019**. In 2018 the share of polymers was PS (33 percent), PE (4 percent), PVC (3 percent), and other plastics such as PET or mixed polymers (61 percent), but this varies from year to year. In 2019, the share were PS (26 percent), PE (5 percent), PVC (0.01 percent), and other plastics such as PET or mixed polymers (69 percent) (United Nations, 2020). The plastic is imported from various countries, (see The Parenthesis is the Monetary Value in US\$, thousands.

Table 12) and in 2019 there was an increase in both quantity and variation of countries. There was a notable increase in waste from other continents, especially North America, but also Europe.

Table 11 Import and Export of Plastic Waste in Lao PDR in Tons.

tons	2015	2016	2017	2018	2019	Source
Import of plastic waste	1,256	1,181	3,909	7,881	98,533	UN Comtrade
Export of plastic waste	862	1,919	1,353	822	1,833	
Import of secondary raw plastic materials	5,092 (452)	452 (1,064)	1,064 (144)	143 (1,543)	1,543 (221)	Raw data from Department of Custom at Ministry of Finance. Data summarized by department of import and export at Ministry of Industry and Commerce
Export of secondary raw plastic materials	4,537 (657)	657 (4,585)	4,585 (1,557)	1,557 (4,903)	4,903 (938)	

The Parenthesis is the Monetary Value in US\$, thousands.

Table 12 Import of Plastic Waste by Country Reported by Lao PDR (United Nations, 2020) in Tons

Country	2015	2016	2017	2018	2019
USA	10	0	0	42	33,704
Thailand	548	572	1,071	4,701	27,273
China, Hong Kong SAR	18	0	0	1,256	17,298
Canada	0	0	0	53	5,857
China	569	505	448	371	5,004
Spain	0	89	0	1,099	3,224

Country	2015	2016	2017	2018	2019
Italy	0	0	0	17	2,272
Australia	0	0	0	0	1,488
Netherlands	0	0	0	4	835
Pakistan	0	0	0	0	438
Japan	0	0	48	81	250
Bosnia Herzegovina	0	0	0	0	222
Bahrain	0	0	0	0	163
Viet Nam	104	15	36	49	118
Belgium	0	0	1,538	149	92
Germany	0	0	0	33	91
United Kingdom	0	0	0	0	66
Mexico	0	0	0	0	63
Poland	0	0	12	0	34
Madagascar	0	0	0	0	23
Curaçao	0	0	0	0	19
Austria	0	0	0	5	0
Cyprus	0	0	655	0	0
Eswatini	0	0	0	15	0
Malaysia	0	0	17	0	0
New Zealand	8	0	0	0	0
Other Asia, nes	0	0	6	0	0
Portugal	0	0	0	5	0
Romania	0	0	77	0	0
World	1,256	1,181	3,909	7,881	98,533

Sorted descending to 2019 figures.

Table 11 also shows the export of waste, which was to China, Vietnam, and Thailand with the only exceptions that in 2015 and 2017 there was exports to Hong Kong and in 2018 to Ethiopia. Around 90 percent of the exported plastic waste throughout the years is reported as other than PE, PS and PVC (United Nations, 2020). It is unknown whether this means that plastic was mixed or sorted into other polymers.

The import of secondary raw materials ready for production is also increasing, while export of secondary raw materials is decreasing. The monetary value (in US\$, thousands) of the import and export of secondary raw materials is observed in parenthesis.

The increase in import of plastic waste could partly be explained by increase in data quality, but the large increase from 2018 to 2019 is most likely a consequence of the Chinese restrictions on import from 2018, followed by other Asian countries. **The capacity to cope with the large increase of plastic waste in Laos does not currently exist.**

4.1.3 Simplified Riverine Plastic Litter Assessment Tool

The riverine survey described above has resulted in an estimated amount of plastic waste leaked into the Mekong River, which will possibly become marine litter. The methodology behind this quantification can be found in Section 2.2.5 and Appendix A, as well as data input.

Table 13 below shows the aggregated results and estimates a total annual leakage of 2,200 tons of plastic from the six cities.

Table 13 Main Results of the Simplified Riverine Plastic Litter Assessment Tool for each City.

2020, in tons/year	Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomvihane	Vang Vieng	Total
Total plastic waste generation	39,779	2,015	2,745	3,712	8,941	2,862	60,053
Recycling, energy recovery & RDF	3,461	115	60	110	89	60	3,895
Landfilling of plastic waste	9,757	699	2,164	753	2,642	530	16,544
Total uncollected plastic waste	26,512	1,197	510	2,845	6,196	2,270	39,530
Total plastic waste entering waterways	3,972	235	126	428	725	624	6,110
Retention in waterways	2,582	153	82	278	471	406	3,972
Direct beach and riverbanks littering	2	7	24	4	2	21	61
Total riverine plastic litter leaked from city (tons/year)	1,393	90	69	155	256	240	2,203

It must be noted the tool is simplified and includes many estimates. Subsequently, the results come with uncertainties. The key figures used as input for the tool are listed in Table 14 below.

Table 14 Key Values for The Input for The Simplified Riverine Plastic Litter Assessment Tool. The Remaining Values can be Observed in Appendices.

No.	Description	Unit	Values
2	How much municipal solid waste does the population produce on average per person and per day for one year?	Kg/day	0.77-1.20
3	What is the share of plastics in the municipal solid waste stream?	Weight-%	6-15%
4	How many people do receive formal and regular municipal solid waste collection services in the area?	% of population	21-81%
9	How much of the generated waste is adequately reused or recycled	% produced plastic waste	1.0-8.7%
14	How much of the uncollected plastic waste is openly burned at household or roadside level, which cannot leak into waterways?	% of uncollected plastic waste	40%
15	How much of the uncollected plastic waste is buried or openly dumped, which cannot leak into waterways?	% of uncollected plastic waste	15-37%
17	How much of uncollected plastic waste can enter waterways but is not directly disposed into waterways	% of uncollected plastic waste	3-25%
30	How much marine litter stems from disposal of plastic waste at beaches and along the coastline (such as from tourist or recreational activities)	kg/day	6-65

In the Figures below, results of the simplified riverine plastic litter assessment tool can be observed for each city.

Figure 21 Vientiane - Results of the Simplified Riverine Plastic Litter Assessment Tool (Tons per Year)

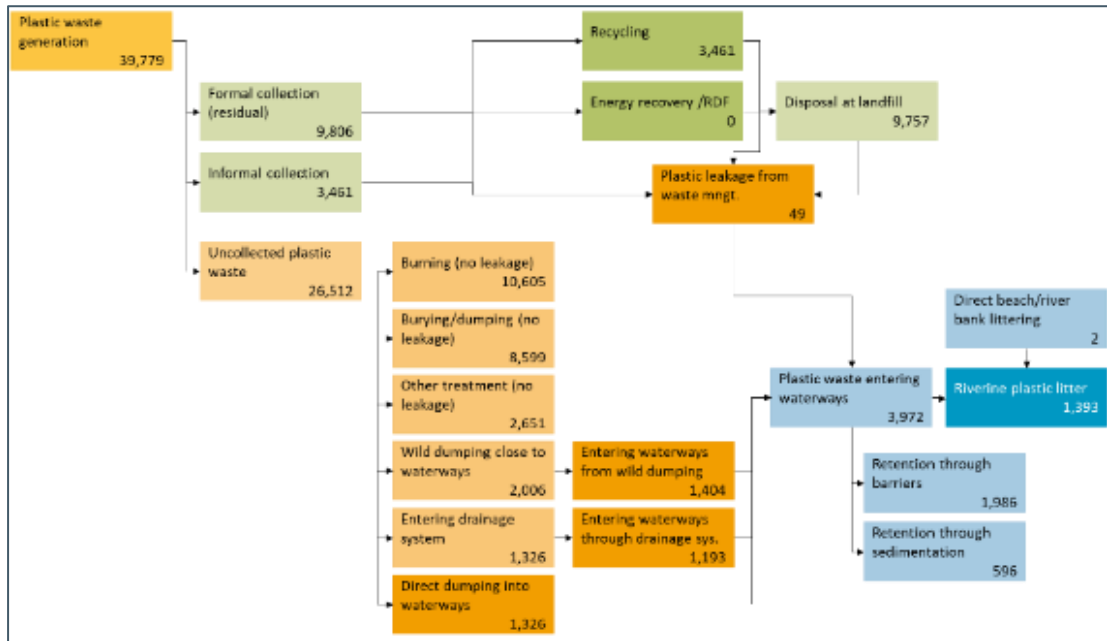


Figure 22 Pakse - Results of the Simplified Riverine Plastic Litter Assessment Tool (Tons per Year)

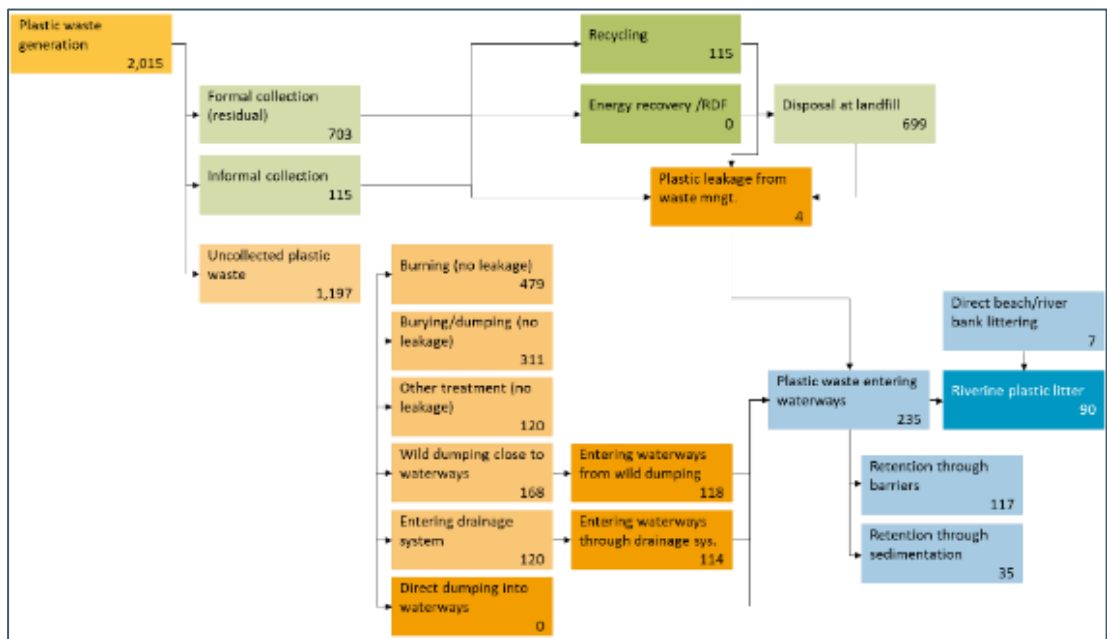


Figure 23 Luang Prabang - Results of the Simplified Riverine Plastic Litter Assessment Tool (Tons per Year)

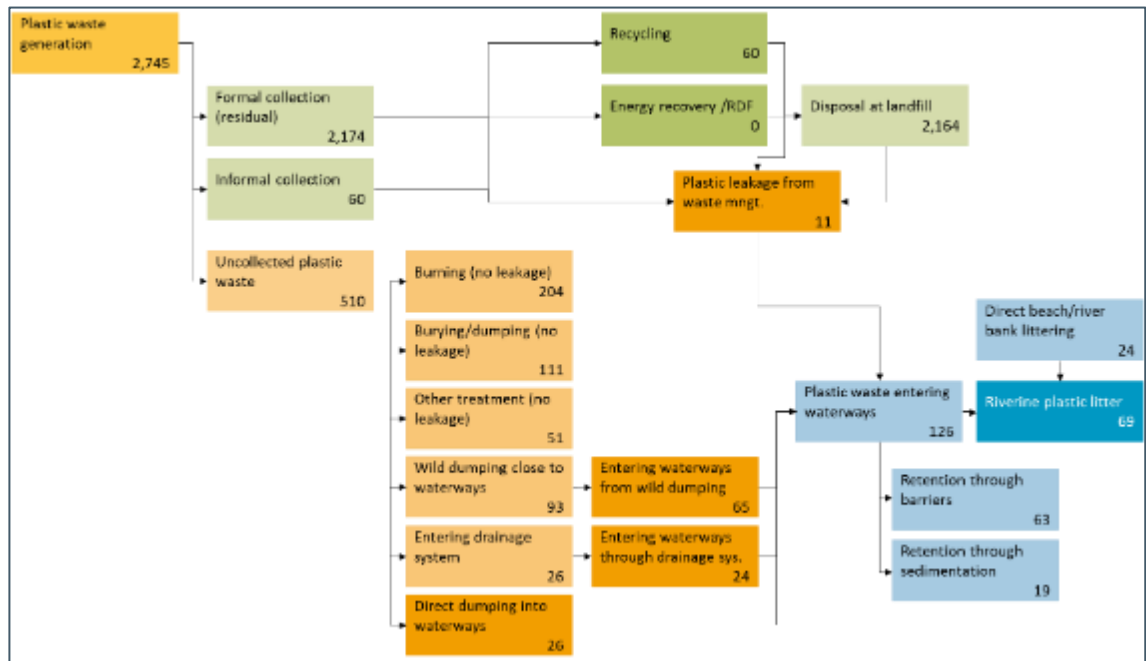


Figure 24 Thakhek - Results of the Simplified Riverine Plastic Litter Assessment Tool (Tons per Year)

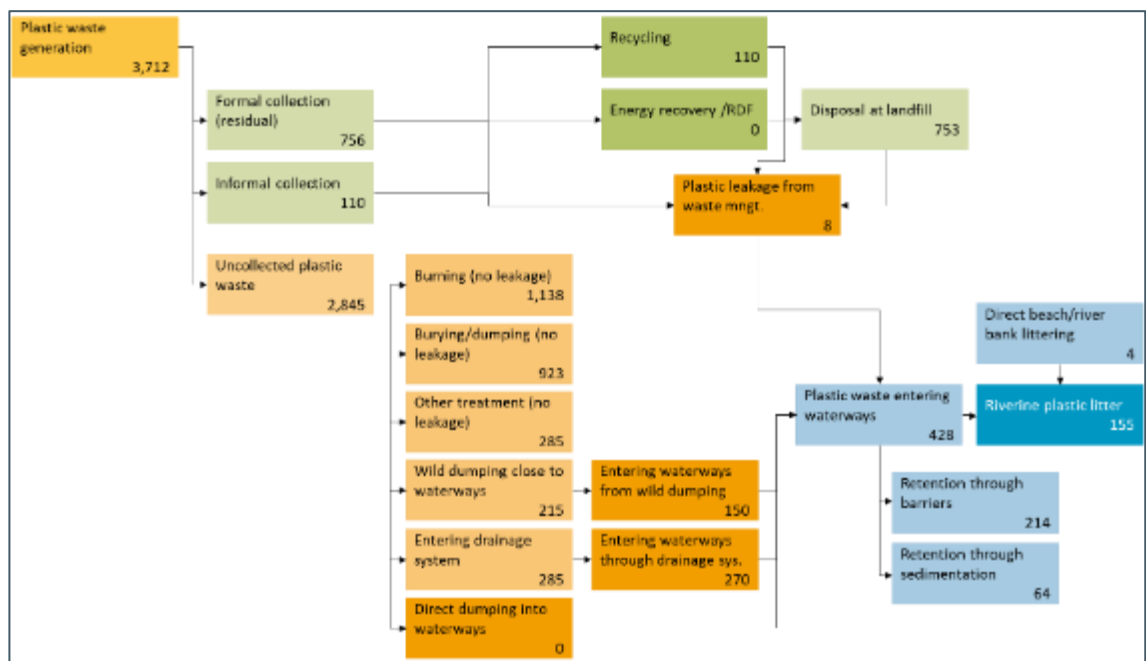


Figure 25 Kaysone Phomvihane - Results of the Simplified Riverine Plastic Litter Assessment Tool (Tons per Year)

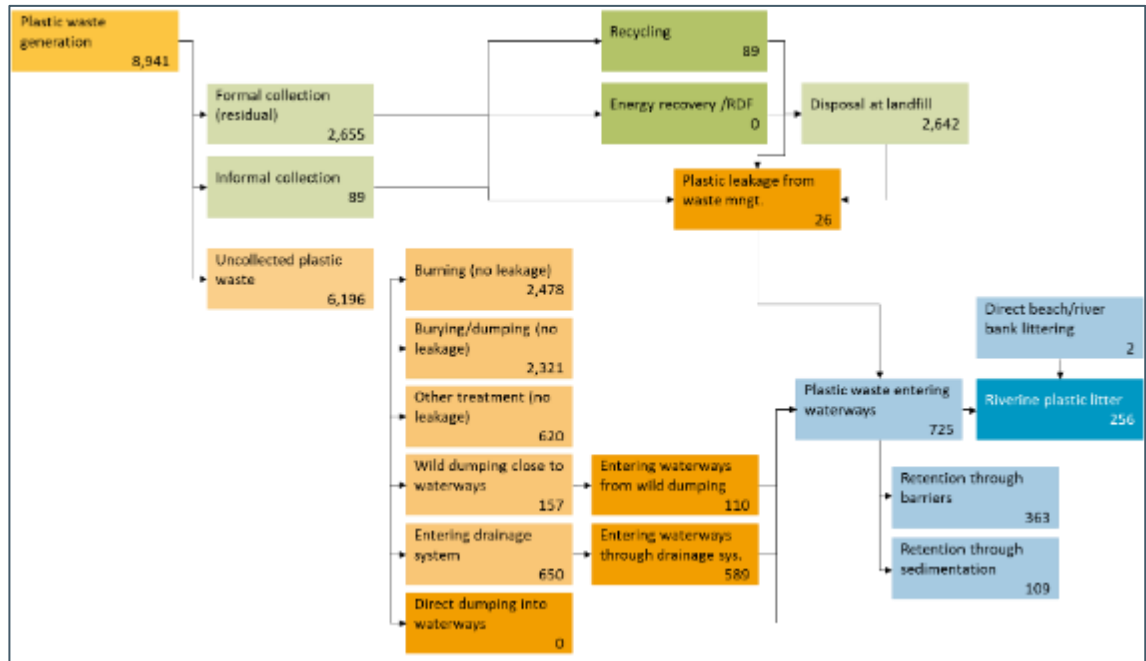
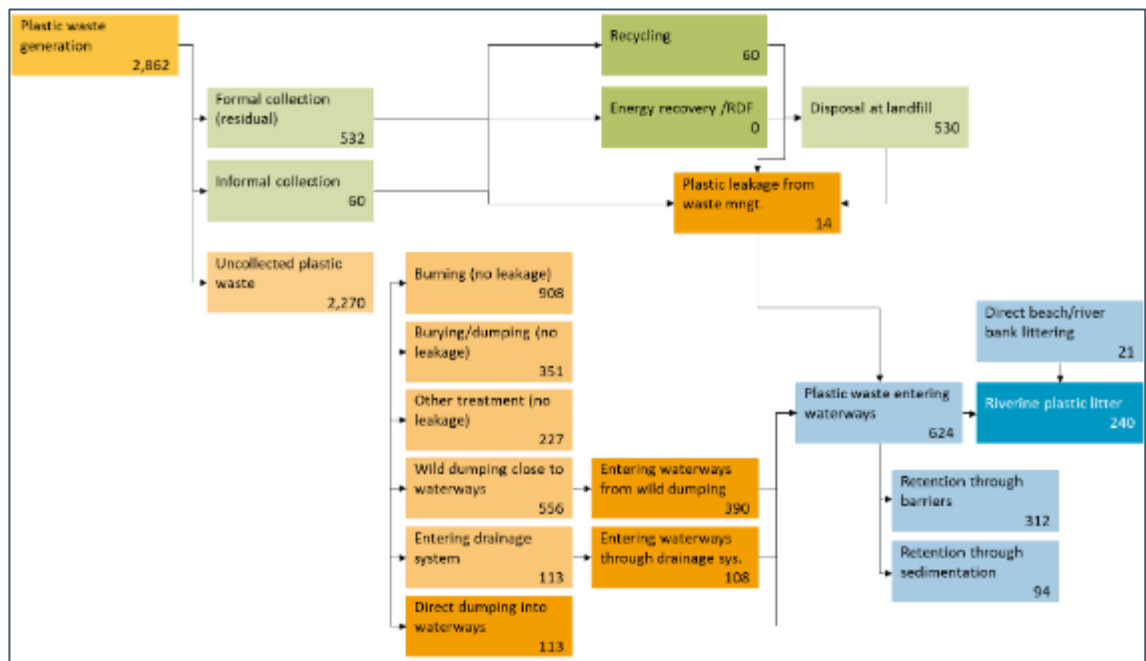


Figure 26 Vang Vieng - Results of the Simplified Riverine Plastic Litter Assessment Tool (Tons per Year)



4.2 Riverine Surveys

The results from the net-trap-surveys are used as basis for a simple estimate of the plastic flow in the river based at the cross section of the net and the river, respectively. The estimated plastic flow for each city is shown in Table 15. It is observed that there is some consistency between the plastic waste flow and the size of the city with larger amounts in large cities compared to smaller amounts in smaller cities. The number of items estimated range from 2 to 20 items per person per year.

Table 15 Main Results for the Net Trap Surveys in the Six Selected Cities

	Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomvihane	Vang Vieng	Total
Plastic waste (no of items)	1,811	221	375	319	950	691	4,367
Plastic waste (weight, kg)	20	4.9	10	6.5	9.3	15	65.5
Duration of experiment (days)	5	5	5	5	5	5	
River/net factor*	40	38	25	64	39	3	
Plastic waste flow (mio. items/year)	5.3	0.6	0.7	1.5	2.7	0.1	11
Plastic waste flow (tons/year)	59	13	18	30	26	3	151

* The factor between the area of the cross section of the river (river width x river depth) over the area of the net (40m x 2m).

In theory, the plastic should accumulate downstream, but we have not observed this in the surveys. **Hence, the reality is more complex and further studies will be necessary to understand the more complex hydrological parameters that are in play.**

4.3 Summary—Quantification of Riverine Plastic Waste

The survey results show an estimated amount of plastic waste in the river in the magnitude of 3-60 tons plastic per year per city (see Table 15). The modelling results show plastic quantities of 70-1,400 tons per year depending on the city (see Table 13). Both methodologies have significant uncertainties. The uncertainties of the modelling are described in Section 2.2.5. It should be noted that the estimates include some uncertainties as the following parameters were not considered:

- Seasonal variations, such as monsoon or dry season, influencing the water level and current of the river, as well as wash-out of plastic (primarily in the beginning of the monsoon season).
- Distribution in the water column due to differences in density of different types of plastic waste.
- Distribution across the river due to currents in river bends. The selected sites for net and boat surveys were chosen at relatively straight parts of the river to avoid this issue.
- Issues related to survey set-up. The nets bent with the water current, so the bottom of the net was further downstream compared to the top of the net. It was observed that some waste could escape under the net due to the water current. It was estimated up to 20 percent of the waste flowing directly into the net escaped.
- Activities that generate plastic waste may have been reduced due to COVID-19. For example, it was observed that the fresh produce markets were less active.

Emmerik et al (2019) investigated the seasonality of riverine macroplastic transport in the Saigon River. They found a large seasonal variation from the smallest in August (4×10^3 items per hour) to the largest plastic flow in December (19×10^3 items per hour). No clear relation between water discharge, rainfall and plastic waste transport could be identified in the study. Therefore, it was concluded that all factors influence the plastic waste flow in a way that needs to be further investigated. Furthermore, the plastic waste transport seemed to be affected by the presence of water hyacinths, acting as accumulation zones for the plastic waste transporting the waste downstream together with the plants.

Emmerik et al (2019) also investigated the distribution in the water column, that is the vertical distribution, and found that almost 90 percent of the plastic waste was present in the top 0.5 meter of the river. This means that the net survey was able to capture most of the plastic flowing by, even though the net did not cover the full depth of the river.

Emmerik et al (2019) found an annual plastic flow in the magnitude of 1.5×10^3 tons per year at the estuary of the Saigon River, which is in the same magnitude of the estimated flow in the Mekong River, 2,200 tons per year (modelled, see Table 13).

Due to the large variations of the results (modelled results as well as the estimates based on the net surveys) the conclusion is that the quantities of plastic waste pollution of the Mekong River in Lao PDR are in the magnitude of 70-1,400 tons of plastic per year. As the interval indicates, the uncertainties of the results are large, and this is an area that should be investigated further.

Lebreton et al. (2017) estimates the plastic inputs to the Ocean from the Mekong River is 18,800 to 37,600 tons per year. The University of Hull estimates the annual flow to be 40,000 tons (University of Hull, 2020). Hence there are still a lot of uncertainties in estimating these flows.

5 Composition of Discharged Plastic Waste

The purpose of this assessment is to obtain an overview of the composition of the discharged plastic in Lao PDR. Under this activity, the following compositions of plastic have been investigated:

- Products
- Polymers

The composition plastic waste is relevant because it shows which products and polymers are most likely to end up in the rivers of Lao PDR. With this information policy measures can be developed that address specific product categories. Understanding of the polymers is also of interest for assessing the possibilities to recycle these products. Both results will be utilized in the *Plastic Policy Assessment* (separate report).

5.1 Products

The plastic composition was determined by sorting of the plastic waste collected in the net-trap-surveys and by boats. The waste was sorted into the product items and product types shown in Appendix B. The composition was assessed based on the number of items as well as by weight. The results presented below mainly represent the overall composition across the six cities investigated (all data). However, some Tables also present the results for each city individually.

5.1.1 Nets and Boat

The results from the nets and boat surveys are presented first as aggregated results followed by an analysis of the differences between the cities.

Aggregated Results from all Six Cities

The overall result from the nets and boat surveys for all six cities shows that **the product types are dominated by food and drink packaging** (see Table 16).

Table 16 The Overall Product Types of the Combined Data for all Cities by Number of Items and by Weight

Product type	No. items	Kg
Food and drink packaging	3,892	45.3
Household products	1,541	41.2
Other packaging	539	8.3
Personal care products	116	2.8
Fishing gear	37	3.8
Smoking materials	1	0.0
Sum	6,126	101.4

The product items can be further divided into specific product items (according to the list of plastic items, see Appendix B). Table 17 presents the distribution of the collected plastic waste from the surveys (nets and boat from all six cities) between the different product items for the number of items and weight respectively. The product items in the Table represent 99 percent of the collected waste both by number and weight. **The top three items are bottles, caps and lids, and bags.**

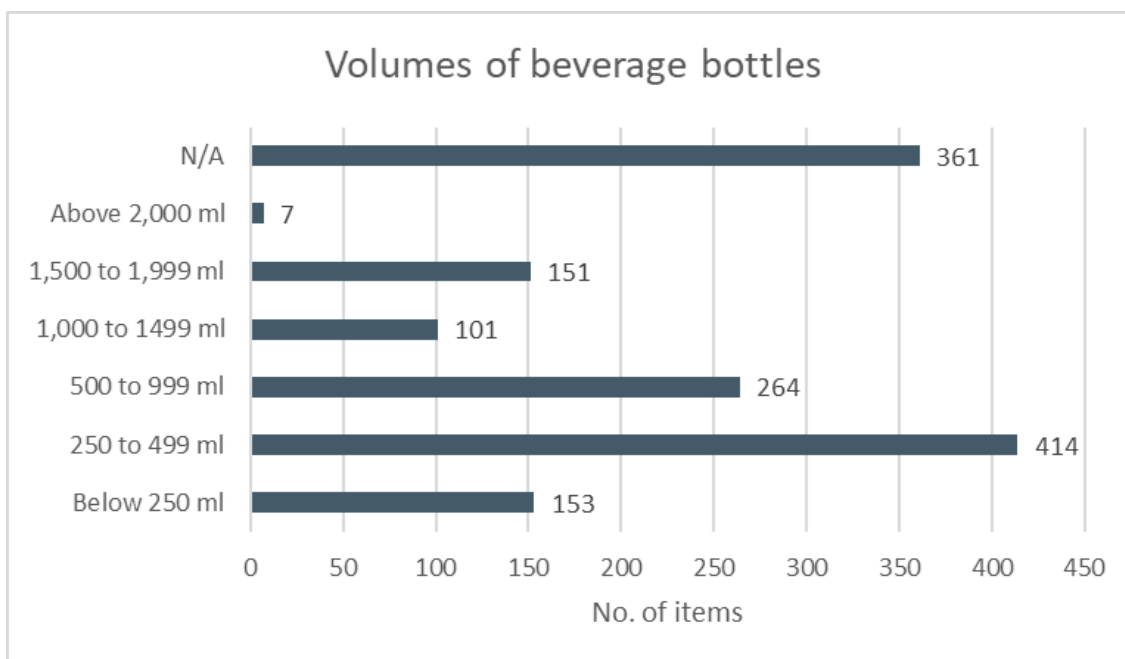
Table 17 The Products Items Which Was Found in Highest Quantity and Weight. Sorted Descending to Number of Items

Product item	No. items	Kg
Bottles	1,451	29.7
Plastic caps and lids, incl. rings from bottle neck	1,316	2.2
Bags	745	10.5
Shopping Bags incl. pieces	661	18.1
Cups and cup lids	397	2.6
Food containers incl. fast food containers	379	1.4
Foam packaging/insulation/polyurethane	374	6.5
Plastic/polystyrene pieces 2.5 cm > < 50cm	230	4.1
Straws and stirrers	162	0.1
Cleaner bottles & containers	133	1.6
Cover / packaging	72	1.9
Shoes/sandals	59	9.0
Crates and containers / baskets	30	0.5
String and cord (diameter less than 1cm)	25	0.6
Other bottles & containers (drums)	21	1.2
Medical/Pharmaceutical containers/tubes	19	0.9
Plastic/polystyrene pieces > 50 cm	4	6.8
Rope (diameter more than 1cm)	1	2.7
Other items	47	1.1
Sum	6,126	101.4

The product item categories do not follow the same order for the two parameters (number of items and weight). This is due to very different weight of the different product types. An example is the plastic cups and cup lids which are great in numbers but do not weigh much.

Bottles are the dominating product item, and these mainly consist of beverage or water bottles. Figure 27 shows the distribution of the volumes of the bottles. It can be noted that 39 percent of the beverage bottles have a volume of below 500 milliliters and are rather small.

Figure 27 The Distribution of Volumes of the Beverage Bottles



The collected waste from the net and boat surveys also contained non-plastic waste items, such as metal, glass, and cardboard. Table 18 shows the share of plastic in the collected waste, which was very high (more than 90 percent) in terms to items, while being significantly lower in terms of weight. This is because plastic is a light material compared to a material such as glass. Furthermore, **there is a high level of consistency in the plastic share of the collected waste items across the cities, between 92 percent and 98 percent.**

Table 18 The Share of Plastic in the Collected Waste from the Net and Boat Surveys (Organic Items (Grass, Leaves, Tree etc.) are not Included)

	Vientiane	Pakse	Luang Prabang	Thakek	Savannaket	Vang Vieng	Total
Plastic share (items)	95%	95%	94%	98%	92%	93%	94%
Plastic share (weight)	67%	73%	82%	92%	45%	84%	73%

Figure 28 illustrates the Top-15 by number of items. The figure shows that bottles, plastic caps and lids, and bags and shopping bags are the most common. **The Top-10 by number of items covers 95 percent of all the collected plastic items,** while the corresponding Top-5 covers 75 percent.

Figure 28 Top-15 by Number of Items. Aggregated Results from All Net and Boat Surveys in All Six Cities

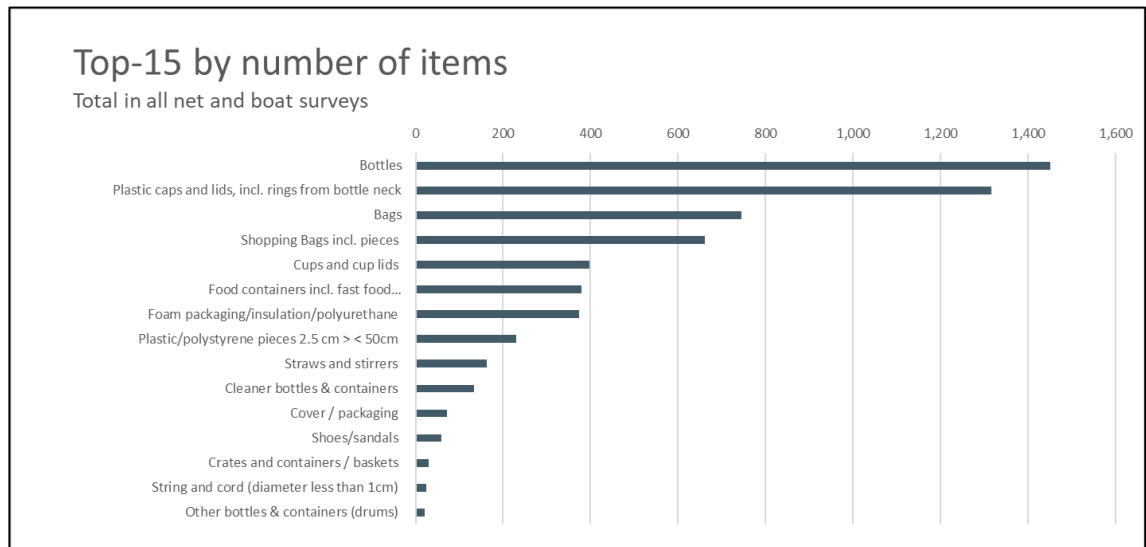


Figure 29 illustrates the Top-15 by weight. The Figure shows that bottles, bags and shopping bags, and shoes and sandals are the most common. Smaller items, such as plastic caps and lids, cups and cup lids, and straw and stirrers, mostly dominate the Top-15 by number of items.

Figure 29 Top-15 by Weight. Aggregated Results from All Net and Boat Surveys in All Six Cities.

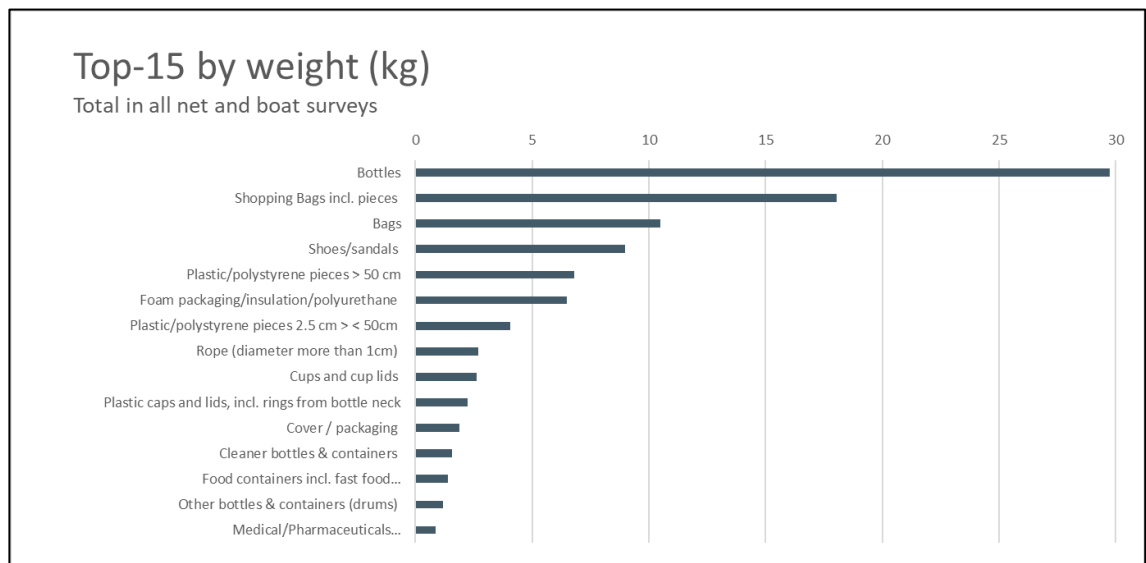









Table 19 shows the definition of the product items in the Top-15 and indicates the typical polymer(s). More information on polymer type for each of the product item categories can be found in Section 5.2.

Table 19 Definition of the Top-15 Items

Product item	Explanation	Example	Typical polymer(s)
Bottles	Beverage bottles		PET
Plastic caps and lids, incl. rings from bottle neck	Lids typically from drinking bottles		HDPE

Product item	Explanation	Example	Typical polymer(s)
Bags	Bags not covered by the categories "Shopping Bags incl. pieces" and "Small plastic bags, e.g. freezer bags incl. pieces"		LDPE, HDPE
Shopping Bags incl. pieces	With a handle		LDPE
Cups and cup lids	Cups for on the go drinks such as coffee or juice		EPS/XPS, PP
Food containers incl. fast food containers	To contain food, typically on the go		EPS/XPS, PP
Foam packaging/insulation/polyurethane	Typically for take-away food, but also construction material		EPS/XPS
Plastic/polystyrene pieces 2.5 cm > < 50cm	Pieces of plastic that are not recognizable as an item		All
Straws and stirrers	For beverages		PP
Cleaner bottles & containers	Containers for shampoo, soap, and other similar products		HDPE
Cover / packaging	Packaging for mainly food items, but also small shampoo packages		LDPE
Shoes/sandals			Other
Crates and containers / baskets	To carry products and items		HDPE
String and cord (diameter less than 1cm)			PA
Other bottles and containers (drums)	Larger containers typically for liquid goods		HDPE

Differences Between the Cities

The analysis showed some differences between the cities, which is illustrated in Table 20. The results are shown in percentage, since the total number of items differs for each city.

The number of bottles is relatively consistent across the cities (12-24 percent), except for Vang Vieng, where the share is much higher (39 percent). This difference may be because Vang Vieng is visited by many tourists that consume more packaged beverages. The difference in "Bags and Shopping Bags", especially for Thakhek, can

be explained by inconsistency between the utilization of the two product items "Bags" and "Shopping Bags incl. pieces". The number of "Cups and cups lids" in Thakhek is larger than the other cities, while the number of "Plastic caps and lids" is lower, which is likely due to an inconsistent use of the survey categories. For the other product categories there is an overall consistency between the cities.

In below Table, shares more than 50 percent larger than the average is colored red. Note that since the largest number of items (33 percent) are from Vientiane, the composition of Vientiane will largely affect the total composition.

Table 20 Product Items by City in Percentage by Number of Items, and the Red Colored Figures Indicated a Figure more than 50 Percent Larger than the Average.

Product item	Vientiane	Pakse	Luang Prabang	Thakhek	Savannak et	Vang Vieng	Total
Bottles	19.1%	11.9%	18.2%	16.1%	21.2%	39.2%	23.7%
Plastic caps and lids	24.0%	13.0%	14.9%	0.0%	22.4%	30.1%	21.5%
Bags	8.5%	23.8%	11.8%	27.9%	15.3%	6.3%	12.2%
Shopping Bags incl. pieces	16.7%	24.2%	13.3%	0.0%	7.5%	6.3%	10.8%
Cups and cup lids	8.8%	1.8%	4.1%	20.5%	5.6%	0.0%	6.5%
Food containers incl. fast food containers	7.3%	4.7%	8.7%	11.8%	7.4%	0.7%	6.2%
Foam packaging/ insulation/polyurethane	5.9%	0.0%	0.0%	0.0%	9.6%	9.5%	6.1%
Plastic/polystyrene pieces 2.5cm - 50cm	0.7%	9.0%	20.6%	11.7%	0.2%	0.3%	3.8%
Straws and stirrers	2.4%	0.7%	1.3%	1.1%	4.4%	3.2%	2.6%
Cleaner bottles & containers	3.3%	2.2%	1.8%	0.2%	3.3%	0.6%	2.2%
Cover / packaging	1.1%	0.0%	1.7%	5.9%	0.3%	0.1%	1.2%
Shoes/sandals	0.5%	0.4%	0.9%	0.7%	0.1%	2.5%	1.0%
Crates and containers / baskets	0.1%	0.0%	0.6%	0.0%	2.0%	0.0%	0.5%
String and cord (diameter less than 1cm)	0.2%	4.0%	0.0%	1.3%	0.1%	0.0%	0.4%
Other bottles & containers (drums)	0.0%	1.8%	0.2%	0.8%	0.4%	0.3%	0.3%
Other items	1.1%	2.5%	2.0%	2.0%	0.2%	1.1%	1.2%

Table 21 Ranking of Product Items by City (Number of Items)

Product item	Vientiane	Pakse	Luang Prabang	Thakhek	Savannak et	Vang Vieng	Total
Bottles	389	33	99	98	249	583	1,451
Plastic caps and lids,	490	36	81	0	262	447	1,316
Bags	173	66	64	170	179	93	745
Shopping Bags incl. pieces	341	67	72	0	88	93	661
Cups and cup lids	179	5	22	125	66	0	397
Food containers incl. fast food containers	149	13	47	72	87	11	379
Foam packaging/ insulation/polyurethane	121	0	0	0	112	141	374
Plastic/polystyrene pieces 2.5cm - 50cm	15	25	112	71	2	5	230
Straws and stirrers	48	2	7	7	51	47	162
Cleaner bottles & containers	68	6	10	1	39	9	133
Cover / packaging	22	0	9	36	4	1	72
Shoes/sandals	11	1	5	4	1	37	59
Crates and containers / baskets	3	0	3	0	24	0	30
String and cord (diameter less than 1cm)	5	11	0	8	1	0	25
Other bottles & containers (drums)	1	5	1	5	5	4	21
Other items	23	7	11	12	2	16	71

5.1.2 Artificial Barriers

The results of the survey at the artificial barriers support the conclusions made above that bottles and bags are the two major product categories. The results in Table 22 show a good agreement amongst the different survey methods. Bottles and shopping bags are the most found items both at the artificial barriers and in the nets and boat survey. As the artificial barriers are located further upstream, it shows that bags and bottles stem not only from activities at the riverbanks, but also enter the river from smaller tributaries and other land sources such as streets.

Table 22 Overall Results for the Survey on Artificial Barriers (in Percent of Items).

City	Vientiane	Pakse	Luang Prabang	Thakek	Savannaket	Vang Vieng	Total
No. of barriers investigated	35	17	37	10	11	18	128
Total number of items collected	442	527	763	812	873	433	3,850
Plastic shopping bag	34%	50%	19%	36%	44%	13%	34%
Plastic beverage bottle	34%	22%	32%	25%	30%	39%	30%
Styrofoam	6%	8%	13%	0%	4%	18%	7%
Food wrapper	7%	0%	8%	0%	0.0%	12%	4%
Plastic cup, plate, utensil	4%	10%	6%	0.5%	10%	6%	6%
Little plastic bag/container (>20L)	0.5%	1%	4%	0.1%	0.1%	3%	1%
Other plastic	14%	10%	18%	39%	11%	9%	18%

5.1.3 Visual Observations

The visual observations were performed for two hours per day for five days. Here, all waste items visible at the surface of the river were registered. Table 23 shows the overall results. The amount of plastic waste compared to waste of other materials was 76 percent. Items which consist of composite material (a combination of plastic and other materials), or could be of either plastic or another material, accounts for eight percent.

In number of items, **the largest product types are bottles (32 percent) and plastic bags (26 percent). This complies with the top product types in the artificial barriers and the nets and boat survey.**

Table 23 Overall Results for the Visual Observations (in Number of Items)

City	Material	Vientiane	Pakse	Luang Prabang	Thakek	Savannaket	Vang Vieng	Total
Water bottle	Plastic	27	1	23	88	37	39	215
Plastic bag	Plastic	46	2	12	52	32	33	177
Foam	Plastic	28	1	10	18	17	27	101
Glass bottle	Glass	5	1	3	16	23	12	60
Can	Aluminum	4	0	1	11	17	13	46
Milk box	Cardboard and plastic	6	2	6	7	11	11	43
Tobacco	Plastic	0	0	2	5	4	3	14
Clothes	Cotton or plastic	0	0	0	5	2	4	11
Detergent container	Plastic	0	0	0	0	0	6	6
Sack	Cotton or plastic	2	0	0	0	0	0	2
Shoe	Cotton or plastic	1	0	0	0	0	0	1
Paper	Paper	0	0	1	0	0	0	1

City	Material	Vientiane	Pakse	Luang Prabang	Thakek	Savannaket	Vang Vieng	Total
Total		119	7	58	202	143	148	677
Total, plastic (%)		85%	57%	81%	81%	63%	73%	76%
Total, partly plastic (%)		8%	29%	10%	6%	9%	10%	8%
Total, non-plastic (%)		8%	14%	9%	13%	28%	17%	16%

5.1.4 Summary—Composition of Product Items

Table 24 shows the common plastic product item categories found during the net and boat surveys, at the artificial barriers and by visual observations. For the artificial barriers and visual observations less detailed categories for product items have been used and the data in the Table are therefore aggregated.

Table 24 Comparison of Common Product Item Categories Found in Net and Boat Surveys, Artificial Barriers and By Visual Observation (Percentage Based on Number of Plastic Items).

	Nets and boat	Artificial barriers	Visual observation
Bottles	24%	30%	42%
Caps, lids, cups, food containers, straw and stirrers	37%	6%	0%
Bags	12%	1%	35%
Shopping bags	11%	34%	
Foam	6%	7%	20%
Total	90%	78%	96%

The Table shows clearly that bottles and plastic bags (bags and shopping bags combined) constitutes a large fraction of the waste across all surveys. These categories were found to a lesser extent in the nets and boat survey. This is possibly because: (1) the artificial barriers and visual observations were only looking at floating items; and (2) smaller items such as straws could not be observed from a distance in the artificial barriers and visual observations.

The smaller items in the combined category “Caps, lids, cups, food containers, straw and stirrers” constituted a large fraction of the waste in the net and boat survey but were much smaller at artificial barriers and not present in the visual observation survey. For the artificial barriers and visual observations, the absence of this fraction was probably due to the small items not being visible in the surface while floating. Foam products were present in all surveys.

Overall, these five product categories covered 78 to 96 percent of the observed items in all the surveys.

5.1.5 Other Studies

Other World Bank studies in the region have been analyzed and overall results are summarized in Table 25 below, together with those of a large international project done by Ocean Conservancy. It should be noted that the categories and the items investigated by the different surveys are not comparable.

The list is ordered in ascending order, based on the results of this Lao PDR study. The other columns show Cambodia, Myanmar, and international Top-10 items from other studies. The last rows marked in grey are the Top-10 items found in Cambodia, Myanmar and internationally, but not found in this current study.[CC3]

Table 25 Overview of Studies and Their Top-10 Items. Grey Items Have Been Found on Other Surveys, But Not Under the Current Study

Country	Lao PDR	Cambodia	Myanmar	International
Based on	6,126 plastic items collected at 6 cities	3,698 plastic items collected over 173 sites	8 beaches and 2 inland waterways	108,981 pounds of waste (13.6 mio. items) in 92 countries
When	May-June 2020	October 2019	November-December 2019	2013
Covers	Macro plastic	Single-use macro plastic	Single-use macro plastic	Marine debris, only plastics included below
Defined by	Number of items	Number of items	Number of items	Unknown
Source	This survey	World Bank Group, Survey of product alternatives for Top-10 plastic items	World Bank Group, Survey of product alternatives for Top-10 plastic items found in Myanmar	Ocean Conservancy, Turning the Tide on Trash (Ocean Conservancy, 2014)

Top 10	Lao PDR	Cambodia		Myanmar		International	
	Description	Top 10	Description	Top 10	Description	Top 10	Description
1	Bottles	5	Beverage bottles			3	Plastic beverage bottles
2	Plastic caps and lids, incl. rings from bottle neck	7	Plastic bottle caps/lids	6	Caps/Lids (mainly HDPE)	4	Plastic bottle caps
3	Bags	2	Bags	1	Small plastic bags and pieces (HDPE and LDPE)	6	Other plastic bags
4	Shopping Bags incl. pieces					8	Plastic grocery bags
5	Cups and cup lids	4	Cups and cup lids				
6	Food containers incl. fast food containers			9	Food containers (expanded PS)		
7	Foam packaging/insulation/polyurethane	6	Foam / polystyrene food containers	3	Styrofoam (food and other) (PS)		
8	Plastic/polystyrene pieces 2.5 cm > < 50cm			5	Plastic pieces (less than 50 cms)		
9	Straws and stirrers	3	Straws and stirrers	7	Straws, cutlery and tray (mainly PP)	5	Straws and stirrers
10	Cleaner bottles & containers						
11	Cover / packaging	1	Food wrappers			2	Plastic food wrappers
		8	Cutlery - spoons or forks	7	Straws, cutlery, and tray (mainly PP)		

	Lao PDR	Cambodia		Myanmar		International	
Top 10	Description	Top 10	Description	Top 10	Description	Top 10	Description
		9	Cigarette butts			1	Cigarette butts
		10	String and cord	2	String & cord (less than 1 cm.) (mainly PP)		
				4	Crisp and sweet packaging (PP and PS)		
				8	Tangled nets		
				10	Foam sponge		

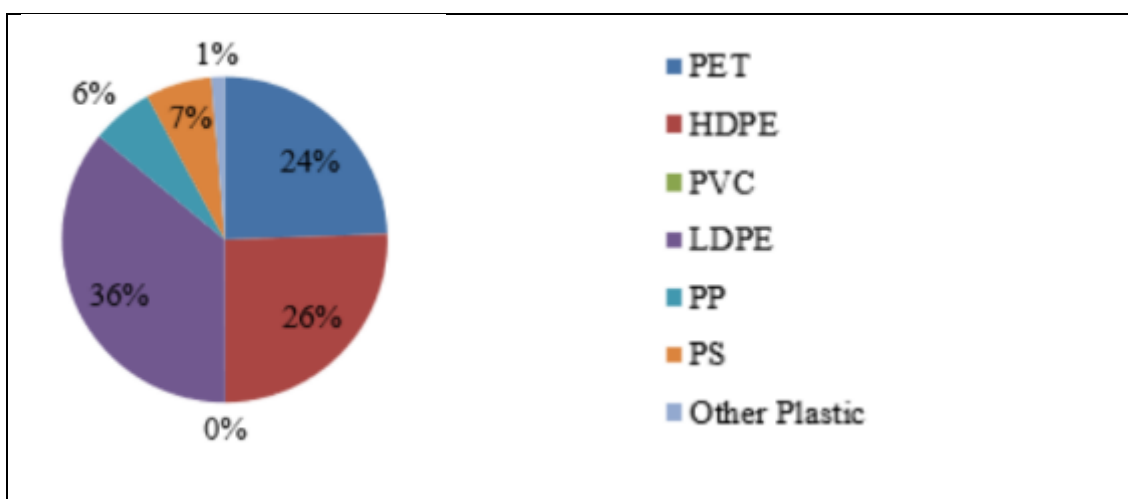
Many of the items found in our study were also found in the other surveys, such as bags, bottles, and caps. Overall, the Top-10 is quite similar amongst the different countries, with six overlapping Top-10 categories for both Cambodia and Myanmar. Some findings:

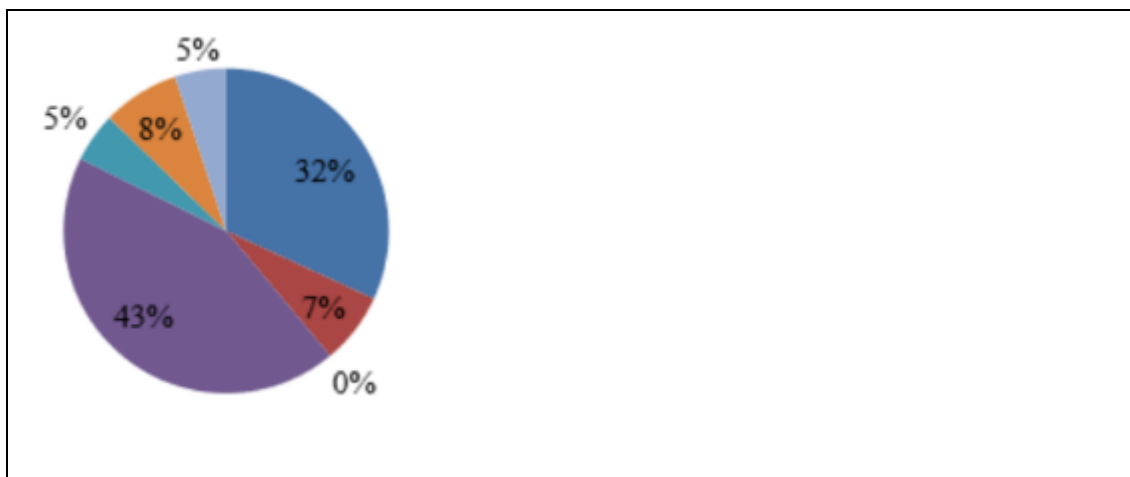
- Bottles are the biggest item found, especially in Lao PDR
- Small items such as cigarette butts were not a part of this survey, as they would sieve through the mesh of the net (mesh size was 19 millimeters)
- There is a surprisingly low amount of fishing equipment in the Lao PDR surveys compared to other studies and the high-level fishing activities on the Mekong
- Furthermore, it surprises us that "Crisp and sweet packaging (PP and PS)" and "Cutlery" were not found in our study, as they were common in the neighboring countries.
- The Lao PDR Top-10 also contained "Cleaner bottles & containers", which were not observed to the same degree in the other studies.

5.2 Polymers

The plastic collected from the net-trap-surveys and boat collection was sorted into different polymers. The overall results are shown in Figure 30 for number of items and weight respectively.

Figure 30 Composition of Plastic Waste from Net-Trap-Surveys and Boat Collection Across Six Cities. The Results Are Shown on The Basis of Number of Items (Above) And Weight (Below)





The Figure shows that the most common polymers are LDPE and PET by weight, while counting number of items, the most common polymers are LDPE, HDPE, and PET. Table 26 shows the typical product items for each polymer (based on the net and boat surveys) and an overall assessment of the recyclability and value of this quality of polymer.

Table 26 The Most Commonly Found Polymers in The Net and Boat Surveys.

Polymer	Typical product items	Recyclability	Value
PET	Drinking bottles	High	High
HDPE	Caps, lids, cleaning bottles	Medium	Medium
LDPE	Bags, wrapping, packaging	Low	Low
PS (incl. EPS/XPS)	Food containers, insulation	Very low	No value
PP	Cups, cutlery, straws, shoes, toys	Medium	Medium
Other plastic	Other products	Very low	Possibly value as RDF

The Table shows that the most valuable polymer is assessed to be the PET fraction consisting almost solely of drinking bottles. This fraction is a relatively homogeneous fraction with a developed international market for recycling. It was found through interviews that traders give around 700-1,400 Kip per kilogram for water bottles – depending on distance to the recycling facilities (number of intermediaries) and could sell them again for 1,000-1,600 Kip per kilogram. Small PET bottles are the most found item in the surveys. This is unexpected as they typically have high recyclability and high value. It might be an indication that their recycling value is not high enough for the market to regulate the littering.

Other items, such as bags made from LDPE, have a low recyclability and value, hence other measurements will likely be necessary to reduce the littering. HDPE and PP also have a possibility of recycling. However, these fractions are more divers in terms of products and the value is generally lower. Other plastic, likely polyolefins (PE and PP), give 400-1,000 Kip per kilogram when delivered to traders. One trader bought "white bottles" for 1,500 Kip kilogram, which is likely HDPE bottles.

The recycling possibilities for LDPE is assessed to be relatively low, since this fraction consists of bags of very mixed quality and often with large share of impurities. This fraction could possibly be used as refuse-derived fuel (RDF) for industries such as cement production. Larger pieces of clear LDPE, typically transportation packaging, has a much higher value. For the category "other plastic" which is a mix of remaining polymers (such as PA, ABS, or others), co-polymers or composites. The PS polymer

mostly consists of expanded PS (EPS/XPS) for which recycling is technically possible, but not yet very common.

6 Impacts of Plastic Pollution

There are multiple impacts from plastic pollution on the environment and this Section summarizes the most relevant ones in Lao PDR. The impacts have been divided into the following groups:

- **Ecological impacts**, including mortality or sublethal impacts on animals and whole ecosystems
- **Socio-economic impacts**, such as impacts on fishery, local communities, tourism, shipping, and harbors.

The impacts of plastic pollution indicated the necessity for the development of appropriate policy measures against plastic littering. The *Plastic Policy Assessment* (separate report) addresses the possible policy measures.

6.1 Ecological Impacts

The ecological impacts typically occur due to entanglement or ingestion of the plastic waste. However, the plastic waste may also cause transfer of chemicals or act as a vector for transport of biota.

6.1.1 Entanglement

Entanglement is a very visible effect from pollution with plastic waste. Entanglement of wildlife may cause drowning or choking, if a mammal or bird is caught underwater or entangled around the neck. In other cases, the entanglement may cause reduced mobility and agility reducing the ability to hunt, escape predators or other dangers, and thereby decreasing the ability to survive. Entanglement may also cause severe tissue damage, amputations and open wounds or prevent reproducing.

Especially problematic items are fishing-related waste, such as abandoned or lost fishing nets, lines, buoys. In addition, packaging material (such as bands, netlike structures, plastic bags) contribute to the problem (González D. , et al., 2016; Werner, et al., 2016).

For the Mekong River in Lao PDR, affected species may primarily be birds, fish and riverine mammals (such as the Mekong River Dolphin). In addition, land-living mammals (wild and domestic) living on the edge of rivers, or coming to the river to drink, may be affected. The risk of entanglement for the specific species depends on the physiology, feeding habits, size, and behavior of the bird or fish or animal.

6.1.2 Ingestion

Ingestion of plastic waste by wildlife in the riverine environment may occur either intentionally, because the waste is mistaken for food (pellets or other smaller items), or by mistake, together with food, such as discarded food waste in plastic bags or predators eating prey with plastic in their stomach.

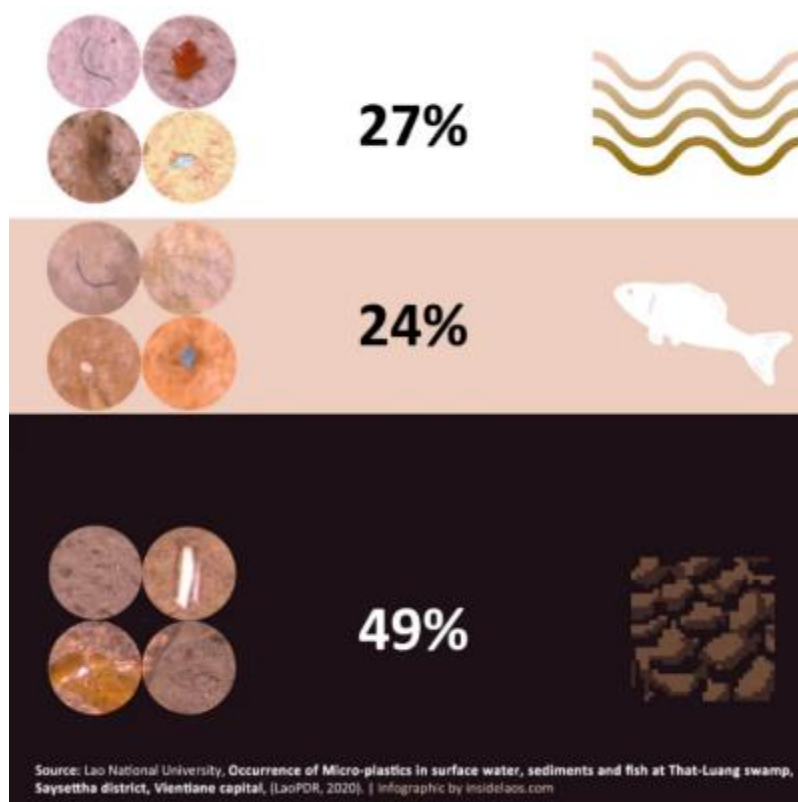
Ingested plastic waste can cause severe impacts, such as obstruction of guts or blockage of intestines, preventing the animal from digesting food. Smaller or fewer items may cause sublethal impacts, such as replacing space for food or affect the instincts to feed causing malnutrition and slower growth.

Plastic waste has been found in birds, fish, and aquatic mammals around the globe, even in very desolated areas. The risk of ingestion of plastic waste for the specific species depends mainly on their feeding habits and physiology.

The most problematic items are the smaller plastics (pellets, lids, small plastic bags or disintegrated larger plastic items), that may be mistaken for the natural food source of the species. Once ingested, the plastic waste does not degrade and often has a shape that prevents it from passing the intestines. Thus, the plastic will accumulate in the body and present an increasing challenge. Furthermore, the plastic waste accumulates to a certain extent through the feeding chain due to plastic content in the prey species (González D. , et al., 2016; Werner, et al., 2016)

In Vientiane Capital, the ingestion of plastic waste in aquatic creatures was first discovered by a research team of the Faculty of Environmental Sciences, National University of Lao. The team conducted a study to explore the existence of microplastic in fresh water by taking samples of surface water, fish, and sediment in That Luang Marsh, the largest urban wetland in Vientiane Capital, which functions as a natural biological wastewater treatment that connects water channels of Vientiane Capital to Mekong River via Huay Mark Hiao water canal. **The study found that from three types of samples, there were 24 percent, 27 percent, and 49 percent of microplastic in fish, surface water, and sediment respectively.** The polymer found in this samples was polyamide, which is a type of polymer that can be found in cloth, tire, fishing gear, and some plastic wears. Unfortunately, the source of microplastic could not be identified (Insidelaos, 2020).

Figure 31 Microplastic in That Luang Marsh (Insidelaos, 2020)



6.1.3 Transfer of Chemical Substances

The plastic waste may cause transfer of harmful chemical substances to wildlife, especially when ingested. The chemical substances may either intentionally be part of the original plastic product (such as bromated flame retardants or other additives) or be absorbed by the plastic waste from the water.

It is difficult to investigate these types of effects, since impacts by harmful substances on aquatic wildlife occur from many additional sources including directly from water pollution. Thus, the impact from transfer of harmful chemical substances from plastic waste is uncertain (González D. , et al., 2016; Werner, et al., 2016).

In Lao PDR, there is a probability that the transfer of chemical substances to aquatic wildlife could occur. The survey of riverine waste in the six target cities, especially in Vientiane Capital, found that product containers (detergent container, lubricant container, shampoo container, lotion container and etc) produced from HDPE are abundant. Among six cities, Vang Vieng has the highest number of HDPE product containers (553 pieces), followed by Vientiane Capital (520 pieces), Kaisone (294 pieces), Thakhek (112 pieces), Luang Prabang (85 pieces) and Pakse (39 pieces). Based on this, there is a high risk of the chemical substance affecting freshwater quality and aquatic wildlife in these cities.

Apart from that, in some districts where cultivation occurred along a stream or riverbank (such as vegetation or banana plantation), plastic containers of chemical products could also be littered into the river and potentially be harmful to ecological system, water quality and personal hygiene in those areas.

6.1.4 Riverine Litter as a Vector for Transport of Biota

Plastic waste items may act as transport vector for biota over longer distances, thus introducing new species in different environments. This may change the dynamic of the native species and may be a threat to local ecosystems.

The species transported typically grow on or adhere to the plastic. The species in question are often microorganisms, weed or invertebrates. Larger species are typically not transported longer distances with plastic waste (González D. , et al., 2016; Werner, et al., 2016).

Figure 32 Plastic Found During the Surveys Showing Clear Biota Growth



6.2 Socio-Economic Impacts

Plastic waste in aquatic environments is a threat not only to aquatic wildlife and ecosystems but also to human health and welfare. It also has a negative impact on vital economic sectors such as tourism and fishery. Furthermore, riverine plastic waste pollution may affect local infrastructure such as blockage of drains, smaller rivers, sewers, and power dams and impact on local farming and fishing. Overall, plastic waste pollution of the riverine environment may cause losses to individuals, enterprises, and communities.

6.2.1 Local Communities and Tourism

There can be severe impacts for the local communities along the river as well as for tourism. In Vientiane Capital, Luang Prabang and Vang Vieng, the issue of plastic and solid waste has caused negative publicity and reduced the aesthetic value for tourists. This is the case at touristic spots where waste collection service does not reach and at some areas where people gather for ritual events or festivals. For example, in Vientiane Capital, plastic and other types of solid waste can be found at a touristic spot called "Walking Street", some temples along the Mekong River where people and tourists gathered for ritual events and along the roads on the outskirts of the city. In Luang Prabang, on the way to Kuang Si waterfall, waste piles along the side of the road can be seen. In addition, some waste piles can be seen nearby restaurants on the banks of Mekong River. These waste piles have blackened the image of these areas in the city.

Changes in lifestyle and consumption due to economic development and ineffective waste management have caused a rapid increase of plastic waste and solid waste in Laos. This, then, leads to the emergence of several illegal landfills. Several types of wastes are disposed of in these illegal landfills. Among the six cities, Vientiane has the highest number of illegal dumpsites (37 sites); following by Thakhek (36 sites); Luang Prabang (26 sites); Pakse (17 sites); Vang Vieng (15 sites); and Kaisone

Phomvihane (14 sites). These illegal landfills damage the reputation of the cities and negatively affect tourism.

Figure 33 An Illegal Dumpsite in Vang Vieng Along the Road



Figure 34 Waste scattered next to restaurants in Luang Prabang.



Figure 35 Waste Dumps at Walking Street in Vientiane Capital (Left) and Along The Riverbank in Vientiane (Right).



Pollution from plastic waste also occurs due to unawareness or negligence of local people. In some areas, plastics and other types of wastes are burned by households. This happens usually in the evening, after cleaning the yard or cleaning wastes along the roadside. Some local people are not aware that this practice pollutes the air with dangerous toxics and PM 2.5 which can cause severe health problems.

Apart from illegal dumpsites, the unmanaged open landfills in Laos are polluting the environment and communities nearby too. They especially affect the health of waste pickers who collect valuable wastes and sell to waste recovery factories. These waste pickers have no protection during their work and live next to the landfills.

Occasionally, fires happen in the landfills. For example, in recent years, there was a blaze at the landfill in Vientiane Capital and Vang Vieng. The toxic smoke caused problems on respiratory system of people living nearby. In addition, unmanaged landfills can also contaminate ground water quality. The study of (Vongdala, 2018) found that the pollution caused by Cd and Cu reached the eco-toxicological risk level in the landfill soils and its vicinity. The vegetable known as *Ipomoea aquatica*, which is consumed by the nearby villagers, was seriously contaminated by Cr, Pb, Cu, and Zn, as the accumulation of these toxic metals was elevated to much greater levels as compared to the WHO standards. This study was the first to warn of serious heavy metal pollution occurring in the water, soil, and plants in the landfill of Vientiane, Laos, which requires urgent phytoremediation.

Figure 36 Burning Plastic Along the Road in Luang Prabang (Chakravorty, 2020).



6.2.2 Fishery and Aquaculture

Fishery may be affected in different ways by plastic pollution of the river. Some of the most important impacts are based on González D. , et al. (2016):

- Restricted catch due to litter in nets
- Lost and damaged fishing gear
- Vessel damage and staff downtime
- Contamination of fish and shellfish with ingested plastic
- Reduced earnings and lost fishing time.

These impacts may cause significant losses for the fishermen as well as the local community depending on the fishing. For aquaculture, similar impacts may be seen due to increased damage of equipment, reduced and contaminated output (fish) and thus overall decreased earnings.

During the collection of riverine waste in six cities some fishermen were interviewed. Most of them claimed that **they always catch plastic waste debris along with fish and aquatic animals**. Waste debris means they must waste time cleaning their nets and catch. The increased amount of plastic waste in fresh water also indicates the lower quality of water and may cause problems to aquatic animals.

The very low amount of lost and abandoned fishing gear found in the surveys was surprising and we do not have an explanation for this. It might have passed under our nets.

Figure 37 A Fishing Net Found in the Net Trap in Luang Prabang



6.2.3 Flooding

Plastic waste has been claimed to be one of the main factors causing the blockage of waterways and drainage systems. Recently, the phenomena of sudden flooding due to downpours in some cities such Vientiane Capital, Kaysone Phomvihane, and Pakse have been obvious. In response, cities are starting to clean the drainage systems in the city on a more regular basis.

Figure 38 Plastic Waste Blocking Waterways and Drainage Channels in Thakhek (Left) and Kayson Phomvihane (Right)



Figure 39 Flooding at Dong Dok, Vientiane Capital, Due to a Downpour Event (Lao Event, 2020).



Figure 40 Waste Clean-up in Drainage System (Lao Event, 2020)



7 Possibilities for Changes

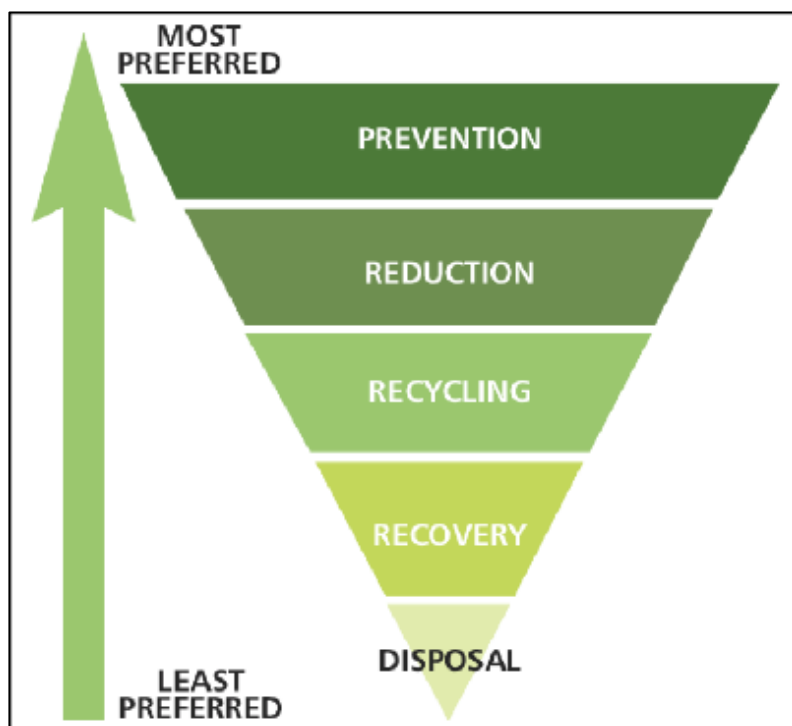
For each of the Top-15 plastic items (by number), alternative products were identified, where possible. These were products with similar functionality but made from wood, paper, or cardboard instead of plastic. In the EU, the market for these alternative products is developing rapidly due to the adopted Single Use Plastic (SUP) Directive and the general policy change towards a more green and circular economy. Therefore, it will be possible to find suggested alternatives on the European market but its availability in Lao PDR will need to be certified.

The found alternative products were analyzed in relation to the following questions:

- What are the costs (selling price) of the alternative products?
- Which companies offer the alternative products and are they made available in Lao PDR?
- Do the alternative products require advanced technologies, or could they be produced locally?
- How common are the products? Is more production capacity needed to cover the Lao market?
- How different is the alternative product in relation to functionality, appearance, costs, and availability, and will it be accepted by the consumers?

For some of the Top-15 plastic products there do not exist suitable alternatives. For these products, the possibilities of reduction, reuse and recycling have been described in line with the Waste Hierarchy. See Figure 41. This approach to managing waste focuses on what is best for the environment and prioritizes the prevention of waste. For such products, focus on reduced consumption and improved waste management will be relevant. Targeted waste management for special product categories could include take back-systems (including deposit-refund systems) and Extended Producer Responsibility (EPR).

Figure 41 Waste Hierarchy⁴



7.1 Possibilities to Reduce, Reuse or Recycle

Each of the 15 items have been evaluated on the potential for:

- **Reducing the waste generation.** This can be done by eliminating the production of the items, reducing the packaging amount, and by increasing the volume or weight per item sold.
- **Reusing the items.** How possible is it for the item to be produced as a reusable item, and are there alternatives to substitute the current single-use item?
- **Recycling.** What is the recyclability in general of that item, and is it possible in Lao PDR?

The items have been evaluated after the score "Low", "Medium" and "High" possibility in the Table below.

Table 27 Possibility to Reduce, Reuse or Recycle

Product item	Typical polymers	Functionality	Reduction potential	Reuse possibilities	Recyclability in Laos
Bottles	PET	Contain beverage on the go	Medium	Medium (especially for water)	High
Bags and Shopping Bags incl. pieces	HDPE/LDPE	Carry groceries home	High	High	Low

4

See:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69403/pb13530-waste-hierarchy-guidance.pdf

Product item	Typical polymers	Functionality	Reduction potential	Reuse possibilities	Recyclability in Laos
Plastic caps and lids, incl. rings from bottle neck	HDPE	To close beverages on the go	Medium	Medium (especially for water)	Low
Cups and cup lids	EPS/XPS, PP	Take away drinks (cold and warm)	Medium	Medium	Low
Food containers incl. fast food containers	EPS/XPS, PP	Serve or carry food to eating destination	Medium	Medium	Low
Foam packaging/insulation/polyurethane	EPS/XPS	Protective packaging for fragile and electronic goods, invariably imported	Low	Low	Low
Plastic/polystyrene pieces 2.5 cm > < 50cm	All	Plastic that have disintegrated to smaller pieces	Unknown	Unknown	Unknown
Straws and stirrers	PP	To ease consumption of drinks. Prepacked beverages often include straws.	High (a nice product, but a need to have product)	Medium	Low
Cleaner bottles & containers	HDPE	To contain cleaning products	Medium (in hotels e.g.)	Medium	Medium
Cover / packaging	LDPE	To wrap food or product	Medium (a lot of very small packages)	Medium	Low
Shoes/sandals	Other	To wear	Low	Not single-use	Low
Crates and containers / baskets	HDPE	To carry bottles or as storage	Low	Not single-use	Medium
String and cord (diameter less than 1cm)	PA	Frequently single use for different purposes	Low	Low	Low
Other bottles & containers (drums)	HDPE	To wrap food or other items	Low	Not single-use	Medium





7.2 Alternative Materials or Reusable Products

The assessment of alternatives is crucial for development of plastic pollution abatement policies. It avoids for instance the banning or discouraging of certain plastic items if there are no alternatives available or they are unaffordable or unsuitable. This is addressed further in the *Plastic Policy Assessment* (separate report). Table 28 shows the current plastic products and their alternatives. There are several explanations for whether an alternative product is a good replacement for the original item, if the product replaces the functionality of the original product, if the cost is reasonable, and if the product is available in the market.







Based on the analysis of the riverine plastic sampling survey results, a list of the most common plastics was established. For these items, potential alternative products have been identified. Their local availability and production were established and assessed along with functionality and price. Using subjective judgement, the expected use of the product as a replacement for single-use plastic was made.






Alternative items were scored on reuse potential from 1 to 3 ("3" being the most likely and "1" the least likely) on two possibilities: (1) there is an alternative reusable item; or (2) there is an alternative material to replace the plastic.






Table 28 Alternative Products to the Top-15 Products Found in the Survey. The Products in the Grey Rows Were not Specific Enough to Find an Alternative







Product item	Current plastic product				Alternatives							
	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
Bottles incl. Plastic caps and lids, incl. rings from bottle neck		Contain beverage on the go	Manufactured in Lao by various companies (see Appendix D for Lao plastic producers)	1,500ml = 1,000 600ml = 500 350ml = 400		Glass reusable	- Readily available imported	Reusable only relevant for water and not for other beverages. Change of habit needed. Need possibility to refill on the go.	- 25,000 - 65,000	- Low	1	1
						Aluminum reusable	- Readily available imported	Reusable only relevant for water and not for other beverages. Change of habit needed. Need possibility to refill on the go.	- 90,000- 240,000	Low		
						Bioplastic	Unknown	Single use. Can be used for on the go beverages (soft drinks)		Unknown		
Bags and Shopping Bags incl. pieces		Carry groceries	Manufactured in Lao by various companies (see section XYZ of Lao)	14,000 Lak/500g		Paper		Single use	Unknown	Unknown	2	2



⁵ Companies, production possibilities', technologies required






Product item	Current plastic product				Alternatives							
	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
			plastic producers). Imported from a range of companies			Textile material	Not available in Lao (example from Bangladesh)	Single use				
						Textile	Readily available bags produced in Lao by handicrafts organizations.	Reusable	starting from 10,000	Low		
						Rattan	Readily available produced in Lao handicrafts	Reusable	55,000 – 95,000	Low		
Cups and cup lids		Take away drinks (cold and warm)	Manufactured in Lao by various companies (see section XYZ of Lao plastic producers). Imported from a range	140-360 Lak /pcs		Paper	Readily available in Lao produced by K-Cup Lao Sole Co., Ltd.	Single use	400 Lak/pcs	High	1	3

Product item	Current plastic product				Alternatives							
	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
			of companies									
Food containers incl. fast food containers		Serve or carry food to eating destination		1,042 Lak /pcs		Paper	Readily available but not produced in Lao PDR (K-Cup Lao Sole Co., Ltd. Are planning to produce a wider range of paper products including food containers)	Single use	700 – 1,200 /pcs	High	2	3
						Paper box	Readily available and produced in Lao (Vientiane Carton Factory)	Single use	start from 500 /box	High		
				450 Lak/pcs		Aluminum	Readily available but not produced in Lao (imported)	Single use	5000 /pc	Low		

Product item	Current plastic product				Alternatives							
	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
						Aluminum, stainless steel	Readily available	Reusable	125,000 Lak	Medium (widely used in rural areas)		
Foam packaging/insulation/polyurethane		Protective packaging for fragile and electronic goods, invariably imported	Unknown	Not individually price packing material especially with electrical and fragile items		Paper	Not available in Lao. Some companies use imported goods.	Single use		Low		1
Plastic/polystyrene pieces 2.5 cm > < 50cm		Plastic that have disintegrated to smaller pieces										
Straws and stirrers		To serve drinks. Prepacked beverages often include straws.		30-80 Lak/pcs		Aluminum	Niche product available but not widely used (imported from China by Greener Laos)	Reusable	45,000 Lak/set	Low	1	2

Current plastic product					Alternatives							
Product item	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
						Bamboo straws	A niche product not widely available	Reusable	2,500/pcs	Low		
						Straws made from rice	Low availability in Lao PDR (Yeonjigonji South Korea, made in Viet Nam)	Single use		Low		
Cleaner bottles & containers		To contain cleaning products	King stella	18,000 (600ml) (price with product)		glass / plastic spray bottle	Available. Some household cleaning producers sell refill economy packs but these are frequently packed in plastic.	Reusable	No price available	Low	1	1
			Haiteer Liquid bleach (Blue)	2500 ML: 20,000 Lak (price with product)		Plastic spray bottle	Some household cleaning producers sell refill economy packs but these are frequently package in plastic.	Reusable	15,000 Lak	Low		

Product item	Current plastic product				Alternatives							
	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
			FINELINE Fabric Softener Pink Floral Scent	3,000 ml: 27,000 Lak								
Cover / packaging		To wrap food or product										
Shoes/sandals		To wear		22,000 Lak - 45,000 Lak		Canvas and rubber			Start from 300,000 Lak			1
						Rubber sandals	Readily available but not produced in Lao (imported).	25,000 Lak - High 55,000 Lak				
Crates and containers / baskets		Case with full bottles usually traded on an empty for full basis. Cases reused until damaged		120,000 Lak		Wood	Potential replacement product - after useful life not readily available in Lao, however, raw materials available	Reusable, biodegradable - after useful life		Low		2

Current plastic product					Alternatives							
Product item	Photo	Functionality	Companies	Cost (LAK)	Photo	Material	Availability in Laos ⁵	Functionality, appearance, acceptance	Cost (LAK)	Coverage of current need	Reuse alternatives score (1-3)	Material alternatives score (1-3)
						Cardboard boxes	String cardboard packing materials available and produced in Lao	Reusable single use / Varies with size and design		Low		
		Reusable storage		35,000		Rattan basket:	Readily available	Reusable	75,000 Lak	Medium		
String and cord (diameter less than 1cm)		Frequently single use for different purposes		7,000Lak/pcs		Plant based string cord,	Available	Frequently single use	9,000 Lak/pcs	Medium		2
Other bottles & containers (drums)		To wrap food or other items										

For all items there is limited potential for replacement of materials, especially if it regards single-use items. Only two items have a replacement that is readily available and comparable in price: (1) cups; and (2) food containers (where paper can replace plastic). For most products, alternatives are either more expensive or have limited availability. However, it should be noted that many of the alternatives are reusable products, which can be used multiple times, which is why the price cannot be directly compared. The price of the current single-use products with reusable alternatives are compared below in Table 29.

Table 29 Price Comparison of Current Single-Use Products with Reusable Alternative Products

Product	Price range current product (LAK)	Price range reusable alternative (LAK)	Times item needs to be reused to balance the price
Bottles incl. Plastic caps and lids, incl. rings from bottle neck	400-1,000	25,000-240,000	25-600
Bags and Shopping Bags incl. pieces	560 (assume a bag weigh 20 grams)	10,000-95,000	18-170
Food containers incl. fast food containers	450-1,042	125,000	120-278
Straws and stirrers	30-80	2,500-7,500 (assume a set of aluminum straws contain 6 pieces)	31-250
Cleaner bottles & containers	18,000-27,000 (incl. content)	15,000	Below 1

The Table shows that some single-use products could be replaced by reusable alternative products for a reasonable price when you consider the times of reuse. Other products such as the food container are more expensive. The cost of the product will also fall upon different stakeholders, which should also be a considered. Lao PDR imports a substantial amount of its consumer products from neighboring countries and therefore has little, if any, control of the packaging used for these products.

Small (350 ml) plastic PET bottles were the most common item found in the surveys (both by number and by weight). While some of the plastic bottles could potentially be replaced by glass or other material, this is unlikely to happen at large scale soon.

'Single use' plastic shopping bags (they can in fact be re-used) are provided free of charge in almost every shop and in market. Alternative reusable bags are available, but these are more expensive and require forethought. Khuadin Market in Vientiane stopped the use of single use plastic bags in May 2020 after a publicity campaign for the intended change started in January. The Vientiane Times report vendor, consumer, and market management reaction 25 May 2020. The five people interviewed thought there was a need to reduce the use of plastic bags because of the environmental damage but vendors had reservations on shopper's reaction particularly because bags had previously been provided free of charge.

Where alternative products are available, it will require consumer and supplier behavior change for their introduction to be successful and that invariably requires mass media campaigns. Alternative products are available but in Lao as in other countries the change might have to be driven by legislation.

Many of these material or reuse alternatives are not suitable for a 1:1 replacement of the plastic item. In addition, the amounts of single-use items are too high to replace them all by other materials. Replacing the plastic with another material does not always involve an environmental improvement as (other) negative impacts of the alternatives are also possible.

The overall focus of policy and regulatory measures should therefore be on reduction, as ranked high on the Waste Hierarchy. The promotion of alternative products should focus on re-usability and not single-use alternative materials.

8 Conclusion

The findings on the amounts of plastic leakage, overall mismanagement, open burning and disposal into the environment, high number of informal dumpsites, the rapid increase of imports of plastic waste and the various described impacts all show the urgency to address the increasing problem of plastics pollution. The findings also show that possibilities to improve plastics management and reduce overall pollution exist. The Government of Laos is committed to improving the plastics situation in the country and has requested the World Bank to support this process including the development and implementation of a National Plastic Action Plan (NPAP).

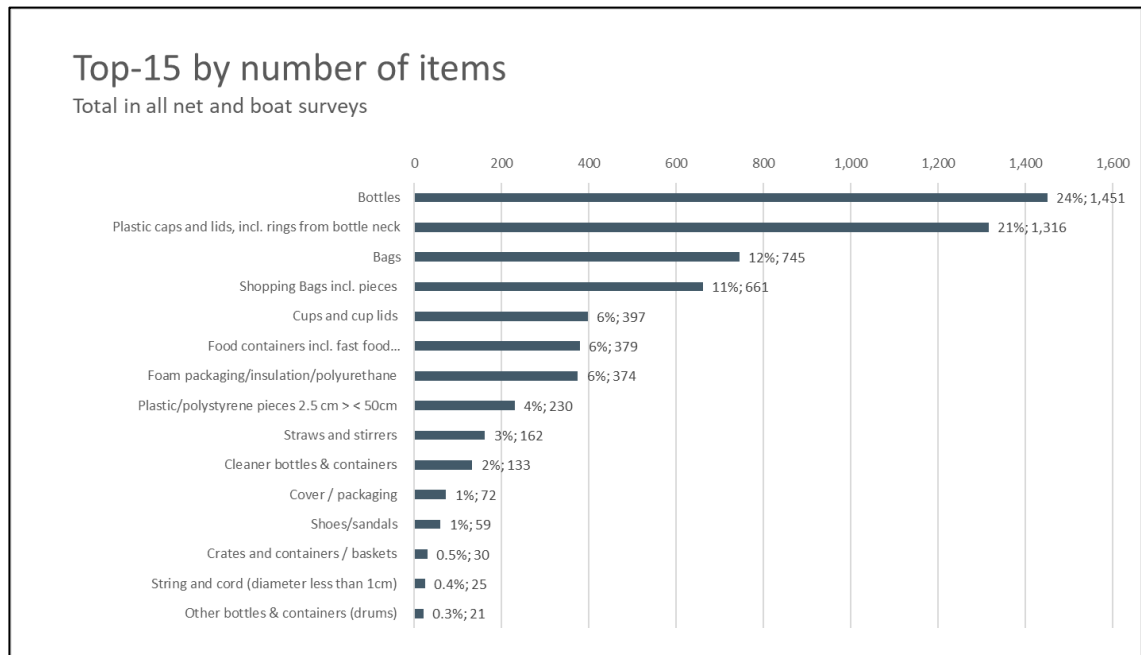
The assessment of plastic waste quantities (Chapter 4) provides several relevant findings. Firstly, products with plastic packaging and plastic products are mainly imported from Thailand, China, and Vietnam. Secondly, there is a small, but not insignificant production capacity in Lao PDR. However, the registration of this is limited. Thirdly, there is a clear increase of import of plastic waste to Lao PDR - almost 10 times increase from 2018 to 2019. Fourthly, the capacity to cope with the large increase of plastic waste in Laos is not currently present. While plastic leakage quantities were roughly estimated in the six cities, establishment of reliable baselines would require further studies.

The most important plastic products that need to be addressed through developing policy measures are the ones listed below⁶. Combined, these items are responsible for around 95 percent of plastic pollution (see Figure 42). By targeting these items with selected feasible and realistic policy measures, overall plastics pollution in Lao PDR can be reduced significantly. For many of these items, good (reusable) alternative products are readily available so that for priority products measures can be developed in the short term.

1. Bottles
2. Plastic caps and lids, incl. rings from bottle neck
3. Bags & Shopping Bags incl. pieces
4. Cups and cup lids
5. Food containers incl. fast food containers
6. Foam packaging/insulation/polyurethane
7. Straws and stirrers
8. Cleaner bottles & containers
9. Cover / packaging
10. Shoes/sandals
11. Crates and containers / baskets
12. String and cord (diameter less than 1cm)
13. Other bottles & containers (drums)

⁶ This list represents 13 of the Top-15 items (by number), but with the "Bags" and "Shopping Bags incl. pieces" combined. Furthermore "Plastic/polystyrene pieces 2.5 cm > < 50cm" have been removed as this cover unidentified items, which is not possible to base policy measures on.

Figure 42 Top-15 Items (By Number) As Found During Net And Boat Surveys For Six Cities in Lao PDR



These identified priority plastic items and the other findings presented in this report serve as basis for the *Plastic Policy Assessment*, under which policy and regulatory measures are proposed to reduce single-use plastics consumption and pollution. The report serves to support the GoL in the identification of suitable measures to reduce plastics pollution by targeting identified priority items and provide the basis for the development of an NPAP and to inform the World Bank in its engagement and support to the GoL in implementing its Green Growth Agenda.

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Appendix A Data Input for Marine Plastic Litter Assessment Tool

A.1 Waste Management in the Cities

The waste management systems of the six selected cities are characterized by low coverage of collection, no source segregation and landfilling as the only official waste management technology. The large share of unmanaged waste, including plastic waste, propose a significant risk of substantial plastic waste pollution of the Mekong River. Table 30 shows basic facts about the existing waste management systems in the 6 selected cities.

Table 30 Basic Description of the Waste Management System in The Six Selected Cities.

	Vientiane ¹	Pakse ²	Luang Prabang ³	Thakhek ⁴	Kaysone Phomvihane ⁵	Vang Vieng ⁶
Total waste generation (ton/year)	277,400	44,530	33,690	20,000	136,528	27,740
Municipal waste generation (kg/person/day)	0.82	1.04	1.03	0.7 (households only)	1.20	0.96
Collected total waste (ton/year)	127,076	19,345	29,086	12,000	71,285	15,450
Coverage of total waste collection (% of waste)	46%	43%	86%	60%	52%	56%
Access to household waste collection (% of households)	72%	74% (31 villages)	81%	28 villages (urban)	66%	29%
Coverage of household waste collection, contracted (% of households)	27%	37%	81%	21%	30%	19%
Source segregation	No	No	No	No	No	No
Collection companies	2 public and 10 private companies contracted by VCOM	One company for household waste	One public and one private company	One company contracted by UDAA	One company	One public and one private company
Landfills	Yes	Yes	Yes	Yes	Yes	Yes
Informal waste management	Informal collection and recycling of e.g. plastic bottles, metals etc. (small scale) Illegal dumping, open burning					

1) 2018 data (VCOM, 2019) and 2019 data (VCOM, 2020), 2) UDAA of Pakse (June, 2020) , 3), 4), 5) UDAA of Kaysone Phomvihane City (2020), 6) 2019 data (UDAA of Vang Vieng (2020)).

The waste generation rates for the six selected cities are found to be around 0.7-1.20 kilogram per person per day. This amount includes waste from guest houses and hotels, grocery stores, schools, hospitals, households, offices, and waste along the road. The assumed quantities for each source are found in Appendix C.

The composition of municipal solid waste for the six selected cities are shown in Table 31. The municipal waste is dominated by a large share of organic waste (50-60 percent by weight). The content of plastic fraction in the municipal waste is typically 6-15 percent (weight) of the waste stream.

Table 31 Composition of solid waste in the 6 selected cities (%). " " means the fraction was not reported in the study.

Material	Vientiane ¹	Pakse ²	Luang Prabang ³	Thakhek ⁴	Kaysone Phomvihane ⁵	Vang Vieng ⁶
Organic	59	62	39	21.2	54	54.82
Plastic	11	6	8	13.6	15	13.63
Glass	7	2	2	11.3	2	3.61
Paper	7	4	6	5.2	9	6.43
Foam	3					
Metal		1	1	3.5	1	1.76
Textile		1	4	1.3	1	4.12
Wood and garden waste		21	30	26	16	3.42
Leather				1.7		
Bone				2.8		
Ceramic						2.19
WEEE						2.99
Ash						1.64
Other	13	3	10	13.4	2	5.4
Total	100	100	100	100	100	100

1) Source: (EEP, 2015), referred in (VCOM, 2020); 2) ; 3) ; 4) Phonekeo and Phouthasom (2010)⁷; 5) ; 6)

Further details can be found in the activity reports in Appendix C.

⁷ https://www.iqes.or.jp/en/archive/wmr/pdf/activity100728/5_Lao_Day1_Session2.pdf

A.2 Data Input to Model

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomviha ne Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
1. General waste management information											
1	Population	How many people live in the area (city, urban district, region) you want to model?	Persons	927,730	88,332	91,382	97,108	136,528	60,026		See Table 1.
2	Municipal solid waste generation per capita	How much municipal solid waste does the population produce on average per person and per day for one year?	Kg/day	0.82	1.04	1.03	0.77	1.20	0.96		See Table 25 and Table 30. Plastic content is considered as Plastic and Foam. T: 10% larger than household generation (0.7 kg/inh/day). Also fits approx. when table 3 in city report is scaled to a year.
3	Municipal solid waste composition	Plastics	Weight-%	14%	6%	8%	14%	15%	14%		
2. Waste management system											
4	Waste collection coverage	How many people do receive formal and regular municipal solid waste collection services in the area?	% of population	27%	37%	81%	21%	30%	19%	Estimate official number for all municipal solid waste	or Percentage of households or population covered by waste collected with a contract.
5	Waste collection efficiency for covered households	How much of the municipal solid waste is collected from the households that are covered by the collection system?	% of waste produced by covered areas	100%	100%	100%	100%	100%	100%	Estimate official number for all municipal solid waste	or Value in no. 4 is the actual collection efficiency.

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomvihane Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
3. Plastic waste treatment											
9	Reuse and recycling at source	How much of the generated waste is adequately reused or recycled at household level or through buy-back centers, door-collections by the informal sector, etc. before reaching the formal or informal collection systems?	% produced plastic waste	8.7%	5.7%	2.2%	3.0%	1.0%	2.1%	Distinguish from no. 6	Vi: A survey conducted by JICA in 2011 indicated a “small” recycling rate of 8.7% in Vientiane. P: The 6 waste recovery facilities sell 5 t PET bottles and 3-4 t other plastic per month L: The one waste recovery factory gathers about 5 tons PET bottles/month T: There is only one waste recycling retailer and they sell approx. 110 tons plastic /year S: Amount unknown. Lower prices than other cities. Estimate 1%. Va: The waste recovery factory sells around 5 t PET bottles per month
10	Collected Waste entering treatment	How much of the formally and informally collected waste is entering formal treatment facilities (e.g. transfer stations, sorting, recycling, RDF, composting, etc.)	% formally & informally collected plastic waste	0%	0%	0%	0%	0%	0%	Capacity treatment facilities, to distinguish from collected waste directly disposed of at the final disposal site	of No recycling in formal sector in any of the cities.

No.	Item	Description	Unit	Vientiane	Pakse	Luang Prabang	Thakhek	Kaysone Phomvihane	Vang Vieng	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
				Value	Value	Value	Value	Value	Value		
11	Formal recycling	How much of the formally collected waste is recycled?	% plastic waste entering treatment	0%	0%	0%	0%	0%	0%	0% Recycling rate within formal waste management system or estimation	No recycling in formal the sector in any of the cities.
12	Energy recovery and co-processing/refuse-derived fuel (RDF)	How much of the formally collected waste is energetically recovered or prepared to be used as refuse-derived fuel (RDF) in cement factories?	% of plastic waste entering treatment	0%	0%	0%	0%	0%	0%	0% Estimation numbers cement factories or waste incinerators	or There is no WtE plants in from Lao PDR.
4. Transmission factors (estimations based on expert assessment)											
14	Uncollected plastic waste: Burning (no leakage into waterways)	How much of the uncollected plastic waste is openly burned at household or roadside level, which cannot leak into waterways?	% of uncollected plastic waste	40%	40%	40%	40%	40%	40%	40% All values are estimates. The transmission factors no. 14, 15 and 16 display in the calculation of uncollected plastic waste that enter waterways and the ocean.	Vi: Estimate based on the statement: The reasons for not using the collection services are the lack of awareness about 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, 2019).

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomvihane Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
											Other cities: The % is similar to Vientiane
15	Uncollected plastic waste: Burying and dumping (without leakage into waterways)	How much of the uncollected plastic waste is buried or openly dumped at household or roadside level, which cannot leak into waterways?	% of uncollected plastic waste	36%	26%	22%	32%	37%	15%		<p>Vi: 40% estimated to be disposed of in dump sites. Estimate based on the statement: 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, 2019). Multiplied by share of m³ illegal dumpsites inland (90%)</p> <p>P: The 40% from Vientiane is used here as well. 65% of the m³ of located dumpsites is located inland.</p> <p>L: The 40% from Vientiane is used here as well. 55% of the m³ of located dumpsites is located inland.</p>

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomviha ne Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
											<p>T: The 40% from Vientiane is used here as well. 81% of the m³ of located dumpsites is located inland.</p> <p>S: The 40% from Vientiane is used here as well. 94% of the m³ of located dumpsites is located inland.</p> <p>Va: The 40% from Vientiane is used here as well. 39% of the m³ of located dumpsites is located inland.</p>
16	Uncollected plastic waste: other treatment (no leakage into waterways)	How much of the uncollected plastic waste is dealt with in a different way at household or roadside level and cannot leak into waterways?	% of uncollected plastic waste	10%	10%	10%	10%	10%	10%		Such as street cleaning. Estimate.
17	Uncollected plastic waste: burning or dumping close to waterways	How much of uncollected plastic waste can enter waterways (different to no. 13 to 15) but is not directly disposed into waterways (different to no. 18)?	% of uncollected plastic waste	4%	14%	18%	8%	3%	25%	Transmission factors no. 17 and 18 need to be considered together	40% estimated to be disposed of in dump sites. Estimate based on the statement: The reasons for not using the collection services are the lack of awareness about the impacts of wastes on their health and the

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomvihane Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
											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, 2019). Multiplied by share of m ³ illegal dumpsites near water.
18	Potential leakage from waste close to waterways (no. 17)	How much of the uncollected plastic waste burned or dumped close to waterways does enter waterways?	% of uncollected plastic waste in no. 17	70%	70%	70%	70%	70%	70%		Dumpsites very close to water (maximum 200 meters).
19	Uncollected plastic waste directly disposed into waterways	Calculated value: all unmanaged waste not accounted for by no. 13, 14, 15, 16 and 20 is assumed to enter directly the water system.	% of uncollected plastic waste	5%	0%	5%	0%	0%	5%	The sum of no. 14, 15, 16, 17, 19 and 21 is 100%.	Estimate based the number of potential hotspots from consumption along Mekong River, these include factories, hotels, markets, public parks, restaurants, and temples. Among those spots, some major hotspots – the places where people and tourists gather and have more potential to leak solid waste to the river

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomvihane Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
											(LCG) Vi: 21 hotspots per 100,000 inhabitants P: 62 hotspots per 100,000 inhabitants L: 201 hotspots per 100,000 inhabitants T: 38 hotspots per 100,000 inhabitants S: 17 hotspots per 100,000 inhabitants Va: 177 hotspots per 100,000 inhabitants
20	Leakage of plastic waste into waterways through wastewater systems	How much waste is leaked additionally into waterways through the wastewater system (e.g. microplastics from washing and cosmetics, etc.)?	% of produced plastic waste	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	Results in We don't consider additional quantities of waste entering waterways and the ocean. Estimates should be prudent as the transmission factor refers to total plastic waste production.	in We don't consider microplastics
21	Uncollected plastic waste entering drainage systems	How much of the uncollected plastic waste enters the drainage system (washing in, dumping,	% of uncollected plastic waste	5%	10%	5%	10%	10%	5%	No. 21 and no. 22 need to be considered together	Vi: Estimate based on large share of artificial barriers, and expected high level of street cleaning

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomviha ne Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
		etc.), considering the characteristics of the system, the quality of street sweeping, etc.?									P: Not as efficient as Vientiane, less tourism, less demand to cleanliness, estimate 10% L: Same as Vientiane T: Not as efficient as Vientiane, less tourism, less demand to cleanliness, estimate 10% S: Not as efficient as Vientiane, less tourism, less demand to cleanliness, estimate 10% Va: Same as Vientiane
22	Plastic waste in drainage systems entering waterways	How much plastic waste is not retained by traps, sinks, technical barriers or other installations (serviced and cleaned in a regular fashion) in the drainage system and thus enters waterways?	% of plastic waste entering the drainage system (no. 21)	90%	95%	95%	95%	95%	95%		Vi: Only 2 of the 35 artificial barriers are clean-up by the Government Other cities: No dedicated cleaning of the artificial barriers was found.
23	Plastic waste leakage into waterways during waste collection	How much plastic waste leaks into waterways during collection (untidy collection points, littering around collection points, uncovered open collection vehicles, etc)?	% of collected plastic waste	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	The transmission factors 23, 24, but street cleaning is 25 and 26 expected to be efficient display in the calculation plastic waste leakage from	Containers are likely not closed and overflowing, but street cleaning is expected to be efficient

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomviha ne Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
24	Plastic waste leakage into waterways during recycling, energy recovery & RDF	How much plastic waste entering treatment stages leaks into waterways during recycling, energy recovery and RDF (e.g. untidy facility management, windblown litter, etc.)?	% plastic waste entering treatment	0.50%	0.00%	0.00%	0.00%	0.00%	0.00%	formal waste collection. Factor 23 considers collection activities including moving	Vi: One factory was located in proximity to waterways. 23 Other cities: Did not have plastic recycling facilities
25	Plastic waste leakage into waterways during waste transportation	How much plastic waste leaks into waterways during waste transportation (e.g. uncovered vehicles, untidy transfer stations, etc.) from treatment to disposal	% of plastic waste transported from treatment to landfill	0.50%	0.50%	0.50%	0.50%	2%	2%	collected waste to treatment facilities or directly to final disposal. Factor 25 refers only to waste transported from treatment or between treatment stages. Factor 10 defines how	Vi: Low, as often compactor trucks P: Low, as often compactor trucks L: Low, as often compactor trucks T: Low, as often compactor trucks K: Both open and compactor trucks Va: Both open and compactor trucks
26	Plastic waste leakage into waterways during landfilling	How much plastic waste leaks into waterways from landfills (e.g. lack of coverage (windblown), untidy site management, informal activities, etc.)	% of landfilled plastic waste	0.00%	0.50%	0.50%	0.50%	0.50%	2%	much waste is entering treatment stages and transported.	Vi: The landfill is not in proximity to waterway, and has daily covers P: The landfill is not in proximity to waterway, but is not covered daily L: The landfill is not in proximity to waterway, but is not covered daily

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomvihane Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
											T: The landfill is not in proximity to waterway, but is not covered daily K: The landfill is not in proximity to waterway, but is not covered daily Va: Practically an open dump
27	Retention factor: technical and natural barriers in waterways	How much waste is retained in waterways actively (e.g. waste traps) or passively (e.g. natural or technical barriers)	% of plastic waste in waterways	50%	50%	50%	50%	50%	50%	The transmission factors no. 27, 28 and 29 display in the calculation the retention of plastic waste in waterways, which hinders plastics from entering into the ocean.	Many barriers
28	Retention factor: sedimentation of plastic waste in waterways	How much plastic waste is retained in waterways by sedimentation processes (the estimate of 15% can be used if more specific data is missing)	% of plastic waste in waterways	15%	15%	15%	15%	15%	15%		Strong flowing river
29	Retention factor: degradation of plastic waste in waterways	How much plastic waste is retained in waterways through degradation (the estimate of 0% can be used if more specific data is missing)	% of plastic waste in waterways	0%	0%	0%	0%	0%	0%		Not likely
5. Additional values (estimations based on expert assessment)											
30	Direct beach and coastal littering	How much marine litter stems from disposal of	kg/day	6.76	20	65	12	6	57	Estimation unrelated	Estimate based the to number of potential

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomviha ne Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
		plastic waste at beaches and along the coastline (e.g. from touristic or recreational activities)								waste management system based on tourist visits, consumption of bottles, beach samplings, etc.)	hotspots from consumption along (e.g. Mekong River, these include factories, hotels, markets, public parks, of restaurants, and temples. Among those spots, some major hotspots – the places where people and tourists gather and have more potential to leak solid waste to the river (LCG) Vi: 21 hotspots per 100,000 inhabitants. At four major hotspots near the river 338 items of plastic was collected. Estimate around 20 g/piece, and that the collected plastic is from one day. Low activity due to Corona, but also low waste management. P: 62 hotspots per 100,000 inhabitants. Amounted related to Vientiane amount and number of hotspots per citizen. L: 201 hotspots per 100,000 inhabitants. Amounted related to

No.	Item	Description	Unit	Vientiane Value	Pakse Value	Luang Prabang Value	Thakhek Value	Kaysone Phomviha ne Value	Vang Vieng Value	Notes	References/ Justifications (Vi: Vientiane, P: Pakse, L: Luang Prabang, T: Thakhek, K: Kaysone Phomevine, Va: Vang Vieng)
											<p>Vientiane amount and number of hotspots per citizen.</p> <p>T: 38 hotspots per 100,000 inhabitants. One of the major hotspots was a beach. Amounted related to Vientiane amount and number of hotspots per citizen.</p> <p>K: 17 hotspots per 100,000 inhabitants. Amounted related to Vientiane amount and number of hotspots per citizen.</p> <p>Va: 177 hotspots per 100,000 inhabitants. Amounted related to Vientiane amount and number of hotspots per citizen.</p>

Appendix B List of Plastic Items

The items of the suggested master list by (JRC, 2013) were divided into eight major product types. There is a total of 86 items.

Food and drink packaging
4/6-pack yokes, six-pack rings
Bags
Bait containers/packaging
Bottles
Cover / packaging
Crates and containers / baskets
Crisps packets/sweets wrappers
Cups and cup lids
Cutlery and trays
Foam packaging/insulation/polyurethane
Food containers incl. fast food containers
Lolly sticks
Other bottles & containers (drums)
Plastic caps and lids, incl. rings from bottle neck
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm
Salt packaging
Small plastic bags, e.g. freezer bags incl. pieces
Straws and stirrers

Household products
Bags
Bait containers/packaging
Bottles
CD, CD-box
Cleaner bottles & containers
Cover / packaging
Crates and containers / baskets
Dog faeces bag
Fin trees (from fins for scuba diving)
Foam packaging/insulation/polyurethane
Foam sponge
Jerry cans (square plastic containers with handle)
Light sticks (tubes with fluid) incl. packaging
Masking tape
Other bottles & containers (drums)
Pens and pen lids
Plastic caps and lids, incl. rings from bottle neck
Plastic flowerpots
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm
Salt packaging
Shoes/sandals
Shopping Bags incl. pieces
Shotgun cartridges
Small plastic bags, e.g. freezer bags incl. pieces
Strapping bands
Tablecloth
Telephone (incl. parts)
Toilet fresheners

Toys and party poppers

Personal care
Bait containers/packaging
Bottles
Cleaner bottles & containers
Combs/hairbrushes/sunglasses
Cosmetics bottles & containers
Cotton bud sticks
Cover / packaging
Crates and containers / baskets
Diapers/nappies
Foam packaging/insulation/polyurethane
Foam sponge
Gloves
Mask
Medical/Pharmaceuticals containers/tubes
Other bottles & containers (drums)
Plastic caps and lids, incl. rings from bottle neck
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm
Sanitary towels/panty liners/backing strips
Small plastic bags, e.g. freezer bags incl. pieces
Syringes/needles

Smoking materials
Cigarette butts and filters
Cigarette lighters
Tobacco pouches / plastic cigarette box packaging

Fishing gear
Bags
Bait containers/packaging
Buckets
Buoys
Cover / packaging
Crab/lobster pots and tops
Crates and containers / baskets
Engine oil bottles & containers <50 cm
Engine oil bottles & containers >50 cm
Fenders
Fin trees (from fins for scuba diving)
Fish boxes - expanded polystyrene
Fish boxes - plastic
Fishing line (entangled)
Fishing line/monofilament (angling)
Fishing net
Floats for fishing nets
Foam packaging/insulation/polyurethane
Jerry cans (square plastic containers with handle)
Light sticks (tubes with fluid) incl. packaging
Mussels nets, Oyster nets

Nets and pieces of net
Nets and pieces of net < 50 cm
Nets and pieces of net > 50 cm
Octopus pots
Other bottles & containers (drums)
Other fishing related
Oyster trays (round from oyster cultures)
Plastic sheeting from mussel culture (Tahitians)
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm
Rope (diameter more than 1cm)
String and cord (diameter less than 1cm)
Synthetic rope
Tags (fishing and industry)
Tangled nets/cord

Packaging materials
Bags
Bait containers/packaging
Bottles
Crates and containers / baskets
Engine oil bottles & containers <50 cm
Engine oil bottles & containers >50 cm
Foam packaging/insulation/polyurethane
Other bottles & containers (drums)
Plastic caps and lids, incl. rings from bottle neck
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm
Small plastic bags, e.g. freezer bags incl. pieces

Industrial products
Bait containers/packaging
Biomass holder from sewage treatment plants
Buckets
Cable ties
Car parts
Cleaner bottles & containers
Cover / packaging
Crates and containers / baskets
Engine oil bottles & containers <50 cm
Engine oil bottles & containers >50 cm
Fertiliser/animal feed bags
Fibre glass/fragments
Foam packaging/insulation/polyurethane
Gloves
Hard hats/Helmets
Industrial pellets
Jerry cans (square plastic containers with handle)
Masking tape
Mesh vegetable bags
Other bottles & containers (drums)
Plastic construction waste
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm

Sheets, industrial packaging, plastic sheeting
Strapping bands
Traffic cones

Other/unknown
Bags
Bait containers/packaging
Bottles
Buckets
Buoys
Cover / packaging
Crates and containers / baskets
Fenders
Foam packaging/insulation/polyurethane
Foam sponge
Injection gun containers
Jerry cans (square plastic containers with handle)
Nets and pieces of net
Nets and pieces of net < 50 cm
Nets and pieces of net > 50 cm
Other bottles & containers (drums)
Plastic caps and lids, incl. rings from bottle neck
Plastic/polystyrene pieces > 50 cm
Plastic/polystyrene pieces 2.5 cm > < 50cm
Rope (diameter more than 1cm)
Shotgun cartridges
Small plastic bags, e.g. freezer bags incl. pieces
Strapping bands
String and cord (diameter less than 1cm)
Synthetic rope
Tangled nets/cord

Appendix C Riverine Surveys Activity Reports

[See separate reports]

Appendix D Plastic Production Facilities

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
Lao Smay Plastic Factory Individual Enterprise	Chantaboury District, Vientiane Capital Tel: 020 55513348	All type of plastic packaging, rope straws, cups, bottles		Domestic	Phone number does not exist
Phontong Koutphet Factory	Chantaboury District, Vientiane Capital Tel: 021 560923	Bottles			Letter Needed
Lao Detergent Factory Co.,Ltd	Saythani District, Vientiane Capital Tel: 021 5521288	Bottles			Phone number does not exist
Jane Plastic Industry Sole Co.,Ltd	Saythani District, Vientiane Capital Tel: 021 732135	All plastic products			Phone number does not exist
J Family Trading Sole Co.,Ltd	Saysettha District, Vientiane Capital Tel: 021 470213	All type of plastic packaging, straws		Domestic Export	& No response
Keophila Pure Drinking water and Ice	Saythani District, Vientiane Capital Tel: 020 55555789	Plastic (drinking water) bottles	30~50	Domestic	Interview conducted
Continental Plastic Industry (LAO) Co.,Ltd	Hadxayfong District, Vientiane Capital Tel: 021 5517964	Plastic bag, bottles		Domestic Export	& Phone number does not exist
Khamphengphet Chengsavang Agriculture Export-Import Sole Co.,Ltd	Naxaythong District, Vientiane Capital Tel: 020 55513692	Bottles		Domestic Export	& No response
Lantiane Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 22245358	Bottles, plastic pellets (granules) by recycling old plastic		Domestic Export	& No response
Lao-China Woven Plastic Sack Sole Co.,Ltd	Sikhodtabong District, Vientiane Capital Tel: 021 252716-7	Plastic bag for sugar, soybean, rice, cement etc.		Domestic	Phone number is removed temporary
Vientiane Plastic Sole.,Ltd	Sikhodtabong District, Vientiane Capital Tel: 021 252677	Plastic bag, hot food bags, rope and other plastic products			No response
Yien Tong JV co.,Ltd	Hadxayfong District, Vientiane Capital Tel: 021 313479	All plastic products		Domestic Export	& No response
Bai Billion International Co.,Ltd	Park Nguem District, Vientiane Capital Tel: 020 55558359	Plastic pellets (granules)		Domestic Export	& Phone number does not exist

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
LLC Plastic Lao Sole Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 23666636	Plastic pellets (PP, PE, PS, ABS, PAG)	1500	Domestic Export	& Interview conducted
Lao Development Plastic Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 58326789	Bags	10	Domestic	Interview conducted
S&P Generate Plastic Products Factory Sole Co., Ltd	Sikhodtabong District, Vientiane Capital Tel: 020 55518562	Bags, other plastic product			Only registered business license, not yet producing
Lao Jinwanshun Plastic Packaging Banana Factory Sole Co.,Ltd	Park Nguem District, Vientiane Capital Tel: 020 55846430	Plastic packaging for bananas			Phone number does not exist
Vilasak Import-Export and Agriculture Promotion Sole Co.,Ltd	Sisattanak District, Vientiane Capital Tel: 020 22403826	Plastic pellets (granules)		Domestic Export	& phone number is out of service
Aura Lao Drinking Water	Hadxayfong District, Vientiane Capital Tel: 020 55519180	Bottles		Domestic	Phone number does not exist
Tingting Plastic Sole Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 55559439	Bags, plastic pellets (granules)			phone number is out of service
Sorjalern Modern Plastic Co.,Ltd	Saythani District, Vientiane Capital Tel: 020 96999899	Plastic pellets (granules), straws, bottles, plastic bag, plastic cup sleeve with handle		Domestic Export	& No response
Green Environment Factory	Saythani District, Vientiane Capital Tel: 020 55111086	Import plastic waste, recycled it by chop and wash then produce a new plastic product	1200~2000	Domestic Export	& Interview conducted
5 Star Development Water Resources Import-Export Sole Co.,Ltd	Naxaythong District, Vientiane Capital Tel: 020 23433235	Bottles		Domestic	No response
Yommanee Plastic Factory	Naxaythong District, Vientiane Capital Tel: 020 96663435	Plastic pellets (granule)	100	Domestic Export	& Interview conducted
Pathooma Drinking Water Factory Sole Co.,Ltd	Hadxayfong District, Vientiane Capital Tel: 020 56244010	Bottles		Domestic	Phone number does not exist

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
Maliphone Plastic Factory	Sikhodtabong District, Vientiane Capital Tel: 020 22207378	Bottles		Domestic	No response
Khampasong Plastic Factory	Sikhodtabong District, Vientiane Capital Tel: 020 22226909	Bottles			No response
Chalernsaeng Plastic packaging	Naxaythong, Vientiane Capital Tel: 020 22232323	Plastic bag			No response
Ice-Drinking Water Dokchampa Factory	Namtha District, Luang Namtha Province Tel: 020 55686222	Bottles		Domestic	No response
Jingfong Export-Import Co.,Ltd	Sing District, Luang Namtha Province Tel: 020 99884479	Plastic packaging for bananas			Phone number does not exist
Guanglong Packaging and LS Import-Export Co.,Ltd	Namtha District, Luang Namtha Province Tel: 020 55577690	All type of plastic bags		Domestic	Phone number does not exist
Plastic Product and Detergent Factory	Nong Maengda District, Oudomxay Province Tel: 020 5680765	All type of plastic bags, other plastic product		Domestic	No response
Sack Oudomxay Factory	Homsay District, Oudomxay Province Tel: 020 55787550	Plastic sacks	1200	Domestic	Interview conducted
Banana Plastic Packaging Factory	Huaysaiy District, Bokeo Province Tel: 020 55684168	Plastic packaging for bananas		Domestic	Phone number does not exist
Jing Wang Ta Co.,Ltd	Huaysaiy District, Bokeo Province	Plastic foam for bananas		Domestic	No contact detail
Yien Mianfu Recycle	Ton Pherng District, Bokeo Province Tel: 020 91515153	Plastic pellets (granules), bag, rope		Domestic	No response
Ku Tao Plastic Pallets Factory	Ton Pherng District, Bokeo Province Tel: 020 5558336				Phone number does not exist
Hua Tai Plastic Recycle	Ton Pherng District, Bokeo Province Tel: 02055311538				No response

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
Huang Xai Plastic Pallets Factory	Huaysaiy District, Bokeo Province Tel: 020 22380408				Phone number does not exist
Chuang Xing Technology Pack	Huaysaiy District, Bokeo Province Tel: 020 59274545				No response
Tavendeng Co.,Ltd	Luang Prabang, Luang Prabang Province Tel: 021 260899	Bottles		Domestic	Phone number does not exist
Chanthavong Plastic Co.,Ltd	Luang Prabang, Luang Prabang Province Tel: 020 55770099	Plastic pellets (granules)			Only registered, does not yet produce products
Lao Jing Jiang Investment Development Co.,Ltd	Sam Neua District, Huaphanh Province Tel: 020 99516666	Bag, chopstick, chair, basket	60~120	Domestic & Export	Interview conducted
Hen Sun Agriculture Development Import-Export Co.,Ltd	Xayaboury District, Xayaboury Province Tel: 020 98351788	Bags, foam packaging for agricultural product			No response
Zouy Fong Company	Xayaboury District, Xayaboury Province	Bags and plastic packaging for agricultural products			Phone number does not exist
Saiysamphanh drinking water company	Phonhong district, Vientiane Province Tel: 020 55623176	Bottles			Phone number does not exist
Ku Feng Foam Company	Phonhong district, Vientiane Province Tel: 020 98701666	Foam packaging for fruit		Domestic	Phone number does not exist
Truong Hong Development Multidisciplinary Group.,Ltd	Paksan District, Borikhamxay Province Tel: 020 22330479	Bags, straws, cups, rope, bottles & caps			Phone number does not exist
Hong Thong Pure Drinking Water Factory	Thakhek District, Khammouane Province Tel: 021 212314	Bottle		Domestic	Phone number does not exist
Bottle Factory Co.,Ltd	Thakhek District, Khammouane Province Tel: 77717608	Bottle		Domestic	Phone number does not exist

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
Khammouane Plastic Company Limited	Thakhek District, Khammouane Province Tel: 020 22174999	Bags		Domestic	Phone number does not exist
HDV Group (Lao) Co.,Ltd	Sepon District, Savannakhet Province Tel: 021 5514137	All plastic products			Phone number does not exist
Plastic bag factory	Kaysone District, Savannakhet Province Tel: 021 212255	Bags, straws, cups, rope, bottles & caps			Phone number does not exist
Lomankham Drinking Water & Ice Factory	Kaysone District, Savannakhet Province Tel: 041 212181	Bottles	120	Domestic	Interview conducted
LTB Manufactory Individuak Enterprise	Kaysone District, Savannakhet Province Tel: 041 252118	Plastic container, bottles, plates, cups			Phone number does not exist
Khamphet Individuak Enterprise	Kaysone District, Savannakhet Province Tel: 020 55645978	Bottles			No response
Bouakhao bottle Co.,Ltd	Kaysone District, Savannakhet Province Tel: 020 22780044	Bottles			Phone number does not exist
Xaynilanh Plastic Indivial Enterprise	Kaysone District, Savannakhet Province Tel: 020 58242111	Bags		Domestic	No response
MHL International Industry Sole Co.,Ltd	Kaysone District, Savannakhet Province Tel: 020 54008877				phone number is out of service
Sovann Industry Sole Co.,Ltd	Sepon District, Savannakhet Province Tel: 020 77375685	All type of plastic		Domestic Export	& Phone number does not exist
Sokmixay Import-Export Sole Co.,Ltd	Kaysone District, Savannakhet Province Tel: 020 54151444	Plastic pellets (granules)	5225	Domestic	Interview conducted
Lao You Suan Plastic and Rubber Factory	Kaysone District, Savannakhet Province Tel: 02097347597	Import plastic waste, then produce plastic pellets from imported items	628	Export	Interview conducted

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
Chalernsup Plastic Pellets Enterprise	Kaysone District, Savannakhet Province Tel: 02098382620		800		No response
Ketsana bottle Factory	Songkhon District, Savannakhet Province Tel: 020 99147059	Bottles	1	Domestic	Interview conducted
Waanchai Plastic Co.,Ltd	Vapi District, Salavan Province Tel: 020 2792266	Bags, straws, ropes, cups, bottles & caps and other plastic products	50	Domestic	Interview conducted
Jampadeng Import-Export Sole Co.,Ltd	Khongxedon District, Salavan Province Tel: 020 95551777	All plastic products	21900	Domestic Export	& 60T/day or depends on order, 60*365
Jarern Industrial Plastic Sole Co.,Ltd	Salavan District, Salavanh Province Tel: 030 9997938	All plastic products		Domestic Export	& Phone number does not exist
S&S Manufacturing and Production of Metal Co.,Ltd	Vapi District, Salavanh Province Tel: 020 99125777	Plastic pellets (granules)	4500	Export	Interview conducted
Lao Plastic Factory	Pakse District, Champasack Province Tel: 020 6699770	Bottles			Phone number does not exist
Keodouangjai Plastic Factory	Pakse District, Champasack Province Tel: 031 214210	Bottles, rope, bags		Domestic	No response
Champa Plastics Factory	Bajieng District, Champasack Province Tel: 020 55631888	Plastic sack	14400	Domestic Export	& Interview conducted
Bolaven Spring Factory Sole Co.,Ltd	Pakse District, Champasack Province Tel: 020 23633666	Bottles		Domestic	Phone number does not exist
Phoufa Pure Drinking Water Sole Co.,Ltd	Pakse District, Champasack Province Tel: 020 97844471	Bottles	1	Domestic	Interview conducted
IRIS Pure Drinking Ice and Plastic Factory Individual	Pathoumphone District, Champasack Province Tel: 020 97973838	Bottles	2	Domestic	Interview conducted

Business name	Address and phone number	Product Description	Capacity (t/yr)	Market	Remark
Fu Jing Plastic Factory	Bajiang District, Champasack Province Tel: 020 91906900		28001		Letter Needed
Rubber Factory	Bajiang District, Champasack Province Tel: 020 97059999				Phone number does not exist
Phieng D Plastic Factory	Bajiang District, Champasack Province Tel: 020 97708088				Phone number does not exist

Appendix E Guidance for GIS Maps

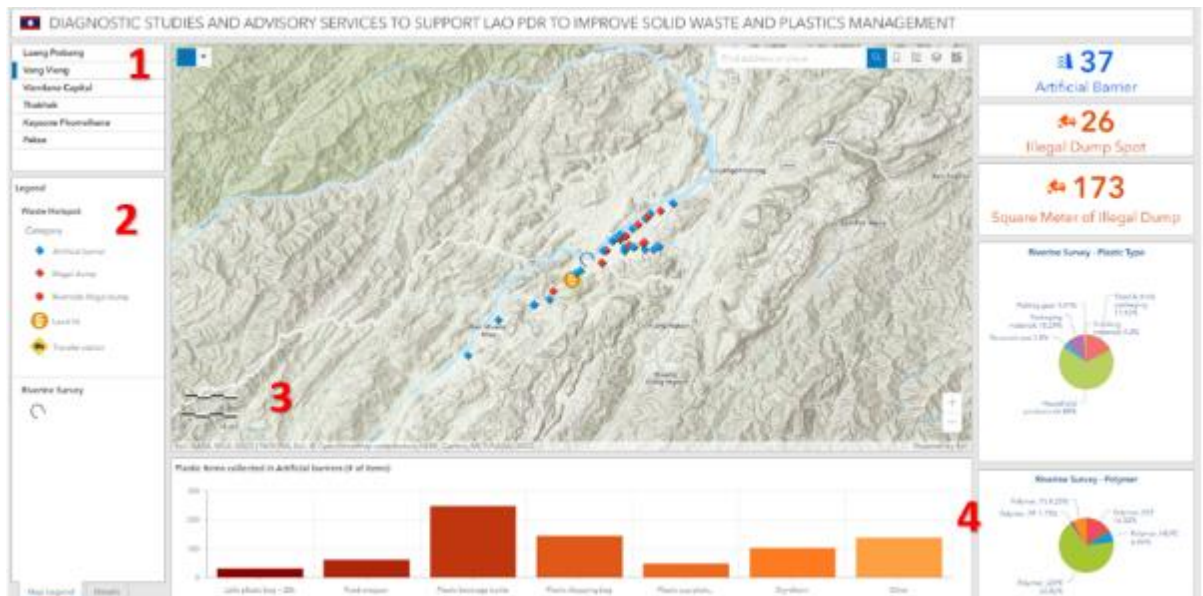
These interactive online maps show the result of the Hotspot and Riverine data collection survey conducted during Spring and Summer 2020 in six urban areas of Laos.

The purpose of these maps is to show and compare in an interactive way data on plastic waste collected by the National University of Laos. It complements the present report.

Two online map tools for two main purposes are available online:

- The 1st map, also called the dashboard allows the end-user to screen areas in the 6 urban areas and read aggregated information as an indicator of the specific selected location.
 - Weblink: <https://bit.ly/3lgnzmb>
- The 2nd map, also called WebApp allows the end-user to explore the data and use simple tools for various uses presented in a GIS environment.
 - Weblink: <https://bit.ly/2SrxboK>

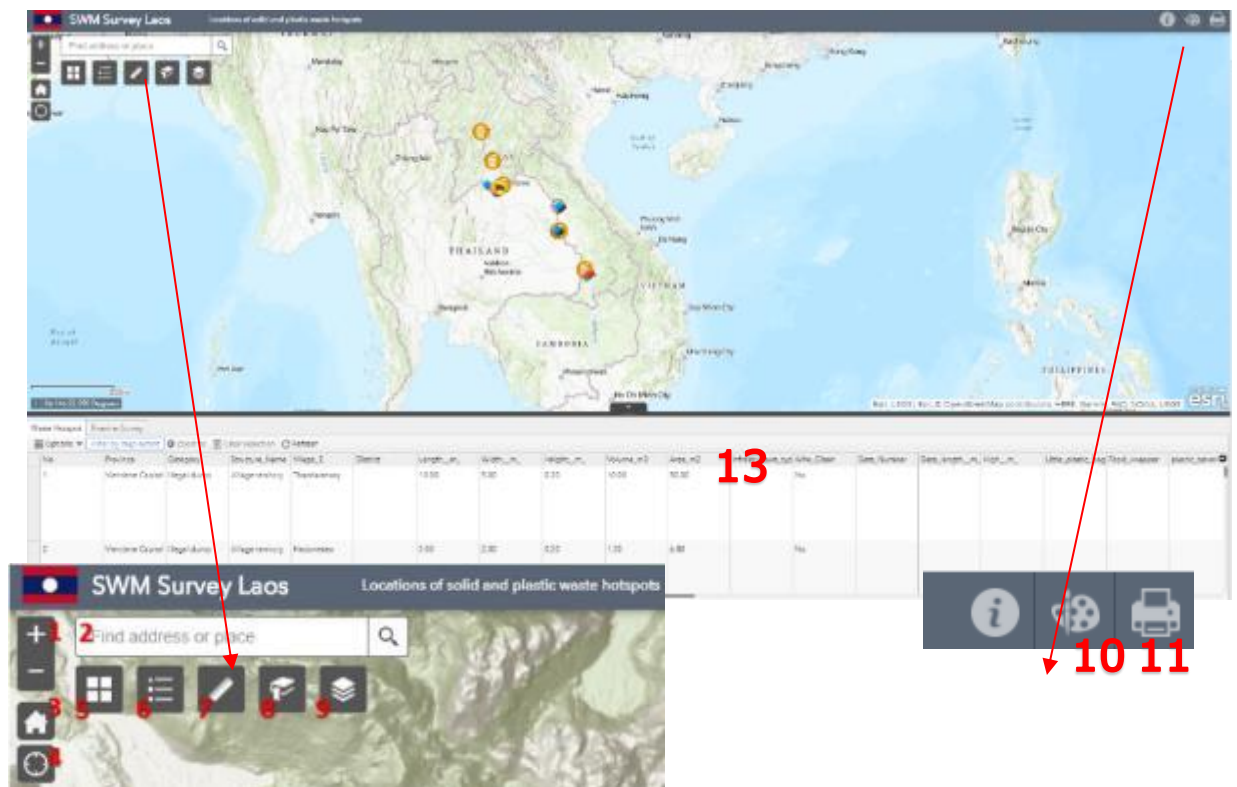
E.1 1st Map: The Dashboard



- 1 **Slider menu:** Allows the end user to directly zoom to the selected urban areas
- 2 **Legend:** Show the description of layer categories
- 3 **Explanatory Map:** Allows the user to navigate through the map, select items, read detailed information with photos by clicking on item symbol. The map is linked with the charts, every change on location will affect the charts display (extra tools are available, see below instruction presented in the 2nd Map).
- 4 **Dynamic Charts, Pie & Indicators:**

- 4.1 **Artificial Barrier:** indicates the total number of infrastructure that potential block the flow of plastic in a waterway.
- 4.2 **Illegal Dump Spot:** Total number of trash dump sites not officially approved by the authorities for disposal purpose.
- 4.3 **Riverine Survey Plastic Type:** shows the proportion of plastic type collected in a fishnet during the riverine survey in the Mekong River except for Vang Vieng area where the river is a tributary called Nam Song.
- 4.4 **River Survey – Polymer:** Idem as 4.3. except that the data are show in proportion by plastic polymer types.
- 4.5 **Plastics Items collect in artificial barriers:** Shows the quantity of plastic items collected at the vicinity of an artificial barriers, the charts segregate the data in main plastic items commonly found in Laos.

E.2 2nd Map: The WebApp



Zoom on tools located in the upper left corner

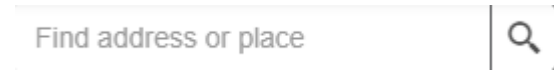


For the Dashboard (1st map) Similar tools are presented in a different order and are in the map windows upper right corner.

E.2.1 Tools Descriptions



- 1 Zoom Slider provides interactive zoom controls in the map display. Click the plus or minus button Zoom Slider to zoom in or out on the map



- 2 Search enables end users to find locations or search features on the map.

When you enter a placename or a keyword in the search box, you see suggestions as you type. If you see an arrow in the search box, you can search on all sources, or click the arrow and choose a locator or layer from the drop-down list.



- 3 Home zooms the map to the initial map extent. Clicking it resets the map extent to the map's initial extent.



- 4 Find your actual location if your device has Geolocation availability.



- 5 Base map Gallery presents a gallery of base maps and allows you to select one from the gallery as your tool's base map. Clicking the Base map Gallery displays all the base maps available clicking one of the base map thumbnails sets it as the active base map for the app.



- 6 Legends displays labels and symbols for layers in the map. The legends automatically updated when the visibility of the layer changes.



- 7 The Measurement Tool allows you to measure the area of a polygon or length of a line or find the coordinates of a point.



- 8 The Bookmark stores a collection of map view extents displayed in the app; the actual bookmark displays the list of urban area hosted by the plastic hotspot survey.



- 9 The Layer List tool provides a list of operational layers and their symbols and allows you to turn individual layers on and off. Each layer in the list has a check box that allows you to control its visibility.

The following layers are available:

9.1 **Waste Hotspot** – Shows the location of Hotspots of accumulated Plastic waste, the waste hotspot layer is classified in 3 main categories: Artificial barriers, Illegal dump and Riverside illegal dump (for Vientiane only)

9.2 **Riverine Survey** – Shows the location of net survey to collect floating plastics

9.3 **Venue Hotspot** - Shows the location of businesses that produce a certain amount of plastic waste. Businesses are classified by type.



10 The Draw widget allows you to draw simple graphics and text on the map. You can also use it to add line distance or polygon area to the feature as text.



11 The Print tool allows the current map to print in various format, size and layout, advance printing format are available where scale, special reference and print quality can be adjusted (recommend for advanced users)

No	Province	Category	Structure_Name	Village_E
1	Vientiane Capital	Illegal dump	Village territory	Thaphalanxay
2	Vientiane Capital	Illegal dump	Village territory	Hadonekeo

12 The Attribute Table displays a tabular view of operational layers' attributes. It displays at the bottom of your web app and can be opened, resized, or closed. When more than one layer's attributes are display, multiple tabs automatically generate in the attribute panel allowing you to switch among the attribute tables. You can use the tool's configuration window to specify the layer or layers to be included in the tabular view, the fields shown, and whether the tabular view can be exported.