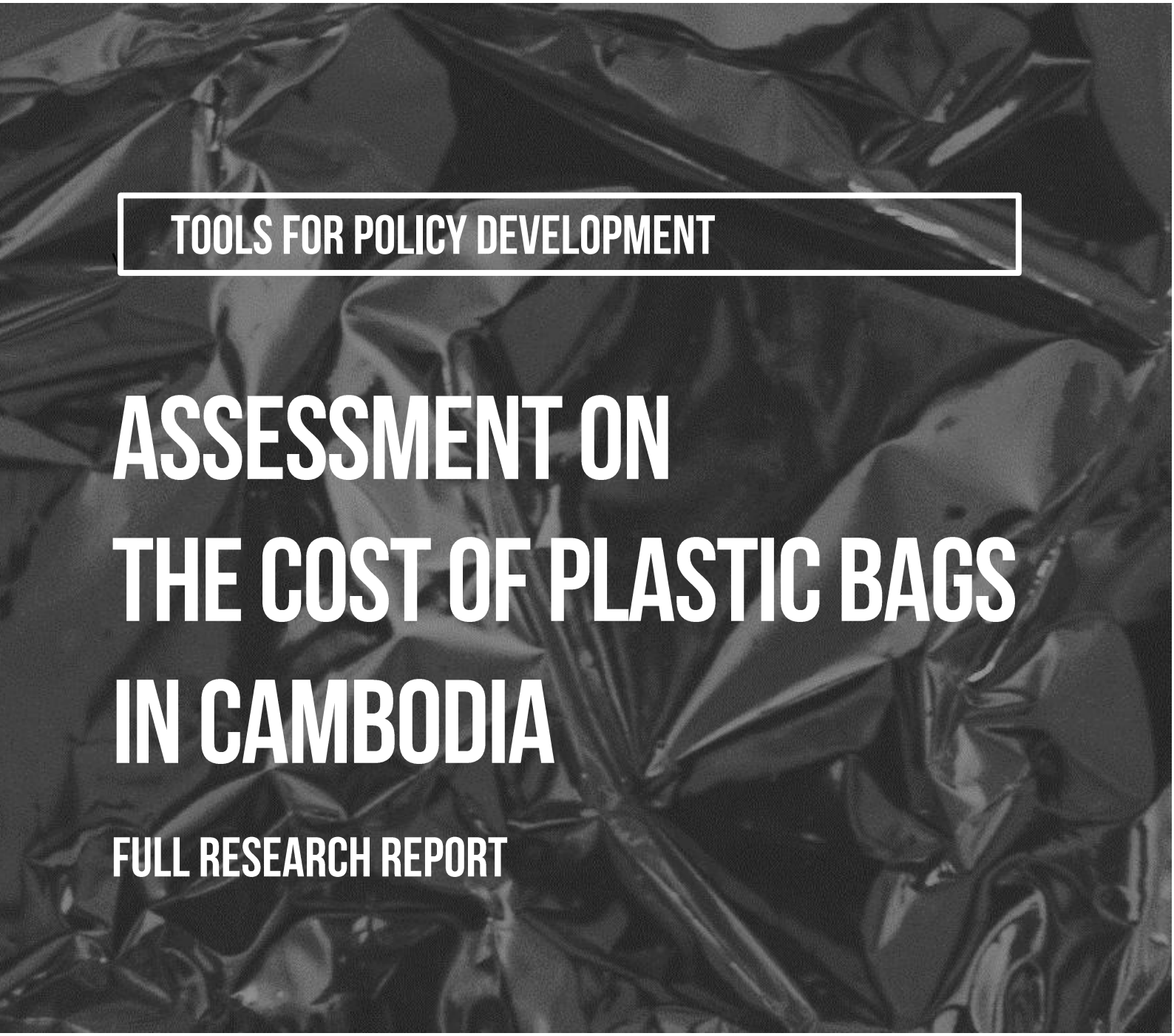
EXCESS BAGGAGE

REDUCING PLASTIC BAG WASTE IN MAJOR CITIES OF CAMBODIA



TOOLS FOR POLICY DEVELOPMENT

ASSESSMENT ON THE COST OF PLASTIC BAGS IN CAMBODIA

FULL RESEARCH REPORT

Fondazione ACRA Italy

Phnom Penh Capital Department of Environment

Royal University of Phnom Penh

National Committee for Clean City Assessment

funded by switchasia PROGRAMME

This publication was produced within the framework of the project "Reducing plastic bag waste in major cities of Cambodia" funded by the European Union under the SWITCH-Asia Programme.

The Project is implemented in Cambodia by Fondazione ACRA, the Phonm Penh Capital Department of Environment and the Royal University of Phnom Penh, in cooperation with the Ministry of Environment, the National Council for Sustainable Development, the National Committee for Clean City Assessment and local authorities.

Author: Serena Arduino

Research coordinators: San Vibol, Spoann Vin

Research team: Check Neangim, Kong Sopheak, Rim Rathkunthea

Editor: Michael Powell

For further information on the European Union, its activities in Cambodia and the SWITCH-Asia programme, please visit:

www.ec.europa.eu
www.eeas.europa.eu/delegations/cambodia
www.switch-asia.eu

For further information on the implementing partners, please visit:

www.acra.it
www.rupp.edu.kh
www.moe.gov.kh

For further information on the project and to download the full report and other resources, please visit **www.excessbaggage-cambodia.org**

TABLE OF CONTENTS

Acknowledgments 2
Abstract 3
1. Introduction 4
2. Methodology 5
3. Urban environment 9
3.1 Restoring the drainage system 9
3.2 Road repaving 16
3.3 Street sweeping 16
3.4 Education and cleaning campaigns 22
4. People 28
4.1 Origin of data 28
4.2 Families 28
4.3 Family businesses 30
4.4 Public concern 31
5. Tourism 35
5.1 Origin of data 35
5.2 Foregone tourism revenues 35
5.3 Tourists' attitude 36
5.4 Costs to the tourism industry 44
6. Human health 46
6.1 Endocrine disruption from contamination of food by plastics 46
6.2 Health costs of endocrine disruption 48
7. Conclusions 50
8. List of contacts 51

ACKNOWLEDGMENTS

For their cooperation in data collection, the research team wishes to thank: Mr. So Platong, Deputy Governor of Siem Reap City, Siem Reap Province; Mr. Prak Visal, Deputy Director, Administration Division, Preah Sihanouk Province; Mr. Hout Rithy, Director of Cooperation and Promotion Division, National Committee for Clean City Assessment-NCCA; Mr. Im Vibol, Deputy Chief of Technical Office, Sewerage and Drainage System Unit, Department of Public Works and Transportation, Siem Reap Province; Mr. Chhorng Vantha, Deputy Chief of Drainage and Sewerage Division Phnom Penh, Ministry of Public Works and Transportation; and Mr. Men Sothet, Director, Pumping Stations, Drainage and Sewerage Division Phnom Penh, Ministry of Public Works and Transportation. The author wishes to thank Michael Powell for his helpful input during the drafting of this report, and the editing of the English language content.

ABSTRACT

This assessment represents the first attempt to measure the cost of plastic bags to Cambodia's economy and society. Costs associated with plastic bags are categorized and presented in four broad sectors: Urban Environment, People, Tourism and Human Health. The choice of the indicators was done based on the primary and secondary data that was collected or available to the research team.

Main findings for each of the four sectors are presented below.

Urban Environment: significant costs presented within this sector include the direct impact of discarded plastic bags in the blocking of the sewerage and drainage systems as well as the indirect costs required to prevent this problem, such as regular street sweeping and education and cleaning campaigns. Plastic bags are estimated to be 20% of the littered waste collected by street sweepers in Phnom Penh, Sihanoukville and Siem Reap. Nevertheless, they are responsible for a much higher percentage of the waste that obstruct the water runoff of these cities: up to 60% in Siem Reap. The direct impact of plastic bags to the sewerage and drainage system exceeds 100,000 USD per year in Phnom Penh city alone. The cost of preventive measures is significantly higher: around 600,000 USD for street sweeping in the urban areas and up to 1,000,000 USD for conducting antilittering and cleaning campaigns in Cambodia are spent every year.

People: significant costs identified and presented within this sector include the direct and indirect impacts of flash floods caused by the obstruction of the drainage system on families and on their businesses. Direct damages to their houses, forgone income, and cost required to prepare before the flash floods, and after they had occurred , were all indicators. The average cost for each family living in flood prone areas, including damage cost and income lost, exceeded 500 USD.

Tourism: the impact of plastic bags on tourists and their experience in Cambodia, and the economic value of plastic bag free tourist sites, were among the indicators analysed in the Tourism sector. The percentage of tourists that mentioned littered waste among their dislikes was as high as 72%. 13% of the tourists interviewed declared in addition that the amount of littered waste deterred them from wanting to visit Cambodia again. Result from the willingness to pay survey conducted showed how the distress to tourists caused by littered waste, of which plastic bags is estimated to contribute to at least 20%, is over 4.5 million dollars.

Human Health: Endocrine Disruption associated with food contamination by plastic bags was the main indicator assessed and included in this category. Although there are no locally available data on health costs associated with the treatment of Endocrine disruption related diseases, data available from the European Union and other countries, suggested that the cost to Cambodia of all the effects of endocrine disruption could be in the range of hundreds of millions of dollars.

1. INTRODUCTION

This assessment of the cost of plastic bags has been conducted within the framework of the *Reducing Plastic Bag Waste in Major Cities of Cambodia* project, co-funded by the European Commission, under the SWITCH Asia initiative, *Promoting Sustainable Consumption and Production* (EuropeAid/133608/C/ACT/CAI). The aim of the assessment is to understand the impact of plastic bags in Cambodia. This information can then be used by policy makers to encourage debate about the issue, and pass new legislation to limit plastic bag consumption, and to promote their proper disposal. The results of the assessment rely mostly on quantitative, but also include qualitative data.

This assessment presents data from research conducted in the three main urban areas targeted by the project, Phnom Penh, Siem Reap, and Sihanoukville. Nevertheless, estimates of the impact at national level were included whenever possible, by extrapolating the data gathered at local level. The output is a description of the impacts of plastic bags on the Cambodian community. For each category of impact, only certain indicators and sub-indicators are analyzed; those for which it was possible to gather information with available resources. When possible, impacts were measured in terms of economic cost. More frequently though, impacts were measured in terms of the effort dedicated to preventing and offsetting the negative consequences of plastic bags, the number of people expressing concern, and the amount of plastic bags creating damage.

2. METHODOLOGY

For this assessment, the consultant was responsible for framing the study, identifying the categories of impact, establishing the methodology to calculate the cost of plastic bags, and summarizing the results. The research team was responsible for setting the research protocols for the original surveys, and for data collection and analysis. Discussions were held frequently, with the participation of local ACRA staff.

2.1 LIMITATIONS, SCOPE AND DECISIONS

The assessment faced a few limitations, which led to a series of decisions:

Limitations	**Decisions**
Collection of existing data proved difficult as several potential key informants declined or were unable, to provide information.	Only indicators for which the data collected allowed some analysis were included in the assessment.
For some indicators, secondary data did not exist or their coverage was not sufficient to allow analysis.	Indicators for which the research team was not able to collect primary or secondary data were not included in the assessment.
Sometimes the sample size of the surveys did not allow robust conclusion to be drawn	In such cases, conclusions provided indications of orders of magnitude, or were limited to qualitative information
Data helpful to measure the impacts of plastic bags was not available for all Cambodian provinces.	This is not a national assessment: some conclusions are drawn for the three cities, and only a few are drawn at national level
For the three cities of Phnom Penh, Siem Reap and Sihanoukville, the data collected were not always comparable	In these cases, conclusions were drawn city by city
In some contexts, it was difficult to distinguish plastic bags from plastic waste, or general litter	In such cases the term “plastic waste”, or generic “waste” are used, and the reader will know that plastic bags are a fraction of it
Data to compile indicators of economic costs were difficult to find	Several indicators were chosen that did not imply calculating economic costs; some impacts are described in terms of social costs, or in qualitative terms
The distinction between direct and indirect costs did not appear significant	Impacts were grouped by sector: urban environment, people, tourism and human health. The distinction between direct and indirect costs was not made.
Originally, the study was meant to focus on the impact of dispersed plastic bags only. While conducting secondary research, one impact associated with the use of plastic bags emerged as very significant.	The cost caused by endocrine disruption, related to the use of plastic bags as food wrap or food container, was included under the health impact category.

2.2 ASSESSMENT FRAMEWORK

Several impacts of plastic bags were discussed and assessed, and were finally categorized in four broad sectors: Urban environment, People, Tourism and Human health. Additional types of impact to biodiversity, ecosystems and human health were considered significant, but were not included in the assessment given that the data available did not allow for clear conclusions. For each sector, broad indicators were chosen and more specific sub-indicators were selected.

I. URBAN ENVIRONMENT

Includes the direct impact of discarded plastic bags on urban infrastructure, such as the obstruction of the sewerage and drainage system, the damage to the roads from floods, and any repair needed.[1] Indirect effects discussed in this sector include the cost of the regular street sweeping required to prevent such damage, and education and cleaning campaigns. Data for the three urban areas were collected through interviews with key informants.

II. PEOPLE

Includes the direct and indirect impacts of discarded plastic bags on families, and family businesses as a consequence of the flash floods caused by the obstruction of the drainage system. The public concern about discarded bags and uncollected waste is also included in this sector. For this type of impact, two specific surveys were designed and conducted by the RUPP research team to collect new data for Phnom Penh and Siem Reap - Sihanoukville is much less prone to flashfloods. Public concern about dispersed plastic bags is measured through the opinions people expressed and the complaints they filed.

III. TOURISM

Includes the direct impact of plastic bags on tourists, and their experience in Cambodia, as well as the indirect impact in terms of loss of revenue from tourism. The cost of collecting discarded plastic bags in tourist areas is included. A third survey was designed and conducted by the RUPP research team on the attitude of international tourists towards plastic bags, including an analysis of their willingness to pay to see the plastic bags removed from tourist sites. The survey was undertaken in the three cities, and results are extrapolated to the national level.

IV. HUMAN HEALTH

Covers the impact of plastic bags on people's health, when plastic bags are used as food containers or food wrap. Health impacts are generated by the endocrine-disrupting chemicals that are contained in plastics, and which contaminate the food. Country-specific data for Cambodia is not available, but an estimate of the order of magnitude of the cost to Cambodia is attempted from estimates available from Europe and the US.

[1] For this report the drainage system includes the canals, the manholes and all runoff ways up to the pump stations.

In total, 11 indicators and 42 sub-indicators were used, as summarized below.

Indicator	Sub-indicator
I. URBAN ENVIRONMENT	
1 Restoring the drainage system	1.1 Labor time dedicated to removing plastic bags from the drainage system
	1.2 Cost of such labor
	1.3 Total equipment and consumable cost
	1.4 Proportion of the Sewerage and Drainage Division budget dedicated to restoring the function and capacity of the drainage system
	1.5 Amount of waste collected from the drainage system
	1.6 Proportion of plastic bags in the waste collected
	1.7 Cost of other impacts
2 Repaving roads	2.1 Cost of repaving roads after they have been damaged by floods
3 Street sweeping	3.1 Number of workers assigned to street sweeping
	3.2 Cost of these workers
	3.3 Equipment cost
	3.4 Amount of waste collected
	3.5 Proportion of plastic bags in the waste collected through street sweeping
4 Education and cleaning campaigns	4.1 Number of campaigns
	4.2 Cost of campaigns
	4.3 Number of volunteers engaged
II. PEOPLE	
5 Families *(survey)*	5.1 Proportion of families who suffered damages from flash floods
	5.2 Average cost of the damages generated by the flash floods
	5.3 Foregone income caused by the flash floods
	5.4 Time to prepare *before* the flashfloods and to restore *after* the flash floods
	5.5 Time to recover from the flash floods
	5.6 Average total cost to families
6 Family businesses *(survey)*	6.1 Proportion of family businesses in flood-prone areas that closed because of flash floods
	6.2 Duration of shop closure
	6.3 Income loss due to shop closure
	6.4 Restoration cost after the flash floods
7 Public concern	7.1 People's perception of how responsible plastic bags were for obstructing the drainage system, and causing flash floods
	7.2 Proportion of households not satisfied with the waste collection service in their area
	7.3 Complaining modalities
	7.4 Cost of complaining
	7.5 Number of complaints on waste management received by public authorities
III. TOURISM	
8 Foregone tourism revenues *(case study)*	8.1 Proportion of tourist groups shortening their tour due to plastic bags
	8.2 Loss of income to the community from group tours
9 Tourists' attitude *(survey)*	9.1 Proportion of international tourists who are bothered by dispersed waste in tourist sites
	9.2 Proportion of international tourists who consider the amount of dispersed plastic bags they saw as "not low"
	9.3 Proportion of international tourists who may not come back to Cambodia because of the dispersed plastic bags
	9.4 Proportion of international tourists willing to contribute money to remove dispersed plastic bags
	9.5 Extent of their willingness to pay
	9.6 Foregone revenues from tourists as a consequence of plastic bags
	9.7 Economic value of plastic-bag-free sites to international tourists

10	**Cost to the tourism industry** *(case study)*	10.1 Cost to local tourism entrepreneurs to run a private waste collection service in tourist areas
IV.	**HUMAN HEALTH**	
11	**Endocrine disruption from contamination of food by plastics**	11.1 Health costs related to endocrine disruption

2.3 DATA

For this assessment, both primary and secondary data were used. Primary data were collected for the People and Tourism sectors: three original surveys, of families, family businesses and international tourists, were designed and undertaken by the research team for the purpose of this assessment. Secondary data were used for the other two sectors; Urban Environment and Human Health, and to complement the People and Tourism sectors. Secondary data were collected through interviews with key informants, mostly representatives of the public administration, and from reports and publications.

3. URBAN ENVIRONMENT

The urban areas in Cambodia suffer from litter and overall improper waste management, and the government provides 5M$/year, to assist the 26 cities of Cambodia to become cleaner.[2]

In an urban environment, litter causes damage to the city's infrastructure. The restoration of the infrastructures' function and capacity, and the prevention of further damage represent a cost to the public administration and to the community.

For this assessment the impact of plastic bags has been considered on:

- the drainage system (dispersed plastic bags obstruct the drainage system and hinder the water runoff, causing flash floods)
- roads (flash floods damage the road surface)
- street cleaning efforts (street sweeping is performed to reduce further dispersion of plastic bags, and the consequent damage to urban infrastructure)
- public engagement efforts (education and cleaning campaigns are organized to prevent, or limit littering).

Data for this sector were collected through interviews with key informants.

3.1 RESTORING THE DRAINAGE SYSTEM

This indicator measures the cost caused by plastic bags when they are thrown away and left dispersed. And in particular, it measures the cost of restoring the drainage system to its original function and capacity. Discarded plastic bags end up in the drainage system, impeding the regular flow of the water, and thus generating flooding in nearby areas. This flooding is generally of relatively low intensity, and would have not occurred had the drainage system not been blocked. This is in contrast with the major flooding that occurs during the rainy season, regardless of the capacity and the functioning of the drainage system. For this reason, flooding caused by clogged drainage systems was called, "man-made floods," or "flash floods."

This indicator refers to the cost of removing the obstructions caused to the drainage and sewerage systems by dispersed waste, including plastic bags. Removing the obstructions leads to restoring the drainage function. Removing plastic bags from the drainage system includes activities along the canals, at manholes and at the pump stations. Solid waste was reported as the main cause of obstruction of the drainage and sewage system, with plastic bags contributing significantly to the system blockage.

3.1.1 ORIGIN OF DATA

For this sector, secondary data were considered, collected through interviews to key informants.

For Phnom Penh, data were obtained from officers within the Drainage and Sewerage Division, Ministry of Public Works and Transportation. For Siem Reap, data were obtained from City Hall and the Technical Office of the Sewerage and Drainage Unit of the Department of Public Works and Transportation. For Preah Sihanouk Province, data were obtained from the Administration Division, the Department of Public Works and Transportation, and the Sihanoukville Tourist Association.

[2] Announcement made by the Minister of Environment Mr. Say Sam Al, 1 April 2015

3.1.2 RESTORATION COSTS IN PHNOM PENH

Brief context.

The Department of Public Works and Transportation (DPWT) cooperates with local authorities in Phnom Penh to maintain and repair the municipal sewage and drainage system. The City partially supports some of these activities, for example, by contributing to the salary of workers. The system combines sewage and storm water. Construction began during the French colonial period and 4-5 km from that time is still in operation around Wat Phnom. The system today is 515,762 km long.[3]

Obstructions in the sewerage and drainage system come from garbage, including plastic bags, mud and dirt from roads. During heavy rain, garbage and dirt from the roads flow into the drainage system; this includes household waste packaged in plastic bags left along the drainage system, or thrown directly into the canals. Typical items found in the plastic fraction of the waste caught in the drainage system in Phnom Penh are plastic bags, straws and food containers. Plastic bags are recognized as having a major impact on the drainage system.[4] In Phnom Penh there exist 16 canals and 11 sewage-pumping stations; two main ones, Beung Trobaek and Beung Tompun, and 9 smaller stations. Pumping stations are equipped with nets to catch debris and garbage; at each station workers collect the material deposited in the nets.

Waste material collected and proportion of plastic bags.

In each of the two main pumping stations, the material collected at the grid reaches 7-8 truckloads per week, while in the 9 smaller pumping stations it amounts to 3-4 truckloads a week. In total, every week of the year, an average of 17-20 truckloads of material are removed from the grids at the pumping stations. As a truck has a volume of about 5 m^3, the material removed corresponds to 85-100 m^3 a week, or 4420-5200 m^3 a year.

Plastic waste and plastic bags collected at the grids of the pumping stations represent 90% and 20% of all the waste collected, respectively.[5] Canals and manholes are cleared at least once a year; here, plastic bags account for about 40-50% and 50% of the total waste respectively. Routine cleaning of canals and manholes is performed every year in the dry season from December to June. In the rainy season, clearing takes place only in damaged and clogged areas.

Labor.

There are 62 workers involved in waste collection at the grids of the 11 pumping stations in Phnom Penh, 26 at the 2 main pumping stations and 36 at the 9 smaller ones, all year round, and 45 workers dedicated to cleaning canals, pipelines and manholes and removing obstructions for 7 months a year from December to June. The former dedicate a total of 744 person-months; the latter 315 person-months.

Labor cost.

Workers cost 340,000R, or 85$, per month and are not included in the budget of the Sewerage and Drainage Division; 60$ is provided by the DPWT, and 25$ comes from the City. The 62 workers at the pumping stations work all year to remove the material accumulated at the grids. At 85$/month, their total cost is 63,240$/year. The 45 workers engaged in cleaning

[3] Personal Communication Mr. Chhorng Vantha, Deputy Chief of the Drainage and Sewerage Division, Phnom Penh, 31 March 2015 at DSD office, Ministry of Public Works and Transportation

[4] Personal Communication Mr. Chhorng Vantha *Ibid*

[5] Personal Communication Mr. Men Sothet, Director of 11 pumping stations in Phnom Penh, 19 August 2015

canals, pipelines and manholes work mainly from December to June. At 85$/month, their total cost is 26,775$/year.

Transportation cost.

Around 17-20 truckloads a week of material are collected at the grids of the pumping stations in Phnom Penh and are transported to the landfill. Each truckload requires 15l of gasoline at the cost of 1$ (4000R)/l. Therefore, the weekly cost for gasoline to transport the solid waste accumulated at the grids of the 11 pumping stations is 255-300$, and the yearly cost is 13,260-15,600$.[6] The cost of the gasoline used to transport the waste collected in the streets is not known. Gasoline is included in the overall budget for the Sewerage and Draining Division (see below).

Dedicated financial resources.

Financial resources to clean the sewerage and drainage system are provided for the most part by the DPWT, with a contribution from the City. For the Sewerage and Draining Division, the money actually spent on removing obstructions in past years, or their final balances, were not made available to the researchers in spite of repeated requests. Instead, the *proposed budget* for 2015 was provided, indicating that the actual cost would not differ much from the forecast. For 2015, the *proposed budget* for the entire Sewerage and Drainage Division is 19,463,842$. Of this, 117,750$ is for the cleaning of pipelines and manholes at 5$ per meter of road, and 4,050,000$ for the cleaning of canals. The total expense for cleaning and removing obstructions thus amounts to 4,167,750$, corresponding to 21.4% of the overall budget of the Sewerage and Drainage Division. As mentioned above, this figure does not include labor costs.

3.1.3 RESTORATION COSTS IN SIEM REAP

Brief context.

In Siem Reap Province, the Department of Public Works and Transportation (DPWT) is responsible for drainage system cleaning, and restoration in urban areas. All the people interviewed about plastic waste in the Siem Reap area confirmed that plastic waste, and plastic bags in particular, have a significant impact on the community.[7]

Two waste collection companies operate in the Siem Reap area:

a) GAEA, in the city, under the responsibility of the Municipality.
b) VGreen (HCC) in the Angkor area, museum and airport, under the responsibility of the Apsara Authority.

In the city, flash floods occur in areas downstream of the system's blockages, with the water level rising by approximately 0.5m. Overall, in 2011, as a result of several floods, these areas remained submerged for about one month.[8] Although sewerage canals are 8-10m deep, plastic bags enter them when the drainage system meets the sewerage system. As a result, plastic bags and other waste have an impact on the wastewater treatment plant and the pumping station. The grids of the pumping station block the plastic bags and need to be cleared by the workers.

[6] Personal Communication Mr. Men Sothet *Ibid*
[7] Mr. So Platong, Deputy Governor of Siem Reap City Hall, and Mr. Im Vibol, Deputy Chief, Technical Unit, Sewerage and Drainage, Siem Reap
[8] Personal Communication Mr. Im Vibol, Deputy Chief, Technical Unit, Sewerage and Drainage, Siem Reap, 17 March 2015 at the DPWT; and phone calls November 2015

Proportion of plastic bags.

The waste generated in Siem Reap is about 270 t/day, of which about 200t/day is collected and the rest is then buried, burned or dispersed in the environment.[9] As per the proportion of plastic bags:

a) according to GAEA, 15% of the waste *collected* is plastics[10]
b) according to the Sewerage and Drainage Technical Unit, 30-60% *of the solid waste creating obstructions in the drainage system* is made of plastic bags, and[11]
c) > 60% is the plastic fraction *trapped by the grids protecting the pumping stations*[12]

Labor.

To remove obstructions from the drainage system, the Sewerage and Drainage Technical Unit allocates a team of 10 workers with 1 truck and 1 excavator, who make on average 10 interventions every three months, each intervention lasting 3-4 days. In total, they thus dedicate 1200-1600 person-days a year. This estimate is based on 22 working days per month; this amounts to 54-72 person-months. These workers clean and remove obstructions at various points in the city – such as the canals along the roads. To remove the material gathered at the grids of the pumping stations 5 workers at a time are required, intervening 2-3 times/year, for 3-4 days each time. In total, they dedicate 30-60 person-days a year, 1.5-3 person-months.

Labor cost.

The cost of labor for the workers cleaning the drainage system is 6$/day, so in total the cost of labor to remove obstructions in the draining system of Siem Reap can be calculated at 7,200-9,600$/year or an average of 8,400$.[13] *(Note that this calculation disagrees with the breakdown of the budget for cleaning and removing obstructions provided here below under "Dedicated financial resources".)* The cost of a worker at the pumping station is 112$/month, therefore, the total labor cost to remove waste at the grids amounts to 168-336$/year.

Waste material collected.

Usually, workers cleaning the drainage system make 3-5 interventions each rainy season to clean the canals with each intervention taking 3-4 days, but they can make 10 interventions if the rain is heavy. The amount of solid waste removed depends on the length of the drainage canal, and whether or not it is a hotspot; an area with high density of dispersed waste. Each time, the waste removed varies between 5 and 15 truckloads (2.5 m^3 each), namely 37-75m^3. Each time waste is removed from the grids of the pumping stations, 3-5 trucks (3m^3 each) are filled. Cleaning occurs 2-3 times a year, therefore the total amount of waste removed from the grids is 6-15 truckloads a year, corresponding to 18-45 m^3.

Dedicated financial resources.

The budget of the Sewerage and Drainage Unit of Siem Reap comes from the fees paid by the users, households and commercial activities, for the services received. In 2014, these amounted to about 55,000$.[14] Of this, about 10,000$, 18% of the Unit's budget, is used for cleaning the drainage system.

[9] Personal Communication Mr. So Platong, Deputy Governor of Siem Reap City Hall, 16 March 2015 at City Hall
[10] Personal Communication Mr. So Platong *Ibid*
[11] Personal Communication Mr. Im Vibol *Ibid*
[12] Personal Communication Mr. Im Vibol *Ibid*
[13] Personal Communication Mr. Im Vibol *Ibid*
[14] Personal Communication Mr. Im Vibol *Ibid*

As an example of the costs, in 2013, the total budget for the cleaning of the drainage system in front of the Build Bright University, a length of 720m, was 3,609 $, including labor, equipment and gasoline.[15] In 2012, the budget for cleaning the Venerable Tep Vong Road, approximately 400m long, was 3,650$.[16] Because of these budget constraints, there is no regular cleaning, but only on demand when blockages occur, or just before the rainy season. In any case, the effects of cleaning do not last long since local residents continue to dispose of their waste improperly, and canals just cleared revert to being clogged in very little time.[17]

Other impacts.

Pumps normally have a working life of 30 years, but as a result of the wear and tear caused by waste in the pumping station, the pump had to be changed 2 years after its installation. The new pump, which had to be imported from the US, cost approximately 8,000$.

3.1.4 RESTORATION COSTS IN PREAH SIHANOUK PROVINCE

Brief context.

CINTRI is the solid waste collection company in Sihanoukville. Drainage cleaning and restoration are the responsibility of the Department of Public Works and Transportation (DPWT). All people met in Preah Sihanouk Province confirmed that the impact of plastic waste is significant; one person defined it as “apocalyptic” and “disgraceful”.[18]

There are two types of drainage system: underground pipeline, and U line. The drainage system covers approximately 50% of the city, for the most part it was built during the French colonial period. Given the increasing population and tourists, the system is under pressure.[19] Due to low local public awareness, the main polluters at the tourist sites of Preah Sihanouk Province are local tourists/day visitors, especially during national holidays. Flying or dispersed plastic bags create problems for the drainage system during the rainy season from June to September; in this season flooding occurs 3-5 times per month.[20]

Thanks to favorable geomorphological conditions and the presence of hills, during the rainy season, most water runoff flows directly into the sea through a large canal. This canal transports floating plastic bags and styrofoam food containers on the surface, while plastic bags mixed with mud become heavy and sink to the bottom. The heavy debris have rendered the canal narrower, making it unable to work to full capacity and, as a consequence, selected areas of the city are flooded at times for a maximum of half, to one hour.[21] Waste is also removed from the drainage system and from the grids that protect the pump station at the wastewater treatment plant. Cleaning activities are performed all year round.

[15] Budget 2013 for Drainage System Cleaning in front of the Build Bright University, Siem Reap - 25 July 2013

[16] Budget 2012 for Drainage System Cleaning along Venerable Tep Vong Road, Siem Reap – 29 February 2012

[17] Personal Communication Mr. Im Vibol *Ibid*

[18] Mr. Prak Visal, Deputy Director of the Administration Division and Project Coordinator of the Integrated Coastal Management (ICM) Program, Preah Sihanouk Province; Mr. Nop Heng, Director of Department of Public Work and Transportation, Preah Sihanouk Ville; Mr. Douglas McColl, Vice-President Sihanoukville Tourist Association

[19] Personal Communication Mr. Nop Heng, Director of Department of Public Work and Transportation, Preah Sihanouk Ville, 13 March 2015 at DPWT

[20] Personal Communication Mr. Prak Visal, Deputy Director of the Administration Division and Project Coordinator of the Integrated Coastal Management (ICM) Program, Preah Sihanouk Province, 13 March 2015 at Provincial Hall

[21] Personal Communication Mr. Nop Heng *Ibid*

Labor.

Three workers are employed by the Sewerage and Drainage Division for the restoration of the drainage system; 1 is a permanent employee, and the other two work on demand. All dedicate an average of 3 days a month to manhole cleaning, or 108 days a year, in total, about 5 persons-months.[22] At the wastewater treatment station, 2 permanent employees dedicate 3 days/month each to remove the waste accumulated at the protection net, for a total of 72 days/year, or 3.3 persons-months.

Labor cost.

At the Sewerage and Drainage Division, for manhole cleaning, a full-time worker costs 137.5$/month; the time he dedicates to cleaning thus costs around 165$/year (4.58$/d x 36 days). The 2 workers on demand each cost 8.75$/d, and therefore 630$/year for both of them (8.75$ x 72 days). In total, they cost about 800$/year. At the pump station of the wastewater treatment plant, the workers cost 137.5$/month. Therefore the cost of their work to clean the nets amounts to about 330$/year (4.58$/day x 72 days).[23]

Equipment and material.

It takes 10l of fuel to extract the waste from the manholes every day. Fuel is 93 cents per liter/l, thus, the total cost for fuel is about 338 $/year (10l x 36 days x 0.93$). At the wastewater treatment plant they require 2 baskets/month, at 5$ each, for a total of 120$/year.[24] To remove the waste from the manholes, an average of 300$/year is needed for various equipment.[25] The total cost of equipment and material needed in a year is about 760$. The waste removed at the wastewater treatment plant is disposed of locally, so no gasoline is needed.

Waste material collected and proportion of plastic waste.

At the wastewater treatment plant they collect about 5 m^3 of waste every day of collection. For 36 days of collection a year, this amounts to 180 m^3. Here, plastic bags represent about 60% of the overall waste. About 10 kg of waste is removed from the manholes every day of collection for a total of 360 kg a year; according to the conversion of 1 m^3 = 400-500kg of waste, this is less than 1m^3.[26] Here the proportion of plastic bags is 20-30%.

As for the proportion of plastic bags, two estimates were provided:

a) plastic bags and food containers represent about 20% of the waste collected by the company CINTRI, about 100t/day of unseparated waste collected on regular days; 150-200t/d on holidays.[27]
b) plastic bags contribute about 30% of the waste obstructing drainage canals.[28]

[22] Personal Communication Mr Pich Pheary, Deputy-Chief Sewerage and Drainage System Division, DPWT, Preah Sihanouk Province, 16 November 2015
[23] Personal Communication Mr Pich Pheary *Ibid*
[24] Personal Communication Mr Pich Pheary *Ibid*
[25] Personal Communication Mr. Nop Heng *Ibid*
[26] V. Kum, A. Sharp, N. Harnpornchai. Improving solid waste management in Phnom Penh City: a strategic approach. Waste management 25 (2005) 101-109
[27] Personal Communication Mr. Prak Visal *Ibid*
[28] Personal Communication Mr. Nop Heng *Ibid*

Dedicated financial resources.

The overall budget of the Sewerage and Drainage Unit amounts to 60,000$, as a result of users' fees. All expenses are listed above, but 5,000$ is spent on cleaning the manholes and the wastewater treatment plant.[29]

3.1.5 SUMMARY

The impact of the blockage of the drainage system caused by dispersed plastic bags is measured through the following sub-indicators:

- Labor time dedicated to removing plastic bags from the drainage system (person-months/year)
- Cost of such labor ($/year)
- Total equipment and consumable cost ($/year)
- Proportion of budget dedicated to restoring the function and capacity of the drainage system compared to the overall budget of the Sewerage and Drainage Division (percentage, yearly)
- Amount of waste collected from the drainage system (in m^3/year)
- Proportion of plastic bags in the waste collected (percentage)
- Cost of other impacts ($).

However, it should be noted that it was not always possible to obtain comparable data for all three urban areas, and that these costs are underestimated. One way of estimating the cost directly attributable to plastic bags is by multiplying the restoration costs by the proportion of plastic bags found in the obstructions. This, however, may be inappropriate, as the responsibility of plastic bags may be higher than their proportion in volume or weight. This is so because floating plastic bags may trap other debris and create a larger obstruction or form a blocking film which would not be produced by other types of waste.

In conclusion:

1.1 Labor time dedicated to removing plastic bags from the drainage system

In the three cities, labor time dedicated every year to removing waste from the sewerage and drainage system ranges from 8 person-months in Sihanoukville, to 65 in Siem Reap, and over 1000 in Phnom Penh. The amount of labor time devoted to this issue in Phnom Penh is a result of the numerous pump stations in the city.

1.2 Cost of such labor

The annual cost of this labor amounts to around 1,000$ in Sihanoukville, 9,000$ in Siem Reap, and 90,000$ in Phnom Penh.

1.3 Total equipment and consumable cost

The annual cost for the equipment and the consumables, e.g. gasoline, to remove waste from the sewerage and drainage system ranges from less than 1,000$, in Sihanoukville, to over 13,000$, in Phnom Penh.

1.4 Proportion of the Sewerage and Drainage Division budget dedicated to restoring the function and capacity of the drainage system

The annual budget dedicated to restoring the function and capacity of the sewerage and drainage system in the three cities represents between 8.3%, and 21.4%, of the overall budget

[29] Personal Communication Mr Pich Pheary *Ibid*

of the Sewerage Drainage Division; 8.3% in Sihanoukville, 18% in Siem Reap, and 21.4% in Phnom Penh.

1.5 Amount of waste collected from the drainage

The amount of waste collected annually from the sewerage and drainage system ranges from only 18m^3 to over 5000m^3, 18-45 m^3 in Siem Reap, 180 m^3 in Sihanoukville and 4400-5200 m^3 in Phnom Penh.

1.6. Proportion of plastic bags in the waste collected

The proportion of plastic bags in the waste removed from the sewerage and drainage systems has been assessed based on estimates provided by the key informants interviewed. Estimates provided vary significantly depending on the city, and on whether sewerage or drainage systems are concerned. In Phnom Penh plastic bags represent 20% of the waste collected in the 11 pumping stations that are part of the sewerage system, and 45% of the waste collected in the drainage system. In Siem Reap plastic bags exceed 60% of the waste collected at the pumping stations, and vary between 15% and 30-60% of the waste collected in the drainage system depending if the waste is collected by GAEA or the City Hall; in Sihanoukville, finally, 20-30% is the percentage of bags associated to the drainage system whereas 60% the one associated to plastic bags collected in the wastewater treatment plant, part of the sewerage system.

1.7 Cost of other impacts

Evidence was gathered on another cost caused by plastic bags to the sewerage and drainage system. At a pump station in Siem Reap, as a result of the wear caused by waste, of which plastics are more than 60%, a pump had to be changed after having been in operation for only 2 years. Usually the pump has an operating life of 20 to 30 years. The new pump, which had to be imported from the US, cost approximately 8,000$.

3.2 ROAD REPAVING

This indicator measures the indirect impact of plastic bags on roads, after flash floods, caused or exacerbated by plastic bags obstructing the drainage system.

3.2.1 ROAD REPAVING IN PREAH SIHANOUK PROVINCE

In Preah Sihanouk Province, about 50,000 USD/year is spent repaving roads after they have been damaged by floods. Here roads are maintained using DBST – Double Bituminous Surface Treatment and are easily damaged.[30]

3.3 STREET SWEEPING

This indicator refers to the effort required to prevent the sewerage and drainage systems from being obstructed and therefore causing floods. It does not focus on the cleaning of the drainage systems *after waste has been deposited into them,* which is covered by the previous "Obstruction of the Drainage System" category, but on the *regular cleaning of the streets* so that the abandoned *waste does not further disperse*. Also, this indicator only refers to the cleaning activities *regularly* undertaken by the waste management companies; it does not cover extraordinary cleaning events, such as cleaning campaigns, for which there is a separate indicator, "Education and Cleaning Campaigns".

[30] Personal Communication Mr. Nop Heng *Ibid*

3.3.1 ORIGIN OF DATA

Data were collected for the three cities. No original surveys were conducted, but conclusions were drawn from the existing data which were made available to the researchers. Unfortunately, the waste management companies, CINTRI for Phnom Penh and Sihanoukville, and VGreen in Siem Reap, did not provide official, precise and up to date information. Several attempts were made to meet with them and several formal requests by ACRA and by RUPP were filed, but meetings were never granted, or set, and then cancelled. To overcome this problem, the researchers used official company data presented at conferences, or informally interviewed the workers of these companies.

For Phnom Penh, official data were obtained from the Department of Environment and a presentation made by CINTRI, while unofficial information was collected through informal interviews with CINTRI workers. The responses of the workers are integrated into the text below. However, these responses are not comprehensive, cannot be considered official, have never been confirmed by the companies, and should therefore be considered with caution. Nonetheless, they provide qualitative data of some interest, are in line with similar information from the other cities, and offer an *indication* of the *orders of magnitude* of some factors. For Siem Reap data came from city and provincial authorities and GAEA. For Preah Sihanouk Province data were collected from the Provincial Department of Environment.

3.3.2 STREET SWEEPING IN PHNOM PENH

Brief context.

CINTRI has had a contract with the Municipality of Phnom Penh for solid waste management since 2002. Their staff regularly collect the waste from designated collection points and sweep selected streets to remove litter and dispersed solid waste. The green areas of Phnom Penh and the urban parks are kept clean by the Garden Unit of the DPWT. [31]

The information related to CINTRI which is provided below was obtained from a CINTRI official at a conference and from two CINTRI workers through informal interviews.

The removal of dispersed solid waste from the street is a regular activity performed by the workers of CINTRI according to a set schedule and routine. Each worker is assigned 0.5 km to 1.5 km of road to sweep, depending on population density and proximity to markets, commercial activities, residential homes, etc. Workers sweep their stretch of road 2 times per day: between 4:00 and 7:00 am and from 12 noon to 3:00 pm. Each stretch of road is assigned to two workers, one for each side. They work 28.5 days a month and are allowed only 1.5 days off.[32]

While sweeping, the workers collect the litter in garbage bins placed along the road, which will be later emptied by other personnel, and taken to the landfill. CINTRI provides trash bins, carts and brooms. Other equipment, such as brushes, gloves, masks, plastic shovels, socks and rain coats, has to be provided by the workers themselves.[33]

[31] Meeting with Mr. Khem Nora, Chief of the Waste Management Office, Mr. Sok Sopheak, Administration Office, and Mr. Tae Sothea, Director Environmental Awareness Office, DoE, Phnom Penh, 31 March 2015

[32] Interviews with two street sweepers of CINTRI in Phnom Penh on 20 and 21 August 2015

[33] Interviews with two street sweepers of CINTRI *Ibid*

Labor.

CINTRI currently employs 347 street sweepers[34] to clean streets in Phnom Penh.[35]

Labor cost.

The cost of a street sweeper is about 130$/month, or 520,000R. This is made up of a 105$ base salary, 5$ incentive money, and a 25$ premium for weekend work.[36] In one year, a worker costs 1,560$, however this estimate does not include social security. The total cost for all the 347 street sweepers in Phnom Penh is thus 45,110$ a month, or 541,320 $ a year.

Cost of equipment and material to CINTRI.

CINTRI has provided 442 bins and 256 carts.[37] Bins cost about 100$ each and last 5 years – the yearly cost for one bin is therefore 1/5 of its price, or 20$.[38] Consequently, while the total cost for 442 bins is 44,200$, their annual cost corresponds to 8,840$. Carts cost about 200$ each and last for 10 years – the yearly cost for one cart is therefore 1/10, or 20$. Consequently, while the total cost for 256 carts is 51,200$, their annual cost corresponds to 5,120$. A street sweeper receives on average 2 brooms per week, or 100 in one year. Therefore, all 347 street sweepers use a total of 34,700 brooms a year.[39] The cost for one broom is 0.50$; all 34,700 brooms used by CINTRI street sweepers in one year result in a cost of 17,350$. In total, the cost to CINTRI for the equipment provided annually to the street sweepers amounts to 31,310$.

Cost of equipment and material to the workers.

In addition to the economic impact on CINTRI, there is an impact on the families of CINTRI workers. They have to provide their own personal equipment such as brushes (0.125$/week), gloves (0.50$/week), masks (0.05$/day), plastic shovels (0.625$/year), socks (1$/month) and rain coats (1.5$/year). Their total personal expense for one year is thus about 63$, as follows: brushes (0.125$ x 52 weeks = 6.50$) + gloves (0.50$ x 52 weeks = 26$) + masks (0.05$ x 336 days of work = 16.8$) + plastic shovels (0.625$ x 1 = 0.625$) + socks (1$ x 12 months = 12$) + rain coat (1.50$ x 1 = 1.50$). Given that the workers earn 1,560$ a year, this expense corresponds to 4% of their salary. Although this is not a cost to the public sector, it is nonetheless a cost to the households that rely on these jobs for their livelihoods.

Amount of waste collected and proportion of plastic bags.

When street sweepers clean their stretch of road twice a day, they collect enough litter to fill about 4 bins in the morning and 2 bins in the afternoon.[40] Each bin contains 50-60kg of litter, soil and solid waste, but an average of only 25kg of solid waste, not considering soil. Plastic bags represent 20% of the solid waste collected in the morning, 5kg out of 25kg in each bin and 12% of the solid waste collected in the afternoon, 3kg out of 25kg in each bin.[41] This

[34] *Street sweepers: the workers of solid waste management companies who sweep the streets and collect litter, including dispersed plastic bags*

[35] Presentation by Mr. Ith Chinda, Director of the City Cleaning Office of CINTRI in Phnom Penh, at the conference "Urban Environment Management toward a Sustainable Society in Phnom Penh", Cambodia-Japan Cooperation Centre, Phnom Penh, 13-14 July 2015.

[36] Interviews with two street sweepers of CINTRI *Ibid*

[37] Presentation by Mr. Ith Chinda, *op cit*.

[38] Interview with two street sweepers of CINTRI *Ibid*

[39] Interview with two street sweepers of CINTRI *Ibid*

[40] Interview with two street sweepers of CINTRI *Ibid*

[41] Interview with two street sweepers of CINTRI *Ibid*

difference is allegedly because the morning sweeping collects the dispersed waste from the previous evening, which includes plastic bags for carrying dinner and beverages.

Therefore, everyday each worker collects about 100kg of solid waste in the morning (25kg x 4 bins), of which 20kg of plastic bags, and 50kg of solid waste in the afternoon (25kg x 2 bins), of which 6 kg of plastic bags: daily, about 150kg of solid waste, including 26kg of plastic bags. In a month, each worker collects 4275kg of solid waste (150kg x 28.5 days of work) with 741kg of plastic bags. In a year, each worker collects 51,300kg of solid waste, with 8,892kg of plastic bags. All workers together collect in one year 17,801,100kg of solid waste (347 workers x 51,300kg), of which 3,085,524kg are plastic bags. The average percentage in weight of plastic bags in the solid waste is 17.3%.

3.3.3 STREET SWEEPING IN SIEM REAP

Brief context.

Two solid waste collection companies operate in the Siem Reap area:

- GAEA, in the city, under the responsibility of the Municipality
- VGreen (HCC) in the Angkor area, museum and airport, under the responsibility of Apsara (Authority for the Protection and Management of the archeological park of Angkor).

The area outside the city, rural areas and wetlands, is not under a company, but under the responsibility of the City, with support from the Provincial Government and relevant departments.[42]

Only data from GAEA and the City are included. Data from VGreen is not included for two reasons:

- being related to a major tourist area, data from VGreen would have been listed under the Tourism category of this assessment, and
- unfortunately, VGreen did not agree to meet the researchers or to provide data, claiming that it is confidential corporate information.

Labor.

The City of Siem Reap employs 65 workers, 15 supported by the City and 50 supported by the Provincial Hall, to clean selected areas outside of the city, and therefore outside of the area of work of GAEA and VGreen.[43] GAEA employs 65 street sweepers to clean only the main roads every day. The set of roads to be cleaned is established by the City, and includes the areas in downtown Siem Reap which are most used and visited by tourists.[44]

Labor cost.

The salary of the City workers is approximately 100$ a month. Overall, the 65 workers cost 6,500$ a month, and 78,000$ a year. The salary of GAEA workers is 105.65$ a month, 105$ base salary + 0.65$ for the National Social Security Fund-NSSF. Overall, the 65 workers cost 6,867$ a month, and 82,407$ a year.[45] The total cost of all 130 street sweepers in Siem Reap,

[42] Interview with Mr. So Platong, City Governor, Mr. Sean Kimthan, Chief of the City Development Office, Mr. Mak Vibol, Chief, Distribution Unit, GAEA, Mr. Sav Sokchetana, Vice-Chairman of GAEA, Mr. Chong Sokhemarak, Deputy Director of the Provincial Department of Tourism, and Mr. Phourng Lina, Director of the Provincial Department of Environment, 16 March 2015

[43] Interview with Mr. So Platong *et al ibid*

[44] Interview with Mr. So Platong *et al ibid*

[45] Interview with Mr. So Platong *et al ibid*

the City's and GAEA's, is therefore 13,367.25$ a month; 6,500$ + 6,867.25$, or 160,407$ a year.

Cost of equipment and material.

It costs the City of Siem Reap 7,963$/year for a one-year supply of large plastic bags and devices used to collect rubbish from the ground.[46] GAEA usually spends 6,800$ a year to replace brooms, garbage bins, billboards and waste containers. The total cost to the City and GAEA combined is 14,763$.

Amount of waste collected and proportion of plastic bags.

The street sweepers of the City work twice a day: 7-10.30 am and 1.30-5 pm. Each collects 4.5kg of waste a day, of which 1kg is plastic (22.2%). In a month street sweepers work 26 working days and each one of them collects 117kg, or 1404kg in a year. All 65 workers together collect in a year 91,260kg. Plastics bags are 22.2% of it, or 20,280kg. The street sweepers of GAEA sweep the streets 2 times a day: 6-10 am and 1.30-5.00 pm. The amount of solid waste collected is about 10kg per worker per day, of which 2 are plastic bags (20%).[47] They work 26 days/month, so the amount collected in a month by each worker is 260kg, of which 52kg of plastic bags, or 3120 kg a year, of which 624 of plastic bags. Considering all 65 workers, total annual collection is 202,800kg, of which 40,560kg is plastics.

3.3.4 STREET SWEEPING IN PREAH SIHANOUK PROVINCE

Brief context.

Both Preah Sihanouk Province and CINTRI have workers dedicated to street sweeping. They all work 6 days/week, from 7 am to 9 am and from 2 pm to 4 pm

Labor and labor cost.

For street sweeping, the Province employs 65 workers, organized in 18 teams of 3-4 workers each. Their salary is 117.50$/month, thus the total labor cost for the provincial street sweepers in one year amounts to 91,650$ and is paid by the Ministry of Environment.[48] For street sweeping, CINTRI employs 10 workers, divided into 5 teams of 2 workers each. Their salary is 65$/month, thus CINTRI's total labor cost amounts to 7,800$.[49] The yearly labor cost of the Provincial government and CINTRI combined is 99,450$.

Cost of equipment and material.

Preah Sihanouk Province provides the street sweepers with carts (10 in total, 250$ each, each lasts 3 years = all together they cost 833$/year), baskets (1 per team or 18 in total, 2$ each, each lasts 6 months = 72$/year), gloves (0.75$ a pair, 1 pair per person every two weeks = 1,170$/year), large brooms (2$ each, 1 per person, lasts 3 months = 520$/year), small brushes (1$ each, 1 per person, lasts 3 months = 260$/year), shovels (4.25$ each, 1 per team or 18 in total, each lasts 1 year = 76.5$/year), masks (1.5$ each package, 1 package per team or 18 packages in total a month = 324$/year), devices to collect dirt from the ground (1$ each, 1 per team or 18 in total, each lasts 6 months = 36$/year) and boots (3$ a pair, 1 pair per person,

[46] Personal communication Mr. Sean Kimthan, Officer of City Development, City of Siem Reap, 17 November 2015, 18 November 2015
[47] Personal Communication Mr. Sav Sokchetana, Vice-Chairman of GAEA, 18 November 2015
[48] Personal Communication Mr. Moeung Sopheap, Vice-Director of the Provincial Department of Environment of the Preah Sihanouk Province, 4 December 2015
[49] Personal Communication Mr. Moeung Sopheap *Ibid*

each lasts 6 months = 390$/year).[50] The total equipment cost for the provincial street sweepers equals 3,681.5$/year.

CINTRI provides the street sweepers with carts (250$ each, 1 cart per team, each lasts 3 years = 416$/year), baskets (2$ each, 1 per team, each lasts 6 months = 20$/year), large brooms (2$ each, 1 per person, each lasts 3 months = 80$/year), small brushes (1$ each, 1 per person, each lasts 3 months = 40$/year), shovels (4.25$ each, 1 shovel per team, each lasts 1 year = 21$/year), gloves (0.75$ a pair, 1 pair per person every two weeks = 180$/year), masks (1.5$ per package, 1 package per team, each package lasts 1 month = 90$/year) and a device to collect dirt from the ground (1$ each, 1 per team, each lasts 6 months = 10$/year).[51] The total equipment cost for the CINTRI street sweepers equals 857$/year. The yearly equipment cost for street sweeping by Preah Sihanouk Province and CINTRI combined is 4,538$.

Amount of waste collected and proportion of plastic bags.

Provincial street sweepers collect a total of 80-90kg of waste per day in each cart, average 85kg/day, or 850kg/day. Of this, about 300kg are plastic bags. Assuming 10 carts and an average of 26 working days in a month, provincial street sweepers collect 265,200kg of waste in a year (265.2 t), of which 93,600 are plastic bags (93.6 t, or 35.3%).[52]

The CINTRI street sweepers collect 60-70kg (average 65kg) of waste per team per day; about 20kg are plastic bags. Considering 5 teams and 26 working days a month, CINTRI street sweepers collect 101,400kg of waste a year (101.4 t), of which 31,200kg are plastic bags (31.2 t, or 30.8%). Together, provincial and CINTRI street sweepers collect 366.6 t of waste, of which 124.8 t are plastic bags (34%).

3.3.5 SUMMARY

The impact of street sweeping and waste collection to remove dispersed plastic bags and prevent their obstructing the drainage system is measured through the following sub-indicators:

- Number of workers assigned to street sweeping (n.)
- Cost of these workers ($/year)
- Equipment cost ($/year)
- Amount of waste collected (t/year)
- Proportion of plastic bags in the waste collected through street sweeping (percentage)

In conclusion:

3.1 *Number of workers assigned to street sweeping*

Workers engaged in street sweeping in the three cities are part of the staff of the private solid waste management companies and of the City or the Province. The number of workers in each target area ranges between 75 and 350. There were 75 in the Preah Sihanouk Province, including 65 from the Province and 10 from CINTRI; 130 in Siem Reap, 65 each from the City and GAEA, and 347 in Phnom Penh from CINTRI.

3.2 *Cost of these workers*

The total annual labor cost for these workers is considerable; almost 100,000$ in Sihanoukville, 160,000$ in Siem Reap, and about 340,000$ in Phnom Penh.

[50] Personal Communication Mr. Moeung Sopheap *Ibid*
[51] Personal Communication Mr. Moeung Sopheap *Ibid*
[52] Personal Communication Mr. Moeung Sopheap *Ibid*

3.3 *Equipment cost*

The equipment and consumable costs related to street sweeping in the three cities is in the order of a few thousand, or tens of thousand dollars. In Sihanoukville, the cost is about 4,500$, 15,000$ in Siem Reap, and 31,000$ in Phnom Penh.

3.4 *Amount of waste collected*

The amount of waste and litter collected annually in the streets of the three cities ranges from almost 300 tons in Siem Reap, to almost 370 tons in the Preah Sihanouk Province, and 17,800 tons in Phnom Penh.

3.5 *Proportion of plastic bags in the waste collected through street sweeping*

The proportion of plastic bags in the overall litter collected through street sweeping in the three cities – as estimated by the key informants – is comparable: 17.3% in Phnom Penh, 20.7% in Siem Reap and 34% in Preah Sihanouk Province.

3.4 EDUCATION AND CLEANING CAMPAIGNS

Education on the impacts of the inappropriate management and disposal of waste are being conducted at a variety of levels: nationally or for communities, neighborhoods and schools. Very often they have a focus on the reduction of plastic bags. These campaigns aim at switching the behavior of people towards more sustainable waste management. Often, education campaigns are stand-alone activities and can be described separately; often they are combined with cleaning campaigns, the cleaning campaign being one major tool to create awareness. As it is not always easy to distinguish between them, they are described jointly in this section.

Education initiatives on waste reduction and proper management are very numerous and frequent throughout the country, and organized by public administration, civil society and other actors. The campaigns that were brought to our attention during the research are listed below and detail the variety of actors, numbers of participants, type of messages, means of intervention and budgets allocated. This is by no means an exhaustive list: many more awareness initiatives are under way than we can record. Based on the limited information we were able to collect, it is clear that considerable time and resources are being used on these initiatives.

3.4.1 EDUCATION AND CLEANING CAMPAIGNS AT NATIONAL LEVEL

NCCA (National Committee for Clean City Assessment), the Ministry of Environment and other public administrations regularly organize national education and cleaning campaigns, for example radio and TV campaigns and events on the occasion of National Clean Up Days and Environment Day. National campaigns are at times run through provincial offices or at city level.

The National Clean City Programme encourages the cleanliness, the proper waste management and public health of urban areas in Cambodia. Assessment is through specific criteria and indicators. Reduction of plastic bags is one of the stated objectives. Activities implemented to attain this goal are education and cleaning campaigns. Generally, clean-up events are organized on the occasion of large traditional events, such as the Water Festival.

Recent education campaigns under the NCCA were conducted through mass media:

- On APSARA and CNC television, every week in January and February 2015. The focus of these campaigns was Clean City Day, and the main message was proper solid waste management, plastic bag reduction, and cleanliness. The cost of these campaigns

were 3000$ per month on APSARA TV, and about 1200$ per week on CNC TV, thus totaling 15,600$ in 2015.
- On the 102 and 106.5 radio, there were numerous announcements to educate the public about plastics. The spot was broadcast 3 times per week, or 156 times a year, at the cost of 3000$ per month, or 36,000$ per year. This was paid by NCCA.

Civil society is very active in education and cleaning activities as well. Education is offered especially through activities on development and conservation, and through programmes of NGOs, both national and international, such as:

- Wildlife Alliance: education campaigns in schools of the Chi Phat community in the Cardamom Mountains as part of the Zero Waste Community-Based Ecotourism.[53]
- Conservation International: education campaigns to properly manage and reuse plastic waste as part of the Tonle Sap Programme.[54]

Cleaning campaigns have been organized as part of world-wide initiatives:

- "Lets's do it!": This is an initiative to clean up the world, through several events run by volunteers. In Sihanoukville, the Sihanoukville Tourist Association has organized the event for the last two years, with volunteer numbers increasing from 400 to 600.[55]

3.4.2 EDUCATION AND CLEANING CAMPAIGNS IN PHNOM PENH

A few initiatives were brought to our attention in Phnom Penh.

Education campaigns by the NCCA

Awareness initiatives are held 2-3 times per year in supermarkets and factories in Phnom Penh along National Road N. 4, targeting workers as the main users of plastic bags, which they discard after having their meals. One is run in the EON and LUCKY markets on Friday, Saturday and Sunday, with the purpose to reduce plastic bags, and manage solid waste properly. During these campaigns, the objective is to stop providing plastic bags to customers on weekends. The effectiveness of the campaign is dubious because of the resistance of vendors – who are afraid of losing customers – and the lack of encouraging policies.[56] Each of these campaigns costs about 4,000$ for posters, leaflets, banners and gasoline. After the Water Festival, NCCA organized a combined education-and-cleaning campaign aimed at removing the litter, and creating awareness. The campaign cost about 2,000$ and was supported by the Ministry of Environment and the Municipality.

Cleaning campaigns by NCCA

Within the Clean City Programme, and in collaboration with the Ministry of Environment, the City and the Union of Youth Federations of Cambodia, a cleaning campaign is held in Phnom Penh every year on the national Clean City Day. In 2015, cleaning activities took place in downtown sites e.g. along the riverside, in Wat Phnom, at the Independence Monument, and along National Road N. 4, a number of *sangkats* in Phnom Penh.[57] In the Daun Penh Sangkat

[53] Personal Communication Mr. Touch Sophany, Project Coordinator, Zero Waste Community-Based Ecotourism, Wildlife Alliance, Phnom Penh, 20 March 2015
[54] Personal Communication Mr. Heng Sokrith, Project Manager, Tonle Sap Programme, Conservation International-CI Cambodia, Phnom Penh, 19 March 2015
[55] Personal Communication Mr. Douglas McColl, *op cit*
[56] Personal Communication Mr. Heng Sokrith, *op cit*
[57] Sanngkats are an administrative region in provincial centers and cities, that are the equivalent of a commune

and the 7 Mekara Sangkat, cleaning also included washing the streets with water. The majority of participants were youth. In 2013 and 2014, cleaning campaigns were held 5-10 times a year.

Education and cleaning campaigns by the Phnom Penh Capital Department of Environment (PPCDE)

The PPCDE organizes education campaigns in schools, markets, households, pagodas and communities. They hold national/international events twice a year in June and November, whose main message is "Litter and solid waste should be properly wrapped." These campaigns are supported by CINTRI, NGOs and the City.[58] In 2015, they had planned to run education campaigns in the two districts ToulKork and Khan PorSenChey; however, they could not do so because of a lack of funds. In 2014, this campaign was held in supermarkets with the aim to reduce plastic bags, at least on weekends. It was run 2 times throughout the year, by 5 teams. The cost of each group was 26$ for posters, leaflets and gasoline, for a total of 260$.[59]

In 2016, PPCDE plans to organize education-and-cleaning campaigns again in communes, for which the budget is unknown. What is known is that the overall approved budget of the Environmental Awareness Office for 2016 is 68 million R, 17,000$.[60] The PPCDE also organizes the cleaning campaign "One Village, One Clean Street" twice a year to clean the streets and educate the people about it. In 2014, 55 people were reported to have joined the event, including 4 officers from DoE, and 1 from the District Agency. The campaign cost DoE 1 million R (250$) for car rental, microphone and water. Other equipment, gloves, brooms, beverages and T-shirts were provided by companies, CINTRI, or other institutions.[61] Local authorities, sangkats, organized the volunteers and distributed leaflets. DoE organizes Clean-Up Days on the occasion of national ceremonies and special events such as the Water Festival.[62] At the 2014 Water Festival, the main message of the education campaign was to wrap waste properly. The associated cleaning campaign was led by a group of Scouts and the Cambodia Red Cross, with financial support from the Ministry of Environment, CINTRI and the City.

3.4.3 EDUCATION AND CLEANING CAMPAIGNS IN SIEM REAP

Education campaigns by DPWT / Sewerage and Drainage Division

The Department of Public Works and Transport (DPWT) has organized education campaigns in communities to reduce the amount of dispersed plastic bags, and limit their impact. Such education campaigns do not have a dedicated budget, but are run with the funds that remain after other activities, which in turn depend on the projects that are funded each year. So far they have run 1-2 campaigns. [63]

They also organize education for the kids and address issues such as white and black water, grease, the environment, etc. They are twinned with two cities in Japan and learn from their experience in raising awareness. Also, after running a campaign in Siem Reap, they learn from the teachers how it went and possibly modify it. They have asked the Ministry of Education to include awareness campaigns on waste at least once a year in the school curriculum.

[58] Personal Communication Mr. Tae Sothea, Director of the Environmental Awareness Office of DoE, 31 March 2015 and 18 November 2015
[59] Personal Communication Mr. Tae Sothea *Ibid*
[60] Personal Communication Mr. Tae Sothea *Ibid*
[61] Personal Communication Mr. Tae Sothea *Ibid*
[62] Meeting with Khem Nora *et al op cit*
[63] Personal Communication Mr. Im Vibol *Ibid*

Education campaigns by NCCA

Education campaigns focused on solid waste management are run about 5 times a year, with 300 to 400 volunteers.[64]

Education and cleaning campaigns by the Provincial Department of Environment (PDoE)

They run education campaigns based on the budget available every year. In 2014 they organized about 40 cleaning campaigns, mainly on the occasion of water festivals, national environmental days, Khmer New Year, etc. Their cost varies: for the Water Festival in 2014, the PDoE spent around 10,000$ to clean streets; smaller campaigns cost around 1000-2000$ each. An estimate of the cost of the campaigns is about 70,000$. In some cases, exact costs are difficult to calculate as PDoE staff are allocated to the campaigns.

Cleaning campaigns by the City

The City Development Office runs a cleaning campaign 6 times a year. Their expenses for these events are about 6000$/year for brooms, large plastic bags, gloves, plastic shovels, hoes, etc; 1,200$/year for car rental; and 6,075$/year for food.[65] In total, the cleaning campaigns in Siem Reap run by this office cost 13,275$ a year.

3.4.4 EDUCATION AND CLEANING CAMPAIGNS IN PREAH SIHANOUK PROVINCE

Education campaigns by NCCA

As in Siem Reap, awareness campaigns focused on solid waste management have been run also in Sihanouk Ville, about 5 times a year, with 300 to 400 volunteers.[66]

Education and cleaning campaigns by the PDoE

The PDoE organizes :

- education campaigns at provincial level twice a year, on the impact of solid waste on the community. Main targets are students and teachers. The main message is that waste represents a loss of income to the community, as tourists will not come. The slogan used is “Rubbish is the enemy of tourism”. The annual cost of these campaigns is 1,000-1,500$.[67]
- approximately 12 education campaigns a year, at the average cost of 200,000-300,000R each (50-75$) for leaflets, posters, banners, gasoline, water and snacks. The total cost for these campaigns is thus 600-900$/year.[68]
- about 45 cleaning campaigns a year, each costing about 2-3,000,000R (500-750$) for large plastic bags, gloves, lawn mowers, masks, gasoline, devices to collect waste from the ground, water and food. Their total cost is therefore 22,500-33,750$/year.[69]
- 3-4 combined education-and-cleaning campaigns a year on Environment Day and similar occasions, for a total cost of 5000$/year for leaflet, banners, TV broadcast, T-

[64] Personal Communication Mr. Heng Sokrith *Ibid*

[65] Personal Communication Mr. Sean Kimthan, Officer of City Development, City of Siem Reap, 17 November and 18 November 2015

[66] Personal Communication Mr. Huot Rithy, Cooperation and Promotion Division, National Committee for Clean City Assessment-NCCA, Ministry of Tourism, and Mr. Neang Chamnap, Assistant to the Director General of Ministry of Tourism, Phnom Penh, 20 April 2015

[67] Personal Communication Mr. Prak Visal, Deputy Director of the Administration Division and Project Coordinator of the Integrated Coastal Management (ICM) Program, Preah Sihanouk Province, 13 March 2015

[68] Personal Communication Mr. Moeung Sopheap *op cit*

[69] Personal Communication Mr. Moeung Sopheap *op cit*

shirts, large plastic bags, gasoline, devices to collect dirt from the ground, gifts for monks, water, chair, masks, gloves. These costs are covered by the Ministry of Environment.[70] These events attract 500-1000 participants, including high-school and university students.[71]

Cleaning campaigns by the City

The City organizes clean-ups about 3 times per month, or 36 times per year, at monuments and beaches. The cost is 500-700$ per campaign for the provision of gloves and water, for a total of 18-25,000$ a year. The work is done by workers of the Department of Environment and volunteer groups, with permission from the local government.[72]

Cleaning campaigns by the Department of Tourism

The Department of Tourism organizes a cleaning event on Environment Day once a year, every year. On these occasions 500-1000 participants, among them students and representative of local institutions, clean beaches and other tourist sites.

Education and cleaning campaigns by the Sihanoukville Tourist Association (STA)

The STA has its own funds, collected from its members or raised from third parties. The Sihanoukville Tourist Association (STA) runs education campaigns in schools and produces posters on public health. Their campaigns include plays for children where actors dress up as rats. So far they have reached 5-6000 children. STA organizes cleaning campaigns in the Ochheuteul area. In one day, and with 60 volunteers, they almost filled a 5-t truck with garbage.

STA organizes a Clean-up Day every year, under the "Let's do it" initiative. The first year they had 400 volunteers, the second year 600. In 2015 they rented an excavator and cleaned-up a stretch of the river and the riparian area. [73]

Cleaning campaigns by others

The Choulin Hotel organizes clean-up days every year, about 2 times per year, with 60-100 participants.

The Prasak organization organizes clean-up days once a year (not every year), engaging 70-100 participants.

Reussey Wat University organizes cleaning days twice a year, with 3-400 participants.[74]

3.4.5 SUMMARY

The effort on education and cleaning campaigns to prevent or limit the dispersion of waste in the urban environment is measured through the following sub-indicators:

- Number of campaigns (n/year)
- Cost of campaigns ($/year)
- Number of volunteers engaged (n/year)

In conclusion:

[70] Personal Communication Mr. Moeung Sopheap *op cit*

[71] Personal Communication Mr. Oeur Vibol, Director of the Koh Rong Eco-Tourism Conservation Committee, Department of Tourism, Preah Sihanouk Province, 11 June 2015

[72] Personal Communication Mr. Prak Visal *op cit*

[73] Personal Communication Mr. Douglas McColl, *op cit*

[74] Personal Communication Mr. Oeur Vibol, *op cit*

4.1 *Number of campaigns*

Through interviews, the research team was able to identify over 180 campaigns, whether for education or cleaning, conducted annually, mainly in the three urban areas of Phnom Penh, Siem Reap and the Preah Sihanouk Province. These campaigns mostly refer to the three cities. Thus, at a conservative average of about 50 education and cleaning campaigns/events per year in each province, it is reasonable to assume that the campaigns that take place annually in the 26 provinces of Cambodia, organized by different public or private entities, and targeting various segments of the population, e.g., schools, universities, pagodas, households, and factories, may reach one thousand.

4.2 *Cost of campaigns*

The data collected so far indicate that campaigns cost between 260$ and 36,000$. Assuming that each campaign may cost a minimum of 1000$ on average, which is a conservative estimate, the overall cost of education and cleaning campaigns held every year in Cambodia may be around 1 million dollars.

4.3 *Number of volunteers engaged*

Education campaigns are likely to involve mainly professional educators and communicators, but cleaning campaigns involve between 10, and several hundred volunteers at a time. Thus, in one year, in Cambodia there will be several thousand volunteers dedicating their time to cleaning activities, for a total number of cleaning days approaching ten thousand.

4. PEOPLE

The obstruction of drainage systems causes problems, not only to urban infrastructure, for example pumping stations and roads, but also to families and livelihoods. This category of indicators focuses on the consequences of flooding, to which dispersed plastic waste contribute enormously, to families and their livelihoods, and on the concern expressed by the public about dispersed plastic bags.

4.1 ORIGIN OF DATA

The impact of plastic bags on people was measured by means of original data collected through surveys of families and family businesses. To describe public concern, also data collected through the interviews to key informants were used. For the surveys, first the research protocol was defined, and information was gathered to select the best sample sites; then the surveys were undertaken by the researchers; finally, data were analyzed and conclusions drawn.

Site selection.

The surveys of family and family businesses were conducted only in Phnom Penh and Siem Reap, two cities where flash floods routinely occur. Sihanoukville was not included because here flooding is limited due to the geomorphology of the city. For each of these two cities, sample sites for the survey were selected based on criteria established by the research team and according to the comments and recommendations of key informants (see List of contacts).

Research protocol.

In the end, a total of 233 families were surveyed, 160 in Phnom Penh and 73 in Siem Reap; and 203 family businesses, 187 in Phnom Penh and 16 in Siem Reap. The low number of shops in Siem Reap is due to the fact that most did not have time for the interview during store hours because of the many tourists. In Phnom Penh, the families and family businesses surveyed were of medium to medium-high income; in Siem Reap they were of lower income. Households and shops were in the same districts, side by side. During the survey, enumerators used the “household questionnaire” if the dwelling appeared to be a home, and the “shop-house questionnaire” if it appeared to be a family business. All respondents were in districts in, or near tourist areas. These districts had been identified as flood-prone areas by the district authorities. The data collected through interviews by the enumerators were analyzed with the software Statistical Package of Social Science (SPSS).

It should be noted that the results of the survey describe the perceptions and the estimates of the respondents, and not actual, objective measurements. Interviews took place in June 2015, at the very beginning of the rainy season. However, 2015 was a particularly dry year, and in June there had been no floods, yet - the first rains occurred in August. Thus, when they provided their answers, respondents did not have a recent experience to refer to, but could only think back to floods occurred in previous years.

4.2 FAMILIES

This indicator measures the impact of plastic bags on households. The objective of the household survey was to estimate the damage families suffered because of the floods caused by the obstruction of the drainage system.

The impact was measured through the following sub-indicators:

- Proportion of families who suffered damages from flash floods (percentage)

- Average cost of the damages generated by the flash floods ($)
- Foregone income caused by the flash floods ($)
- Time to prepare before the flashfloods and to restore after the flash floods (hours)
- Time to recover from the flash floods (days)
- Average total cost to families ($)

In conclusion:

5.1 *Proportion of families who suffered damages from flash floods*

Almost 93% of the respondents living in flood-prone areas had experienced a flashflood. During the latest flood, 71% of families suffered damages to the house; over 40% suffered illnesses, mainly from waterborne diseases, diarrhea, skin diseases such as dermatitis, parasites, insect bites, and 14% experienced injuries of some sort from tripping, slipping or falling. Forty eight per cent had damage to appliances, and 31% to vehicles. Finally, in 35% of families the children missed at least 1 day of school, while 25% reported a loss of income. Fewer households experienced high-level water for several hours, waste abandoned on the ground, and damage to crops.

During the latest flash flood, the water level in the house reached on average 35cm - 30cm in Phnom Penh and 48cm in Siem Reap. Compared to the households in Phnom Penh, those in Siem Reap experienced more damage to houses and vehicles and less to appliances, slightly higher loss of income, more injuries/illnesses and fewer school days missed.

5.2 *Average cost of the damages generated by the flash floods*

Average damage costs per family including treatment and foregone income amounted to 8$, and 43$ for illnesses and injuries respectively; 15$, 80$ and 38$ was the damage caused to house, appliances and vehicles respectively; other damages amounted to over 16$.

5.3 *Foregone income caused by the flash floods*

Due to flash floods, families suffered losses in their income. This ranged from an average of 103$ per family lost by all family members engaged in wage labour, and an average of 76$ per family lost by self-employed members of the family e.g., street vendors, taxi drivers. These losses referred to the latest flood experienced by the household, and were always higher in Siem Reap than in Phnom Penh.

5.4 *Time to prepare* before *the flashfloods and to restore* after *the flash floods*

To prepare for the flash floods and minimize damage, 45% of households removed waste from the drainage system, 28% built small barriers to protect the house from the water, 22.5% moved vehicles to higher ground, while 18.5% levelled the ground around their homes. All these activities cost time and money. Others thought of dredging the canal nearby, moving their waste to areas away from the draining system, or paying someone to move goods away from the places the water would flow to. Only very few replaced part of the drainage system or made improvements to it, or paid extra money to waste collection workers to have a more efficient service. Compared to the households in Phnom Penh, those in Siem Reap did much less work on the drainage system and the canals, but moved waste, appliances and vehicle to safer places a great deal more.

After the floods, 90.4% of the households cleaned their houses, 38.5% removed the waste left in the drainage system; others leveled the ground around their homes, or fixed parts of the drainage system to avoid future floods. Again, these measures involved some costs. In Phnom Penh, some households replaced parts of the drainage system, or paid more for a better waste collection system. Compared to Phnom Penh, households in Siem Reap worked much less

around the drainage system, but 25% of them dug a drainage canal outside of their houses. In total, on average, households spent 14.5 hours to implement prevention measures before the floods and restoration measures after the floods; 17 hours in Phnom Penh and 10 in Siem Reap.

5.5 *Time to recover from the flash floods*

On average, it took households 1.5 days to go back to a normal life and over 5 days to recover from the economic impact. Recovery took longer in Siem Reap than in Phnom Penh.

5.6 *Average total cost to families*

The total direct and indirect average cost to families, damage cost and income loss, amounted to 525$; 606$ in Phnom Penh and 316$ in Siem Reap. This amount referred to either the latest flood experienced by the household, or the first flood of the previous rainy season. This surprisingly-high figure can be explained by the fact that respondents included in their estimates the cost of one-time operations performed every year to make their dwellings flood-proof; e.g., leveling ground, or constructing mini-barriers. Those measures are likely to last for all the flash floods taking place in the rainy season. It is therefore not the amount households will have to face for each flood.

The latest flashflood in which they suffered damages was in 2014 for the vast majority of respondents; 70% in Phnom Penh and 51% in Siem Reap. One point five per cent had suffered from a flashflood in June 2015 at the time of the interviews. The year was a particularly dry year, with the first rains starting in August, rather than at end of May as usual. For all other households, the latest flood to cause damages was prior to 2015.

4.3 FAMILY BUSINESSES

This indicator measures the impact of plastic bags on livelihoods. The objective of the Family Businesses survey was to estimate the income loss experience by family-run businesses because of the floods caused by the obstruction of the drainage system.

The impact was measured through the following sub-indicators:

- Proportion of family businesses in flood-prone areas that closed because of flash floods (percentage)
- Duration of shop closure (hours)
- Income loss due to shop closure ($/hour)
- Restoration cost after the flash floods($)

Respondents listed several consequences of flooding:

- Flooding of shop and house, and of the area in front of it
- A bad smell from the drainage and the waste, and as a result difficulty breathing
- Traffic jams and difficulty driving bicycles
- Need for cleaning and repair
- Difficulty going outside, and walking to the market
- Difficulty buying food and goods
- Difficulty carrying goods
- Dispersion of waste and litter, in the street and in front of the shop
- Closure of the shop
- No customers and loss of income
- Damage to goods and to property
- Difficulty preparing and selling food
- Snakes

- Fear of children drowning
- Equipment getting wet
- Mud
- Diseases
- Loss of amenities in the city
- No time for the children to do their homework

6.1 *Proportion of family businesses in flood-prone areas that closed because of flash floods*

Of all the respondents, 49% closed their shop at least once because of flash floods.

Those who did not close the shop, did so because:

- The shop or the area in front of it did not flood, was flood-proof, or is on high ground
- The flood lasted a short time
- Were able to keep the water out by means of barriers/boards
- Were afraid of losing customers and kept open in spite of the flood
- The flood occurred during the night when the shop was already closed

6.2 *Duration of shop closure*

The shops that decided to close, did so for an average of 7 hours, but the most frequent length of time reported by the respondents in both cities was 3 hours - with a maximum of 1 shop closing for 1 day in Phnom Penh, and 2 shops closing for 3 days in Siem Reap.

6.3 *Income loss due to shop closure*

On average, shops that closed experienced an income loss of 9$ per hour. This average was lower in Phnom Penh, 7$, and higher in Siem Reap, 30$, but the majority of respondents had losses between 1$ and 12.50$ per hour.

6.4 *Restoration cost after the flash floods*

All shops were cleaned after the floods. To do so, on average 40% incurred some costs for cleaning-related supplies and equipment; the average amount spent was just over 4$. More shops in Siem Reap had cleaning-related costs, 69%, than in Phnom Penh, 37%. About 14% of all respondents claimed having had other costs as a result of concern about flash floods. These included prevention measures such as building a small barrier to the water at the entrance of the shop, or leveling the ground; the average cost for these other expenses was 23$ - 12.5$ in Phnom Penh and 60$ in Siem Reap. More effort was made in Siem Reap to restore the condition of the shops after a flood, and to prevent damages from future floods, perhaps a reflection of them having more to lose from flash floods given the higher number of tourists.

4.4 PUBLIC CONCERN

This indicator measures public concern about plastic bags. The family survey captured public opinion on plastic bags and highlighted the concern people feel.

The following sub-indicators were used:

- People’s perception of how responsible plastic bags were for blocking the drainage system and causing flash floods (percentage of people holding certain perceptions)
- Proportion of households not satisfied with the waste collection service in their area (percentage)
- complaining modalities
- Cost of complaining ($)
- Number of complaints on waste management received by public authorities (n).

7.1 *People's perception of how responsible plastic bags were for blocking the drainage system and causing flash floods*

In the family survey, 95% thought that the cause of flash floods in their area was the obstruction of the drainage system. Forty-seven per cent thought that future floods due to blockages in the drainage system would be more severe - 38% in Phnom Penh and almost 70% in Siem Reap. Among all those who responded that future events would be more severe, over 95% thought that this was due to an increase in plastic bags being thrown away in the open, 100% in Phnom Penh and 90% in Siem Reap. Over 78% agreed or strongly agreed, that reducing the blockage created by plastic bags was important to reduce flash floods. Very few people were comfortable with flash floods, either because they thought it was a natural occurrence, or because their neighbors had the same problem, or they were used to it. Most people felt angry, annoyed, or sick for the following reasons:

- it keeps happening
- bad smell from the water, the drainage and all around
- diseases, itching, headaches
- loss of income and lack of livelihood
- mice in the drains and cockroaches
- tiring moving of the goods and cleaning
- dispersed waste, floating litter, mud
- worried about the children falling in the water or becoming ill
- difficult to buy and to sell food and goods
- difficult to move, walk, ride motorbikes, travel
- wet clothes
- as the water withdraws, more plastic bags get to the drainage system
- no amenities
- schools were closed
- loss of public order.

7.2 *Proportion of households not satisfied with the waste collection service in their area*

When asked to express their opinion on the quality of the solid waste collection service in their area, 16% of the families said they were not satisfied - 9.4% in Phnom Penh, and 26% in Siem Reap.

7.3 *Complaining modalities*

When the unsatisfied households were asked whether they had ever complained about the service, about 42% of them said they had. Of these, 43% had voiced their complaints only to their neighbors; 29% had complained in person at the site of the problem, for example by talking to a street sweeper; 14.3% had made a group complaint, and only very few, 7%, had called the local authorities by phone. The result of complaint varied: 54.5% said there was no change, 27% said there was an inspection by local authorities. A timely solution to the problem occurred in 27% of the cases. This anomaly can be explained by the fact that more than one answer applied. Their complaints aimed at having a cleaner environment, improving the collection of dispersed waste, and doing something about the bad smell, all of which affect health and business. For the 58% who did not complain, the main reasons for not complaining were that they were convinced they would get no response or action in return, 47%; there was no direct impact on them, 42%; complaining was difficult, 37%; and 21% said they did not have the time to complain.

7.4 *Cost of complaining*

People described the cost of complaining in terms of the time, 91%, and the money spent, 9%. On average, their estimates of these costs was 14$ per complaint.

7.5 *Number of complaints on waste management received by public authorities*

The research for this assessment did not include a systematic analysis of the complaints made on waste, but a few reports of complaints were collected during the interviews with key informants. During these interviews, key informants reported that they had received complaints related to solid waste management and plastic bags. These did not include interagency complaints, those raised by one agency with another, but only the complaints raised by the public. A list follows:

In Phnom Penh:

- Department of Environment of Phnom Penh: received complaints in 2013 and 2014 on solid waste management. Normally, people complain with the village chiefs and the district authorities, and some issues can be resolved at that level. Non-resolvable matters are referred to DoE.[75]

- CINTRI, the solid waste management company in Phnom Penh, received complaints on two issues: the irregular collection of waste, and the bad quality of their service. However, some complaints were solved by the local authority.[76]

In Siem Reap:

- The City of Siem Reap has installed a comments & complaints box, organized public forums, participated in radio shows, and opened a Facebook page to solicit and receive comments and suggestions from local residents. Complaints and comments have come in, but have not been analysed.[77]

- The City Development Office of the City of Siem Reap is responsible for addressing complaints. They have set up a mechanism to monitor improper waste disposal in public places, and cooperate with the Provincial DoE to resolve any issue brought to their attention. Of all the complaints received by this office, it is estimated that 20% were related to waste.[78]

- The Department of Public Works and Transport sent a few letters to the Provincial Government to complain about solid waste management stressing the fact that if solid waste is not well managed, the sewerage and drainage system will be affected. This has happened at least 2-3 times since 2010. The provincial government referred the complaints to GAEA, the solid waste management company in Siem Reap.[79]

  The Sewerage and Drainage Division of DPWT receives 2-3 complaint letters a year, and at times oral complaints by individuals representing larger groups of people who

[75] Personal Communication Mr. Khem Nora *et al op cit*
[76] Personal Communication Mr. Khem Nora *et al op cit*
[77] Interview with Mr. So Platong *et al ibid*
[78] Interview with Mr. So Platong *et al ibid*
[79] Personal Communication Mr. Im Vibol, Deputy Chief of the Technical Unit, Sewerage and Drainage, Siem Reap, 17 March 2015 at the DPWT

live where there is no drainage system, or where the drainage is not connected to the pipeline. Sometimes they can resolve the problem, sometimes not.[80]

In Preah Sihanouk Province

- The Provincial Government is aware of 5 complaints received via email, and 2 letters to the Governor in 1 year, to express dissatisfaction about waste management. These complaints were mainly made by foreign business people.[81]

- DoE received complaints from DPWT, complaining that the obstruction of drains came from solid waste.[82]

- The Department of Public Works and Transport has received 2-3 complaints a year about dispersed waste. Local residents usually submit their complaints to the district office or the Provincial Government, and then those complaints are forwarded to the Department. A process to receive complaints, comments and suggestions from the public has not been set up at department level.[83] The department often raised the issue of the obstruction of the drainage system in the monthly meetings of the Provincial Government attended by other provincial departments, the Ministry of Environment and CINTRI, the solid waste management company in Preah Sihanouk Province.[84]

- The Koh Rong Eco-Tourism Conservation Committee's Director in 2011 and 2013 received 2 complaints on dispersed waste. They were referred to the Department of Tourism.[85]

This is a preliminary list based solely on the comments captured during the interviews to selected authorities. Not counting the interagency complaints, key informants interviewed said that they had received at least 20 complaints from the public in the last 12 months. As these were not systematically reported, it can be assumed that the actual number of complaints received by the authorities on this issue in Cambodia is much larger. Our interviews show that there is no formal complaint mechanism in place, nor record about the action undertaken to address the complaints, but the number and form of complaints received by the authorities is an indication of how strongly people feel about dispersed plastic bags in Cambodia. Based on the information available, people's concern is very high and their degree of satisfaction very low: the population is annoyed and distressed by the dispersed waste. As the number of complaints received by the public authorities is often used to prioritize constituents' issues, this again points to the urgent need to act on curbing plastic bags.

[80] Personal Communication Mr. Im Vibol *op cit*
[81] Personal Communication Mr. Prak Visal, Deputy Director of the Administration Division and Project Coordinator of the Integrated Coastal Management (ICM) Program, Preah Sihanouk Province, 13 March 2015
[82] Personal Communication Mr. Prak Visal *op cit*
[83] Personal Communication Mr. Nop Heng *op cit*
[84] Personal Communication Mr. Nop Heng *op cit*
[85] Personal Communication Mr. Oeur Vibol *op cit*

5. TOURISM

Measuring the impact of plastic bags on tourism is highly significant given that tourism is a considerable source of revenue for Cambodia; over 4.5 million international tourists entered the country in 2014, contributing 2,736 million $ to the economy.[86]

The impact of plastic bags on tourism is measured through three indicators:

- Foregone tourism revenues
- Tourists' attitude
- Costs to the tourism industry

5.1 ORIGIN OF DATA

Data on foregone tourism revenues and on the costs of plastic bags to the tourism industry were collected through interviews to key informants; these two indicators are described by means of case studies, and the cost estimates are only an example. Data on the tourists' attitude towards dispersed plastic bags are original and were collected through a survey of international tourists in the three cities.

5.2 FOREGONE TOURISM REVENUES

A concrete example of foregone tourism revenues due to plastic bags comes from the Zero-Waste Community-Based Ecotourism project run by the Wildlife Alliance in Chi Phat, a community in the Southern Cardamom Mountains.[87]

The project aims at reducing and recycling waste through education in schools, awareness raising in the community, and waste recycling and reduction measures. Specific activities are designed to reduce the use and dispersal of plastic bags. Among the results are *increasing economic benefits to the community by making the tourist area more visually and environmentally attractive*, and reducing diseases that might affect tourists.[88] There are 2000 inhabitants living in 600 households in Chi Phat. Roughly 1200 tourists visit the community every year, about 80% of them as independent travelers and 20%, 240 people, in groups guided by tour operators. Group tours normally last 3 days and two nights. Group size ranges from 3 to 15 people, but usually tourists come in groups of 12.

The zero waste CBET project has calculated that about 10% of the tourist groups brought in by tour operators halved their length of stay at the site because of dispersed plastic bags and other waste. This mostly happened when groups arrived in the community after a local wedding celebration. In 6 years since the beginning of the project, 12 groups have shortened their visits. This corresponds to 5% foregone revenue for the community. At an average income for the community of 35$ per tourist per day, 80% of what the tourists pay, foregone tourism revenue for the community from group tours in a year is 1260$, and 7560$ in 6 years. The actual loss would be much higher if the independent travelers were included.

[86] Tourism Statistics Report. Ministry of Tourism, Kingdom of Cambodia, Statistics and Tourism Information Department, September 2015

[87] Personal Communication Mr. Sophany Touch, Project Coordinator, Wildlife Alliance, 20 March 2015, Phnom Penh

[88] Zero Waste Community-Based Ecotourism: Protect the Cardamom Mountains Rain Forest. Leaflet

In the feedback sheets that all tourists to Chi Phat are requested to fill in upon their departure, about 30% of tourists complained about plastic waste.[89] The high risk of foregone tourism revenues because of dispersed waste is highlighted by the slogan used in education campaigns in Preah Sihanouk Province: "Rubbish is the enemy of tourism". The campaign message is, "If there is waste, tourists will not come".

5.2.1 SUMMARY

The impact of plastic bags on foregone tourism revenues can be measured through the following sub-indicators:

- Proportion of tourist groups shortening their tour due to plastic bags (%)
- Loss of income to the community from group tours (%)

In conclusion:

8.1 *Proportion of tourist groups shortening their tour due to plastic bags*

About 10% of the tourist groups brought in by tour operators cut their visit short by half because of discarded plastic bags and other waste. In 6 years, out of 120 groups 12 groups have shortened their visits.

8.2 *Loss of income to the community from group tours*

This corresponds to a 5% foregone revenue for the community. In the case study, this amounts to over 1,200$ a year.

5.3 TOURISTS' ATTITUDE

A survey of the tourists' willingness to pay was undertaken to measure the value the international tourists in Cambodia place on a clean urban environment without plastic bags. This allowed for an estimation of the value of a plastic-bag free environment to the tourism sector. The total number of tourists interviewed was 383, 128 in Phnom Penh, 125 in Siem Reap and 130 in Sihanoukville. Interviews took place in June 2015 at the tourist sites below:

- In Phnom Penh: at River Side, in front of the Royal Palace and in cafés on the 20-21 June 2015
- In Siem Reap: at the night market, Angkor Wat, Bak Kaeng Mountain on the 7-9 June 2015
- In Sihanoukville: at Ocheuteal and Otres Beach on the 10-12 June 2015

Enumerators were recommended to select respondents from different geographic regions, age, gender, type of tourism, e.g., back-packers, guided tours, single travelers. The sample was composed of 383 tourists, as follows:

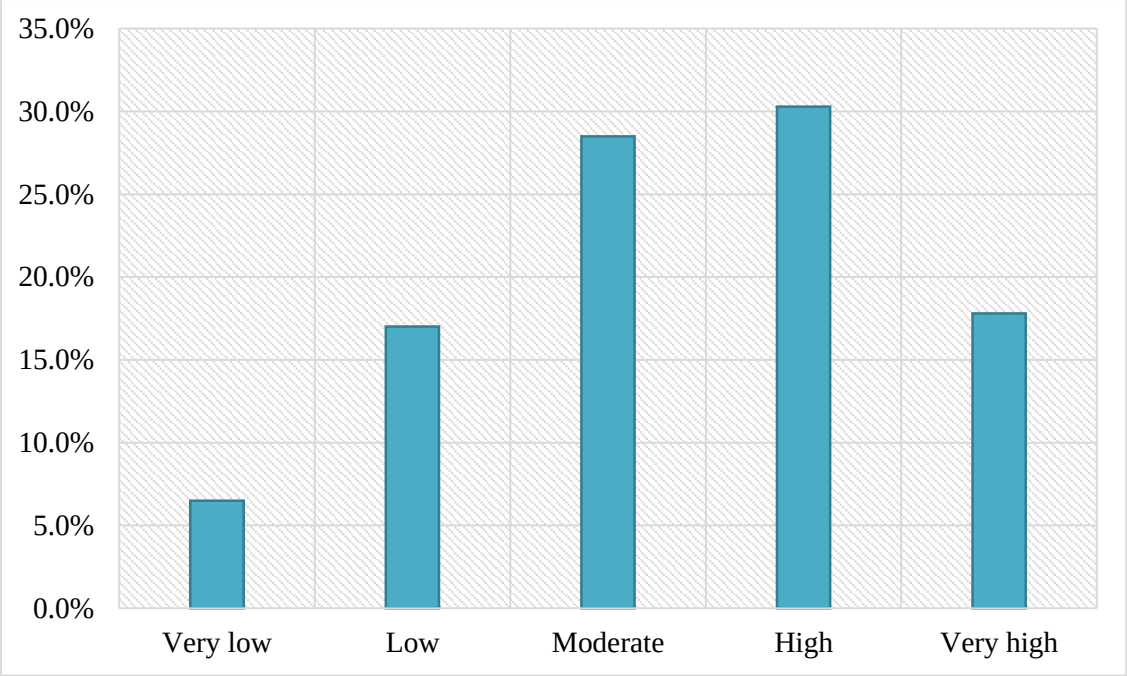
Characteristics of the surveyed tourists	(%)
Gender of surveyed tourists (n=383/383)	
Male (n=194/383)	51.00
Female (n=188/383)	49.00

[89] Personal Communication with Mr. Sophany Touch *Ibid*

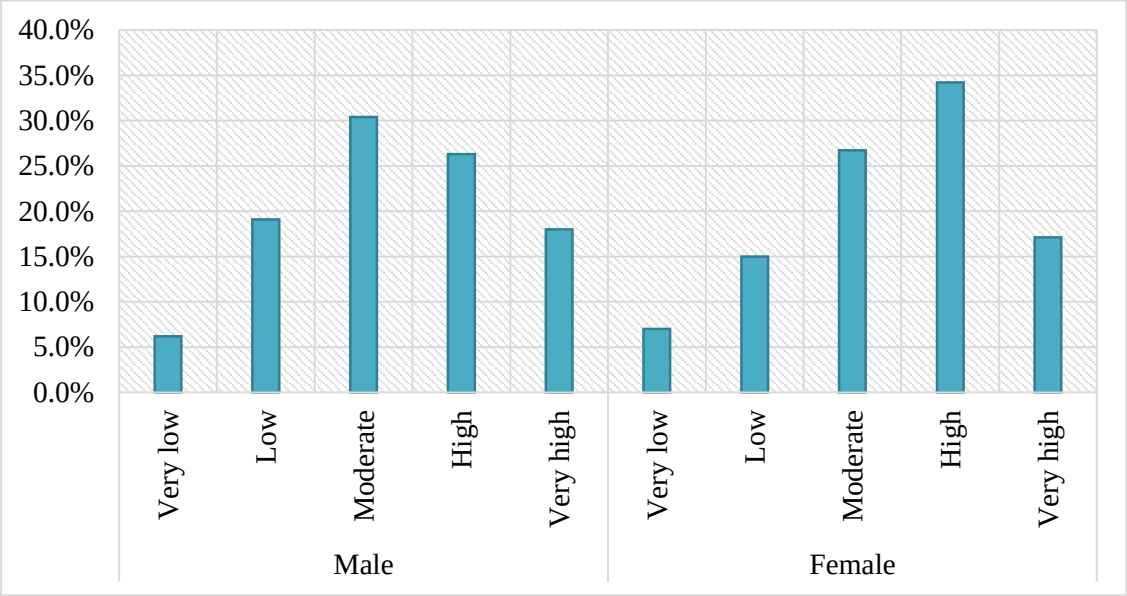
Range of the age of surveyed tourists (n=381/383; 2 did not answer the question)	
Less than or equal 25 years (n=171/383)	44.80
Between 26 and 35 years (n=105/383)	27.70
Between 36 and 45 years (n=38/383)	9.90
46 years and above (n=67/383)	17.50
Highest level of education of surveyed tourists (n=380/383; 3 did not answer the question)	
High school (n=90/383)	23.60
Undergraduate (n=75/383)	19.70
Graduate (n=122/383)	32.00
Master degree holder (n=80/383)	21.00
Ph.D (n=13/383)	3.40
Range of the monthly income of surveyed tourists (n=350/383; 33 did not answer the question)	
Equal or lower than 500 USD (n=71/383)	20.20
Between 500 to 1,000 USD (n=47/383)	13.40
Between 1,000 to 1,500 USD (n=59/383)	16.80
Between 1,500 to 2,000 USD (n=82/383)	23.30
Over 2,500 USD (n=91/383)	25.90

Interviews were undertaken in English. Before the actual questionnaire on the willingness to pay took place, the tourists were asked to declare what they had particularly liked or disliked about Cambodia up to that time. Tourists reported being impressed with the friendliness of Cambodians, the natural environment, and beautiful landscapes. They particularly liked the beaches and islands in Preah Sihanouk Province, the Angkor temples in Siem Reap, and the forest landscapes and views in Ratanakiri and Mondulkiri in the northern part of Cambodia. They also declared their dislike of traffic congestions, air pollution in the city, and that so much waste was discarded in public places. They said they had seen waste everywhere along roads, and in open drains or canals. On average tourist estimated that about 20-30% of the total uncollected waste was plastic bags.

It is significant that over 72% of the respondents mentioned waste and litter among their dislikes. When asked to quantify the amount of plastic bag that they saw, 76.6% of all respondents considered the amount moderate to very high - see table below for details. A slight difference can be noticed between men and women: almost 52% of the women declared that the amount of dispersed plastic bags was high or very high, while only 44% of the men gave the same answer.

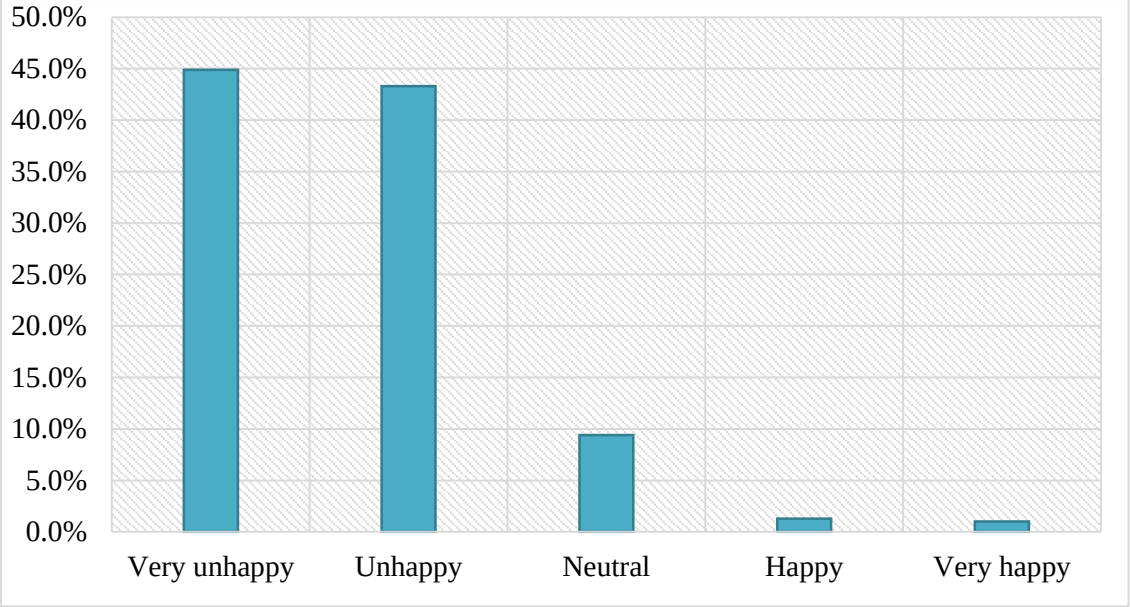


Tourists' perception of the amount of dispersed plastic bags in tourist sites

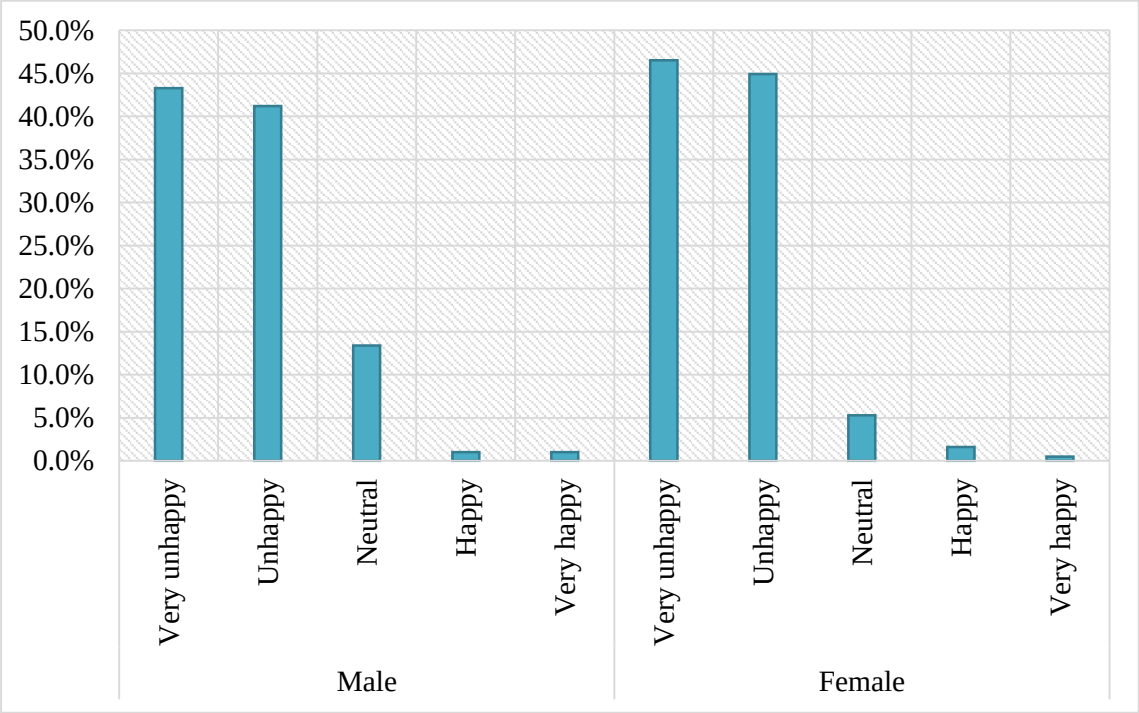


Tourists' perception of the amount of dispersed plastic bags in tourist sites, by gender

Respondents were asked to describe their feelings in relation to dispersed plastic bags, see table below for detail. Over 88% of the tourists were not at all pleased with the amount of dispersed plastic bags, 84.5% men, and 92% women. Also in this case, women seem to be more sensitive to dispersed waste than men.

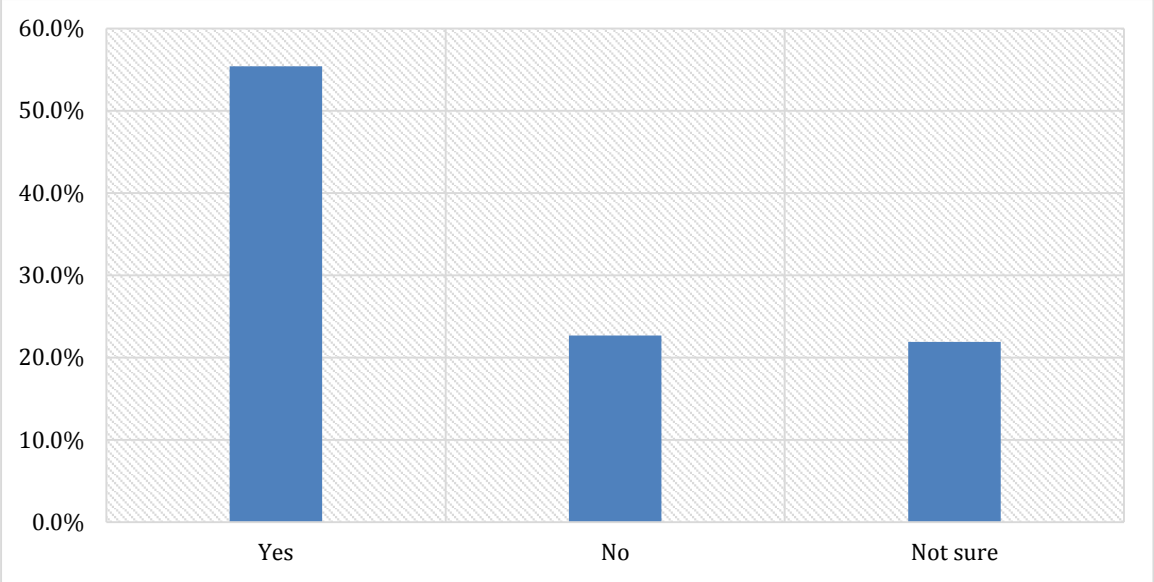


Tourists' feelings about dispersed plastic bags in tourist sites



Tourists' feelings about dispersed plastic bags in tourist sites, by gender

Over 13 per cent of tourists responded that dispersed plastic bags deterred them from visiting Cambodia again. It is interesting to note that, when these figures are separated by gender, a higher percentage of men, 17.5%, than women, 9.6%, feel this way. Asked whether they were willing to pay a one-time additional amount to contribute to the collection of dispersed plastic bags in tourist areas, 55.4% responded yes, 22.7% no, and 21.9% not sure. In this instance, the category "not sure" was considered as "no".



Willingness to contribute money to remove dispersed plastic bags from tourist sites

Those who responded "no" did so for the following reasons - some of their responses are quoted below:

I don't think I should spend money to remove dispersed plastic bags in Cambodia, but the government should do it.

25-yearold Australian tourist
Interviewed in Preah Sihanouk, 10 June 2015

Dispersed plastic bags is not a tourist problem. It is a Khmer problem.

25-year-old Canadian tourist
Interviewed in Phnom Penh, 20 June 2015

Paying money to remove dispersed plastic bags is not a problem for me, but I am worried about how the money will be effectively used.

46-year-old American tourist
Interviewed in Phnom Penh, 20 June 2015

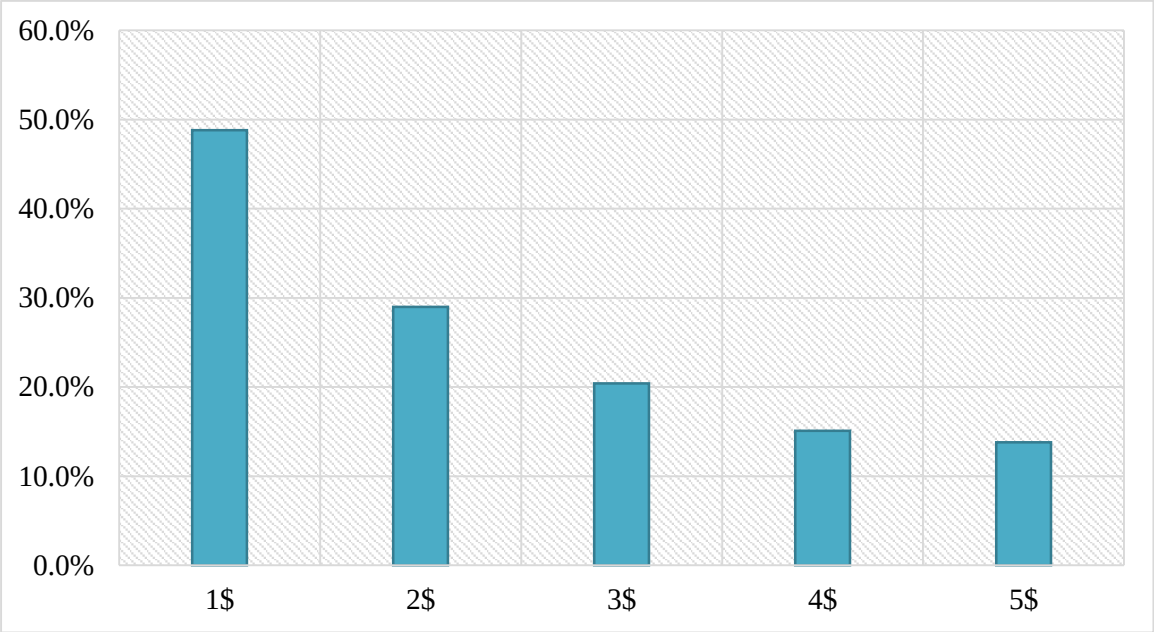
Money from tourists will not help to remove dispersed plastic bags from the tourist areas if the local people do not help to reduce, recycle, and avoid using them and continue to dispose of them everywhere.

46-year-old German tourist
Interviewed in Siem Reap, 9 June 2015

The tourists' willingness to pay for the removal of the dispersed plastic bags was then tested for different amounts of money. In our survey, the "Willingness to pay" is the maximum amount a tourist in Cambodia is willing to pay to have the dispersed plastic bags removed from the tourist areas they have visited. To allow tourists to visualize their potential financial commitment, the proposed mechanism for paying was through their hotel: a one-time

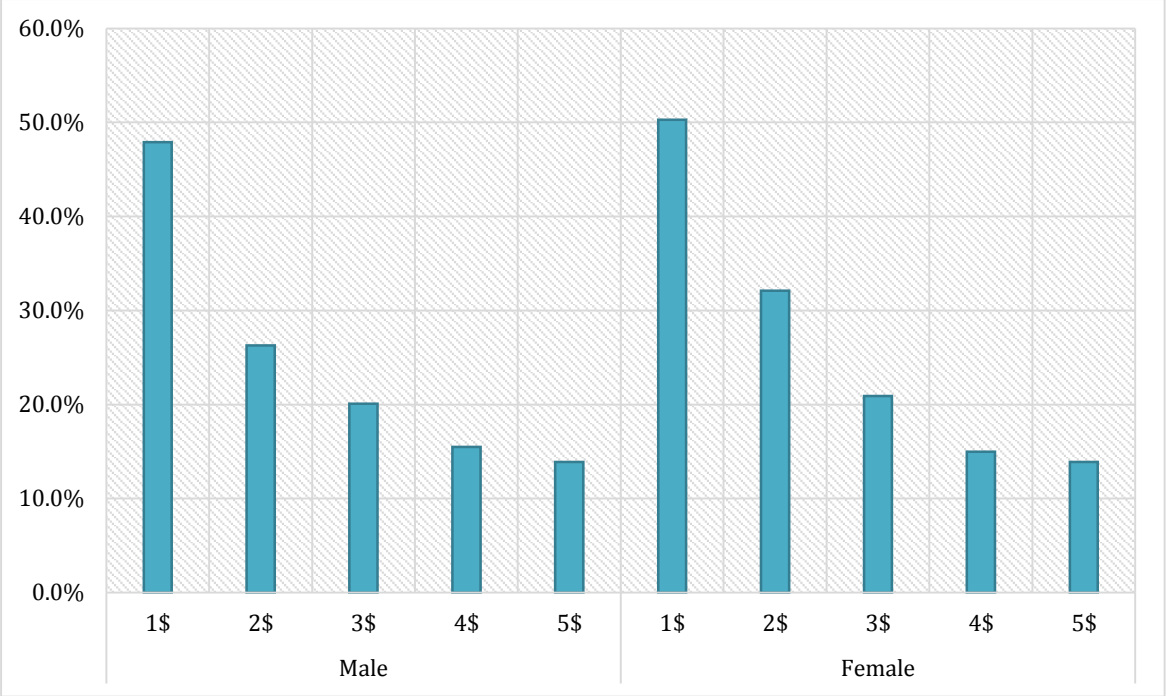
payment of the given amount for each hotel receipt the tourist would be issued; one hotel receipt could be for one single person, a couple, a family or a group. The attention was not on designing a workable mechanism for fee collection: payment through the hotel was proposed because it would be quickly understood by the respondents, would allow them to rapidly calculate and state their willingness to pay.

The minimum amount used to test the respondents' willingness to pay was 1.00$, and the maximum was 5.00$, with increments of 1$ at a time. Of the respondents who said that they were willing to contribute some money to remove dispersed plastic bags, 48.8% declared that they were willing to pay only as much as 1.00$, 29% were willing to pay up to 2.00$, 20.4% up to3.00$, 15.1% up to 4.00$, and 13.8% up to 5.00$. In addition, among those who said that they were willing to pay, but not as much as 1$, some said that they would gladly pay 0.50$ instead.



Tourists' WTP to remove dispersed plastic bags from tourist areas

For the vast majority of goods and services, an increase in price will lead to a decrease in the demand or WTP. This survey proved to be no exception: the tourists' WTP was high when the price was low at 1.00$, and it gradually decreased as the price steadily rose from 1.00$ to 5.00$. Disaggregated by gender, the percentages showed only a slight difference. The men who were willing to pay 1.00$, 2.00$, 3.00$, 4.00$, and 5.00$ to remove plastic bags were 47.9%, 26.3%, 20.1%, 15.5%, and 13.9% respectively, while the women were 50.3%, 32.1%, 20.9%, 15%, and 13.9%, respectively.



Tourist's WTP to remove dispersed plastic bags from the tourist areas of Cambodia, by gender.

Conclusions from the WTP

Most of the tourists enjoyed Cambodia's landscapes and natural endowments during their visit. However, they were disappointed to see that a considerable amount of plastic bags were dispersed everywhere. They thought that dispersed plastic bags should be removed from the tourist sites. Some tourists were willing to contribute money to do it, while others felt that it was not their responsibility. A proper strategy to reduce dispersed plastic bags should quickly be put in place, as they not only spoil the landscape, but also are likely to discourage tourists from coming to Cambodia. Ultimately, this outcome will affect the livelihood of the local people dependent on tourism. Plastic bags, and waste in general, bother the tourists, so much so that some are thinking of not coming back to Cambodia because of this, and most are willing to pay to help resolve the problem. The results of the WTP survey suggests two ways to estimate the impact of plastic bags on tourists, and on the tourism sector.

1. Calculating the cost to the tourism sector of the 13.6% of tourists who said that dispersed plastic bags made them not want to re-visit Cambodia in the future

Given that dispersed waste deterred 13.6% of tourists from coming back, removing waste would increase the number of tourists and boost the tourism sector. In 2014, international tourists to Cambodia were 4,502,775 and revenues totaled $ 2,736 million.[90] It is reasonable to assume that current tourism figures are below their potential because of the amount of rubbish that tourists see.

2. Placing a value on the discomfort and inconvenience tourists suffer from dispersed plastic bags, using the amount they are willing to pay.

The analysis of the willingness to pay to remove plastic bags from tourist sites sets a value for the inconvenience and discomfort tourists suffer. Establishing at 1$ the sum that each tourist

[90] Tourism Statistics Report. Ministry of Tourism, Kingdom of Cambodia, Statistics and Tourism Information Department, September 2015

is willing to pay to see the dispersed plastic bags removed from the tourist sites, and knowing that total tourists in 2014 were 4,502,775, the value of the distress to tourists caused by plastic bags can be estimated at over $4.5 million. This is also a conservative estimate because the WTP survey has shown that some tourists are willing to pay more.

5.3.1 SUMMARY

The impact of plastic bags on tourists' attitude can be measured through the following sub-indicators:

- Proportion of international tourists who are bothered by dispersed waste in tourist sites (%)
- Proportion of international tourists who consider the amount of dispersed plastic bags they saw as moderate to high (%)
- Proportion of international tourists who may not come back to Cambodia because of the dispersed plastic bags (%)
- Proportion of international tourists willing to contribute money to remove dispersed plastic bags (%)
- Extent of their willingness to pay (percentage for each amount of $)
- Foregone revenues from tourists as a consequence of plastic bags ($)
- Economic value of plastic-bag-free sites to international tourists (economic cost) ($)

In conclusion:

9.1 *Proportion of international tourists who are bothered by dispersed waste in tourist sites*

It is very significant that - when asked the question about what they particularly disliked about Cambodia, without any prompting on waste or plastic bags by the enumerators - over 72% of the tourists who were surveyed mentioned waste and litter among their dislikes.

9.2 *Proportion of international tourists who consider the amount of dispersed plastic bags they saw as moderate to high*

When they became informed of the focus of the survey, they reported having seen waste everywhere in public places, along roads, and in open drains or canals; 76.6% had noticed plastic bags and thought that the amount they saw was significant, "moderate" to "high." Tourists estimated that about 20-30% of the total uncollected waste was plastic bags.

9.3 *Proportion of international tourists who may not come back to Cambodia because of the dispersed plastic bags*

Over 88% of the tourists were not pleased with the amount of discarded plastic bags, and 13.6% responded that this deterred them from wanting to visit Cambodia again.

9.4 *Proportion of international tourists willing to contribute money to remove dispersed plastic bags*

Asked whether they were willing to pay a one-time additional amount to contribute to the collection of dispersed plastic bags in tourist areas, 55.4% responded positively. The proposed mechanism for paying was through their hotel bill: one-time payment each time a receipt was issued, regardless of the number of nights and people in the group.

9.5 *Extent of their willingness to pay*

As for the amount they were willing to pay, 48.8% declared that they were willing to pay only as much as 1.00$, 29% were willing to pay up to 2.00$, 20.4% up to 3.00$, 15.1% up to 4.00$,

and 13.8% up to 5.00$. Among those who said that they were willing to pay, but not as much as 1$, some said that they would gladly pay half of it: 0.50$.

9.6 *Foregone revenues from tourists as a consequence of plastic bags*

Given that dispersed waste deterred 13.6% of tourists from coming back, removing waste would increase the number of tourists and boost the tourism sector. In 2014, international tourists to Cambodia were 4,502,775 and revenues totaled $ 2,736 million. It is reasonable to assume that current tourism figures are below their potential because of the amount of rubbish that tourists see.

9.7 *Economic value of plastic-bag-free sites to international tourists (economic cost)*

Establishing at 1$ the sum that each tourist is willing to pay to see the dispersed plastic bags removed from the tourist sites, and knowing that total tourists in 2014 were 4,502,775, the value of the distress to tourists caused by plastic bags can be estimated at over $4.5 million.

5.4 COSTS TO THE TOURISM INDUSTRY

Case study: the private solid waste collection service performed by the Sihanoukville Tourist Association in Preah Sihanouk Province.

Sihanoukville Tourist Association

The Sihanoukville Tourist Association (STA) is a community-based organization, funded through the contributions of the local tourism businesses. It employs 13 cleaners to clean beaches; and, with the permission of the governor, installed 70 bins in the areas regularly cleaned by them. STA organises a regular waste collection service at Ochheuteul Beach, employing 13 workers. After being collected, the waste is taken by cart to the shops and the restaurants at the beach that participate in the initiative, for later pick-up by CINTRI.[91]

Labor.

The 13 workers are divided into 2 groups: 9 on the beach and 4 on the streets behind it. The service operates every day from 6 am to 12 noon.[92]

Labor cost.

Workers cost 80$ a month or 960$ a year. The total annual cost to STA for the 13 workers is therefore 12,480$.[93]

Equipment and other material.

STA provides carts, brooms, garbage braces, gloves, raincoats, and masks. Shop and restaurant owners provide trash bins.[94]

Carts: 2, they cost 250$ each and last on average 2 years. The total annual cost is therefore 250$.

Brooms: 16 a month, or 192 a year. They cost 2$ each, so the total annual cost is 384$.

Garbage braces: 13 a year. They cost 1$ each, so total annual cost is 13$.

[91] Personal Communication Mr. Douglas McColl, *op cit*. Personal Communication with Mr. Neang Sophal, former supervisor of the Sihanoukville Tourist Association (STA), August 2015

[92] Personal Communication Mr. Neang Sophal *Ibid*

[93] Personal Communication Mr. Neang Sophal *Ibid*

[94] Personal Communication Mr. Neang Sophal *Ibid*

Gloves: 52 pairs a month, or 624 a year. They cost 0.63$ a pair, so total annual cost is 393$.

Raincoats: 13. They cost 5$ and last 2 years, so total annual cost is 32.5$.

Masks: 5 packages a month, or 60 a year. They cost 1.25$ each, so total annual cost is 75$.

In addition, STA has installed 70 bins, for 5-10$ each (average 7.5$), so their annual cost is around 525$.

The total annual cost paid by STA for equipment is then 1672.5$.

Amount of waste collected and proportion of plastic bags.

Every day, the waste collected on the beach fills 3-4 carts, and on the streets 1-2 carts. This amounts to an average of 5 carts a day. Each cart carries about 500kg. The proportion of plastic bags is about 4% in the waste collected at the beach, and 2% of the waste collected in the streets, for a weighted average of 3.4%. Thus, every day the STA waste collection service collects about 5 carts of waste for a total of about 2500kg of waste. Of this, about 85kg - 70-100kg - are plastic bags. In one year these figures amount to 912,500kg and 31,025kg, respectively.

5.4.1 SUMMARY

The impact of plastic bags on the tourism industry can be measured through the following sub-indicators:

10.1 *Cost to local tourism entrepreneurs to run a private waste collection service in tourist areas ($/year)*

The total annual cost of the private waste collection service is over 14,000$; about 12,480$ for the 13 workers and 1,670 for equipment and consumables.

6. HUMAN HEALTH

6.1 ENDOCRINE DISRUPTION FROM CONTAMINATION OF FOOD BY PLASTICS

In Cambodia, plastic bags are used extensively by market and street vendors to wrap food without additional lining. Then these bags are taken away by customers, who very often eat and drink directly from them. Food taken this way may be solid or liquid, hot or cold. Among the impacts of plastic bags, it is important to consider what effects they may have on human health when they enter in contact with food. The concern arises because fossil fuel-derived plastic contains chemical substances that, if absorbed by human beings through the ingestion of contaminated food, will act as endocrine disruptors.

Endocrine disruptors are not yet widely known by the public and an explanation is due here, to justify the inclusion of this indicator into the assessment. For more details, it is suggested to consult the website of The Endocrine Disruption Exchange that makes complex scientific evidence clear to a non-scientific audience, and the report *State of the Science of Endocrine Disrupting Chemicals 2012*.[95]

The International Programme on Chemical Safety (IPCS) defined an endocrine disruptor as "(…) an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations".[96] This definition is commonly used by intergovernmental organizations such as WHO, UNEP and ILO, all partners in the IPCS, and has been adopted by several other agencies. In simpler words the European Commission has defined endocrine disruptors as "chemicals that interfere with hormone systems, which may lead to harmful effects on public health and the environment".[97] According to The Endocrine Disruption Exchange, Inc. (TEDX), "Endocrine disruption is the insidious trespass of man-made chemicals into every vital organ system in your body that comprises or is controlled by the endocrine system, such as the thyroid and parathyroid, pancreas, adrenals, thymus, male and female reproductive organs, the heart, digestive system, and skeletal system -- all the systems that participated in how you were constructed in the womb and how you are functioning today".[98]

Endocrine disruption chemicals (EDCs) "include components of *plastics*, pesticides, flame retardants, fragrances and more. They are found in our homes, schools and work places, toys, clothing, cosmetics, sunscreens, electronics, furniture, cleaning products, lawn care products,

[95] See http://www.endocrinedisruption.org/ for more information. TEDX, The Endocrine Disruption Exchange "is the only organization that focuses primarily on the human health and environmental problems caused by low-dose and/or ambient exposure to chemicals that interfere with development and function, called endocrine disruptors. It "provides (…) a science-based foundation for individuals to act and promote responsive public policy-making", accessed 2 December 2015. See also the United Nations Environment Programme, World Health Organization (2013). *State of the Science of Endocrine Disrupting Chemicals 2012. Summary for Decision-Makers.* Ed. A.Bergman, J. J. Heindel, S. Jobling, K. A. Kidd, R.T. Zoeller

[96] See http://www.unep.org/chemicalsandwaste/SAICM/EndocrineDisruptingChemicals/EDCsDefinitions/tabid/130227/Default.aspx Accessed 1 December 2015

[97] Endocrine Disruptors: Commission publishes summary report on the public consultation http://ec.europa.eu/health/endocrine_disruptors/docs/ip_20150724_en.pdf). Accessed 2 December 2015

[98] See (http://www.endocrinedisruption.org/) accessed 2 December 2015

automobiles, building materials, food, and *food packaging"*.[99] Plastic containers, for example water bottles and other kitchenware, food containers, plastic wraps, are known to contaminate the food they enter into contact with, thus representing a health hazard to humans. The literature on this is immense, and there is indication that plastic bags behave the same way.

The issue is so critical that at the European Joint Research Centre in Ispra, Italy, there exists a European Reference Laboratory for Food Contact Materials (EURL-FCM), informing the EU institutions on this matter in view of future legislation. "Ensuring that what we eat is safe does not stop at testing the food itself. Everything that comes in contact with food as it is produced, packaged, transported, stored, prepared and consumed also needs to be safe. Materials such as *plastics*, paper and board, metals, ceramics are commonly used for the manufacturing of food packaging. The safety of such materials relies on ensuring that during contact there is no migration of unsafe levels of chemical substances from the material to the food".[100]

With regards to plastics, endocrine disruptors are represented by several categories of substances such as phthalates, chemical compounds used as plasticizers, bisphenol, dioxins and furans, chemical substances released when plastics is combusted, such as in waste incineration and trash burning at the curb. These chemicals are also food contaminants.

Packaging *meant* to be for food, such as formal containers for food and beverages, normally undergo strict controls, and yet have been found to contaminate what they contain. Plastic bags that are *not meant* to wrap food may therefore contain even larger quantities of endocrine disruptor chemicals, undetected, and they also, of course, migrate into the food. Plastic bags of the sort which is used in Cambodia are most likely to fall under this category. For the most part, they are not designed and produced with the primary objective of containing food and beverages, and yet become the most common type of food packaging and food containers. This is especially true for the small, clear, thin and light plastic bags that are used by street vendors to sell food, and by customers that often eat their food directly from them. Indeed, several Cambodians in urban areas eat most of their meals this way, thus exposing themselves to frequent and high exposure to endocrine disruption. The effect of the endocrine disruptors in the bags are in contrast to how Cambodians see plastic bags as being associated with cleanliness, hygiene and health.[101] There are no studies on the migration of endocrine disruptors into food specifically from plastic *bags*. But warnings on how plastic bags may alter the food they contain, especially, but not only, when the food and the container are heated, abound.

According to TEDX, endocrine disruptors are stealth chemicals, as they "fly below the government toxicological tests": visible impairment does not show at the time of exposure, but several years later. Furthermore, effects are critical if exposure happens in the womb: the consequences of the exposure to endocrine disruptors are particularly serious during the first 38 weeks of pregnancy. Endocrine disruptors have been found in all body fluids, in glands and in sexual organs. Endocrine disruptors alter the functioning of the endocrine system with biological as well as behavioral effects, and this explains why endocrine disruptors raise such

[99] The Endocrine Disruption Fact Sheet, The Endocrine Disruption Exchange, Inc. (TEDX). Emphasis added

[100] European Union Joint Research Service EURL Food Contact Materials https://ec.europa.eu/jrc/en/eurl/food-contact-materials accessed 10 December 2015. Emphasis added

[101] Personal Communication 17 Triggers consultants, 16 November 2015

deep concern. “Laboratory studies and human epidemiological studies confirm that EDCs have a wide array of effects on the body” and “Disorders of the endocrine system, now at epidemic proportions, include learning disabilities and behavioral and mood problems, infertility, abnormal gonad development, cancers of the reproductive organs, unusual pubertal onset, diabetes, obesity, allergic and asthma reactions, and more.” Boys seem to be more at risk than girls.[102]

6.2 HEALTH COSTS OF ENDOCRINE DISRUPTION

“[Scientists] have linked widely dispersed chemicals with many disorders that are currently burdening society and governments with inestimable costs for diagnosis, treatment, alleviation, and life-long care”.[103] According to the most recent study on this topic, in the European Union the health cost attributable to endocrine-disrupting chemicals is estimated to be 157 billion euros annually, corresponding to 1.23% of the EU Gross Domestic Product.[104] These figures are greatly underestimated given that:

- they consider direct costs of health care, costs of rehabilitation and lost productivity; several disabilities or dysfunctions caused by endocrine-disrupting chemicals, such as behavioral issues, are not treated and would therefore not appear in the calculations, and yet generate serious social impacts;
- they exclude the effects generated by the chemicals that have been banned by Europe, in spite of the fact that they may continue to contaminate the EU population;
- they refer to 2010, the most recent year for which prevalence/incidence data could permit robust estimation;[105]
- “these costs will accrue annually insofar as exposures that are harmful continue unabated”.[106]

Another recent study estimates that the cost to society of the effects of endocrine disruptors *on male reproductive health alone* in the five Nordic European countries, Denmark, Finland, Iceland, Norway and Sweden, reaches 36 million euros per year of exposure.[107] When this figure is extrapolated to the entire European Union, the costs grows to almost 600 million euros, and when the undiscounted cost is considered, the cost today from past exposure, the figure rises to over 1.2 billion euros per year of exposure. In the US, according to TEDX, the cost of treating health conditions, for which exposure to Endocrine-Disrupting Chemicals is implicated, is over $1 trillion a year.[108] Based on these estimates, the cost to Cambodia of all

[102] See http://www.endocrinedisruption.org/ for more information

[103] Colburn. T., 2010. Endocrine Disruption, Public Health and National and International Security. In http://www.psr.org/environment-and-health/environmental-health-policy-institute/responses/endocrine-disruption-public-health-and-national-and-international-security.html, accessed 6 December 2015

[104] Trasande L. et al. Estimating Burden and Disease Costs of Exposure to Endocrine-Disrupting Chemicals in the European Union. The Journal of Clinical Endocrinology and Metabolism, 2015 Apr;100 (4):1245-55

[105] Ibid., p. 6

[106] Ibid., p. 8

[107] Olsson I-M. et al. The cost of inaction. A Socio-economic analysis of costs linked to effects of endocrine disrupting substances on male reproductive health. Nordic Council of Ministers 2014. TemaNord 2014:557

[108] http://ec.europa.eu/health/endocrine_disruptors/docs/ip_20150724_en.pdf, accessed 5 December 2015

the effects of endocrine disruption, to which plastic bags contribute considerably, is in the range of the hundreds of millions of dollars per year.

7. CONCLUSIONS

Indeed, the impacts of plastic bags on the Cambodian community are numerous, measurable and significant. And yet this assessment is only partial. Plastic bags impact on additional sectors which were not considered for this assessment, for example biodiversity and ecosystems. In addition, for the four sectors addressed in the assessment, more indicators and sub-indicators could have been included, if time and information had been available. Finally, several sub-indicators have been measured using conservative estimates. As a consequence, the results presented in the report are an incomplete description of the impact of plastic bags on the Cambodian community, and the estimates offered through the sub-indicators are most likely to underestimate some costs and the impact of plastic bags.

However these results are helpful in four ways. First, they offer a preliminary map of the impact of plastic bags on the public and the private sector and on individuals; this map can be made more comprehensive in the future with the cooperation of additional key informants, and the collection of new primary data. Secondly, they represent the Cambodian contribution to the international debate on plastic bags; these results can be taken to conferences and roundtable discussions, and promote further debate on the topic. Thirdly, they provide an order of magnitude of the resources dedicated to preventing, or offsetting, the damage of plastic bags; the notion that these resources could be dedicated to other uses is an indication of the opportunity cost of plastic bags. And, fourthly, they represent a starting point for authorities and policy-makers to act on curbing the use of plastic bags: the information available at this point is already a compelling argument.

8. LIST OF CONTACTS

Ministry of Environment

1. Mr. Chin Sothun, former Deputy Chief of the Solid Waste Management Office, Ministry of Environment, Phnom Penh

Ministry of Tourism

2. Mr. Hout Rithy, Director of Cooperation and Promotion Division, National Committee for Clean City Assessment (NCCA), Phnom Penh
3. Mr. Neang Chamnap, Assistant to Director-General of Ministry of Tourism, Deputy Director of Cooperation and Promotion of NCCA, Phnom Penh

Municipality of Phnom Penh

4. Mr. Chhorng Vantha, Deputy Chief of Drainage and Sewerage Division, Ministry of Public Works and Transportation, Phnom Penh
5. Mrs. Krouch Sokunmealea, Director of Administration-Staff Office, Drainage and Sewerage Division, Ministry of Public Works and Transportation, Phnom Penh
6. Mr. Khim Nora, Chief of Waste Management Office, Department of Environment, Phnom Penh
7. Mr. Sok Sopheak, Deputy Chief of Planning and Law Office, Department of Environment, Phnom Penh
8. Mr. Tae Sothy, Chief of Environmental Dissemination and Education Office, Department of Environment, Phnom Penh
9. Mr. Men Sothet, Director, Pumping Stations, Drainage and Sewerage Division, Ministry of Public Works and Transportation, Phnom Penh
10. Mr. Leap Sinit, Director, Riverside Pumping Stations (Riverside 1, 2, 3 and 4), Phnom Penh
11. Mr. Bun Vannret, Director, Riverside 1 Pumping Station, Phnom Penh
12. Mr. Em Pharin, Director, Riverside 2 Pumping Station, Phnom Penh
13. Mr. Un Vanna, Director, Riverside 3 Pumping Station, Phnom Penh
14. Mr. Khan Sang, Riverside 4 Pumping Station, Phnom Penh
15. Mr. Phal Phon, Director, Boeung Tompun Pumping Station, Phnom Penh
16. Mr. Khiev Kosal, Director, Boeung Trobek Pumping Station, Phnom Penh
17. Mr. Va Kok, Director, Konsrov Pumping Station, Phnom Penh
18. Mr. Sok Saroeun, Director, Toul Sompov Pumping Station, Phnom Penh
19. Mr. Dy Sokha, Director, Toul Kork 1 Pumping Station, Phnom Penh
20. Mr. Yin Vutha, Director, Toul Kork 2 Pumping Station, Phnom Penh
21. Mr. Kem Rey, Director, Kilometer 9 Pumping Station, Phnom Penh

<u>Districts (Khan)</u>

22. Mr. Eam Sitha, Chief of District Environmental Office, Khan 7 Makara, Phnom Penh
23. Mr. Leang Somet, Chief of District Environmental Office, Khan Doun Penh, Phnom Penh
24. Mr. Veth Darith, Chief of Sangkat Beung Kok I, Khan Toul Kork, Phnom Penh
25. Mr. Sum Sarith, Chief of Sangkat Phsar Kandal I, Khan Daun Penh, Phnom Penh
26. Mrs. Keo Sokol, Chief of Sangkat Veal Vong, Khan 7 Makara, Phnom Penh
27. Mr. Chhay Bunthan, Chief of Village 6, Sangkat Veal Vong, Khan 7 Makara, Phnom Penh
28. Mr. Chon Chan Leap, Chief of Village 7, Sangkat Veal Vong, Khan 7 Makara, Phnom Penh
29. Mr. Vat Many, Chief of Village 8, Sangkat Veal Vong, Khan 7 Makara, Phnom Penh

30. Mr. Phen Ry, Chief of Village 12, Sangkat Veal Vong, Khan 7 Makara, Phnom Penh

Siem Reap Province

31. Mr. So Platong, Deputy Governor of Siem Reap City, Siem Reap Province
32. Mr. Sean Kimthan, Chief of City Development Office, Siem Reap City, Siem Reap Province
33. Mr. Chung Sokhemarak, Deputy Director of Tourism Department, Siem Reap Province
34. Mr. Im Vibol, Deputy Chief of Technical Office, Sewerage and Drainage System Unit, Department of Public Works and Transportation, Siem Reap Province
35. Mr. Phourng Lina, Director of Siem Reap Provincial Department of Environment
36. Mr. Leang Piseth, Director of Salakonseng, Chrolong and Vat Chok Pumping Stations, Siem Reap

Districts (Khan)

37. Mr. Huoy Han, Second Deputy Chief of Sangkat Kork Chork, Kouk Chork Commune, Siem Reap Province
38. Mr. Kheav Soth, Chief of Slokram Commune, Siem Reap Province
39. Mr. Sam Lan, Chief of Sala Komreuk Commune, Siem Reap Province
40. Mr. Tith Sokhom, Assistant of Tropaeng Seh Village, Kork Chork Commune, Siem Reap Province
41. Mr. Khat Sareoun, Vice-Head of Veal Village, Kork Chork Commune, Siem Reap Province
42. Mr. Vith Samorn, Vice-Head of Wat Bo Village, Sala Komreuk Commune, Siem Reap Province

Solid Waste Management Companies

43. Mr. Sov Sokchetana, Deputy Director, GAEA Company Plc., Siem Reap Province
44. Mr. Mak Vibol, Chief, Distribution Unit, GAEA Company Plc., Siem Reap Province

Preah Sihanouk Province

45. Mr. Prak Visal, Deputy Director, Administration Division and Project Coordinator of the Integrated Coastal Management Programme, Preah Sihanouk Province
46. Mr. Nop Heng, Director of Department Public Works and Transportation, Preah Sihanouk Province
47. Mr. Kong Sokha, Former-Chief of Environmental Pollution Control Office, Department of Environment, Preah Sihanouk Province
48. Mr. Pich Pheary, Deputy Chief of Drainage and Sewerage Unit, Department of Public Works and Transportation, Preah Sihanouk Province
49. Mr. Oeur Vibol, Director, Koh Rong Eco-Tourism Conservation Committee, Department of Tourism, Preah Sihanouk Province

Other provinces

50. Mr. Hong Pheareak, Deputy Director of Takeo Capital Department of Environment, Takeo Province
51. Mr. Suy Thea, Director of Kompot Capital Department of Environment, Kompot Province
52. Mr. Choub Saron, Director of Bathombong Capital Department of Environment, Bathombong Province
53. Mr. Kong Sophal, Director of Kep Capital Department of Environment, Kep Province
54. Mr. Khy Tanglay, Director of Kompong Cham Capital Department of Environment, Kompong Cham Province

55. Mr. Orng Bunthean, Deputy Director of Kompong Thom Department of Environment, Kompong Thom Province
56. Mr. Morn Sophal, Director of Koh Kong Capital Department of Environment, Koh Kong Province
57. Mr. Phan Morkot, Director of Pursat Capital Department of Environment, Pursat Province
58. Mr. Hak Vimean, Former Director of Steung Treng Capital Department of Environment, Steung Treng Province
59. Mr. Keut Saroeun, Director of Svay Rieng Capital Department of Environment, Svay Rieng Province
60. Mr. Korng Seangpheng, Deputy Director of Ratanakkiri Capital Department of Environment, Ratanakkiri Province
61. Mr. Chheum Ra, Deputy Director of Kandal Capital Environmental Pollution Control Office, Department of Environment, Kandal Province
62. Mr. Kong Sombath, Deputy Director of Preah Vihear Capital Department of Environment, Preah Vihear Province
63. Mr. Thai Sophy, Deputy Director of Banteaymeanchey Capital Department of Environment, Banteaymeanchey Province
64. Mr. Touch Varatha, Director of Prey Veng Capital Department of Environment, Prey Veng Province
65. Mr. Ngor Huor, Director of Odormeanchey Capital Department of Environment, Odormeanchey Province
66. Mr. Kau Thim, Director of Kompong Chhnang Capital Environmental Pollution Control Office, Department of Environment, Kompong Chhnang Province

Non-Government Organizations / Civil Society

67. Mr. Douglas McColl, Vice-President, Sihanoukville Tourist Association (STA)
68. Mr. Neang Sophal, former Supervisor of Sihanoukville Tourist Association (STA)
69. Mr. Heng Sokrith, Project Manager, Tonle Sap Programme, Conservation International-CI Cambodia, Phnom Penh
70. Mr. Simon Mahood, Technical Advisor, Biodiversity Conservation, Wildlife Conservation Society-WCS, Phnom Penh
71. Mr. Touch Sophany, Project Coordinator, Zero Waste Community-Based Ecotourism, Wildlife Alliance, Phnom Penh