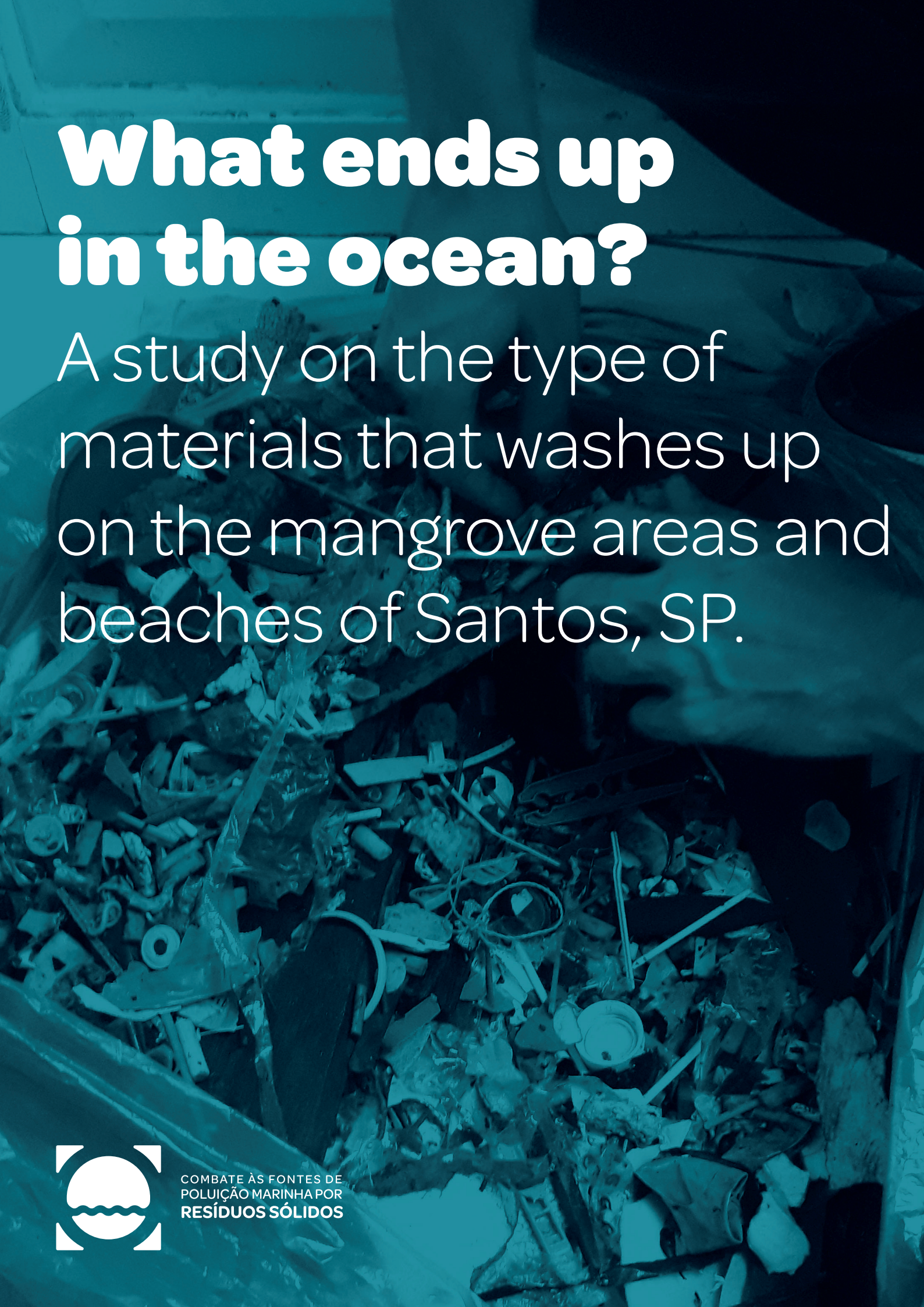
What ends up in the ocean?

A study on the type of materials that washes up on the mangrove areas and beaches of Santos, SP.



COMBATE ÀS FONTES DE
POLUIÇÃO MARINHA POR
RESÍDUOS SÓLIDOS

CONCEPT AND COORDINATION

Brazilian Association of Public Cleansing and Waste Management Companies (ABRELPE)/ (secretaria@abrelpe.org.br).

ABRELPE is a non-profit organization that gathers and represents companies that operate in the urban cleansing services and management of municipal solid waste. Its mission is based on the principles of environmental preservation and sustainable development and its main objective is to promote technical and operational development of the solid waste sector in Brazil.

In an international context, ABRELPE is the representative in Brazil of the ISWA – International Solid Waste Association, the main global entity dedicated to the solid waste matters; it's also the head office of the Regional IPLA Office for South America (International Partnership for the development of waste management services together with local authorities), a well-known program supported by the UN through the UNCRD – United Nations Centre for Regional Development. Moreover, ABRELPE is part of the Municipal Solid Waste Initiative of the CCAC (Climate and Clean Air Coalition), an international partnership for the environment agenda that operates on several fronts to reduce short-lived climate pollutants and fight climate change.

AUTHOR

EcoFaxina Institute - Cleaning, Monitoring and Environmental Education, is a civil non-profit association founded in 2008 in the city of Santos to fight marine pollution in Santos and São Vicente estuary through the elaboration of projects and promotion of public policies for the reduction of plastic waste in the ocean. The main strategy is the recovery of degraded mangrove areas and the reduction of floating solid waste in the estuarine system due to irregular dwellings dumping. To this end, voluntary de-pollution activities are developed in order to warn society about the critical situation of marine pollution and deforestation of mangroves in the estuary. At the same time, volunteers remove as much waste as possible from the coastal ecosystems, especially plastic. The activities are also a tool for research and environmental awareness, which provide a new perspective of the problem for those who participate. So far, EcoFaxina has carried out 97 voluntary activities, involving 2,263 volunteers in the collection of more than 52 tons of solid waste from marine environment.

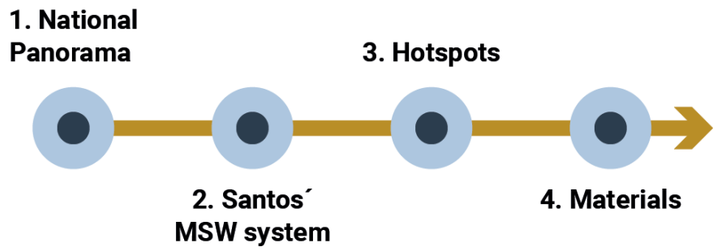
SUMMARY

INTRODUCTION

The present study is a continuity of the report entitled “Where does the marine litter come from” and aims to qualify and quantify the solid waste present in the two main land-based sources of the insular part of the municipality of Santos, SP: the mangrove areas near stilt houses communities and the beachfront.

The information provided here is the result of collection activities carried out by the EcoFaxina Institute’s team between October 2018 and March 2019.

With this fourth report, the project “Fighting the sources of solid waste marine pollution”, implemented by ABRELPE with resources provided by the Swedish Environmental Protection Agency (SEPA), closes a diagnostic cycle, which began with the Panorama of Actions in the country; highlighted the definition of the Solid Waste Local Management Scenario; and identified and described the major land-based sources in response to the question “Where does the marine litter come from”. The project overview with the sequence of the four diagnostic reports is presented below.



1. METODOLOGIES

Two indexes were adopted to evaluate the pollution’s level caused by solid waste in Santos’ mangroves and beaches: The Clean Coast Index (CCI) and a General Index (GI).

1.1. CLEAN COAST INDEX

The CCI is a measurement tool derived from the Clean Coast Program and aims to account for plastic and styrofoam waste as an indicator of ecosystem cleanliness (ALKALAY et al., 2007). According to the methodology, the plastic rated by the index comprises any artificial waste made, or partially made, of plastic such as nylon fishing lines, styrofoam remains and plastic bags of all sizes. The calculation of the index followed the following formula:

$$CCI = \frac{\text{total items collected (plastic and styrofoam)}}{\text{transect area or plot}} \times K$$

Being K = 20, the coefficient inserted by statistical convention and to facilitate the interpretation of the values[1].

The results of the index were classified as follow:

1 - Instead of considering 0.1 item/m2, the index allows the value to be transformed into 2, in other words, an integer, which facilitates the analysis.

Table 1. Clean Coast Index.

Coastal Index	Very clean – no waste observed in the coastal region	Clean – no waste observed in most of the coastal region	Moderate – some waste observed in the coastal region	Dirty – too much waste observed in the coastal region	Extremely dirty – waste observed covering the coastal region
Numerical Index	0 - 2	2 - 5	5 - 10	10 - 20	20

Source. ALKALAY et al., 2007

1.2. GENERAL INDEX

The general index accounts for all types of materials found in the mangrove plot or beach transect[2] and follows the same classification proposed by the CCI (Table 1). The calculation of the index was based on the following formula:

$$IG = \frac{\text{total items collected (all materials)}}{\text{transect area or plot}} \times K$$

2. DATA COLLECTION

2.1. MANGROVE PLOT

Figure 1. Map with the location of the plot established in a mangrove fragment in Santos.

In order to obtain data on the solid waste found in the Santos mangrove area, a 10m x 10m plot was established for collection on 09/12/2018 in the 98th Volunteer Action of the EcoFaxina Institute in the mangrove area adjacent to the Jardim São Manoel neighborhood, according to methodology adapted for studies in mangrove areas developed by Schaeffer-Novelli, Vale and Cintrón (2015). The target area was previously cleaned on 23/09/2018 during the 96th Voluntary Action, totaling a 76-day interval between cleaning activities.

2 - Line drawn in a certain area along which the wastes found are recorded and counted.

The delimitation of the plot started at 9 o'clock with the assistance of a GPS, a 50-meter track, stakes and marking tape. The tides were 1.6 m - 4:27; 0.3 m - 10:58; 1.4 m - 16:37. The collection was carried out by a group of 10 volunteers and occurred under syzygy tidal, during the period of tidal ebb[3] (ALKALAY et al., 2007), in transition from new moon to crescent, starting at 9 o'clock and 30 minutes and finishing at 11 o'clock. After being collected, the waste (> 2.5 cm) was submitted to a qualitative-quantitative analysis.

COLLECTED DATA

PLOT COORDINATES: 23°55'47.10"S - 46°23'1.61"O
PLOT AREA: 10 m x 10 m
ITEMS FOUND WITHIN THE PLOT (TOTAL): 5,209
ITEMS FOUND WITHIN THE PLOT (PLASTIC AND STYROFOAM): 4,819
GENERAL CONCENTRATION (ITEM/M²): 52.09
PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²):48.19
GENERAL INDEX: 1,041.8 – extremely dirty
CCI: 963.8 – extremely dirty

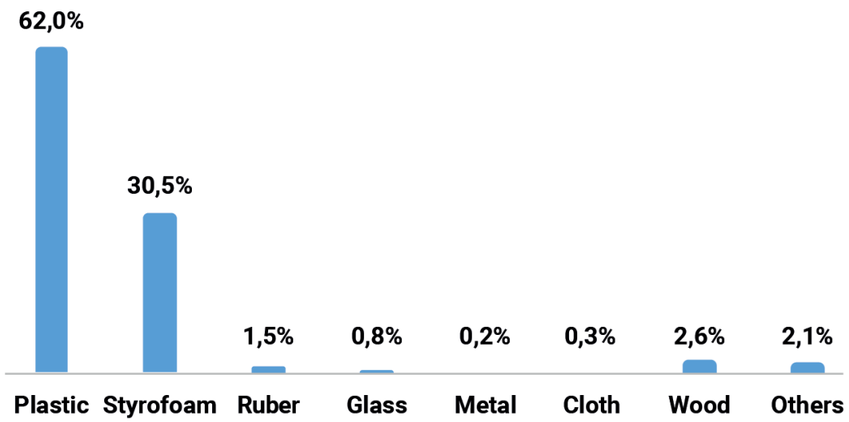
Table 2. Solid Waste data collected from mangrove plot.

Material	Number	Type of waste	Items		%
Plastic	1	Fragment (plastic film)	384	3,231	62
	2	Food packaging (plastic film)	321		
	3	Plastic bag	312		
	4	Food packaging (rigid plastic)	302		
	5	PET bottle caps	263		
	6	Laboratory equipment (small plastic tubes)	190		
	7	Bottle cap ring	172		
	8	Cotton bud stick	164		
	9	Cosmetics packaging	143		
	10	Lollipop stick	135		
	11	Lids	120		
	12	Toy	110		
	13	Fragments or pieces (rigid plastic)	92		
	14	PET bottles	83		
	15	Drug packaging	69		
	16	Straw	68		
	18	Cigarette lighter	43		
	19	Disposable vaginal applicator	42		
	20	Hygiene product packagings	40		
	21	Pen	38		
	22	Spray nozzle	36		
	23	Carton packaging for food and beverages cap rings	23		
	24	Cleaning products packaging	18		
	25	Pen refill	15		
	26	Toothbrush	13		
	27	Hair comb/brush	13		
	28	Decor item	12		
	30	Hairclip	4		
	31	Polyurethane foam	2		
	32	DVD covers	2		
	33	Plastic folder	1		
	34	Galoon of lubricating oil	1		

3 - The explanations on the influence of the tide on waste circulation is presented in the report "Where does the marine litter come from? Study on potential land sources in Santos, Brazil." pages 8, 38 and 41.

Styrofoam	35	Fragments	774	1,588	30.5
	36	Food packaging	728		
	37	Product protection (styrofoam packaging)	86		
Rubber	38	Slippers/flip-flops	67	79	1.5
	39	Party balloons	6		
	40	Condom (packed)	5		
	41	Tire	1		
Glass	42	Bottles	19	41	0.8
	43	Cosmetic packaging	17		
	44	Perfume bottle	5		
Metal	46	Aluminium cans	6	12	0.2
	47	Food cans	3		
	48	Spray cans	3		
Cloth	49	Clothing	13	13	0.3
Wood	50	Construction timber	136	136	2.6
Others	51	Footwear (sneakers, shoes, sandals)	36	109	2.1
	52	Light bulb	17		
	53	Carton packaging for food and beverages[4]	15		
	54	Candle (paraffin)	12		
	55	Syringes	9		
	56	Electric wire	8		
	57	Electric wire (fragments)	6		
	58	Baby pacifiers	4		
	59	Bycicle seat	1		
	60	Plush toy	1		
TOTAL			5,209		100

The Graph 1 below shows the data of Table 2 by percentage of material collected:



Graph 1. Percentage of material collected within the mangrove plot.

4 - The material was inserted in the category “others” because it has different materials within the composition, such as plastic, aluminum and cardboard.

2.1.1. PHOTOGRAFIC REPORT OF THE WASTE COLLECTION ACTIVITY IN THE MANGROVE AREAS

Figures 2 and 3. Volunteers during the waste collection within the mangrove plot.

Figure 4. Mangrove plot after the waste collection.

Figures 5 and 6. Volunteers showing the waste collected within the mangrove plot.

Figures 7, 8 and 9. Volunteers segregating the waste collected.

Figures 10 and 11. Waste collected within the mangrove plot.

2.2. BEACHES TRANSECTS

In order to obtain data on the quantity and types of waste found at Santos beaches, a transect with a width and length of 10 m was established, from the end of the sidewalk to the seawater border, totaling seven transects (Figure 12). Their delimitations began at 03:00 am and were made with the assistance of a GPS, a 50-meter track, stakes and marking tape. The geographic coordinates of each transect was defined by drafting a letter representing one of 5 pre-determined areas on each beach and the exact locations of the transects were determined by the absence of obstacles such as public leisure equipment and lighting poles.

On the 21st of January, 2019, (full moon) the winds followed the predominant pattern in the region, which is south-southeast (SSE), with intensity varying between 6 and 7 m/s during dawn, changing to northwest (NW) around 06:00am, and returning around 09:00am to south-southeast (SSE) with intensity between 3.5 and 4 m/s. The tides were 2.0 m - 4:27; 0.2 m - 10:29; 1.8 m - 15:51. The precipitation accumulated in the period of 56 hours prior to the waste collection was 18 mm and therefore, the floodgates of the canals were not opened, and there were no solid waste coming from drainage canals to the beaches. Wave height varied between 1 and 1.5 m near the coast (Figure 13). The high amplitude of tides added to the south-southeast winds and the strength of the waves resulted in a large contribution of solid waste in the intertidal zone of the beaches. The samples were collected under tidal influence during the tidal ebb period (ALKALAY et al., 2007), starting at 07:00 am in Ponta da Praia and ending at 11:00 am on José Menino beach.

In each transect, solid wastes (> 2.5 cm - including cigarette butts) were collected manually at the surface and at the first layer of the sand (<5 cm). Ten waste collectors used scythes, shovels and garbage bags to collect the material. All waste collected, including natural organic matter composed of leaves, propagules and mangrove branches were deposited by the sea and discarded by beach visitors since the last cleaning. The bags received an identification (name of the beach) and were sent to EcoFaxina Institute headquarters, where the wastes were washed in sand sieves (3 mm), separated from the organic matter and sand, and then dried, qualified and quantified.

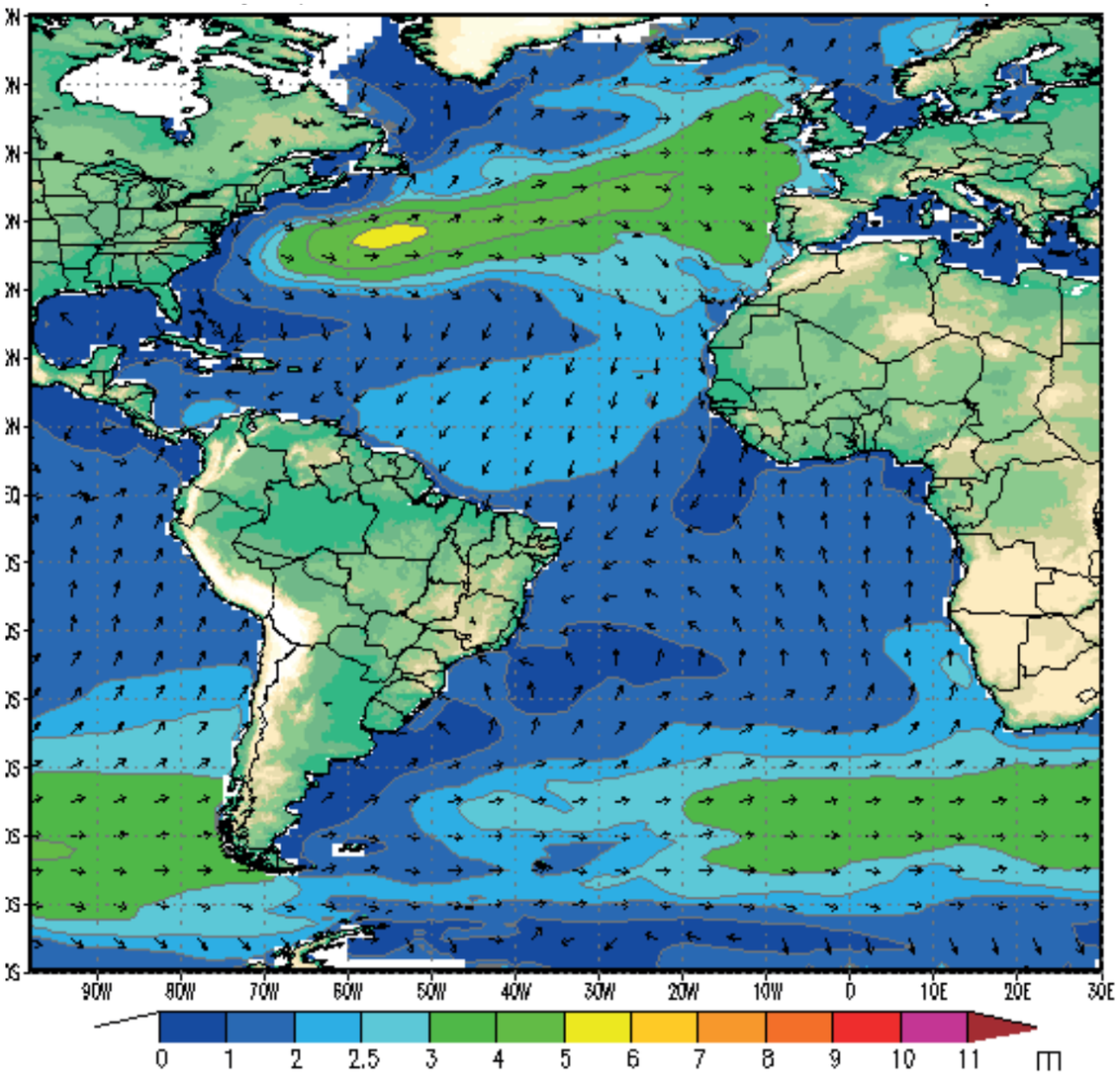


Figure 13. Significant height (m) and direction of the waves on 01/21/2019. Source: INPE/CEPETEC/MCT/WWATCH.

Figure 12. Map with the location of the Santos beaches transects. From left to right: Beach 1- José Menino; Beach 2- Pompéia; Beach 3- Gonzaga; Beach 4- Boqueirão; Beach 5- Embaré; Beach 6- Aparecida; and Beach 7- Ponta da Praia.

Figure 14. Transect set up at Ponta da Praia beach at around 4 o'clock during high tide.

Figure 15. Cleaning tractor passing through the shallow water, outside the transects, so as not to interfere with the samples.

Figure 16. Waste collectors working within the Pompéia beach transect.

JOSÉ MENINO BEACH

2.2.1. TRANSECT 1

Figure 17. Map with the location of the José Menino beach transect.

OBTAINED DATA

COORDINATES: 23°58’9.75”S - 46°20’52.66”O

BEACH AREA: 119,000 m²

TRANSECT AREA: 249 m x 10 m

TOTAL ITEMS FOUND WITHIN THE TRANSECT: 891

PLASTIC AND STYROFOAM: 436

OTHERS: 455

GENERAL CONCENTRATION (ITEM/M²): 0.36

PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.18

GENERAL INDEX: 7.16 – moderado

CCI: 3.50 – limpo

ESTIMATION OF BEACH[5] ITEMS (GENERAL): 42,840

ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM): 21,420

5 - Estimation of general and specific plastic and Styrofoam items were made throughout the beach, based on the concentration present in the transect. The calculations were:

i) Estimation of beach items (general) = General concentration (item/m2) x Beach area

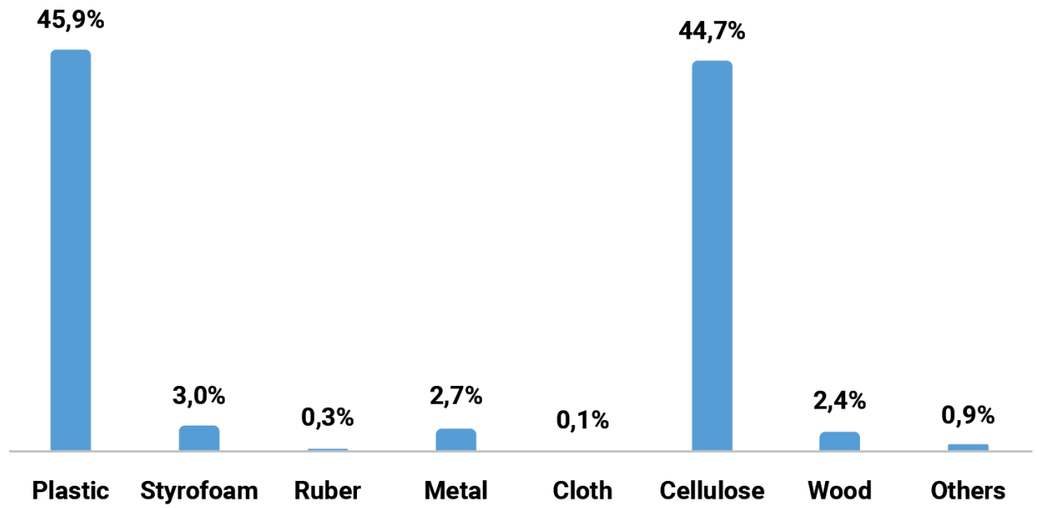
ii) Estimation of beach items (plastic and Styrofoam) = Concentration of plastic and Styrofoam (item/m2) x Beach area

Table 3. Data of the waste collected[6] within the José Menino beach transect.

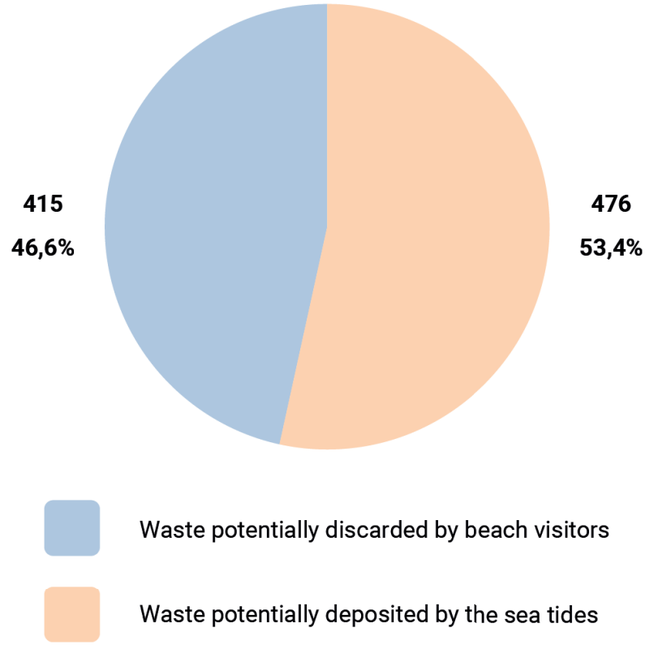
Material	Number	Type of waste	Items		%
Plastic	1	Fragment (plastic film)	142	409	45.9
	2	Fragment or piece (rigid plastic)	131		
	3	Lollipop stick	22		
	4	Food packaging (plastic film)	18		
	5	Cotton bud sticks	16		
	6	Straws	11		
	7	External sealing cap (plastic film)	10		
	8	PET bottle cap	9		
	9	Food packaging (rigid plastic)	9		
	10	Bottle cap ring	9		
	11	Disposable cup	8		
	12	Laboratory equipment (small plastic tubes)	6		
	13	Cutlery	4		
	14	PET bottle	3		
	15	Polyurethane foam	3		
	16	Toys	3		
	17	Plastic bag	2		
	18	Cork	2		
	19	Cigarette lighter	1		
Styrofoam	20	Fragments	25	27	3.0
	21	Food packaging	2		
Rubber	22	Party balloon	3	3	0.3
Metal	23	Beer sealing	20	24	2.7
	24	Bottle cap	2		
	25	Ring-pull tabs	2		
Cloth	26	Clothing	1	1	0.1
Cellulose	27	Cigarette butt (cellulose acetate)	384	398	44.7
	28	Receipts	6		
	29	Pack of cigarettes	4		
	30	Food packaging	2		
	31	Fragment of cardboard (box)	1		
	32	Sandpaper	1		
Wood	33	Barbecue sticks	12	21	2.4
	34	Construction timber	7		
	35	Ice-cream sticks	2		
Others	36	Internal sealing cap	4	8	0.9
	37	Paraffin (fragment used in surfboards)	2		
	38	Carton packaging for food and beverages	2		
TOTAL			891		100

6 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 1 are presented in percentage in Graph 2 and the Graph 3 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.



Graph 2. Percentage of waste collected at transect 1 on José Menino beach.



Graph 3. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

POMPÉIA BEACH

2.2.2. TRANSECTO 2

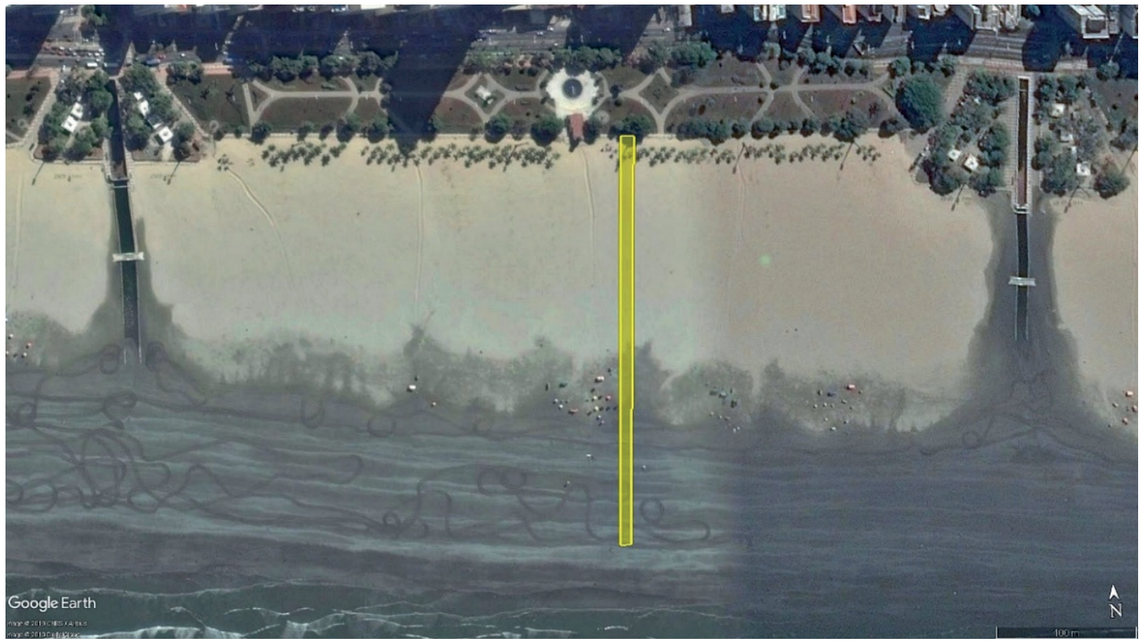


Figure 18. Map with the location of the Pompéia beach transect.

OBTAINED DATA

COORDINATES: 23°58’10.93”S - 46°20’31.84”O

BEACH AREA: 208.000 m²

TRANSECT AREA: 293 m x 10 m

TOTAL ITEMS FOUND WITHIN THE TRANSECT: 953

PLASTIC AND STYROFOAM: 511

OTHERS: 442

GENERAL CONCENTRATION (ITEM/M²): 0.33

PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.17

GENERAL INDEX: 6.51 – moderado

CCI: 3.49 – limpo

ESTIMATION OF BEACH ITEMS (GENERAL): 68,640

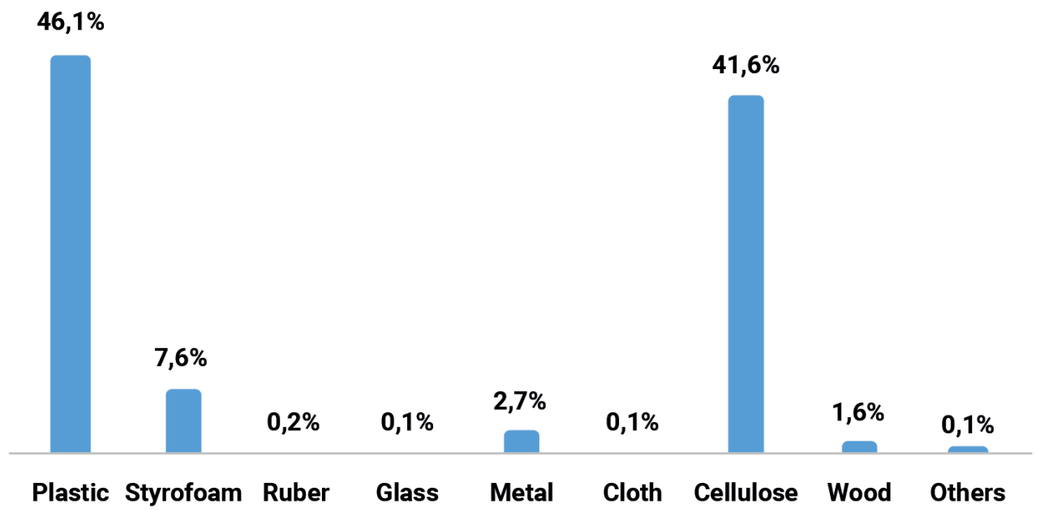
ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM): 35,360

Table 4. Data of the solid waste collected[5] within the Pompéia beach transect.

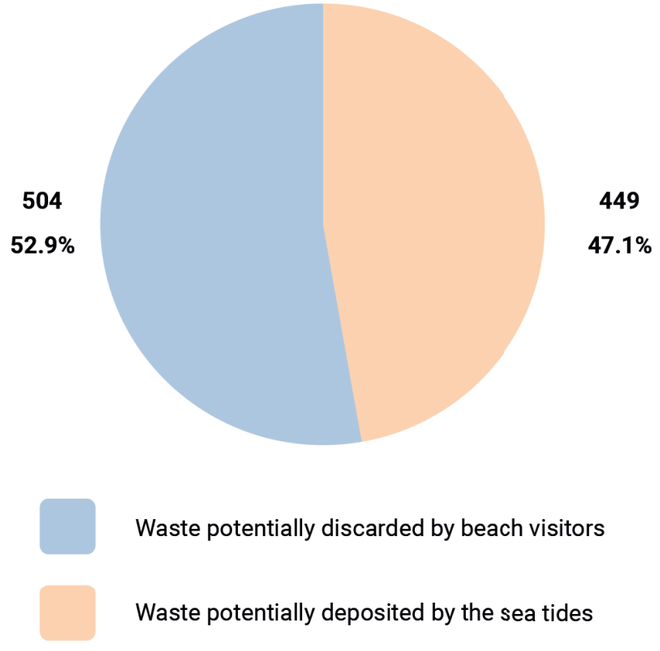
Material	Number	Type of waste	Items		%
Plastic	1	Fragment (plastic film)	162	439	46.1
	2	Fragment or piece (rigid plastic)	137		
	3	Lollipop stick	25		
	4	Food packaging (plastic film)	18		
	5	Cotton bud stick	16		
	6	PET bottle cap	14		
	7	Bottle cap rings	11		
	8	Straw	9		
	9	Disposable cup	7		
	10	Caps	6		
	11	Laboratory equipment (small plastic tubes)	6		
	12	Food packaging (rigid plastic)	5		
	13	Toys	4		
	14	PET bottles	4		
	15	Cleaning product packaging	3		
	16	Plastic bag	3		
	17	Cutlery	2		
	18	Hygiene product packaging	2		
	19	Disposable vaginal applicator	2		
	20	Drug packaging	2		
	21	Bowl or container	1		
Styrofoam	22	Fragments	71	72	7.6
	23	Food packaging	1		
Rubber	24	Flip-flops	1	2	0.2
	25	Balloons	1		
Glass	26	Drug packaging	1	1	0.1
Metal	27	Beer sealing	22	26	2.7
	28	Ring-pull tabs	4		
Cloth	29	Cleaning cloth	1	1	0.1
Cellulose	30	Cigarette butt (cellulose acetate)	396	396	41.6
Wood	31	Construction timber	8	15	1.6
	32	Ice-cream sticks	4		
	33	Barbecue stick	3		
Others	34	Diaper	1	1	0.1
TOTAL			953		100

5 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 2 are presented in percentage in Graph 4 and Graph 5 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.



Graph 4. Percentage of waste collected in transect 2 at Pompéia beach



Graph 5. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

GONZAGA BEACH

2.2.3. TRANSECT 3

Figure 19. Map with the location of the Gonzaga beach transect.

OBTAINED DATA

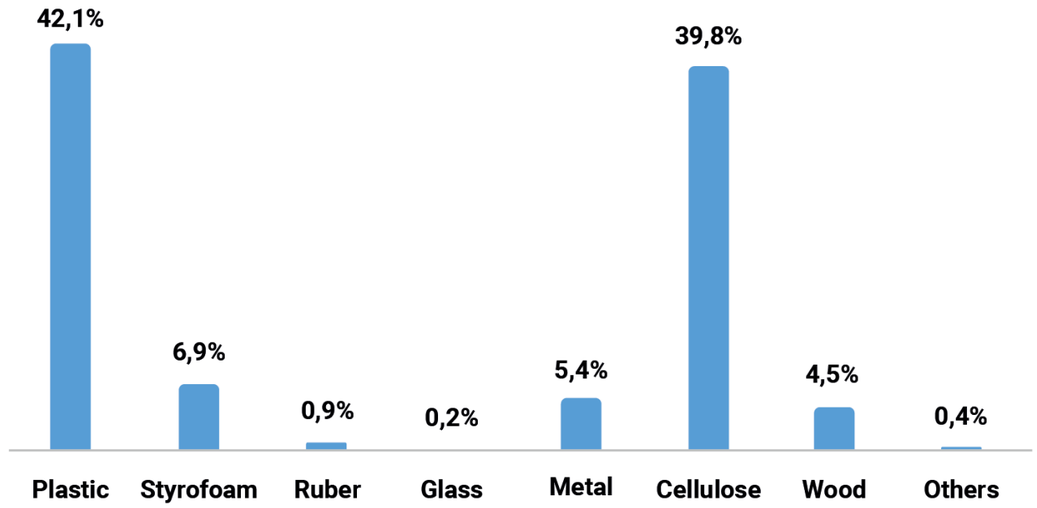
COORDINATES: 23°58’12.71”S - 46°20’13.69”O
BEACH AREA: 326.000 m²
TRANSECT AREA: 290 m x 10 m
TOTAL ITEMS FOUND WITHIN THE TRANSECT: 1,044
PLASTIC AND STYROFOAM: 511
OTHERS: 533
GENERAL CONCENTRATION (ITEM/M²): 0.36
PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.18
GENERAL INDEX: 7.20 – moderado
CCI: 3.52 – limpo
ESTIMATION OF BEACH ITEMS (GENERAL): 117,360
ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM): 58,680

Tabela 5. Data of the solid waste collectedt[6] within the Gonzaga beach transect

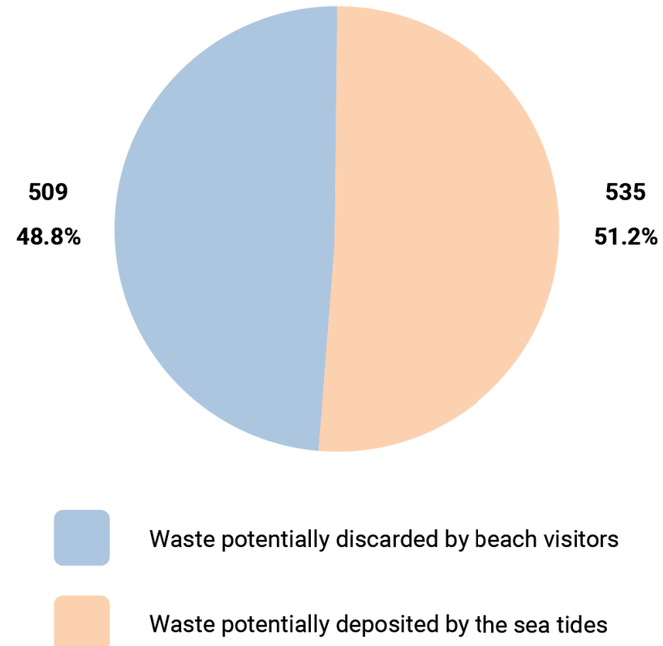
Material	Number	Type of waste	Items		%
Plástico	1	Fragment or piece (rigid plastic)	143	439	42.1
	2	Fragment (plastic film)	138		
	3	PET bottle caps	17		
	4	Lollipop stick	16		
	5	Bottle cap rings	16		
	6	Caps	12		
	7	Cotton bud stick	12		
	8	Laboratory equipment (small plastic tubes)	10		
	9	Straws	10		
	10	Monofilament line	9		
	11	Cutlery	8		
	12	Tag pin	8		
	13	Disposable cups	7		
	14	Food packaging (plastic film)	6		
	15	External sealing caps (plastic film)	5		
	16	Food packaging (rigid plastic)	5		
	17	Corks	4		
	18	Plastic bags	4		
	19	Toys	3		
	20	Carton packaging for food and beverages cap rings	2		
	21	PET bottle	1		
	22	Decor items	1		
	23	Cosmetic packaging	1		
	24	Drug packaging	1		
Isopor	25	Fragments	68	72	6.9
	26	Food packaging	4		
Borracha	27	Balloons	5	9	0.9
	28	Fragments	3		
	29	Flip-flops	1		
Vidro	30	Cosmetic packaging	1	2	0.2
	31	Perfume packaging	1		
Metal	32	Beer sealing	49	56	5.4
	34	Bottle cap	6		
	35	Tie wire	1		
Celulose	36	Cigarette butt (cellulose acetate)	411	415	39.8
	37	Guest check	4		
Madeira	38	Construction timber	18	47	4.5
	39	Ice-cream sticks	10		
	40	Barbecue stick	7		
	41	Burn matches	5		
	42	Cotton candy sticks	4		
	43	Toothpick	2		
	44	Corks	1		
Outros	43	Paraffin (fragment used in surfboards)	3	4	0.4
	46	Syringes	1		
TOTAL			1,044		100

6 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 3 are presented in percentage in Graph 6 and the Graph 7 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.



Graph 6. Percentage of waste collected in transect 3 at Gonzaga beach.



Graph 7. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

BOQUEIRÃO BEACH

2.2.4 . TRANSECT 4

Figure 20. Map with the location of the Boqueirão beach transect.

OBTAINED DATA

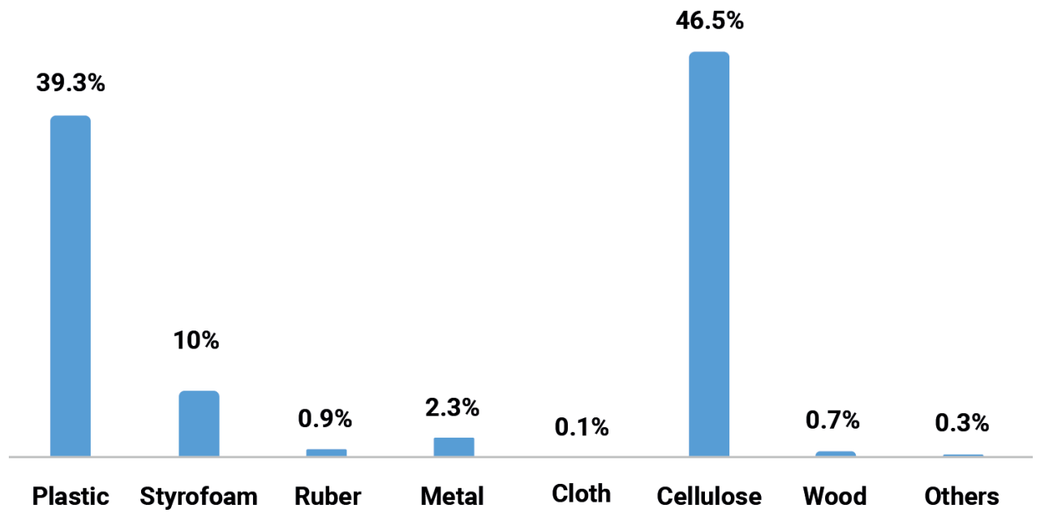
COORDINATES: 23°58’23.05”S - 46°19’32.43”O
BEACH AREA: 191,000 m²
TRANSECT AREA: 242 m x 10 m
TOTAL ITEMS FOUND WITHIN THE TRANSECT: 919
PLASTIC AND STYROFOAM: 453
OTHERS: 466
GENERAL CONCENTRATION (ITEM/M²): 0.38
PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.19
GENERAL INDEX: 7.60 – moderado
CCI: 3,74 – limpo
ESTIMATION OF BEACH ITEMS (GENERAL): 72, 580
ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM): 36,290

Table 6. Data of the solid waste collected[7] within the transect on Boqueirão beach.

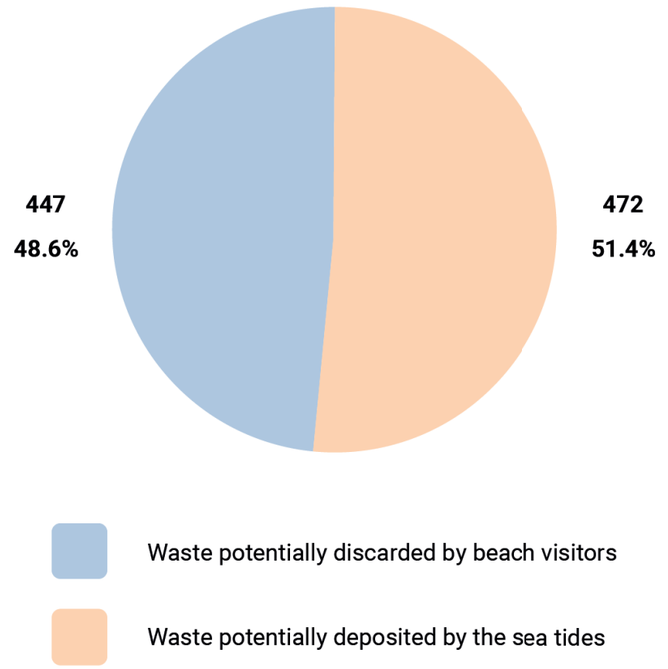
Material	Number	Type of waste	Items		%
Plastic	1	Fragment or piece (rigid plastic)	121	361	39,3
	2	Fragment (plastic film)	111		
	3	Monofilament line	17		
	4	Lollipop sticks	16		
	5	Cotton bud sticks	13		
	6	Food packaging (plastic film)	12		
	7	PET bottle caps	10		
	8	Bottle cap rings	9		
	9	Straws	9		
	10	Caps	8		
	11	External sealing caps (plastic film)	8		
	12	Laboratory equipment (small plastic tubes)	5		
	13	Cutlery	4		
	14	Food packaging (rigid plastic)	4		
	15	Polyurethane Foam (fragment)	3		
	16	Plastic bags	2		
	17	Disposable cups	2		
	18	Toys	2		
	19	Sausage tag	2		
	20	PET bottle	2		
	21	Cigarette lighters	1		
Styrofoam	22	Fragments	92	92	10,0
Rubber	23	Baloons	6	8	0,9
	24	Condom	1		
	25	Bottle nipple	1		
Metal	26	Beer sealing	12	21	2,3
	27	Ring-pull tabs	7		
	28	Bottle cap	2		
Cloth	29	Clothing	1	1	0,1
Cellulose	30	Cigarette butt (cellulose acetate)	427	427	46,5
Wood	31	Construction timber	4	6	0,7
	32	Ice-cream sticks	1		
	33	Corks	1		
Others	34	Bandage	2	3	0,3
	35	Pacifier	1		
TOTAL			PACIFIER		100

7 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 1 are presented in percentage in Graph 8 and the Graph 9 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.



Graph 8. Percentage of waste collected in transect 4 on Boqueirão beach.



Graph 9. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

EMBARÉ BEACH

2.2.5. TRANSECT 5

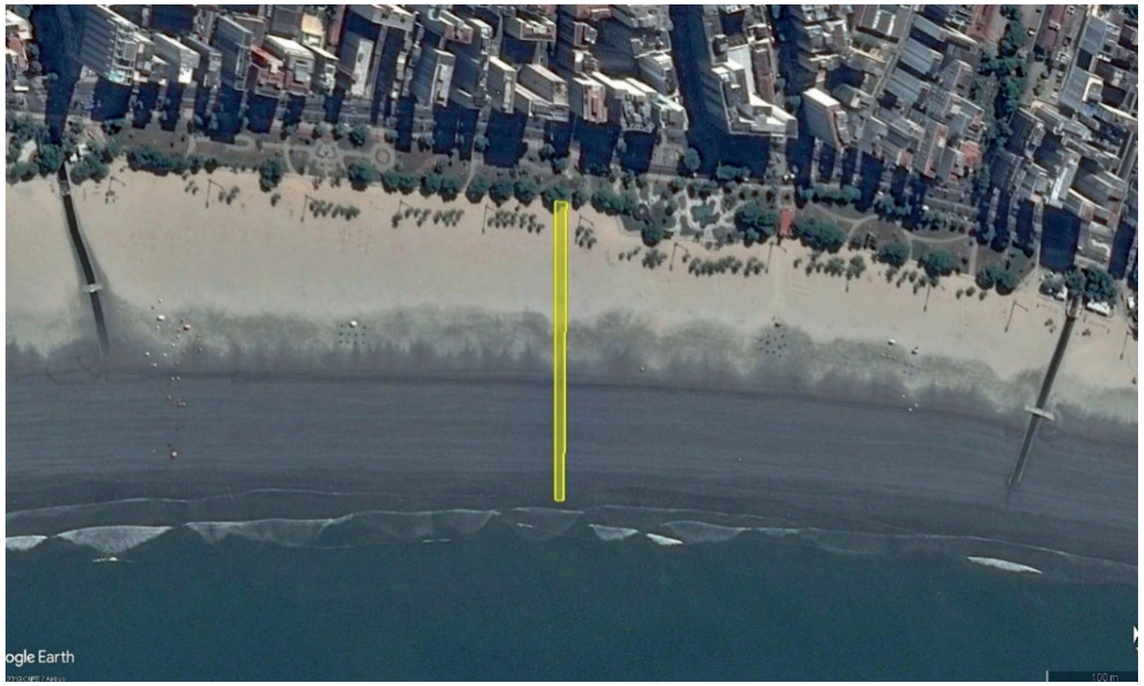


Figure 21. Map with the location of the Embaré beach transect.

OBTAINED DATA

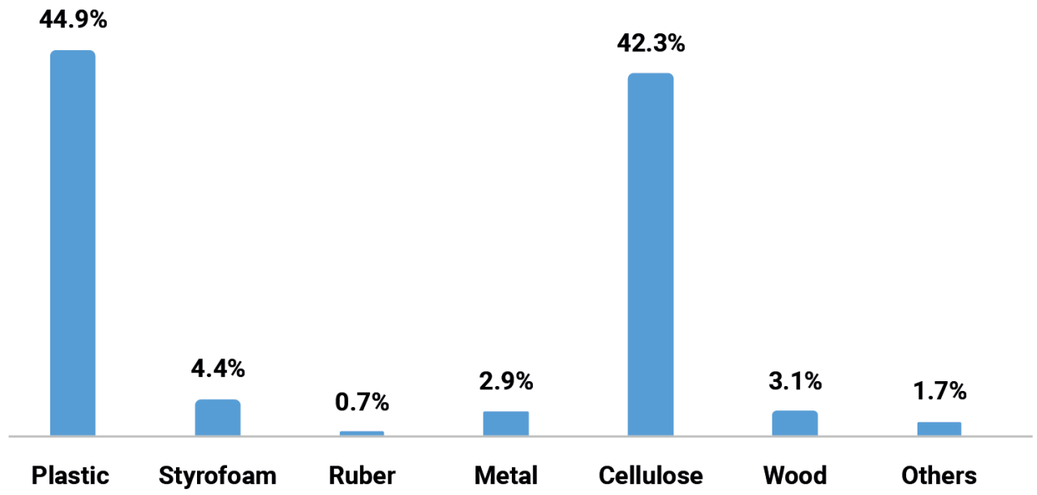
COORDINATES: 23°58’36.78”S - 46°19’6.47”O
BEACH AREA: 118.000 m²
TRANSECT AREA: 149 M X 10 M
TOTAL ITEMS FOUND WITHIN THE TRANSECT: 1,162
PLASTIC AND STYROFOAM: 573
OTHERS: 589
GENERAL CONCENTRATION (ITEM/M²): 0.78
PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.38
GENERAL INDEX: 15.60 - sujo
CCI: 7.69 – moderado
ESTIMATION OF BEACH ITEMS (GENERAL): 92,040
ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM): 44,840

Table 7. Data of the solid waste collected[8] within the Embaré beach transect.

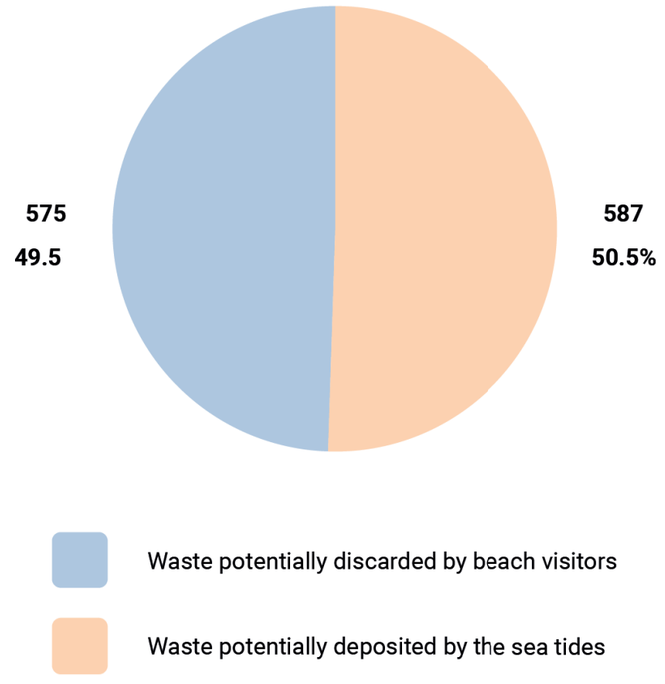
Material	Number	Tipo de resíduo	Items		%
Plástico	1	Fragment (plastic film)	191	522	44.9
	2	Fragment or piece (rigid plastic)	174		
	3	Cotton bud stick	19		
	4	Monofilament line	16		
	5	Laboratory equipment (small plastic tubes)	15		
	6	Lollipop stick	15		
	7	PET bottle caps	11		
	8	Tag pin	11		
	9	Food packaging (plastic film)	9		
	10	Caps	9		
	11	Straws	8		
	12	Food packaging (rigid plastic)	7		
	13	Cutlery	6		
	14	Bottle cap rings	6		
	15	Polyurethane foam	6		
	16	External sealing caps (plastic film)	5		
	17	Screw bushing	4		
	18	Plastic bags	4		
	19	Decor items	3		
	20	Cigarette lighters	2		
	21	Toys	1		
Isopor	22	Fragments	51	51	4.4
Borracha	23	Balloons	8	8	0.7
Metal	24	Beer sealing	29	34	2.9
	26	Bottle cap	3		
	27	Ring-pull tabs	2		
Celulose	28	Cigarette butt (cellulose acetate)	491	491	42.3
Madeira	29	Construction timber	11	36	3.1
	30	Toothpick	8		
	31	Barbecue stick	6		
	32	Matches	6		
	33	Ice-cream sticks	5		
Outros	34	Paraffin (fragment used in surfboards)	11	20	1.7
	35	Internal sealing caps	7		
	36	Hair elastic	1		
	37	Broom	1		
TOTAL			1,162		100

8 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 5 are presented in percentage in Graph 10 and the Graph 11 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.



Graph 10. Percentage of waste collected in transect 5 at Embaré beach.



Graph 11. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

APARECIDA BEACH

2.2.6 . TRANSECT 6

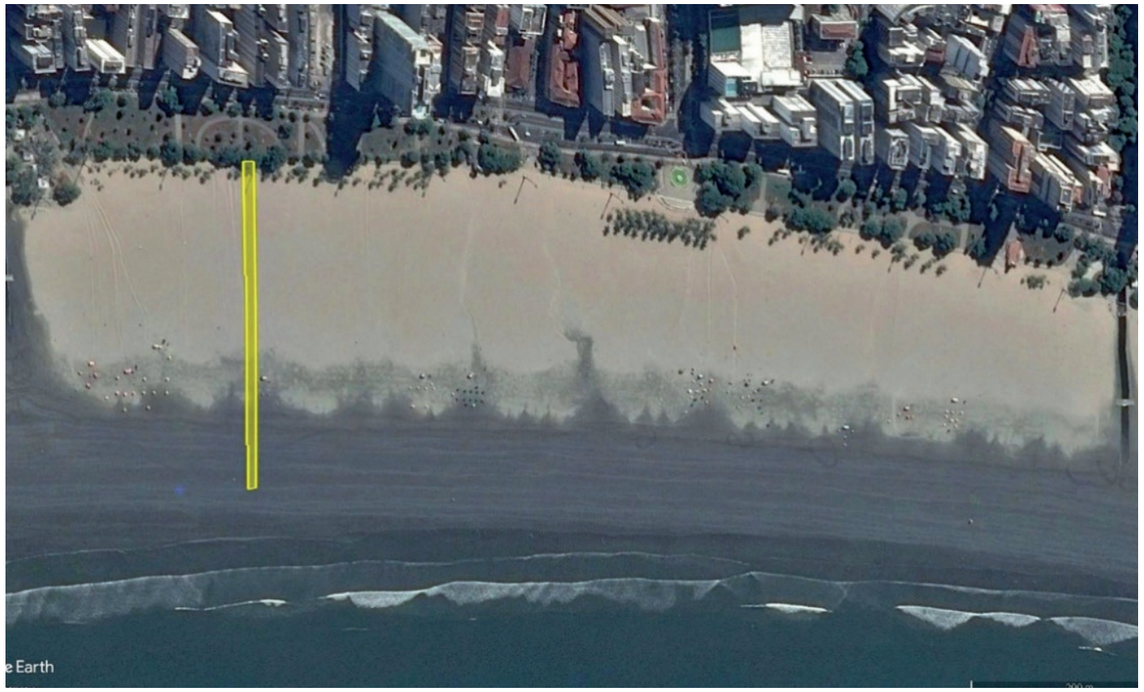


Figure 22. Map with the location of the Aparecida beach transect.

OBTAINED DATA

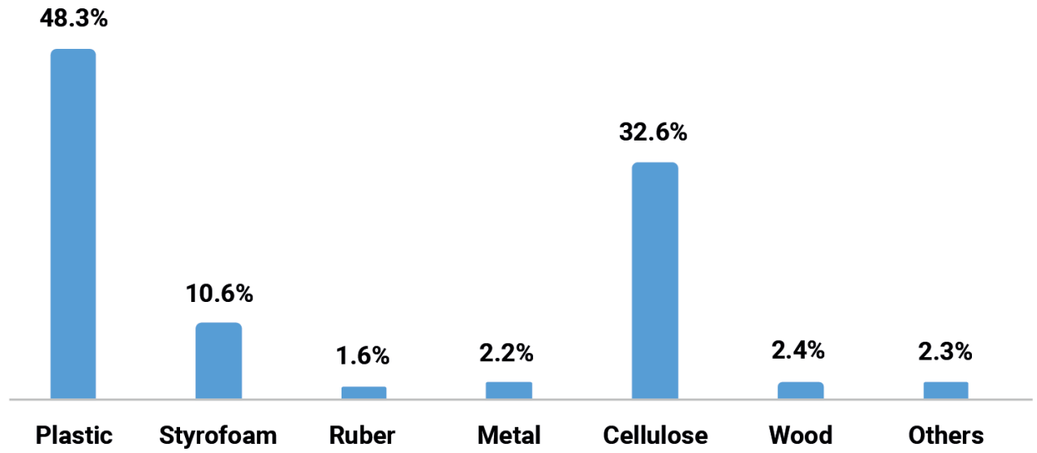
COORDINATES: 23°58’53.52”S - 46°18’45.98”O
BEACH AREA: 120,077 m²
TRANSECT AREA: 118 m x 10 m
TOTAL ITEMS FOUND WITHIN THE TRANSECT: 1,125
PLASTIC AND STYROFOAM: 662
OTHERS: 463
GENERAL CONCENTRATION (ITEM/M²): 0.95
PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.56
GENERAL INDEX: 19.07 - sujo
CCI: 11.22 – sujo
ESTIMATION OF BEACH ITEMS (GENERAL): 114,073
ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM): 67,243

Tabela 8. Data of the solid waste collected[9] within the Aparecida beach transect

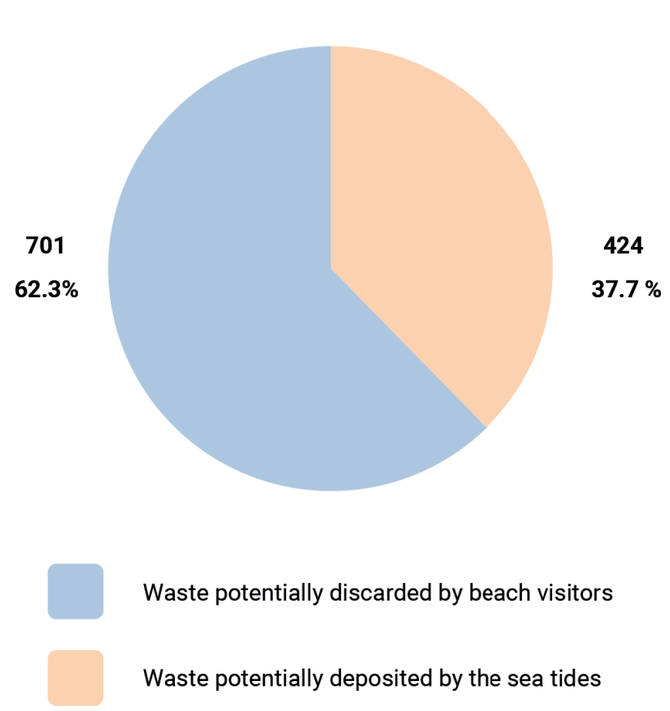
Material	Número	Tipo de resíduo	Itens		%
Plástico	1	Fragment or piece (rigid plastic)	183	543	48.3
	2	Fragment (plastic film)	133		
	3	Cotton bud sticks	31		
	4	Monofilament line	27		
	5	Lollipop sticks	26		
	6	Laboratory equipment (small plastic tubes)	25		
	7	PET bottle caps	19		
	8	Tag pin	17		
	9	Caps	14		
	10	Bottle cap rings	11		
	11	Polyurethane Foam	10		
	12	Food packaging (rigid plastic)	9		
	13	Food packaging (plastic film)	6		
	14	Straws	6		
	15	Decor items	6		
	16	Plastic bags	3		
	17	Cutlery	3		
	18	Toys	3		
	19	External sealing caps (plastic film)	3		
	20	Spray nozzle	3		
	21	Pen refill	2		
	22	Carton packaging for food and beverages cap rings	1		
	23	Toothbrush	1		
	24	Hairclip	1		
Isopor	25	Fragments	119	119	10.6
Borracha	26	Balloons	16	18	1.6
	27	Flip-flops	1		
	28	Condom	1		
Metal	29	Beer sealing	18	25	2.2
	30	Electric wire	6		
	31	Cosmetic packaging	1		
Celulose	32	Cigarette butt (cellulose acetate)	367	367	32.6
Madeira	33	Construction timber	17	27	2.4
	34	Barbecue stick	5		
	35	Ice-cream sticks	3		
	36	Corks	2		
Outros	37	Paraffin (fragment used in surfboards)	17	26	2.3
	38	Electric wire (fragments)	6		
	39	Footwear (sneakers)	1		
	40	Remote Control	1		
	41	Candle (paraffin)	1		
TOTAL			1,125		100

9 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 6 are presented in percentage in Graph 12 and the Graph 13 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.



Graph 12. Percentage of waste collected in transect 6 at Aparecida beach



Graph 13. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

BEACH PONTA DA PRAIA

2.2.7 . TRANSECT 7

Figure 23. Map with the location of the Ponta da Praia beach transect.

DADOS OBTIDOS

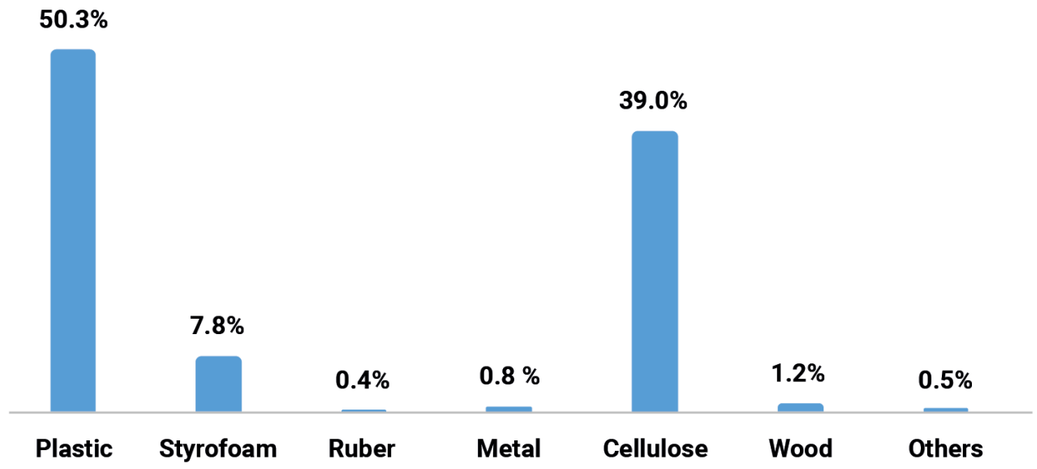
COORDINATES: 23°59’5.17”S - 46°18’34.54”O
BEACH AREA: 35.119 m²
TRANSECT AREA: 131 m x 10 m
TOTAL ITEMS FOUND WITHIN THE TRANSECT: 925
PLASTIC AND STYROFOAM: 537
OTHERS: 388
GENERAL CONCENTRATION (ITEM/M²): 0.71
PLASTIC AND STYROFOAM CONCENTRATION (ITEM/M²): 0.41
GENERAL INDEX: 14.12 - sujo
CCI: 8,20 – moderado
ESTIMATION OF BEACH ITEMS (GENERAL): 24,935
ESTIMATION OF BEACH ITEMS (PLASTIC AND STYROFOAM) : 14,399

Tabela 9. Data of the solid waste collected[10] within the Ponta da Praia beach transect.

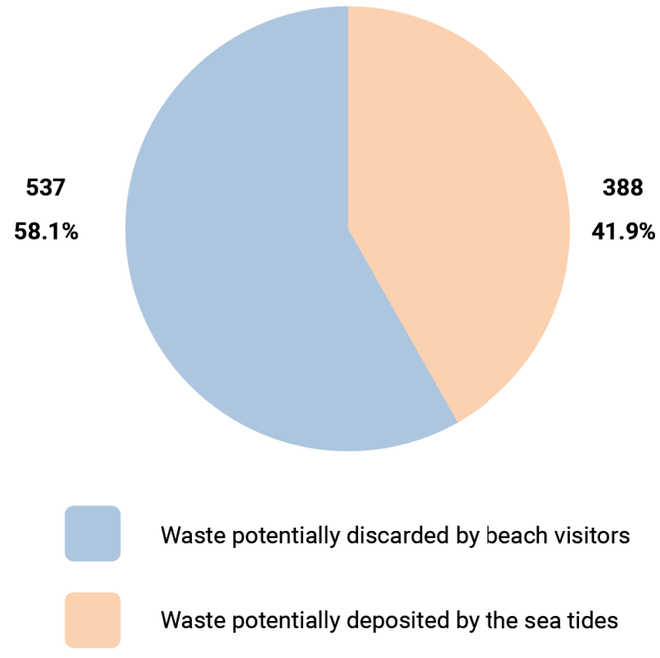
Material	Número	Tipo de resíduo	Itens		%
Plástico	1	Fragment or piece (rigid plastic)	184	465	50.3
	2	Fragment (plastic film)	143		
	3	Lollipop sticks	18		
	4	Monofilament line	16		
	5	Cotton bud sticks	15		
	6	Straws	11		
	7	Tag pin	11		
	8	Caps	9		
	9	PET bottle caps	9		
	10	Food packaging (plastic film)	9		
	11	Laboratory equipment (small plastic tubes)	8		
	12	Bottle cap rings	7		
	13	Plastic bags	4		
	14	Food packaging (rigid plastic)	4		
	15	Hygiene products packaging	3		
	16	Cutlery	3		
	17	Toys	3		
	18	Cigarette lighters	2		
	19	EVA (fragments)	2		
	20	Cosmetic packaging	2		
	21	Pen	1		
	22	Cleaning products packaging	1		
Isopor	23	Fragments	69	72	7.8
	24	Food packaging	3		
Borracha	25	Balloons	3	4	0.4
	26	Footwear soles	1		
Metal	27	Beer sealing	4	7	0.8
	28	Bottle cap	3		
Celulose	29	Bottle cap	361	361	39
Madeira	30	Cigarette butt (cellulose acetate)	8	11	1,2
	31	Construction timber	3		
Outros	32	Ice-cream sticks	3	5	0,5
	33	Candle (paraffin)	2		
TOTAL			925		100

10 - Waste potentially discarded by beach visitors Waste potentially deposited by the sea tides.

The material found within the transect 7 are presented in percentage in Graph 14 and the Graph 15 compares both wastes potentially discarded by beach visitors and waste potentially deposited by the sea tides.

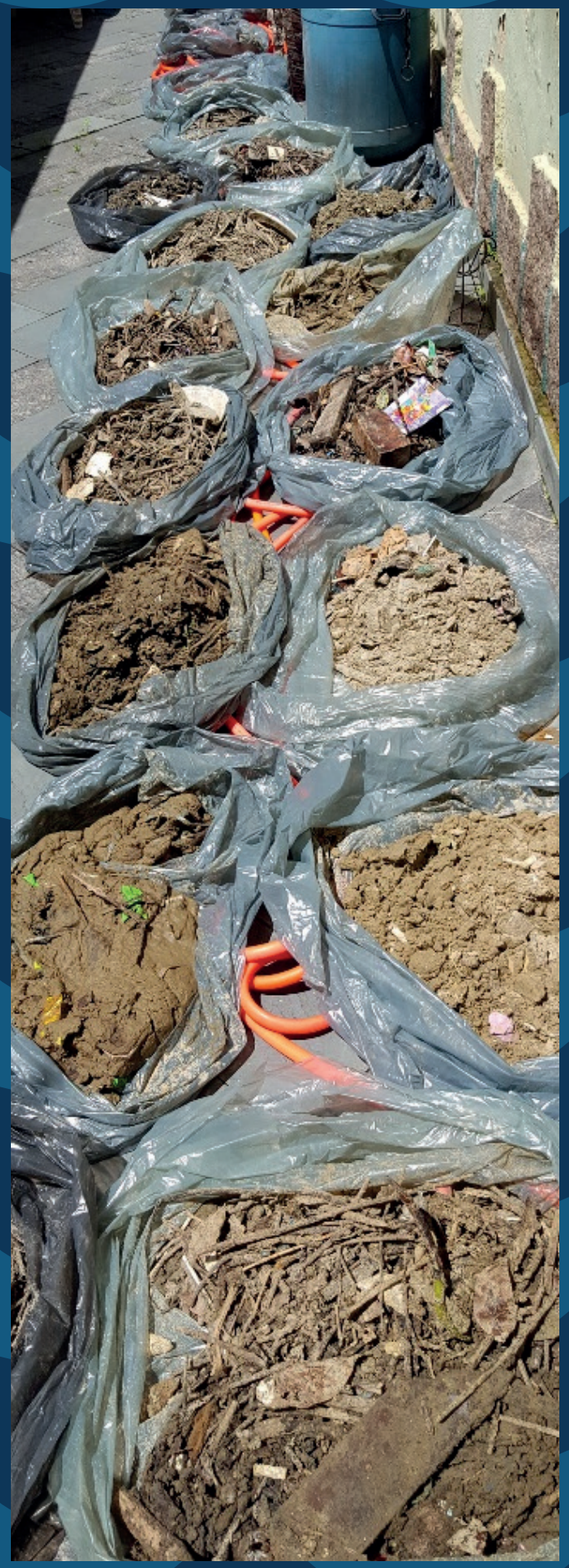


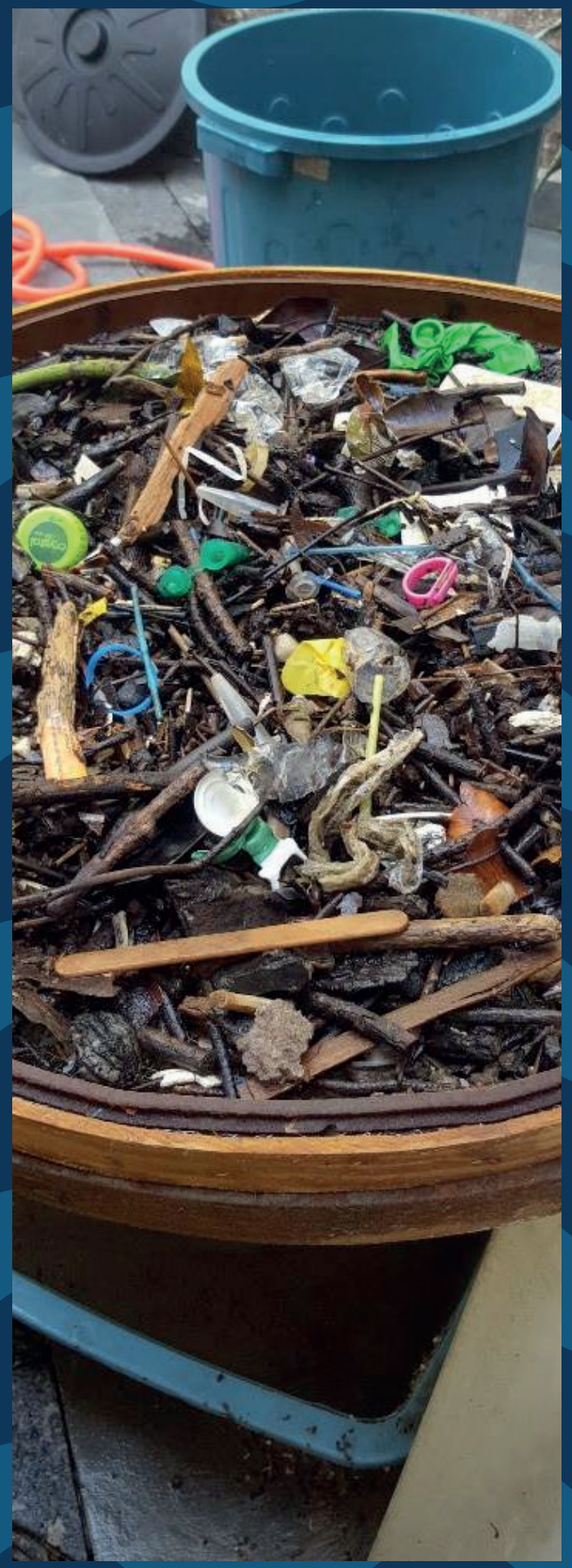
Graph 14. Percentage of waste collected in transect 7 at Ponta da Praia beach.



Graph 15. Comparison between the waste potentially discarded by beach visitors and waste potentially deposited by the sea tides.

2.2.8. PHOTOGRAFIC REPORT OF THE WASTE FOUND AT THE BEACHES





Figures 24, 25 and 26. Solid waste collected by waste collectors during cleaning and analysis at EcoFaxina Institute headquarters.

Figure 27. Rigid plastic items collected on beach transects.

Figure 28. Rigid plastic fragments collected on beach transects.

Figure 29. Laboratory equipment (small plastic tubes) collected on beach transects.

Figure 30. Lollipop sticks collected on beach transects.

Figure 31. Pin tags collected on beach transects.

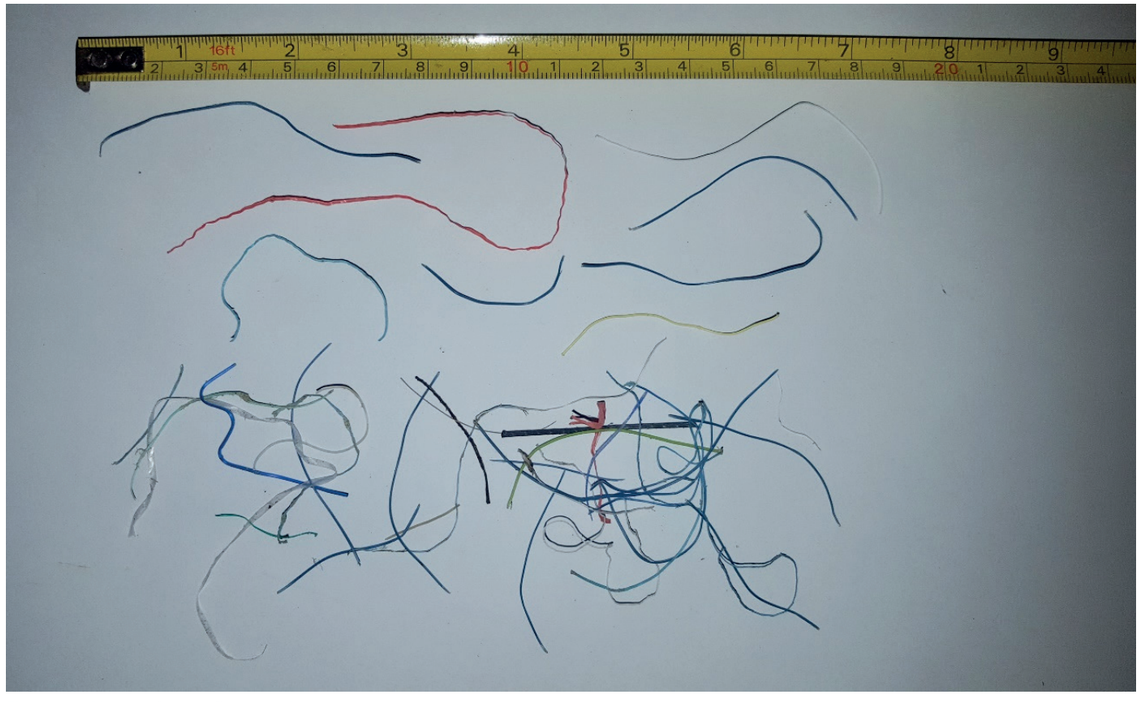


Figure 32. Pieces of monofilament lines collected on beach transects.

Figure 33. Styrofoam fragments collected on beach transects

Figure 34. Styrofoam fragments (food packaging) collected on beach transects.

Figure 35. EVA fragments collected on beach transects.

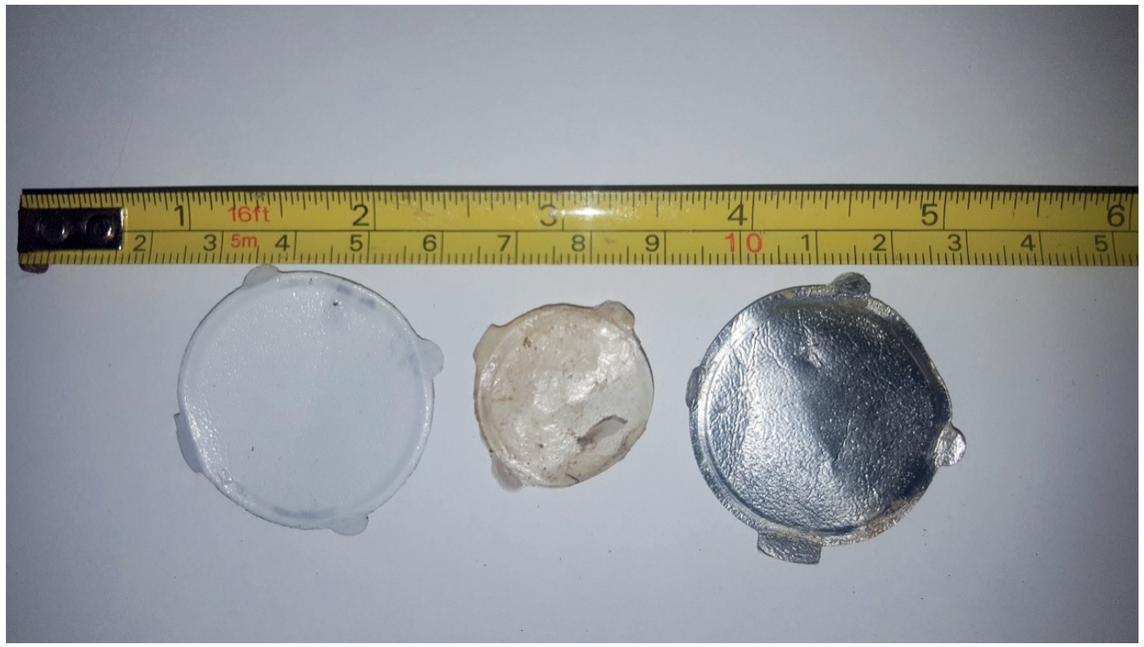


Figure 36. Internal sealing cap collected on beach transects.

Figure 37. Balloons fragments collected on beach transects.

Figure 38. Metallic wastes collected on beach transects.

3. CONCLUSION AND CONSIDERATIONS FOR THE NEXT STEPS

Due to the morpho dynamics of the beaches, the influence of the tide differs from one to the other (figure 12). Thereby, during the period of syzygy it is possible to observe that on the beaches of Embaré, Aparecida and Ponta da Praia, closer to the canal of the Port of Santos, the sea water covers from sand strip to sidewalk in several points. The beaches of Boqueirão, Gonzaga, Pompéia and José Menino have a much larger sand strip, which makes it possible to identify a clear division between the waste deposited by the sea (wet plot) and the waste generated by beach visitors (dry plot).

Figure 12. Map with the location of the Santos beaches transects. From left to right: Beach 1- José Menino; Beach 2- Pompéia; Beach 3- Gonzaga; Beach 4- Boqueirão; Beach 5- Embaré; Beach 6- Aparecida; and Beach 7- Ponta da Praia.

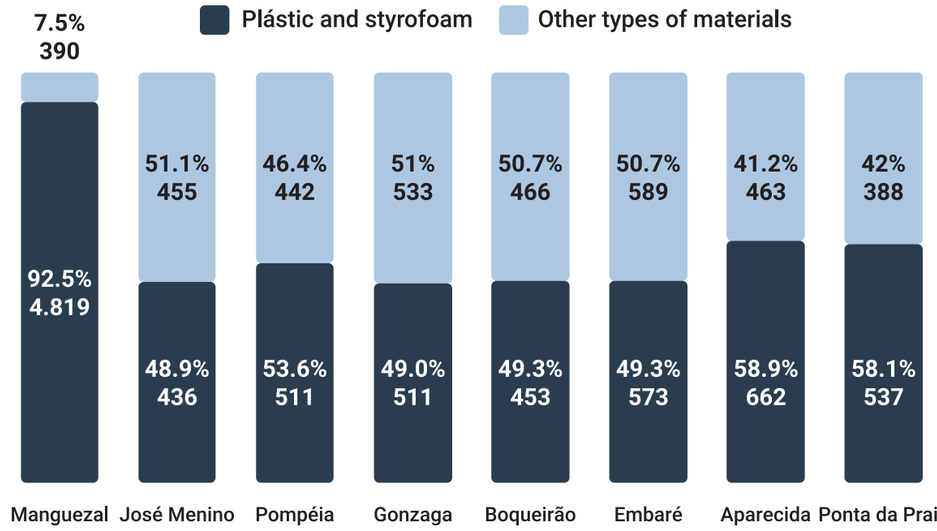
Therewith, the beaches of Embaré, Aparecida and Ponta da Praia accumulate more solid waste deposited by the tide, whereby waste of domestic origin (stilt houses communities) such as personal hygiene products, clothing, footwear and electrical and electronic products are mixed with the waste discarded by beach visitors, such as cigarette butts and others generated by the commercialization and consumption of food and beverages in the sand strip. On the beaches of Boqueirão, Gonzaga, Pompéia and José Menino, a gradient division is observed along the transects, composed of intertidal zone waste and dry sand strip waste, collected separately, allowing a better characterization of the relative waste polluting sources. Table 15 shows the comparison between the beaches in terms of the CCI and General Indexes.

Table 10. Comparison between CCI and General Indexes for all the seven analyzed beaches of Santos.

Transect	José Menino	Pompéia	Gonzaga	Boqueirão	Embaré	Aparecida	Ponta da Praia
Length	249	293	290	242	149	118	131
Items	891	953	1.044	919	1.162	1.125	925
Plastic and Styrofoam	436	511	511	453	573	662	537
Others	455	442	533	466	589	463	388
General Index	7,16 Moderate	6,51 Moderate	7,20 Moderate	7,60 Moderate	15,60 Dirty	19,07 Dirty	14,12 Dirty
CCI	3,50 Clean	3,49 Clean	3,52 Clean	3,74 Clean	7,69 Moderate	11,22 Dirty	8,20 Moderate

As to the identification of the waste deposited by the sea in the intertidal zone, its comparison with the materials collected in the mangrove allows to observe the presence of the same types of waste in the two ecosystems. In addition, fouling and staining items were identified on the collected samples, a clear characteristic evidencing that the waste had been in the mangrove ecosystem for an extended period.

The main materials found in both ecosystems were plastic items, which represent 62% of all wastes collected in the mangrove and 45% of all wastes collected at the beaches, such as plastic film, laboratory equipment (small plastic tubes) and lollipop sticks. Additionally, considering that the styrofoam contains plastic in its composition, the plastic becomes even more representative. The number of plastic items collected loses only to the cigarette butt, which was the most collected material. Graph 16 shows the comparison between plastic and styrofoam waste and other materials found in the mangrove and beach transects.



Graph 16. Comparison between polymers and other materials collected within the beach and mangrove transects.

As to the identification of the waste deposited by the sea in the intertidal zone, its comparison with the materials collected in the mangrove allows to observe the presence of the same types of waste in the two ecosystems. In addition, fouling and staining items were identified on the collected samples, a clear characteristic evidencing that the waste had been in the mangrove ecosystem for an extended period.

The main materials found in both ecosystems were plastic items, which represent 62% of all wastes collected in the mangrove and 45% of all wastes collected at the beaches, such as plastic film, laboratory equipment (small plastic tubes) and lollipop sticks. Additionally, considering that the styrofoam contains plastic in its composition, the plastic becomes even more representative. The number of plastic items collected loses only to the cigarette butt, which was the most collected material. Graph 16 shows the comparison between plastic and styrofoam waste and other materials found in the mangrove and beach transects.

4. REFERENCES

ALKALAY, R., PASTERNAK, G. & ZASK, A. 2007. Clean-coast index- A new approach for beach cleanliness assessment. Ocean and Coastal Management 50:352-362.

LIPPIATT, S., OPFER, S., & ARTHUR, C. 2013. Marine Debris Monitoring and Assessment. NOAA Technical Memorandum NOS-OR&R-46.

COMBATE ÀS FONTES DE
POLUIÇÃO MARINHA POR
RESÍDUOS SÓLIDOS

abrelpe

NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY