

# Cariocas Beaches: Know to Conserve: Prai Amar Project

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Abstract: The sandy beaches of Rio de Janeiro, known worldwide for their beauty, are intensely exploited natural resources. These ecosystems are very prone to environmental impacts, such as the accumulation of solid waste. The objective of the PraiAmar Project was to present the ecosystem of sandy beaches to students of the public education system of the city of Rio de Janeiro to promote environmental awareness, encourage the construction of critical thinking about consumption patterns, and change student perception of sandy beach ecosystems and the problem of the impact of solid waste. The present project was performed in three municipal public schools through five meetings with each target group. At the first meeting, students were asked to draw a beach. Then, the project sought to show that the beaches are not biological deserts and to identify the main anthropic impacts on this ecosystem. Experiments, debates, solid waste reuse workshops and field trips were carried out throughout the project. At the last meeting, the students drew a beach again. Thus, it was possible to verify changes in the environmental perception of the students between the two design periods. The drawn beaches were categorized as urbanized, conserved, preserved, impacted, generalized or reductionist. Natural elements and organisms observed during the outdoor class at the beach were more present in the drawings from the second period. In this period, drawings of conserved and preserved beaches were more common, as were the negative aspects of human presence. It was shown that student ecological knowledge about sandy beaches was enriched and that the environmental perceptions about beaches were positively altered. Thus, knowledge is a key piece for conservation.

Key words: environmental education, coastal environments, content analysis, solid wastes, environmental impacts

## 1. Introduction

Sandy beaches constitute dynamic systems defined by fluctuations in environmental conditions, such as the action of winds, tides and currents, which result in complex hydrodynamic and depositional processes [1]. The constant variation of these conditions in association with anthropic factors influences the richness, diversity and mobility of the macrobenthic species of sandy beaches. These ecosystems have high socioeconomic value and are intrinsically related to human culture, being more frequented by humans than any other type of coastal environment [2] and presenting as intensely exploited natural resources for recreation and tourism.

However, ecological knowledge about sandy beaches is still absent, which is reflected the relationship of the population with these environments, which recognize the beaches as biological deserts, being able to cause a distancing of this ecosystem and causing an increase in environmental degradation once this conception constructs incorrect concepts about beaches [4]. Rio de Janeiro cityhas an extensive coastline, with intensive use of the beaches throughout the year, in addition to owning some of the most frequented beaches in Brazil [2], making these environments quite prone to various aspects of environmental degradation, such as the accumulation of solid waste [3].

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The accumulation of solid waste causes several impacts, such as the pollution of organisms and the consequent dispersion thereof, which may lead to bioinvasion of species and impacts on local ecological diversity [5, 6], changes in water permeability and heat transfer between sand grains, affecting benthic communities [7]. Visual pollution diminishes the aesthetic value of beaches, impacting the city economically. Public health is also an issue that deserves to be highlighted since the accumulation of solid waste can lead to the emergence of diseases propagated by vectors and rodents [8]. Some waste can fragment into smaller particles, such as microplastics, and enter the food chain through ingestion by marine fauna [9], in addition to being easily dispersed by marine currents [10].

The impacts caused by solid waste could be reduced with active participation of the population, since certain tasks are only concretized by the commitment of the individual [11]. Behavior change is encouraged by notions of respect for ecosystems, which can be important environmental awareness tools [12]. In this sense. environmental education, through the construction of a critical point of view regarding environmental degradation, is presented as an essential tool of reflection to awareness. Analysis of environmental perception during environmental education actions is able to guide and verify the efficiency of the action. Drawings can be used as a tool for the analysis of environmental perception based on the presence, absence and association of represented elements [13].

The objective of the PraiAmar Project is to present the ecosystem of sandy beaches to students of the public education Rio de Janeiro city to promote environmental awareness, encourage the construction of critical thinking about consumption patterns, changes in student perception of sandy beach ecosystems and the problem of the impact of solid waste.

## 2. Materials and Methods

Three municipal public schools were chosen for the project, with classes in the 6th and 7th grades of elementary school, in which the age of the students varies between 11 and 15 years. The classes were named by the letters A, B, C, D, E, F and G to avoid divulging the name of the schools, as required by municipal legislation.

The actions occurred between 2015 and 2016, with five meetings. At the first meeting, students were asked to draw a beach. After the drawings were collected, subjects were discussed about scientific work on sandy beaches. The theme "beach pollution" was addressed, and the problem of solid waste in the marine environment was discussed. The objective of this study was to deconstruct the concept of *garbage* and approach the idea of extending the useful life of solid waste.

In the second meeting, the issue of microorganisms, their ecological functions and their use as bioindicators of the environmental quality of beaches (thermotolerant coliforms) were discussed. An experiment was carried out with microorganisms and an approach to the conscious use of water, basic sanitation and the final disposal of effluents.

In the third meeting, we discussed patterns of consumption, habits, sustainability and recycling (based on the principle of the 3Rs — reduce, reuse and recycle). We presented the impacts of marine debris and performed a workshop for the reuse of domestic solid waste.

At the fourth meeting, the class took place on a sandy beach. Three fixed work teams were set up by the leaders, and each team was responsible for addressing study areas developed on sandy beaches: (1) benthic macrofauna, through observation of organisms present in the field (*Emerita brasiliensis, Atlantorchestoidea brasiliensis, Excirolana braziliensis* and *Donax hanleyanus*), (2) benthic meiofauna (*Copepoda* and *Nematoda*) and their use as bioindicators of environmental quality, and (3) rocky

shore, trophic webs and main impacts of solid waste on sandy beaches. The classes were also divided into three groups, and each group participated in the activities of each of the work teams.

Two beaches in Rio de Janeiro city were chosen for this activity: Praia de Fora, which is located in a military area with restricted access to authorized people and which has an abundant and diversified macrobenthic biota; and Praia Vermelha, which has no access restriction, is very crowded, and has substantial infrastructure and low richness and abundance of macrobenthic species. The execution of this project for the field activities was always in Praia de Fora; however, entry to this beach depends on prior authorization, and it was not always possible to reconcile the dates of the field lessons with the release of authorization. For classes B, C, D and E, the class was adapted for Praia Vermelha. Organisms of the benthic macrofauna were not observed in the field due to their no occurrence on this beach but were presented to students after the field class on the same day in research laboratories.

In the last class, the students were asked about solutions to the problem of solid waste pollution on the beaches. Then, they were asked to draw a beach again.

The content analysis was used for the interpretation and analysis of the drawings [14]. Items that are naturally found on beaches were considered natural elements, and items of human nature were considered anthropic elements.

It was possible to perceive patterns in the drawings that enabled the creation of categories in relation to the presence, absence or simultaneity of elements. The following categories were created: urbanized, conserved, preserved, impacted, generalized or reductionist, described in Frame 1.

Frame 1 Features and details of each category.

Category/details	Urbanized	Conserved	Preserved	Impacted	Generalized	Reductionist
Features	Infrastructure, buildings and people	Marine organisms; human elements	Marine organisms	Negative human aspects	Negative human aspects, marine organisms	Few elements; romantic expressions
Characterization	More human than natural elements. Negative impacts absent	More natural elements than humans. Negative impacts absent	Absence of human elements	Solid wastes, sewage, absence of marine species	Solid wastes, sewage	Sunset; only sea and sand

Quali-quantitative analyses were performed to detect differences and the changes in perception observed between the drawings of the first class and the last class through the established categories. *Student's t-test* was used for independent samples to compare the differences between the designs throughout the meetings. Statistically significant results were considered for values of p < 0.05. The variables of beach and class were also investigated.

## 3. Results and Discussion

In total, 182 students were directly sensitized by the action. Indirectly, the present project expands beyond the target population, since the participating students

#### play the role of multipliers.

### 3.1 Expected and Observed Results at Each Stage

At the first meeting, discussions about research activities in coastal areas and the presentation of the ecosystem of sandy beaches, their fauna and main variables were able to strengthen student interest in sandy beaches and the importance of scientific research. In the second meeting, in which we approached practical experiments with microorganisms, students were interested in scientific questions. During the practical lesson on the beach, it was also possible to perceive the positive results of this class, since the students brought up the question of sewage discharge at sea and inquired about marine pollution and bacterial growth as a consequence.

In the third meeting, the students were already more involved and willing to participate in the proposed debates. Recycling themes, sustainability and solid waste reuse workshops were well received. In the fourth meeting, the main objective of the field class was the construction of ecological knowledge of sandy beaches. In the last meeting, the answers to the questions proposed showed a good use of the project by the students. The students were very interested in talking about the proposed topics and sharing their new knowledge and observations about sandy beaches. The proposed solutions to environmental degradation involved political engagement, conscious voting, organizing the public, scientific knowledge, changes in consumption patterns and changes in habits.

## 3.2 Change in Environmental Perception — Analysis of Drawings

A total of 353 drawings were produced and analyzed, 177 in the first class and 176 in the last class. In total, 66 different elements were observed in the two design periods. Drawings of the different categories can be seen in Fig. 1.





The most frequent natural elements in the drawings were the sea, sun and sand, while the most frequent human elements were people, parasols and beach towels. Natural elements appeared more in the second drawings; however, the difference was not significant between the two periods (p > 0.05). On the other hand, the elements of human nature were more present in the first drawings, also without significant difference between the two periods (p > 0.05). The frequency of elements seen in the practical class (benthic organisms, algae, rocky shore and solid residues) was higher in the drawings of the second class, varying significantly from the first class (p < 0.05). Considering the drawings of the two classes, the combination of sea and sand was observed in 68% of the drawings. These two elements were the most common elements to occur simultaneously, followed by sea and sun, together in 47% of the drawings. Possibly, the association of sea and sand represents the two main aspects that come in mind when suggesting the theme of sandy beaches. They are the physical spaces that define the beaches [15], and the strong simultaneous representation indicates the physical notion of the authors of the drawings.

In both periods, the urbanized category was the second most frequent; however, there was a significant

reduction in this category between the two drawing periods (p < 0.05). The conserved category, present only once in the first period, was seen 22 times in the second period, and the preserved category was observed only in the last period, both varying significantly between the two periods (p < 0.05). The number of times that impacted beaches were represented also varied significantly between the two drawing times, and the same pattern was seen for generalized beaches (p < 0.05). Reductionist beaches decreased in frequency from the first to the second period; however, this difference was not significant (Fig. 1).

In general, between the first and last class, the drawings showed considerable changes in the represented elements. The most frequent items and the most representative changes are shown in Frame 2.

Frame 2 Most frequent items and main changes. P1 and P2: first and second production periods of the drawings, respectively.

Natural         Total         647         712           Sea         165         162           Sun         121         120           Sand         120         101           Field organisms         5         72           Rocky shore         2         15           Anthropic         Total         398         296           Umbrellas         78         46           People         68         57           beach towels         39         23           Chairs         27         16           Kiosks         20         6           Buildings         12         9           Boardwalk         11         13           Trash         10         34           Dumpster         5         9           Violence         1         0           Sewage         0         3           Researchers         0         4           Item         P1         P2           Anthropic         Umbrellas         78         46           People         68         57           Beach towels         39         23           Cha		Item	P1	P2
Sea         165         162           Sun         121         120           Sand         120         101           Field organisms         5         72           Rocky shore         2         15           Anthropic         Total         398         296           Umbrellas         78         46           People         68         57           beach towels         39         23           Chairs         27         16           Kiosks         20         6           Buildings         12         9           Boardwalk         11         13           Trash         10         34           Dumpster         5         9           Violence         1         0           Sewage         0         3           Researchers         0         4           Item         P1         P2           Anthropic         Umbrellas         78         46           People         68         57           Beach towels         39         23         6           Chairs         27         16         6	Natural	Total	647	712
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Sand         120         101           Field organisms         5         72           Rocky shore         2         15           Anthropic         Total         398         296           Umbrellas         78         46           People         68         57           beach towels         39         23           Chairs         27         16           Kiosks         20         6           Buildings         12         9           Boardwalk         11         13           Trash         10         34           Dumpster         5         9           Violence         1         0           Sewage         0         3           Researchers         0         4           Item         P1         P2           Anthropic         Umbrellas         78         46           People         68         57           Beach towels         39         23           Chairs         27         16           Kiosks         20         6           Swimmers         13         8           Surfers         1		Sun	121	120
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Balls         11         2           Boardwalk         11         13		Buildings	12	9
Boardwalk 11 13		Balls	11	2
		Boardwalk	11	13

	Boats	10	10
	Trash	10	34
	Salesmen	7	1
	Soccer	6	2
	Street	6	2
	Volleyhall	6	4
	Sand castle	5	6
	Showers	5	1
	Dumpster	5	9
	Tables	5	1
	Warning plates	5	8
-	Core	3	1
	Tubs		1
	Dialogue	2	1
	Salfia	2	0
	Sellie	2	0
	Ads	1	1
	Violence	1	0
	Bikes	1	0
	Caipirinna	1	0
	Bikers	1	0
	Helicopters	1	0
	Sunglasses	l	1
	Bus	l	1
	Parachute	1	0
	Fishermen	1	1
	Kite	1	2
	Swimming pool	1	0
	Submarine	1	0
	Airplane	0	1
	Money	0	1
	Sewage	0	3
	Researchers	0	4
	Total	398	296
	Item	P1	P2
Natural	Sea	165	162
	Sun	121	120
	Sand	120	101
	Clouds	71	65
	Fishes	35	55
	Birds	33	38
	Vegetation	21	13
	Coconut trees	20	14
	Sky	18	23
	Sugar loaf	13	13
	Mountain	6	3
	Island	5	4
	Field organisms	5	72
	Algae	2	4
	Shell	2	2
	Rocky shore	2	15
	Dolphin	2	1
	Moon	2	1
	Manta Ray	2	1
	Corcovado	1	1
	Turtle	1	4
	Total	647	712

Frame: Natural items represented in the drawings (a total of 21 items).

The reductionist category was the most observed in both periods, which may be for different reasons. Many

drawings with more abstract and romantic aspects, such as representations of the sunset, were placed in this category. In these drawings, the representation of concepts commented on during the lessons of the project was not clear, but the drawings may reflect a naturalistic view of the beaches as places of scenic beauty alone. They may also reflect anthropocentric visions, where the beaches signify a place of human contemplation. In this case, the group of reductionist beaches, although it is the most representative, did not present clear view points about the concept of sandy beaches, which means that the decrease in its frequency is quite positive for this study. Among the first and last drawings, the reduction in urbanized beaches, which represent drawings showing utilitarian and anthropocentric functions for the beaches, shows that new concepts have been assimilated by the target population. This can be confirmed by the increased frequency of the conserved, preserved, impacted and categories. generalized The representation of conserved and preserved beaches shows the assimilation of practical content. For the impacted and generalized categories, although they address negative aspects of human action on the beaches, they also demonstrate the assimilation of the content addressed in the practical and theoretical classes. The presence of solid waste and sewage in the drawings demonstrates an increase in the perception about this reality, which was scarcely evident in the first drawings.

Between the two periods, the greatest reduction in urbanized beach drawings was observed in class A, and the largest increase in conserved beach drawings was observed in class F. The preserved category had a larger increase in class E, which did not present conserved beach drawings in the second period. Impacted beach drawings had the highest increase between the two periods in classes B, C and D. Class G presented the highest increase in the generalized category. Reductionist beaches were less represented in the last drawings by all classes, except for those of class C. Therefore, elements mentioned in the theoretical and practical classes were present in the final drawings of all the classes, although each category was not always present.

Considering the field locations — Praia de Fora (restricted access) or Praia Vermelha — it was observed that in the second drawing period, the reductionist beaches were proportionally more represented by the classes with the field location at Praia Vermelha (Table 1). For these classes, a higher percentage of urbanized beaches was recorded, while students who had classes in Praia de Fora had a higher percentage of conserved beaches. Because they did not see the macrofauna of sandy beaches in the natural environment, the classes that had adapted field locations may have represented few conserved, preserved and generalized beaches because this is not the reality of Praia Vermelha.

# 3.3 Critical Environmental Education and the Formation of Ecological Subjects

A point of great importance in environmental education is the possibility of broadening the vision about the environment in which one lives. In addition to ecological information, this project aims to encourage the formation of critical citizens facing the environmental problems that are observed in society.

The ampliation of the field of vision on sandy beaches, the perception that they are not a biological desert and the behavior change in this environment fomented by the present action is a stimulus for critical thinking and for the adjustment of habits in other natural and urban areas. The beaches are configured as adequate environments for the critical visualization of the global environmental issue from local perspectives.

Table 1	<b>Proportion</b>	(%)	) of categories in	period 2.
		· · · /		

	Praia Vermelha	Praia de Fora
Urbanized	20.39	8.33
Conserved	7.77	19.44
Preserved	6.8	8.33
Impacted	12.62	9.72
Generalized	0.97	16.67
Reducionist	51.46	37.5

Critical environmental education should encourage the formation of a critical citizen who is capable of reflecting on and interfering with his/her world [16]. In this conception, the transformation of society is the cause and consequence of the transformation of each individual. There is a reciprocity that facilitates the transformation of both educated and educator into social agents that act in the process of social transformation; therefore, teaching is theory/practice, and it is praxis [16]. Critical environmental education aims for a broader understanding of the exercise of social participation and citizenship, an indispensable practice for democracy and social and environmental emancipation, assuming that the way we live does not meet everyone's expectations and that new paths must be created [17].

Scientific and ecological knowledge tells us the effects of our behavior and practices and clarifies the impact of our actions [18]; it is up to humans choose the mode of development they want, in terms of the values that evolve in the course of public debates.

### 4. Conclusion

The impact on beaches caused by the accumulation of solid waste was possibly one of the main aspects that caused agitation and motivated the development of this project, but it would be utopian to believe that the present action would completely solve the problem. However, sharing scientific information on sandy beaches has proved to be an efficient tool in altering the perception of sandy beaches by the target public. The perception analysis on sandy beaches proved to be an important indicator of the effectiveness of the project. The environment and approaches proposed for activities were also fundamental to obtaining good results in this action.

Based on our methodology, the PraiAmar Project directly expands the environmental perception of sandy beaches in preadolescents. The next steps are actions in new classes and schools, monitoring of classes already affected and dissemination and expansion of the project. Sharing scientific information is a great instrument for environmental awareness action because it can encourage positive changes in habits and behaviors. Thus, knowledge is a key piece for conservation.

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