BLUE BOX

4 IMPLEMENTATION OF PREVENTION AND MANAGEMENT TOOLS

FLOATING BARRIERES: RIVER BOOM AND BIOBARRIERS

A PRODUCT DEVELOPED WITHIN THE FRAMEWORK OF:

PROMAR Prevención de Residuos Marinos

On behalf of:
Federal Ministry
for the Environment, Nature Conservation,
Nuclear Safety and Consumer Protection
of the Federal Republic of Germany

Floating Barrieres: River Booms and Biobarriers
PARLEY, adelphi
First edition, September 2023

Project: Prevention of Marine Litter in the Caribbean Sea (PROMAR)
Project leader: adelphi consultants (Germany)
Implementing Partners: CEGESTI (Costa Rica), Abrelpe (Brazil), Parley (Dominican Republic) and Socya (Colombia)
Development of the guide:
Eddy Frank - Parley for the Oceans,
Prof. Dr. Florian Schindler Consultant-adelphi,
Richard Berner - adelphi, Alejandra Duque - Consultant adelphi

Technical revision:
Prof. Dr. Florian Schindler - Consultant adelphi

PROLOG

ABOUT THE PROMAR PROJECT

The PROMAR - Prevention of Marine Litter in the Caribbean Sea project aims to reduce the flow of plastic waste (mainly plastic packaging and single-use plastics) reaching the Caribbean Sea by promoting Circular Economy solutions in the Dominican Republic, Costa Rica and Colombia. The project is funded by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and led by the German organization adelphi.

The project created the PROMAR BlueBox, a collection of various tools, guidelines, tutorials and materials to help you implement Circular Economy solutions to reduce marine litter in your municipality. The following guide “Floating Barriers: River Booms and Biobarriers” is part of the PROMAR BlueBox.

The objective of the tool is to systematize the steps to install floating barriers in canals, drains, streams, rivers or other water bodies. The barriers prevent floating plastic waste from land-based sources from becoming marine debris by intercepting it as it passes through different bodies of water before it reaches the ocean.

The guide is aimed at municipalities, environmental groups, NGOs, community organizations, private companies and the general public involved in ocean protection. The publication of the tools is expected to motivate their use in coastal communities and thereby contribute to the reduction of terrestrial waste streams that reach marine environments.

Eddy Frank
Parley for the Oceans

Prof. Dr. Florian Schindler
Consultant adelphi

CONTENT

INTRODUCTION

The BlueBox has been designed to provide you with a detailed overview of effective tools to combat marine pollution. In this guide, we focus on the installation of two main types of floating barriers: Biobarriers (also known as Biofences) and River Booms.

To prevent poorly managed waste from land-based sources from ending up on beaches and in marine ecosystems, floating barriers are presented as a technological solution to intercept and redirect floating waste in bodies of lotic or flowing water to appropriate disposal destinations. These barriers are designed to trap waste generated from upstream to downstream, allowing the waste to be intercepted at a single point and facilitating its subsequent treatment.

The main benefits of floating barriers are:

- Significant decrease in marine debris generation, facilitating its interception and treatment before reaching the sea,
- Enhancement of national capacity to integrate innovative technologies in the fight against marine pollution,
- Reduction of land-based stressors to the environment through the protection of critical habitats,
- Improving water quality and natural resources in the impact zone,
- Facilitation of the sustainable management of lotic water bodies.
- Awareness raising and education on good environmental practices aimed at the communities surrounding the water bodies.

The Guide for the Installation of Floating Barriers: Biobarriers and River Boom is based on a structure that goes from a general discussion of the base structures for floating barriers, to the differential characteristics of River Booms and Biobarriers, complementing each design with case studies in the Dominican Republic and Colombia. The River Boom is a more advanced style of floating barrier for a higher volume of debris, while the Biobarrier is a simpler type of floating barrier, ideal for interception of a lower volume of litter.

After the general design of the structure and operation of a floating barrier, the construction and installation of a Biobarrier is presented, using the case study of its application in Santa Marta, Colombia. This section of the guide describes the main characteristics of the Biobarrier model, as well as its construction, installation and maintenance process, including the results obtained in the pilot project. Unlike the River Booms, the Biobarriers are floating barriers made from a set of recovered plastic bottles, grouped by circular nets that allow catching the floating waste.

In the next part of the guide, a case study on the installation of a River Boom in the Dominican Republic is described. Using the case study as a basis, a guide is established that covers the entire process of planning, construction and operation of a River Boom, including the identification of relevant local stakeholders and the consideration of possible obstacles.

The River Boom comprises an elaborate structure containing a floating river, basin or waterway barrier designed to intercept high volume debris. In addition, it includes the installation of a 20-foot container for educational purposes, a conveyor belt and a container for waste disposal -all powered by solar panels.

With this guide, we hope to provide you with valuable and practical information about both types of floating barriers, thus advancing the fight against marine pollution in the Caribbean region. Let's begin this journey towards a cleaner and more sustainable marine future!

1. DESCRIPTION OF THE PROBLEM

1.1. REMOVAL OF PLASTICS IN WATER STREAMS

Figure 1. Waste retained by floating barrier.*

The release of solid waste into water bodies is caused by multiple factors, including the direct dumping of waste, the displacement of solid waste on soils in urban and rural areas, and poor solid waste management, which allows its release from any point in the management chain.

Most of the solid waste that enters bodies of water consists of plastic waste. This is primarily due to its durability and low density, which enables it to easily float along various water currents. During periods of heavy rain or strong winds, plastic waste from land-based sources ends up floating in water bodies. Floating barriers serve the purpose of capturing and accumulating these floating plastic waste materials in bodies of water, facilitating their effective disposal.

*Source: Photo- Floating Barrier, River boom, plastic waste, from AdobeStock_River_boom_127489851, last visited 03.06.2023.

1.2. FLOATING BARRIERES

With floating barriers, it is possible to carry out the cleanup of the bodies of water in a non-invasive manner that is safe for the environment and the surrounding communities. Although direct removal of floating debris is not the solution to the problem because it does not address the root cause of poor waste management, it is a necessary action to protect the health of the environment and communities while other solutions are implemented.

Figure 2. Floating oil spill containment booms.*

Floating barriers can be handmade or industrially manufactured. However, their function always remains the same: Retention of floating solid residues in bodies of water. There are also floating booms that are built exclusively to retain hydrocarbons floating in bodies of water in cases of oil spills.

In the case of floating solid waste management, these booms allow for an effective retention of these wastes and thus promote the cleanliness and health of the municipalities that live on the shores of the water bodies where these wastes arrive. By intercepting floating plastic waste in the water, subsequent management is facilitated. The waste has a greater potential for recovery if it does not show the deterioration caused by sand, stones or the sun to which it is exposed if it is intercepted on the shores.

Ref. ANTOLUC, Logistica Integral en Protección, 2023 Chile, https://www.antoluc.cl/producto/barreras-de-contencion-para-interior-de-puertos/

2. DIFFERENCES BETWEEN BIOBARRIERS AND RIVER BOOMS

2.1. GENERAL INFORMATION

Biobarriers and River Booms are two different types of floating barriers but both have the same function: they retain solid debris that floats on bodies of flowing water.

2.2. BIOBARRIERS

Biobarriers are an **artisanal system** for intercepting floating debris in bodies of lotic or flowing water. These biofences are generally used for cleaning water bodies with low or medium flows.

Biobarriers can be made with few resources and by volunteer groups from municipalities and/or Non-Governmental Organizations (NGOs). To make the design even more accessible and affordable, recycled plastic containers can be used for the body of the barrier. Many environmental NGOs use Biobarriers to retain floating waste in impacted communities.

Figura 3. Biobarriers “handmade”*

Figure 4. Biobarda located in a stream.**

Biofencing projects are aimed at the public sector to minimize the environmental and health impacts of floating solid waste. The Colombian environmental foundation "Salva tu Río" uses them to promote awareness of good environmental practices in communities near bodies of water.

*Source: Save your River, 2022, "Construction and implementation of "Trash Trap Barriers" to intercept floating solid waste in the Gaira and Manazanales rivers (Colombia).
**Source: Save your River, 2022, "Construction and implementation of "Trash Trap Barriers" to intercept floating solid waste in the Gaira and Manazanales rivers (Colombia).

2.3. RIVER BOOMS

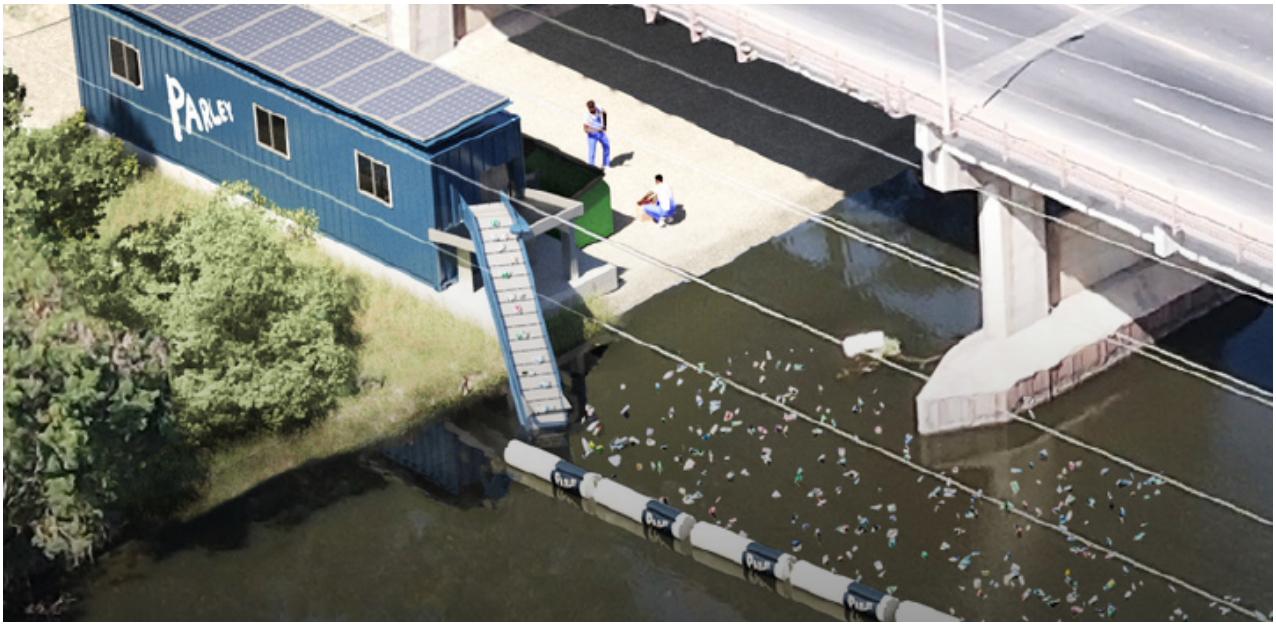


Figure 5. River Boom installed in the Ozama River, Dominican Republic.

Compared to Biobarriers, River Booms are industrially manufactured and are often used both upstream and at the estuaries facing the ocean. Traditionally, floating booms were used to retain hydrocarbons in the ocean, but have evolved to intercept solid waste. River Booms are composed of different materials depending on their final location.

Figure 6. River Boom on a river bank.**

River Booms consist of a polymer-coated fabric membrane. Lightweight booms, for general cleaning in harbors and rivers, consist of nylon (Polyamide (PA) or polyester (PE)) fabric coated with chlorinated polyvinyl (PVC) or polyurethane (PU). Barriers for open water or bodies of water with a higher flow rate are made of stronger and heavier materials, such as stainless steel. The design of the booms must always ensure that a high degree of flexibility can be maintained to facilitate deployment, retrieval and storage. Some River Booms use air captured in the coated membrane for buoyancy.

*Source: River Boom locating in the Ozama River, Santo Domingo, Dominican Republic as part of pilot project (Parley for the Oceans, 2022).
**Source: Floating Barrier, AdobeStock_River_Boom_356771404, September, 2022, last visited 03.06.20BB23

3. BENEFITS OF FLOATING BARRIERS

3.1. FLOATING BARRIERS IN PRACTICE

Two case studies of floating barriers installed in the Caribbean region can be found in the Annexes section: The installation of Biobarriers in Colombia (Fundacion Salva tu Rio) and the installation of a River Boom in the Dominican Republic (Parley for the Oceans).

The following is an international example of the DESMI company EnviRo-Care, Combating Marine Pollution & Protecting Waters and the effects of the implementation of a River Boom:

Figure 7. Comparison of debris retention effect with a River Boom installed in a canal in Hyderabad, India.*

*Fuente: EnviRo-Care, Combating Marine Pollution & Protecting Waters (DESMI)https://www.desmi.com/segments/enviro-clean/enviro-care-clean-waterways/ última visita 03.06.2023

4. DESIGNS OF FLOATING BARRIERS

4.1. FUNCTION-BASED DESIGNS

There are different designs of floating barriers depending on their function and final location. Some of the factors to be taken into account are the different flows, different hydrology and different geographical characteristics present. Below are the designs for floating barriers depending on their application:

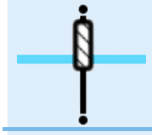
	TYPE	APPLICATION	DESCRIPTION
	**Zooom Boom**	**Rapid Response** Coastal and offshore oil spill emergencies	• Rapid deployment • Auto-deployment and inflation • Excellent wave tracking features • Ultra-compact storage
	**PermaGuard Boom**	**Permanent** Containment of waste and spills at port facilities and water intakes	• Rotomolded floats • High durability and buoyancy-to-weight ratio • High stability, no ballast required • Foam filled floats • UV / marine growth inhibited
	**InShore Boom**	**Prevention / Response** Spill containment and recovery in protected water conditions	• Closed cell froth flotation • Drop-down boom reel • Ballast/lower tension chain • Top tension cable/strap
	**OffShore Boom**	**Response** Spill containment for coastal and offshore conditions	• Air Inflated • Boom Reel Deployable • Lightweight
	**ShoreSeal Boom**	**Prevention** Protection of land, beaches and tidal areas	• High Abrasion / Puncture Resistance • Water Ballast & Air Buoyancy Chambers
	**River Boom**	**Response** Flowing rivers and streams (lotic water bodies)	• Excellent performance • High strength • Rolled closed cell flotation
	**General Purpose Boom**	**Prevention / Response** Projects where protection against hydrocarbons and debris is required	• Rolled closed cell flotation • Cost effective solution

Table 1. Floating barrier designs and their application*.

Altough several of these booms were designed for oil spills, during the German Agency for International Cooperation (GIZ) project Caribe Circular the idea emerged to recycle them for plastic interception in municipalities.

*Fuente: Versatech Products Inc, .https://www.versatech.com/boom-comparison-chart.php última visita 03.06.2023

4.2. COOPERATION BETWEEN PORTS AND MUNICIPALITIES

Ports and oil companies have floating booms to contain oil spills. In ports, the coast guard, firefighters and the navy have a lot of experience with floating booms as they are part of their daily work. According to the firefighters and coastguards interviewed, floating booms have a useful life of seven (7) to ten (10) years depending on their use, storage and materials. Due to the resistant materials used, if the life of the oil booms ends, the ports can facilitate their recycling for use as floating plastic waste booms.

Figure 8. Floating barrier intercepting plastic debris in waterway (Scheldt River, Belgium)

In fact, many companies that previously only manufactured floating booms for oil spills have now expanded their operations to include floating booms for floating solid wastes such as algae or plastic wastes. Although there are booms that are exclusively for floating solid waste, such as River Booms, most booms that have other applications can also be used for solid waste interception.

To install, operate and maintain these types of floating booms, engineering knowledge is necessary to do so safely and effectively. In areas where floating booms of other applications are already in use, firefighters, coastguards, and shipping and port companies in the region should have the necessary expertise.

*Fuente: Smart Water magazine, 11/05/2022, https://smartwatermagazine.com/news/ecocoast/longest-river-barrier-europe-removes-plastic-waterways última visita 11.06.2023

To ensure safety, a set of best practices and measures are needed that depend on the technicians who operate and review the floating barriers. For the Parley for the Oceans project in the Ozama River, Dominican Republic, it was described as "a formula for safety factors for structures, following recommended minimums as a basis for the barrier, cables, anchors and connecting lines. This formula allows us to install a resistant barrier and manage risks in the long term." The rules and regulations for the installation and operation of floating barriers are described below. There are also additional processes in case the barriers have to be anchored to the bottom of water bodies.

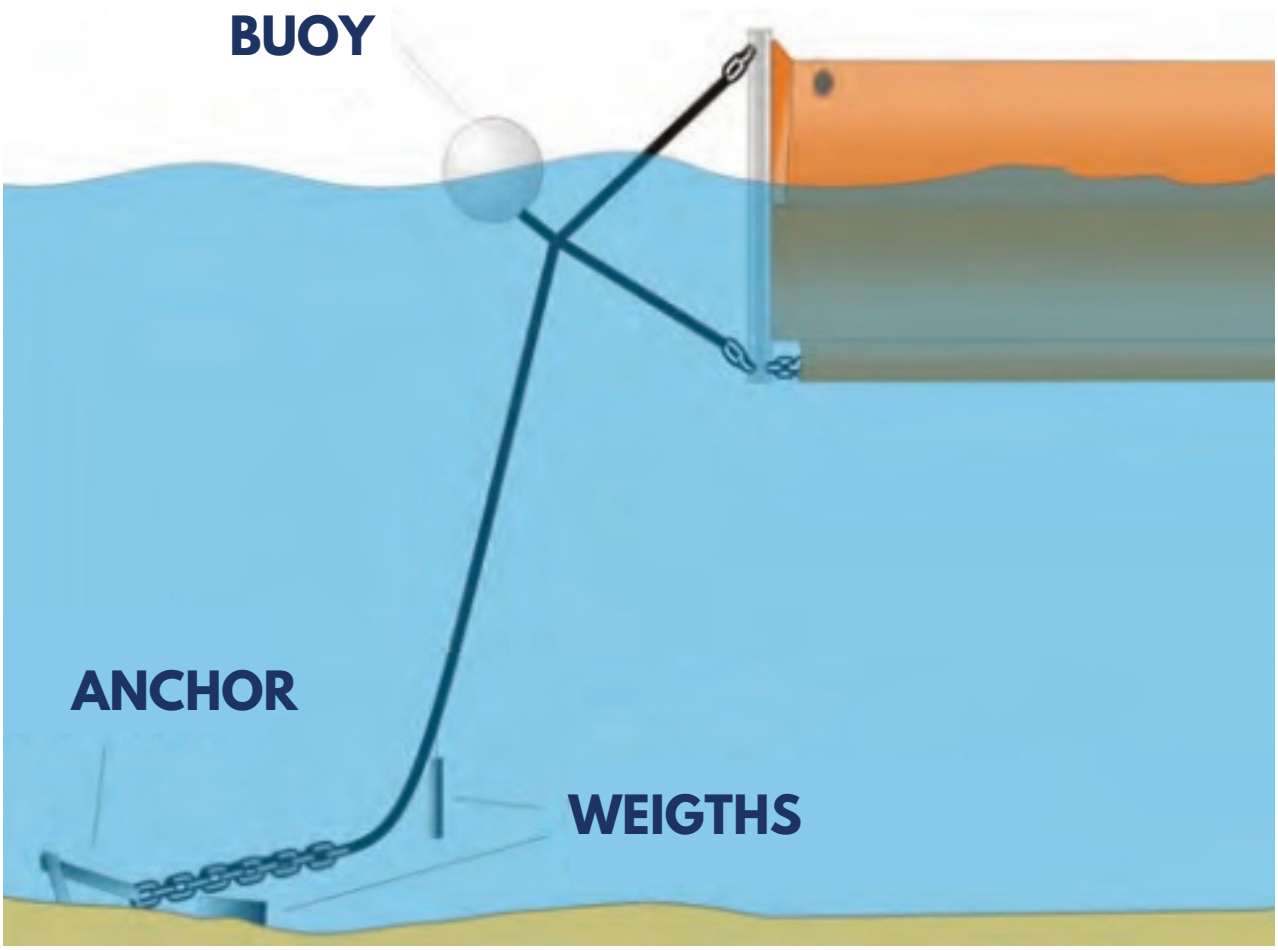


Figure 9. Graph showing anchor attachments of a River Boom to the ground/bottom of a water body.*

*Source: Attachments of a floating boom / river boom on the bottom, https://www.uvm.edu/seagrant/sites/default/files/uploads/TIP3UseofBoomsinOilPollutionResponse.pdf of the "Internatinal Tanker Owners Pollution Federation Ltd. (ITOPF), last visited 03.06.2023.

5. EXPERIENCES

E1. REGIONAL INICIATIVES OF RIVER BOOMS AND BIOBARRIERS

There are numerous initiatives for the installation of River Booms and Biobarriers in the region. Below are some of these experiences:

Municipal Government Flores Peten, Guatemala

- Municipal Public Services carry out continuous cleaning and maintenance activities for the Biobarda of "El Ahorcado" stream, one of the major sources of contamination of Lake Petén Itzá.

Motagua River, Guatemala

- Former President Jimmy Morales presented the method as the solution to the problem of garbage in the Motagua River and it was something that the former president highlighted in his third government report.
- The Minister of Environment and Natural Resources, Alfonso Alonzo, thus launched the project of the so-called eco-fences or bio-fences ***

Salado River, San Fransico, Honduras

- Bilateral work of the Secretariat of Natural Resources and Environment (MiAmbiente+), with the support of the Ministry of Environment and Natural Resources of the neighboring country, to install the first biofarm in Rio Salado, community of Boca del Toro. ****

Asunción, Paraguay

- Speaker of the Lower House, Carlos María López (PLRA- Cordillera) and legislator Pastor Soria (ANR-San Pedro) drafted a proposal to mitigate the problem of water pollution by using floating barriers to intercept floating plastic waste. *****

*Source: https://munisanandres.gob.gt/creacion-de-bio-bardas-casco-urbano-sanh-andres-peten/
**Fuente: https://de.scribd.com/document/428694877/Bio-Bardas
***Source: https://atalayar.com/en/node/6861
****Fuente: https://www.pressreader.com/honduras/diario-la-prensa/20180629/282046212838521
*****Fuente: http://www.diputados.gov.py/index.php/noticias/proponen-uso-de-barreras-flotantes-en-cauces-hidricos-para-atrapar-plasticos

ANNEXES

A1. CASE STUDY OF THE PROMAR PROJECT - SANTO DOMINGO, DOMINICAN REPUBLIC - PARLEY.

A1.1. CONTEXT

Numerous rivers and waterways throughout the Dominican Republic serve as major conduits for transporting plastics into the Caribbean Sea. In 2018, heavy rains in the Dominican Republic resulted in a significant amount of plastic debris being washed from rivers near Santo Domingo. The waters became so saturated with plastic that literal waves of plastic were seen crashing onto the province's beaches. The debris was mainly household and commercial waste, such as food containers and utensils, beverage containers, plastic bags, clothing, diapers and other similar debris. Parley, together with the government and other partners, cleaned up as much of this as possible, but significant amounts of this debris were washed back into the sea. Parley Dominican Republic, as an implementing partner of the PROMAR project, funded by the German Federal Ministry for the Environment, Nuclear Safety and Consumer Protection (BMUV), offered the Ministry of the Environment and Natural Resources a specially constructed Tuffboom floating waste interceptor barrier to be piloted on the Yaque del Norte River, an extremely important river for the entire northern region of the Dominican Republic that is highly polluted due to the large volume of waste that is dumped into it.

A1.2. IMPLEMENTATION

The implementation of the Tuffboom floating debris interceptor barrier is part of Parley's River Interception program that aims to install interceptors in key waterways in the Dominican Republic providing a municipal-level strategy, with potential national replicability, that prevents waste dumped in the river from reaching the Caribbean Sea. The first barrier of its kind to stop potential marine debris in the Dominican Republic intercepts floating debris in the Yaque del Norte River. A mechanized conveyor belt helps to remove the material from the water to a collection container located on the riverbank. It will serve as a temporary location to intercept the waste collected there and then transport it to its final disposal destination with the help of recycler Cilpen Global. The barrier is a direct, innovative and important measure to position Santiago as a leading city in responding to the marine pollution that affects the Dominican Republic.

A1.3. LOCATION OF THE PILOT

In this initial pilot project, the barrier will be strategically placed upstream of the La Otra Banda reservoir on the Yaque del Norte River, situated in the city of Santiago de los Caballeros within the Santiago province. This positioning is intended to effectively intercept solid waste that, due to discharges from ravines, drainage systems, and communities along the river, would otherwise flow downstream and potentially impact the coastline of the Caribbean Sea in the province of Montecristi. It's important to note that Montecristi is a wildlife refuge in the Dominican Republic.

Figure 10. The photo shows the previously selected demonstration site on the Haina River, Dominican Republic.

PERMITS

In the identification of stakeholders, take into account those who are impacted within the environment where you will install the barrier, for example: city hall, water authorities and ministries. Invite them to participate in the project, understand the process and get their permission!

*Source: Photographs taken by Parley for the Oceans (2023).

A1.4. INFRASTRUCTURE

To achieve the effective operationalization of the barrier, it will be accompanied by an operational infrastructure that will allow the temporary collection of the intercepted waste and its subsequent removal to be directed to the final disposal destination. The components of the peripheral infrastructure include a 20-foot container for educational purposes, a conveyor belt and a container for waste disposal, all powered by solar panels. The functionality of these components is briefly described below:

1. Floating Barrier: floating barrier for rivers, basins or waterways branded Tuffboom, designed to intercept high volume debris. Datasheet included as an attachment to this document.
2. Container: consists of a 20-foot logistic container that would serve as a space to raise awareness and educate the public about the problem of marine pollution.
3. Conveyor belt: a 7.62m x 0.9m conveyor belt that will redirect the waste from the river interceptor waste wagon.
4. Waste wagon: a structure that will serve to temporarily store the waste until it is removed by the local competent authority and Parley's collection partner.

Tuffboom, a U.S.-based company, presents a diverse range of structures tailored for the interception of various waste types in specific scenarios. It is essential to assess the designated space meticulously to identify the optimal structure, taking into account both the nature of the waste and the characteristics of the terrain. Drawing inspiration from the successful implementation in the Dominican Republic, the Tuffboom Series serves as an exemplary model suited for rivers with a moderate flow that consistently receive waste, particularly domestic and commercial waste. Careful consideration of such factors ensures the selection of a structure that aligns seamlessly with the unique conditions of each environment.

*Source: Photographs taken by Parley for the Oceans (2023).

A1.5. IMPLICATIONS AND BENEFITS

Floating barriers do not pose a risk to any of the species found in rivers and represent an innovative solution to stop marine pollution. Some of their main benefits are:

- Significant decrease in the generation of marine debris, facilitating its interception and treatment before reaching the sea.
- Enhancing national capacity to integrate innovative technologies in the fight against marine pollution.
- Reduction of land-based stressors to the environment through the protection of critical habitats.
- Improving water quality and natural resources in the impact zone.
- Facilitation of the sustainable management of lotic water bodies or streams.
- Raising awareness and education on good environmental practices.

Te implementation of this pilot project will help to significantly reduce the amount of marine litter that reaches the estuary of the Yaque del Norte River in the province of Montecristi.

TECHNICAL ASPECTS

Identify the disciplines involved for the optimal and functional design of the barrier, you will most likely need:

Hydrology / hydraulics: Hydrological and hydraulic study, to determine parameters of water level at maximum flood; water velocity; thrust force with debris dragging.

Topography: Topographic survey to define geography and location of the different components.

Geotechnics: Soil study to determine the bearing capacity of the soil where the structure will be anchored.

Structure: Structural design of concrete element for anchorage.

A1.6. STAKEHOLDER PARTICIPATION

For the development of this pilot, the participation of different actors is needed, to contribute to the sustainability and effective implementation. Among them, the following have been foreseen:

Municipalities

- The participation of local governments is of utmost importance to facilitate the effective planning and implementation of the pilot. They can help by facilitating the use of public space, environmental assessments and linkages with other stakeholders at the community level.

Government Actors

- They facilitate the necessary permits for the installation of the barrier. In the case of this pilot, the participation of CORAASAN (Santiago's public water and wastewater company) has been considered.

Actors for Waste Treatment

- They ensure the proper treatment and recycling of as much of the waste intercepted through the barrier as possible. In the case of this pilot, the participation of CILPEN Global has been considered for these purposes.

COLLECTED WASTE

It is very important to identify an actor that will allow you to take back the collected waste. An actor must also be able to process the collected waste in order to close the cycle.

This BlueBox tool is under development, but will contain RiverBoom best practices, experiences, methodologies and implementation criteria to guide possible replication.

A2. CASE STUDY - SANTA MARTA, SAVE YOUR RIVER, COLOMBIA

A2.1. INTRODUCTION

The "Trash Trap Barriers" project arose as an initiative of the environmental foundation Salva Tu Río with the purpose of reducing the floating waste by a high percentage that is thrown into the bodies of water. Thus reducing the environmental impact of solid waste dumping in the Manzanares and Gaira rivers, which is also affecting the marine ecosystem. For this reason, the Santa Marta Sostenible and Salva tu Río foundations established a strategic alliance to build and install seven "Trash Trap Barriers" in the Caira and Manzanares rivers in the city of Santa Marta, Colombia.

A2.2. DESCRIPTION

The "Trash Trap Barriers" are tools designed for physical intervention in bodies of lotic water such as rivers (in stretches of their lower basins) and whose main function is the retention of waste dumped and transported in the form of floating solids along the tributaries for subsequent extraction. This project aims to show the main characteristics and specificities in the construction, implementation and results obtained through the use of "Trash Trap Barriers" as well as the benefits it represents in the environmental component for ecosystems such as oceans and populations along the banks of rivers and their surroundings.

A2.3. JUSTIFICATION

Taking into account the current physical and environmental conditions of the lower basin of the Manzanares River (18 km long),several determining factors in the contamination problem were identified. These are: a lack of boundaries of water courses and human settlements; wastewater discharges (gray and black), solid waste: deforestation and erosion of the water course, and absence of citizen awareness and bad environmental practices. These factors have directly contributed to the deterioration of the lower basin of the Manzanares River and make it necessary to design, develop and implement tools to provide solutions to the negative impacts on this type of ecosystem. This led to a device focused on the retention of floating solid waste that is dumped by the communities surrounding the lower basin of the Manzanares River. It is expected to reduce the volume of floating solid waste that circulates within the water level of the lower basin of the Manzanares and Gaira Rivers by an estimated 80% to 90%, which would effectively mitigate the negative impact of these discharges.

A2.4. GENERAL OBJECTIVE

Implement "Trash Trap Barriers" as an alternative to minimize the environmental impact generated by the dumping of floating solid waste into bodies of water.

A2.5. SPECIFIC OBJECTIVES

- *Retain* the largest possible volume of floating solid waste in the channel of a body of water or stream,
- *Enable* the retrieval and subsequent categorization of the captured floating solid waste, aiming for its optimal utilization as reusable material. Additionally, consider value-added transformation processes to integrate it into Circular Economy initiatives.
- *Promote* awareness and education in good environmental practices aimed at communities, schools, the general population and decision-makers in the vicinity of water bodies,
- *Prevent* a high percentage of solid waste thrown into rivers from reaching the sea, affecting marine ecosystems.

A2.6. TARGET POPULATION

This project is aimed at public sector institutions and Non-Governmental Organizations (NGOs) that are interested in promoting the construction and implementation of tools to minimize specific environmental impacts, such as dumping and displacement of floating solid waste in bodies of water, organizations that promote and develop circular economy projects and the use of solid waste.

A2.7. BACKGROUND

The "Trash Trap Barriers" benchmark in the District of Santa Marta is an ecological and practical model which was in operation in the section of the Manzanares River located between Carrera 5ª and 6ª with Avenida del barrio Taminaca. According to the monitoring and follow-up carried out, it was possible to make an approximate calculation of the volume of solids retention in the course of a day. During the days with the least amount of floating solid waste, the volume collected was 1m³/day on average, while during the days with the highest flow of floating solids, the volume collected was approximately 6m³/day in a single barrier. It should be noted that the volume of waste retained depends on environmental conditions such as: precipitation, flow, runoff or winds. Also anthropic conditions such as: dumping of waste into the river and the surrounding environment. Five (5) critical points have been identified along the lower basin of the Manzanares River and two (2) critical points in the Gaira River where two (2) barriers have already been installed, thus reducing at least 80% or 90% of the floating material that reaches the sea at the estuary.

Initially, the project is designed to be implemented along the lower basin up to the mouth of the Manzanares and Gaira rivers within the territory of the urban area of the District of Santa Marta, at the following points:

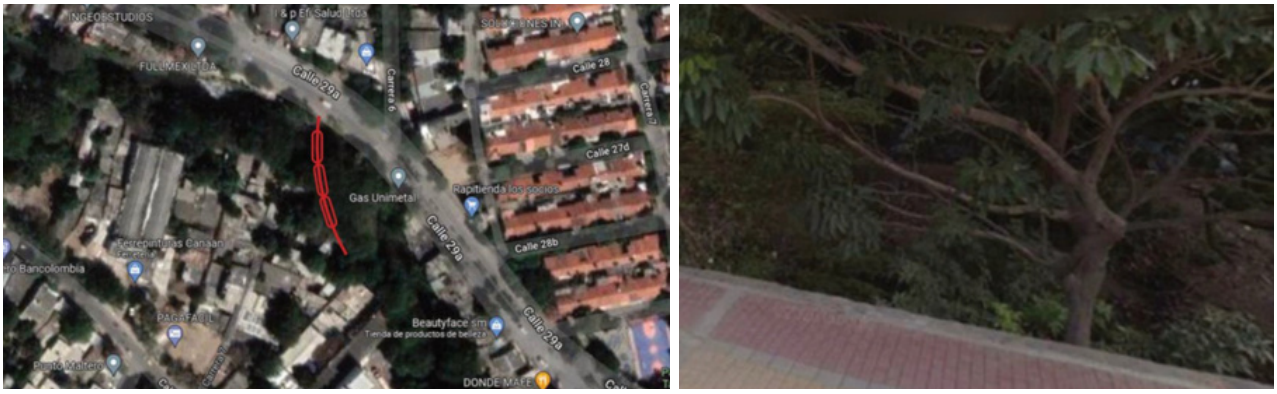


Figure 11. Manzanares River - Santa Marta
Point 1: Av del Río Calle 29a with Carrera 6.

Figure 12. Manzanares River - Santa Marta
Point 2: La Palatina Bridge, Carrera 8 with Street 30.

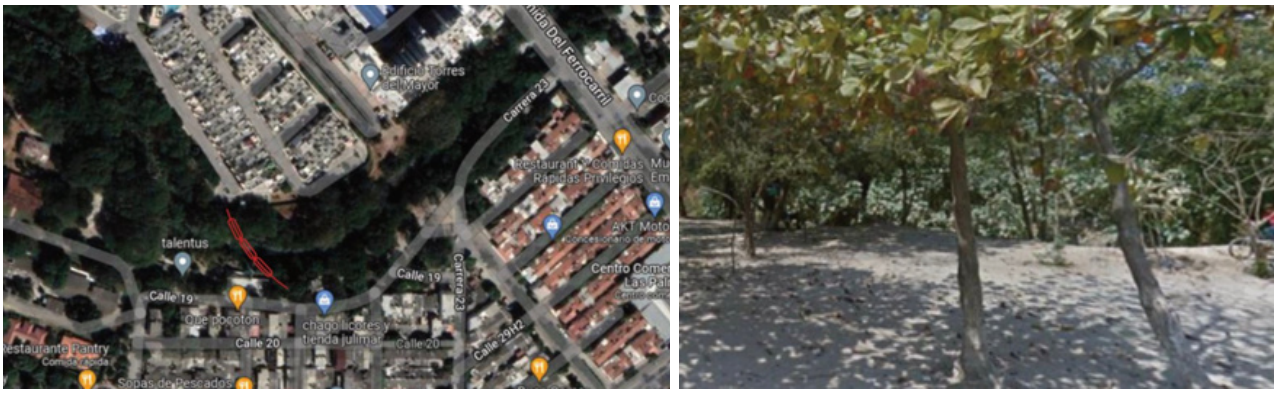


Figure 13. Manzanares River - Santa Marta
Point 3: El Mayor Bridge, Street 19 with Carrera 21.

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

Figure 14. Manzanares River - Santa Marta
Point 4: Las Malvinas Bridge, Av del Río with Street 29.

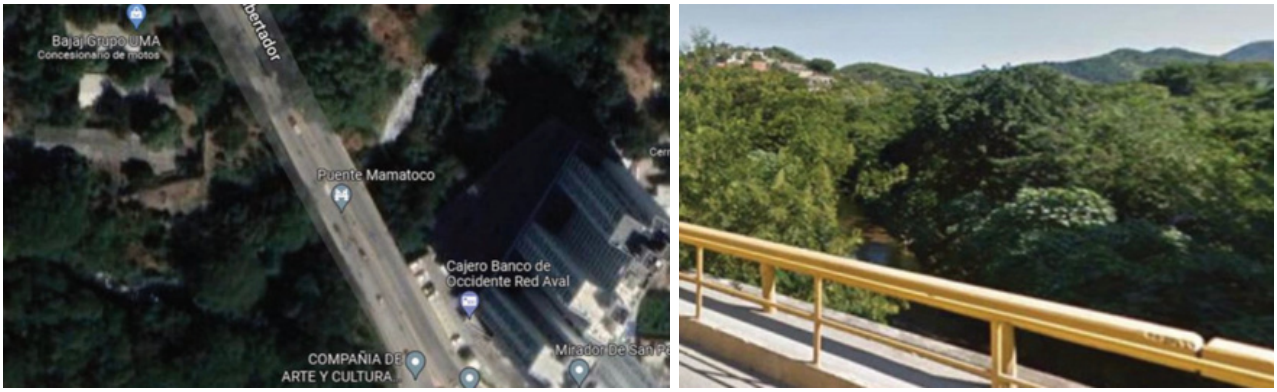


Figure 15. Manzanares River - Santa Marta
Point 5: Mamatoco Bridge, El Libertador Av.

Figure 16. Gaira River - Santa Marta
Point 1: Carrera 14 Gaira with Carrera 7.

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

Figure 17. Gaira River - Santa Marta
Point 2: Old Bridge of Gaira, Carrera 13a.*.

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

A2.8. FINANCIAL, MATERIAL AND TECHNICAL RESOURCES

FINANCIAL RESOURCES:

MANZANARES RIVER BUDGET

	FREQUENCY	QUANTITY	UNIT VALUE (COP)	ANNUAL VALUE (COP)
Construction	Once	5	$ 7.000.000	$ 35.000.000
Installation	Every time you install	5	$1.000.000	$ 5.000.000
Cleaning	monthly	5	$1.000.000	$ 60.000.000
Maintenance	every two months	5	$ 2.500.000	$ 15.000.000
Supervision	monthly	2	$ 1.000.000	$ 24.000.000
Cleaning Days and Workshops	every three months	2	$ 12.000.000	$ 24.000.000

Table 2. Budget for Biobarrier installation in Manzanares River, Santa Marta, Colombia*.

Total Cost for Manzanares River Barrier =

COP $ 163.000.000 ($33.462 USD)

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

CAIRA RIVER BUDGET

	FREQUENCY	QUANTITY	UNIT VALUE (COP)	ANNUAL VALUE (COP)
Construction	1 time	2	$ 7.000.000	$ 14.000.000
Installation	Every time you install it	2	$1.000.000	$ 2.000.000
Cleaning	monthly	2	$1.000.000	$ 24.000.000
Maintenance	every two month	2	$ 500.000	$ 6.000.000
Supervision	monthly	1	$ 1.000.000	$ 12.000.000
Cleaning Days and Workshops	every three month	1	$ 12.000.000	$ 12.000.000

Table 2. Budget for Biobarrier installation in Manzanares River, Santa Marta, Colombia*.

Total Cost for Caira River Barrier =

COP $ 70.000.000 ($16.900 USD)

Figure 18. Biobarda, Santa Marta.*

HUMAN RESOURCES:

All persons belonging to the “Save Your River“ Environmental Foundation involved in the elaboration of ideas, supporting documents and physical structure of the "Trash Trap Barriers" are volunteers, given the organization's corporate name.

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

MATERIAL AND TECHNICAL RESOURCES:

Measurements for Trash Trap Barriers.

Each section has dimensions of: 3.5m in length (6 modules) and 0.45m diameter.

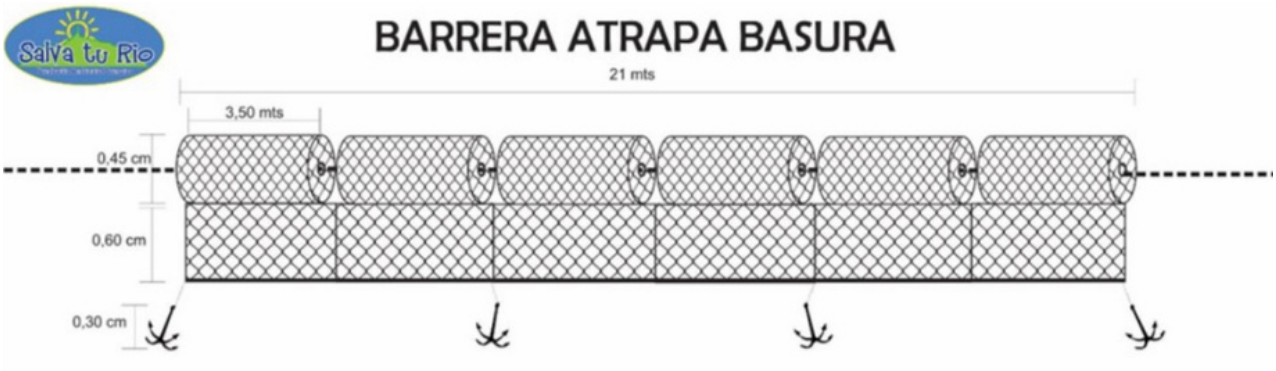


Figure 19. Graph describing the structure of the Trash Trap Barrier (Biobarrier).

Trash Trap Barrier Materials

- **No. 10-gauge chain link netting**
- **Tension wire**
- **Recycled plastic containers of different volumes**
- **Safety wire**
- **Steel ferrules**
- **Steel safety end ferrules for the ends of the guaya**
- **Barrier aquatic anchoring hooks**
- **Plastic safety straps**
- **Pelex paper**
- **Thick nylon loop**
- **Wide transparent tape**
- **Anchoring in concrete where required**
- **Transportation**
- **Construction and installation labor**

Total Cost for 21 meter Trash Barrier = COP $ 7.000.000

*Fuente: Construcción e Implementación de Barreras Atrapa Basuras para la Retención de Sólidos Flotantes en los Ríos Gaira y Manzanares, Fundación Salva tu Río (última visita 06/2023)

A2.9. PHOTOGRAPHIC MATERIAL OF THE FIRST PROTOTYPE IN PILOTING

Figure 20. Elaboration of Biobarda with recycled material, Santa Marta.

Figure 21. Biobarrier installation in Rio, Santa Marta.

Figure 22. Elaboration of Artisanal Biobarda, Santa Marta.

Figure 23. Cleaning Day and Workshop, Santa Marta.

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

A2.9. PHOTOGRAPHIC MATERIAL OF THE FIRST PROTOTYPE IN PILOTING

Figure 24. Biobarrier in operation, Santa Marta.

Figure 25. Biobarda facility, Santa Marta.*

*Source: Construction and Implementation of Trash Trap Barriers for the Retention of Floating Solids in the Gaira and Manzanares Rivers, Fundación Salva tu Río (last visit 06/2023).

BLUE BOX

A PRODUCT DEVELOPED WITHIN THE FRAMEWORK OF:

PROMAR Prevención de Residuos Marinos

On behalf of:

Federal Ministry
for the Environment, Nature Conservation,
Nuclear Safety and Consumer Protection

of the Federal Republic of Germany

Version Number: 1.0 English;
October 2023

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