Stockholm Junior Water Prize Ecuador 2021

ConCiencia Verde

Ecobardas: an ally of nature

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Abstract: *The pollution of rivers in residential areas, seas, and oceans, has been affected by the misuse of solid residues, causing islands of plastics in the oceans. To counteract and reduce the amount of plastics in the hydric affluents we developed the assemble and implementation of Ecobardas in the Capelo river. This is an artisanal system for the capture of floating waste in the water. The second phase of this project consists in eco-blocks design and manufacture with triturated recycled waste material. Eco-blocks can be used for any type of constructions and will be mainly directed to people of scarce resources or who are in vulnerability situations because of their low price.*

Key words: Ecobarda, pollution, rivers, water, eco-blocks

Resumen: *La contaminación del agua en zonas residenciales, se ha visto afectada por el mal uso de los desechos sólidos, provocando islas de plásticos en los océanos, para contrarrestar y reducir la cantidad de plásticos en los afluentes hídricos se desarrollará la construcción e implementación de Ecobardas en el río Capelo, siendo este un sistema artesanal para la captación de residuos flotantes en el agua, de este modo con el material reciclado se triturará, diseñará y fabricará eco-bloques para posteriormente realizar cualquier tipo de construcciones dirigidas principalmente a personas de escasos recursos o que se encuentren en casos de vulnerabilidad, debido a su bajo costo.*

Palabras clave: Ecobarda, contaminación, agua, ríos, ecobloques

My name is Andrea Pinto, I am from Ecuador, and I live in a town called Rumiñahui. This area has a lot of tourist attractions, culture, art, and biodiversity. Rumiñahui region has five main rivers. The people who live in this area interact daily with these rivers. However, some of these rivers are polluted and the water has not been treated. Consequently, waste accumulation in these rivers, causes the presence of pests, environmental and health problems in the neighbor community. Intending to solve this problem the project ConCiencia Verde was born.

1. Introduction

1.1. Introduction

Our project was born out of concern of the plastic waste excess present in the rivers. This project has the aim to extract plastic material from the rivers. With this objective, we have implemented an artisanal system designed to catch solid waste that we called ecobarda. Ecobarda consists in the adaptation of recycled plastic bottles or eco-blocks (full used bottles with compacted plastics), placed inside a closed (net) mesh. The ecobarda is placed across the river, it collects plastic materials that went downstream. When it has full of waste, all materials are removed, carefully classified and proper disposal is carried out. The system does not affect the riverbank wildlife. With the classified plastic a crushing process begins for the eco-blocks construction (rectangular concrete blocks), this material will be used in ecological constructions.

1.2. Background

The pollution in rivers, lakes, lagoons and seas began since the development of the industry with the implementation of basic necessities in single-use materials, such as bottles, plastic bags, rubber, tires, among others; being these one of the main pollutants of water resources on Earth. It is important to take in account that approximately 70% of the planet surface is covered with water. (Auge, 2007).

Due to the inefficient or in some cases no environmental education and awareness, the

population has generated a bad habit by throwing out most of the waste without prior classification, either in containers, streets or rivers. Consequently, large plastic islands are formed in the oceans and seas. (Socas González, 2018).

1.3. Problem Statement

Many of the waste from citizens' homes and from the massive factories' production ends up in water feeds until they reach the mouth of rivers and flow into seas and oceans. Resulting in the increase of large plastic islands in the world. The accumulation of these wastes causes the arrival of pests and diseases, affecting families who live near rivers. How can solid waste be counteracted in water affluents?

1.4. Justification

To counteract the expansion of plastics in the world, an artisanal floating waste collection system is implemented in the riverbed. Through an inspection, an assess is carried out to determine the places with the largest amount of solid waste. Then ecobardas are placed at these strategic points of the water flow.

1.5. Objectives

1.5.1. General Objective

Clean the rivers by the retention of floating waste that flows through the current of rivers, by the implementation of ecobardas located in strategic places of the aquatic affluents. Additionally, the objective is to use the collected plastic and manufacture eco-blocks for any type of construction. In this study, the ecobarda is placed in the Capelo river in San Pedro parish of the Rumiñahui canton.

1.5.2. Specific Objectives

Reduce the amount of plastic waste found in rivers with the implementation of ecobardas, as a floating waste storage system. Consequently, the community health system and life conditions will be improved reducing the risk of pests due to accumulations of garbage in rivers.

Analyze the waste that circulate through the rivers, at first a classification is conducted according to the type of material, afterwards the origin of these waste is researched. This research is done with statistical extrapolation systems to figure out the possible starting points of garbage generation.

Recycle the collected plastic, the material is crushed for the eco-blocks manufacture. Eco-blocks can be used in any type of construction. The remaining waste will be delivered (depending on their composition) to the corresponding entities for a specific purpose.

2. Theoretical Framework

The Pacific Ocean is the largest ocean of the five existing on Earth. It was named by the Portuguese navigator Fernando de Magallanes when he saw the calm water and the favorable winds. This sea is located between the Arctic Sea and the Antarctic Sea bounded by the continents of Asia and Australia in the west and the Americas in the east.

The Great Ocean has a water volume of 714 million cubic kilometers and occupies an approximated area of 165.25 million square kilometers, which is equivalent to almost a third of the earth's surface. Its economic importance is remarkable because of the constant flow of goods between Asia and America. Furthermore, it contains oil, gas and fuel reserves, it is a source of minerals, sand and gravel for the construction industry. (Montero Llácer, 2014)

Within the major problems linked to consumerism is the huge production of waste and its process that reaches natural systems. One of the most significant examples is the seas and oceans pollution by waste, which has become a global problem in little more than a half of a century. The annual entry of 6.4 million tons of garbage into the sea is evaluated, about 200 kilos every second, where 80% of the plastic comes from land activity, the remaining percentage corresponds to the activity carried out in the sea, in this way, plastic is the component that leads marine pollution. (Jaen , Esteve , & Banos-González, 2018, pág. 2)

The floating waste that reaches the sea has formed plastic islands, the largest one is located in the north of the Pacific between Hawaii and California with an approximated area of 1.6 million square kilometers, called the Great Spot. This is, comparing with the extension of the Ecuadorian territory, five times its territory, being the territorial extension of 283,560 km2. The mentioned plastic island has a weight of approximately 80,000 tons, where 8% consist of microplastic. (Ballester Bayarri, Arnal Arnal, García Fayos, & Sancho Fernández, 2020)

According to statistics, decomposition time of this type of material is approximately 150 years for plastic sleeves, while commonly used bottles such as for soda or any liquid substance are generally PET plastic bottles, this type of plastic takes approximately 500 years into its decomposition. This characteristic allows the use of these plastics in other applications such as eco-blocks, which could be reuse for different activities in the construction sector, such as family houses for vulnerable people or with low resources. (Gómez Serrato, 2016)

An ecobarda is an artisanal system elaborated by the adaptation of a mesh, rope, and recycled bottles. It is designed for the implementation in rivers, which allow the capture of floating solid waste This has been an effective operation to avoid the dragging of waste and eliminating floating waste by the superficial river currents. (Ministerio de Medio Ambiente y Recursos Naturales El Salvador, 2019)

The design of an ecobarda has a quite simple adaptation, it consists of placing bottles in a circular shape, with the difference that the bottle in the center must have a greater weight to stabilize the system, placed one next to the other, so that the bases are matching with the bases and the caps with the caps. The ecobarda must have a length similar to the river in

which it is desired to be implemented, in order to avoid plastic leakage. (Dirección de Formación y Participación Social del Ministerio de Ambiente y Recursos Naturales de Guatemala, 2018)

An eco-block is an ecological structure based on recycled materials, such as the use of plastic waste to be reused giving a new application in different designs. Some of them can be compacted bottles with plastic waste inside, rectangular blocks under an INEN standard with measures established by the regulatory body, it can also be done by melting or with a plastic injection process.

An eco-block is made with bottles in good condition of 1.5 to 3 liters, which will be filled with non-biodegradable waste that gives a high resistance to pressure.

An eco-block under the INEN standards establishes measures of 40 cm length, 20 cm height and the width can be 10, 15 or 20 cm, this depending on the use that it is given. The eco-block consists of crushed plastic alloy, cement, sand and water, these are compacted in a mold with the established measures. (INEN, 1993)

2.1. Sustainability

Sustainability is the action that seeks to give a new way of managing resources, where the development of a society will not cause a problem in the future. Sustainable development is a technique that reduces the indiscriminate use of natural resources, minimizing the degradation process in the environment and presenting an economic improvement contributing to development without representing a loss for both current and future society. Conciencia Verde is a sustainable project that aims to implement water cleaning systems based on recycling and low economic resources, achieving great ecological benefits. (Domínguez & Achkar, 2005)

Moreover, sustainability seeks to satisfy the needs of the present without affecting future generations, without neglecting the environmental, social, and economic commitment. (Macedo, 2005)

2.2. Effectiveness

The effectiveness seeks that the objectives proposed for a company or project are met, it measures the ability to reach and achieve results. In ConCiencia Verde, efficiency is developed in the correct operation of both the ecobardas and the eco-blocks, systems that accomplish the objectives of ecological use. (Fernández Rios & Sánchez, 1997)

2.3. Efficiency

Efficiency is obtaining the goals set with the least use of time and resources, in this way there is a correct management of resources for a specific purpose. That is, the efficiency applied to the project is evident in the correct use of recycled materials and their use for an ecological purpose without waste of any kind and with the correct fulfillment of expected results. (Fernández Rios & Sánchez, 1997)

2.4. Feasibility

Feasibility refers to the level of accessibility of the necessary resources and the study of the probability of success for the implementation of a project, business, or action. In this way, both ecobardas and eco-blocks have great feasibility as they are made with materials available in the world, especially plastic that is discarded by tons daily and its costs are accessible.

2.5. Circular Economy

The idea of Circular Economy appears in Pearce & Turner's book (1991), which talks about Economics of Natural Resources and the Environment, the circular economy is currently being implemented in different areas and places, but a long journey is ahead. It is an attractive and viable alternative in the social, environmental, economic and business sphere that is being explored with the aim of providing a different alternative to the traditional economy that has blocked the possibility of generating new economic strategies based on renewables resources of a circular economy.

The circular economy seeks to generate new production systems based on the reuse of waste that can be used in a new industry, maximizing material and energy resources so that they remain as a material of continuous use for a longer time. In this way, it avoids the over-exploitation of natural resources as raw material, which generates a great environmental impact. In addition, it opens new jobs vacancies by reusing this waste for the elaboration of most consumed daily products.

The cycles of water and nutrients abound in nature, discards become resources for others. However, humans continue to "produce, use, and eliminate." A third of the plastic waste worldwide is not collected or managed. Conventional waste management is promoted by minimizing the costs of collection and disposal, landfill versus recycling or incineration. In a circular economy, the goal is to maximize the value at each point of a product life, for which new development positions will be created and systems will be needed in each process. In this way, a circular economy model is proposed under the structure of ConCiencia Verde. (Stahel, 2016)

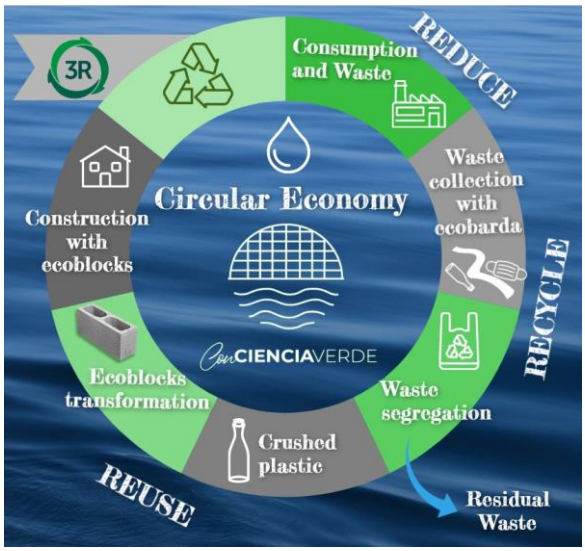


Illustration 1 Circular Economy Diagram in ConCiencia Verde

The problem begins with the consumption and disposal of polluting materials to water resources, for which a floating solid waste collection system is implemented, the waste is classified, and the selected plastic is crushed to make eco-blocks. They will be used in construction, while residual waste will be delivered to the corresponding entities for correct disposal, reducing water pollution. In this way, it generates great social, economic and environmental benefits that reduce the risk of flooding, keep rivers clean, conserve aquatic and terrestrial flora and fauna improving the landscape, which generates greater tourist attraction and investments, and supports economic and business reactivation through the Circular Economy.

3. Methodology

3.1. Experimental design

For the implementation of this system, we asked the municipality of the Rumiñahui canton for an authorization for the placement of the ecobarda. The organization guided us to the Capelo River that has an approximate length of 3.5 km and crosses the urban and rural area of the canton. The river is born from the union of two rivers coming from an urban and a rural area. The community surrounding the river had requested a treatment, due to the excess of garbage and pollution present in it. In order to find the correct location for the ecobarda we went on an expedition across the river bank. (Peralta, 2021)

Several catchment tests have been carried out in different strategic sectors such as: places with low and high flow rates, generating results through the ecobarda in the mentioned river, corresponding to the San Pedro parish of the Rumiñahui canton with an average flow of 121.93 l / s according to a study carried out by Escuela Politécnica Nacional. (Calo Gualpa & Guerrero Muñoz , 2019)

The construction process

First, water is placed in the middle of the bottles, then the mesh is woven covering the bottles placed 4 and 4 alternating the empty ones and those that include water to give stability to the eco-fence. The prototype, like the original ecobarda, can be made by anyone, it must be tightened appropriately to the bottles so that they do not move with the strength of the river current. The ecobarda has an approximate radius of 0.15 meters; the ecobarda can carry from four to eight bottles of 1 to 3 liters reaching a radius of approximately 0.5 meters in the mesh, this depends on the river width. (Ministerio del Ambiente y recurso Naturales Guatemala, 2018)

Ecoblock production

The eco-block measures 40 cm long, 20 cm high and 15 cm wide with a tolerance of approximately ± 1cm. For the elaboration of the eco-block, different proportions of mixtures between crushed plastic, cement, sand, rainwater, and eco-blocks of bottles filled with single-use plastic were tested within the center of the rectangular blocks. The crushed plastic comes from the Ecobarda's classified waste, the crushing process was developed at the FUCAE an NGO based in San José de Minas, which has a crushing machine.

Table 1 Proportion of material for an eco-block

Treatment	Chushed plastic [Kg]	Cement [Kg]	Sand [Kg]	Rainwater [Kg]	Ecoblock (bottle) [U]
1	6	1,8	1,8	1,8	2
2	6	3,6	3,6	0,9	1
3	6	2,4	4,8	0,9	1
4	6	1,2	3,6	1	1
5	**4**	**1,6**	**5**	**1**	**1**

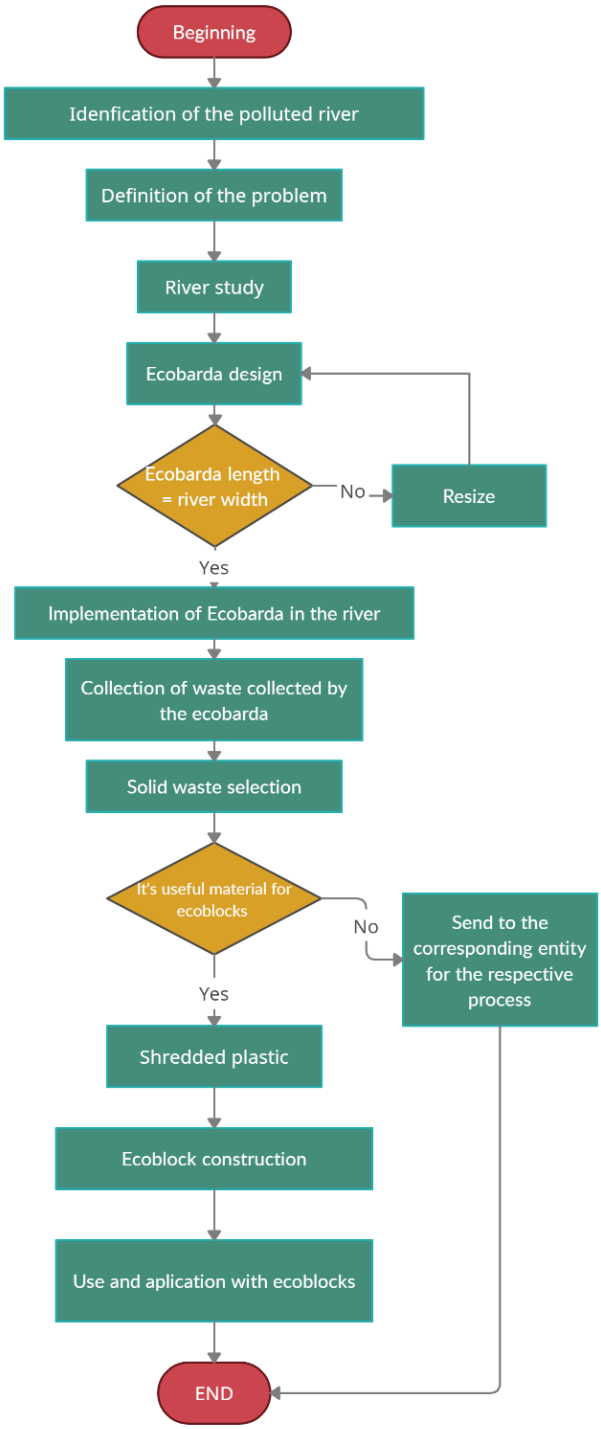
For the elaboration of the ecoblock, several treatments were carried out, the fifth treatment was more effective.

Generating a block with low environmental impact with an approximate cost of 0.20 USD, in each of them a saving of 0.12 USD per-block. This result in a saving of 37.5% for the acquisition of blocks.

The resistance and durability of an eco-block is greater than a common block, presenting an approximate average of 3 MPa, being 0.5 MPa below the standard amount under the INEN 632 standards [3.5 MPa], which requires generating a subsequent study with the

implementation of binders and agglomerates. However, in terms of acoustic resistance it presents a higher level of noise elimination between rooms as it presents major closed porosity due to the presence of plastic itself. (Ganchozo Rojas & Zambrano Rueda, 2017)

3.2 Process Flow Diagram



4. Parameter to be measured in experimentation

The parameter to be measured in the experimentation is the volume of waste that can be captured in a determined time. For our study, it is the collection of plastic waste (bottles) per hour, day and weekThis depends on the ecobarda location in strategic sectors where there is a greater amount of waste in the rivers, especially at the edge of towns, allowing the analysis of the variety of waste found in water currents. In this way, reduce the amount of plastic waste that reaches the seas, estimating an average of 65% in reduction and collection of plastics with the implementation of the ecobarda whose objective is to decontaminate rivers, beaches, seas, and oceans. (Dirección de Formación y Participación Social del Ministerio de Ambiente y Recursos Naturales de Guatemala, 2018)

Both the ecobarda and the eco-blocks are systems that any community can access, thanks to their reduced implementation cost, generating clean water resources, better quality of life and access to affordable and ecological housing.

5. Analysis and Discussion

5.1. Data Analysis

According to the materials used for the elaboration of the 5-meter-long ecobarda, an approximate cost of 5 USD is estimated, 10 meters of rope to support and anchor the catchment system at a cost of 2.50 USD, the bottles are recycled without any additional cost; giving a total cost of 12.50 USD.

Therefore, based on these recorded data, a general cost of 1 USD for each meter of mesh, 0.50 USD for each meter of rope is estimated, resulting in a total of 1.50 USD for each meter of ecobarda built.

In the same way, for manufacturing eco-blocks the average cost is 0.21 USD for each block 40 cm long, 20 cm high and 15 cm wide, distributed as follows: 0.03 USD in sand, 0.18 USD in cement. No cost for rainwater (which was collected for the process, in order to reuse natural resources) and the crushed plastic is based on recycled material captured through the ecobarda.

With the ecobarda implemented, a large amount of waste is collected in the river: after one hour the presence of only organic waste was collected, in an approximate time of 24 hours 4 plastic bottles were collected, subsequently in one week 11 plastic bottles could be collected. Details of the waste collected are shown in Table 2.

Table 2 Measured data

Measured data			
Time	**Bottles**	**Organic waste**	**Others**
8 hours	1	2	1
1 day	4	3	1
1 week	11	12	3

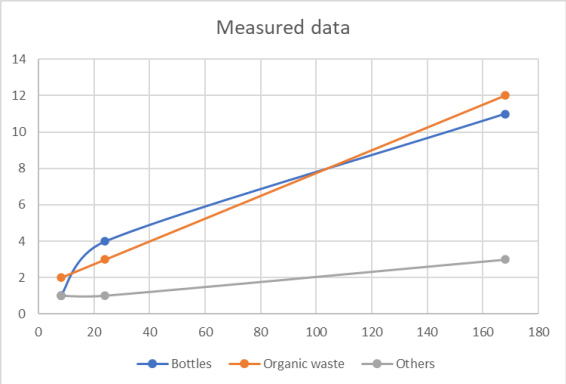


Illustration 2 Measured data.

Based on these data, an approximation to one month and one year can be estimated through a linear progression.

Table 3 Estimated data in one month.

Time	**Bottles**	**Organic waste**	**Others**
1 week	11	12	3
2 week	22	24	6
3 week	33	36	9
4 week	44	48	12
1 month	**44**	**48**	**12**

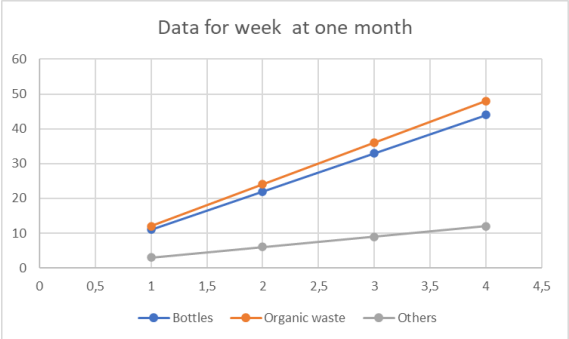


Illustration 3 Data for weeks in one month.

Table 4 . Estimated data in one year

Time [month]	Bottles	Organic waste	Others
1	44	48	12
2	88	96	24
3	132	144	36
4	176	192	48
5	220	240	60
6	264	288	72
7	308	336	84
8	352	384	96
9	396	432	108
10	440	480	120
11	484	528	132
12	528	576	144
1 year	**528**	**576**	**144**

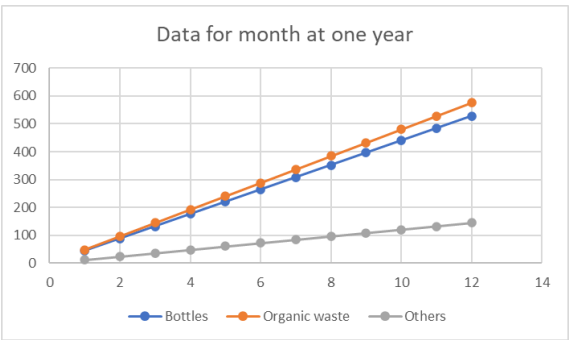


Illustration 4 Data for months in one year.

The data presented are taken in a river at a strategic point, this system can be implemented in several points of the river, however, two collection systems could be placed in each river upstream and downstream of a residential area, in order to improve the efficiency of the ecobarda system.

In the Rumiñahui canton there are five rivers, only by implementing two ecobardas in each of them, and with ten waste collection systems in the rivers, based on the estimation presented in the previous tables, an average of 5280 bottles collected per year is estimated.

The removal of the collected waste must be done constantly, in the best case daily to avoid the accumulation of waste and prevent the presence of pests.

The collection system should be changed immediately when minimal wear is observed to avoid the detachment of microplastics.

5.2. Problems due to environmental phenomena

The floating waste collection system can be implemented in any river, especially in places with low flow and little vegetation on its banks. However, in winter season or during volcanic eruption, the system is deficient due to a large increase in the water volume in the river, causing creek landslides, river overflows, among other environmental phenomena. This produces a poor functioning of the artisanal system, so it is advisable to remove it at these times.

5.3. PESTEL Analysis in "ConCiencia Verde"

The analysis of the adequacy and collection of solid waste is developed under a strategic direction that involves different resources and capacities. they are described based on an external environment study. It analyzes political factors, delves into economic factors, studies social factors, explains technological factors, identifies ecological and environmental factors, and describes legal factors, denominated PESTEL analysis. (Çitilci & Akbalık, 2020)

5.3.1. Political factor.

The developed project has been socialized in collaboration with the municipality, in this way the different government entities are encouraged to carry out similar projects for the benefit of water resources. It is important to mention that for this project a connection was already stablished, and it could be the first step to promote the implementation of ecobardas in Rumiñahui sector.

5.3.2. Economic factor

The implementation of the ecobarda is a low-cost system, the application will result in the reduction of garbage present in the rivers, improving the landscape, which increases the wealth of the neighboring community by promoting tourism in the areas, generating economic cycles.

5.3.3. Social Factor

The communities adjacent to the rivers are the main actors in developing and implementing the ecobarda. Local people will be in charge of providing constant maintenance and information about it. Therefore, this system will be implemented with help of community collectives or "*mingas"* (mingas in spanish, work together to achieve a common goal), generating commitment and promoting awareness for cleaning up and recycling as well as prevention. Furthermore, it will be a reduction not only of waste collected with the ecobarda, but also reducing the inappropriate disposal of garbage that reaches the rivers caused by the community itself. In this way, community awareness is generated.

5.3.4. Technological Factor

Through technological tools, the development of a project with great environmental and social impact will be socialized.Information and Communication Technology (ICT) will allow us to reach major public through the dissemination of the proposed artisanal system through social networks. This project can be implemented globally without a face-to-face technical direction.

5.3.5. Environmental factor

The concern for environmental wear and tear and inappropriate waste disposal motivates us to seek solutions and strategies to improve environmental protection. In this way the implementation of ecobarda will allow the capture of floating solid waste, avoiding the contamination of communities and decreasing this waste material that end up in the seas.

5.3.6. Legal factor

Motivate government entities to effectively comply with all environmental protection programs under properly planned rules, regulations, laws and statutes, supporting new ideas and educational, institutional and business projects.

6. Conclusions

The implementation of ecobarda, successfully retained different floating solid waste (bottles) that circulated through the current of the Capelo river in the Rumiñahui canton in the chosen and verified sites. We stablished a site in a lower area of the river that is accessible to set the ecobarda. It was verified that in an approximate time of 24 hours, 4 plastic bottles were collected. Subsequently, the plastic captured by the ecobarda was used and together with a concrete mixture, we built an eco-block.

With the ecobarda adaptation in the Capelo river, it is possible to reduce the amount of plastic waste found in the water currents, using it as a floating waste storage system.

When collecting the waste with the ecobarda, a great variety of floating waste was observed that circulates through the current of the rivers such as: plastic bags, cardboard, masks, soda and plastic bottles (soda and

water bottles), organic waste such as branches and other products.

The ecobarda placed in the river worked as expected and after making the respective measurements we obtained the following conclusions: eco-fence implementation can be carried out in any river in a functional way with the observation that in high currents the effectiveness decreases. As an initial incentive we have started in the Rumiñahui canton. However, the goal would be the implementation of the ecobarda using the help of the community living along the contaminated river, promoting waterbody clean-up and most important - raising awareness in the society about a circular economic process.

7. Recommendations

When the implementation of the ecobarda is carried out, it is necessary to make a previous geological study to avoid landslides which can lower the uptake of wastes.

Carry out community campaigns for the implementation of this artisanal system surrounding the banks of the river, this improves the health and lifestyle of the beneficiaries.

Implement the collector system in the rivers of the Ecuadorian coast. Considering that the speed of the water flow is lower, will allow a greater scope of this project in the collection of waste, and benefit from an easy access due to low altitude ravines.

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Appendix 1. River inspection looking for the best location.

Illustration 5 Expedition on the Capelo river

Appendix 2. Ecobarda elaboration

Illustration 6 . Elaboration of Ecobarda and implementation in the tributary of the Capelo River

Appendix 3. Crushed plastic in FUCAE

Illustration 7 PET plastic shredding at the FUCAE foundation

Appendix 4. Elaboration of the eco-block

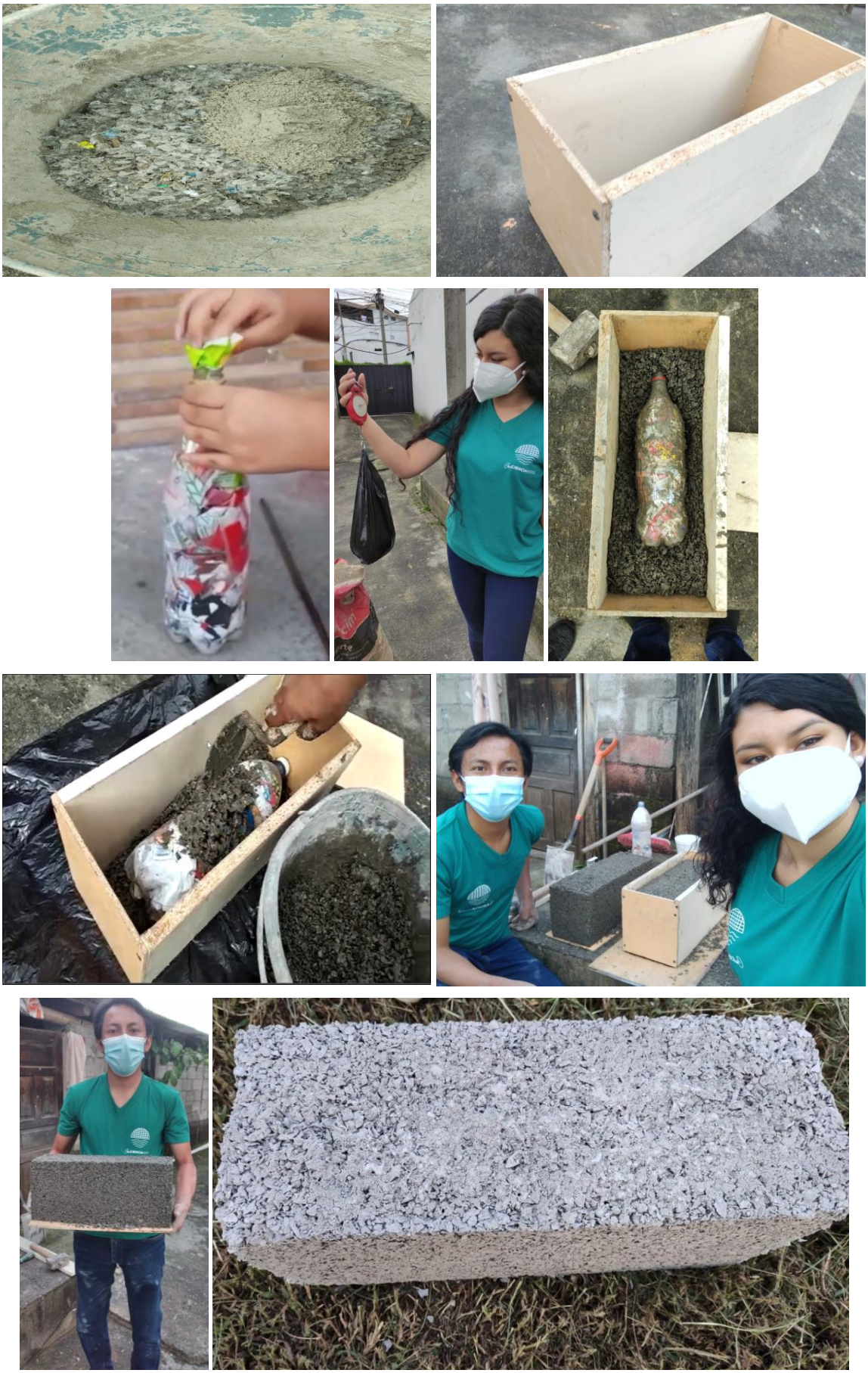

Illustration 8 Eco-block elaboration process