



GREEN FILTERS LATIN AMERICA

CARING FOR THE WATER OF A CONTINENT



With financial support from



german
cooperation

DEUTSCHE ZUSAMMENARBEIT

KÄRCHER



GNF also wants to thank the municipalities of Puerto Parra (Colombia), León (Nicaragua), Pihuamo (Mexico) and Canindeyú (Paraguay).

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PREFACE



Udo Gattenlöhner
Executive Director
Global Nature Fund

Humanity faces the greatest social and ecological challenges in its history. The three most important problems are the exponential population growth (the world population grows by 250,000 people every day), the threatening climate changes caused by our obsolete fossil energy systems (we emit around 110 million tons of CO₂ daily) and the dramatic loss of biodiversity (150 species go extinct every day). Other environmental problems are also growing, threatening the basic needs of millions of people. Even in countries with sufficient rainfall, such as Colombia or Paraguay, there is often a lack of clean drinking water.

All these problems are anthropogenic, i.e. caused by humans. But we are not (yet) helplessly exposed to the mercy of a bleak future — mankind also has the ability to develop and implement solutions. This applies in particular to problems that can be solved technically. A prime example for innovative and sustainable solutions are so-called green filters, which GNF has planned and built together with various engaged project partners in Latin America. These filters offer cost-effective solutions for wastewater treatment and thus not only benefit the population, but also protect sensitive lakes and their flora and fauna, from the Caribbean to the Andes highlands.

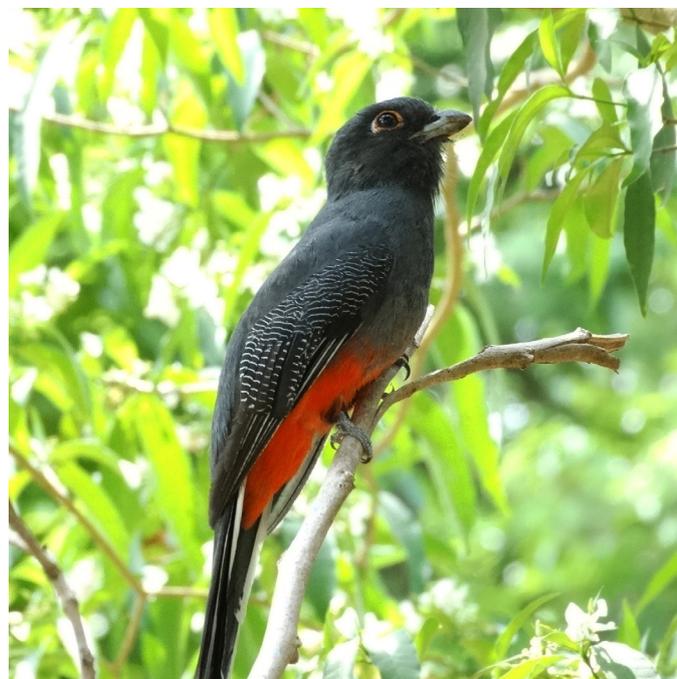
Green filters not only clean wastewater, they even create new wetlands and near-natural habitats. It is encouraging to see that threatened bird or amphibian species can be observed at the filters only after a few months of the filters installation. Nature helps itself, when you provide space and leave it alone.

I would particularly like to thank the community partners in our four pilot countries who have committed themselves with great engagement to this natural technology. We are very glad that more and more communities in South and Central America, but also in other regions of the world, show interest in this innovative and cost-effective technology. And of course we thank our project supporters, above all the Federal Ministry for Economic Cooperation and Development (BMZ), the Alfred Kärcher SE & Co. KG and the Sika AG. And last but not least, GNF's project partner organizations, which have implemented those new ideas with a great deal of personal commitment.



INTRODUCTION

On many occasions, major environmental challenges require simpler solutions than we could imagine. Green filters are a clear example of how simple technology can improve the quality of life for thousands of people and eradicate wastewater pollution in hundreds of water bodies around the world.



WASTEWATER

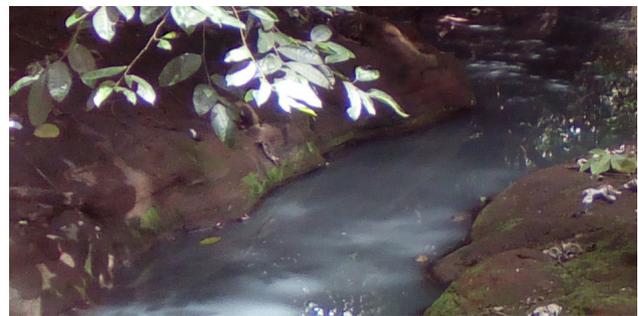
By **Martha Isabel Mejía De Alba**, Chemical Engineer, MSc. In Environmental Engineering - Universidad Distrital Francisco José de Caldas. Colombia · **Diana Carolina Callejas Moncaleano**, Environmental Engineer Ambiental, MSc. In Civil Engineering, Ministry of Environment and Sustainable Development. Colombia.

... a pending subject for sustainable development. The access to water is a right. Water is the vital fluid that runs in every cell of every ecosystem. This is why it is important to preserve it in its best, since its pollution is the source of many diseases and damages the ecosystems.

The incredibly fast growth rate of the population in the most recent decades and the rise of goods and services are causing more pressure on water bodies. It is necessary to extract greater volumes of water everyday in order to cover the basic needs of the population, and thus the amount of wastewater has also risen. This rise of human population has also changed the number and types of pollutants in wastewater. This changes can be perceived in different ways: some affect the organoleptic characteristics of water, giving different flavors, smells or colors to this fluid; others decrease the amount of oxygen available in water sources; and others increase the concentration of toxic substances in underground and superficial water sources, posing a threat to aquatic life and human health.

In most developed countries, the wastewaters are treated, having a minor effect on the environment; however, in the emerging and developing countries the wastewater does not received a proper treatment or, in some cases, is not treated at all. This wastewater, depending on their source (households or other activities), carries organic material, fecal microorganisms and remainders of chemical compounds used in farming and other industries. This situation has two main consequences.

The first, the contamination of superficial and underground water sources. Considering that many water sources are interconnected, the hydrological, hydraulic and geochemical conditions of the place they are will determine if the contamination at one point of the network can be spread generating a big scale catastrophe. This might disturb the water cycle, altering water availability in both its quality and quantity, and thus, having negative effects in aquatic ecosystems, such as wetlands, estuaries, swamps, and others. The sudden changes that untreated wastewater produces in ecosystems have



Current situation of many rivers in the world.

a negative impact on natural habitats, threatening biodiversity and the species that can not adapt to or stand such strong and fast changes.

The second consequence is the impact on human population, that is part of the hydrologic cycle and depends directly or indirectly of these ecosystems to survive. Water is fundamental for sustainable development, the social and economic growth and energy and food production to all communities on the planet, no matter their size. According to the Monitoring of Water Supply Program of the WHO and UNICEF, at least 1.8 billion people around the world drink water from sources not protected from feces. Even a greater number of people drink water distributed by systems vulnerable to pollution. This lack of sanitary measures demonstrates the reality exposed in the Agenda 21 at the UN Earth Summit: near the 80% of all diseases are caused by contaminated water consumption. This is why the access to safe water sources is a key element to reduce diseases and improve health conditions, educational levels and productivity.

Thus, the reduction of polluted water sources through the decrease of excessive water consumption, controlled water extraction, and of course effective water treatment are a priority for natural conservation and preservation. Water bodies are a sources of life.

THE JOURNEY

Since many decades, green filters have given a new cycle to wastewater and have eliminated excess of pollution in receptive water bodies all over the world. Their operation reproduces a wetland, the thick vegetation keeps and transforms an important percentage of the organic material carried by water. However, it was due to the work of professional of the Universidad Politécnica de Madrid and Fundación Global Nature of Spain that this technology was effectively structured and optimized for its dissemination and application in four continents.

LL Conference
St. Lucia
South Africa

20
02

01 SPAIN



- 7 Filters
- Fundación Global Nature
- European Union

Built filters

Executors

Sponsors

Location

LL Conf. Living Lakes Conferences

P. GFLA Green Filters Project Latin America meetings

LL Conference
The Broads
United Kingdom

20
03

LL Conference
Columbia Wetlands
Canada

20
04

02 DOMINICAN REPUBLIC



- 1 Filter
- Fundación Global Nature
- Ayuntamiento de Madrid, Fundación Biodiversidad, Fundación Eroski, Cemex Dominicana

LL Conference
Laguna de Bay
Philippines

20
05

LL Conference
Poyang Lake
China

20
06

03 SPAIN



- 5 Filters
- AENA Aeropuertos Españoles y Navegación Aérea

04 DOMINICAN REPUBLIC



- 2 Filters
- Fundación Global Nature
- Ayuntamiento de Madrid, Fundación Biodiversidad, Fundación Eroski, Cemex Dominicana

20
07

05 SRI LANKA



- 2 Filters
- Fundación Global Nature
- AECID (Agencia Española de Cooperación para el Desarrollo)

LL Conference
Lake Trasimeno
Italy

20
08

2009

LL Conference
Chapala Lake
Mexico

06 PARAGUAY



- 1 Filter
- Fundación Global Nature
- AECID, Rapunzel, FMB, FGN

2010

2013

LL Conference
Poyang Lake
China

07 COLOMBIA



- 1 Filter
- Fundación Humedales
- Kärcher, GNF

2014

2015

Project GFLA
Kick-off meeting
Fúquene Lagoon
Colombia

08

CLEAN WATER FOR THE WORLD



- | | | |
|--------------------------------|------------------------------|---------------------|
| MEXICO | SOUTH AFRICA | COLOMBIA |
| 1 Filter | 1 Filter | 3 Filters |
| Instituto Corazón de la Tierra | Wildlands Conservation Trust | Fundación Humedales |

2016

Project GFLA
Forum
Chapala Lake
Mexico



- PHILIPPINES
- 2 Filters
- Friends of Seven Lakes Foundation, Society for the Protection of Philippine Wetlands

2017

Project GFLA
Final Conference
Chapala Lake
Mexico

09 GREEN FILTERS PROJECT LATIN AMERICA



- | | |
|---------------------|--------------------------------|
| COLOMBIA | MEXICO |
| 1 Filter | 2 Filters |
| Fundación Humedales | Instituto Corazón de la Tierra |

2018

LL Conference
L'Albufera Wetland
Spain



- BURUNDI
- 1 Filter
- Biraturaba
- Kärcher

2019



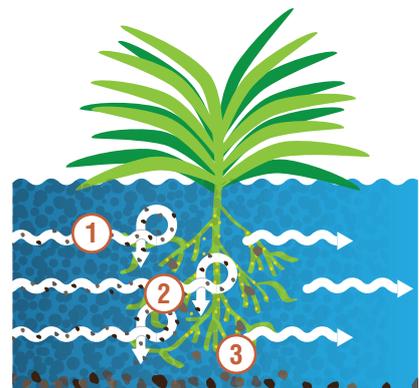
- | | |
|--------------|--------------------------|
| NICARAGUA | PARAGUAY |
| 1 Filter | 3 Filters |
| Fundar | Fundación Moisés Bertoni |
| BMZ, Kärcher | |

HOW DO FILTERS WORK

A green filter is a sustainable, eco-friendly and cost-efficient alternative for the treatment of wastewater effluents -originating from domestic use and agricultural activities- that are generally diverted directly into natural bodies of water without being treated, causing diseases and water deterioration worldwide. It is a technology that can be easily adapted in communities with difficult connection to the central treatment system or those aiming to a more sustainable and autonomous management of their wastewater.

In a green filter, wastewater goes through long, narrow and shallow canals. In the canals native water plants, called macrophytes, are sown, being the responsible of cleaning the water.

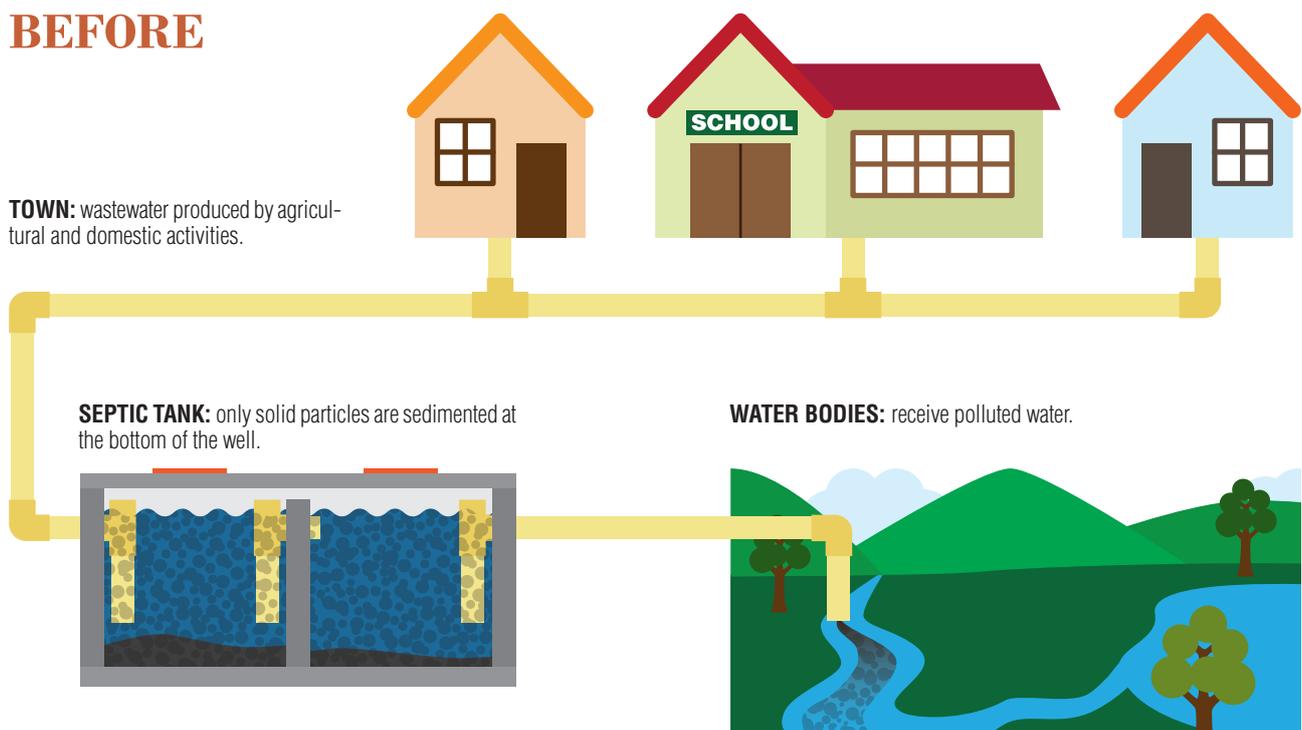
- 1 The water comes into contact with the roots of the plants and the bacteria that develop in them.
- 2 The bacteria convert the organic matter into nutrients that are absorbed by the plants and make them grow.
- 3 The thick and heavy material gets trapped by the roots, and falls on the bottom of the canal where it starts its degradation process.



80% - 95% | organic material removed

60% - 70% | nutrients removed

BEFORE

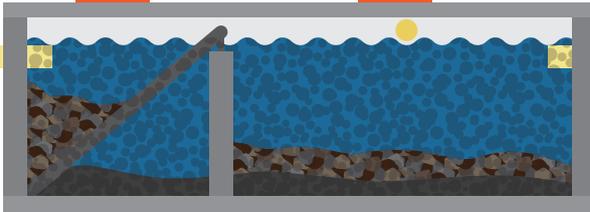


AFTER

TOWN: wastewater produced by agricultural and domestic activities.



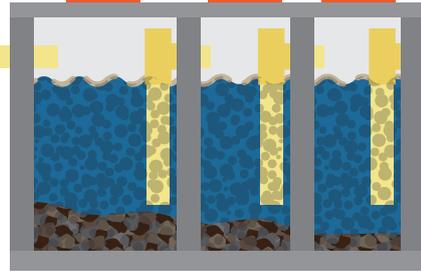
PRETREATMENT: it reduces the speed of the water flow coming from the sewage system and performs an initial depuration.



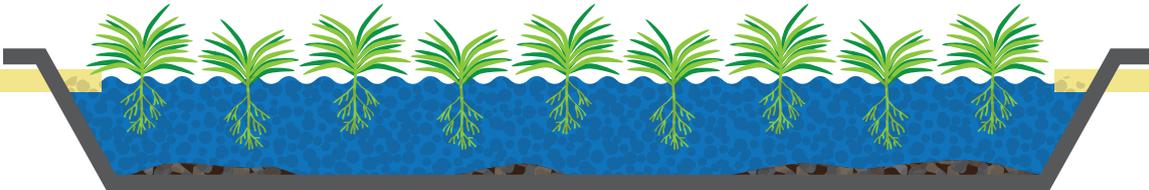
Sieving

Sand trap

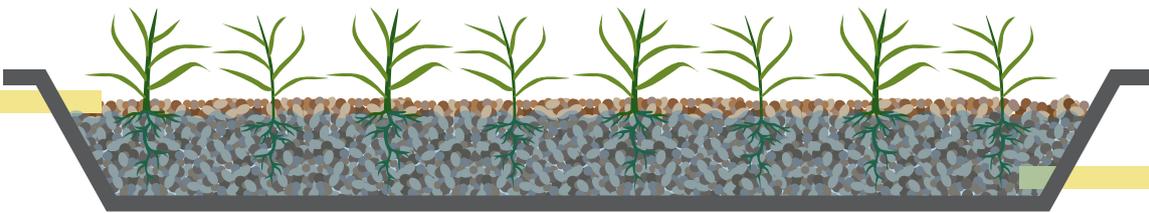
PRIMARY TREATMENT: it holds back fats and oils while pursuing the sedimentation process.



SECONDARY TREATMENT: wastewaters are diverted through long, narrow and shallow canals that contain native water plants. Depending on the construction site, two different configurations are used:

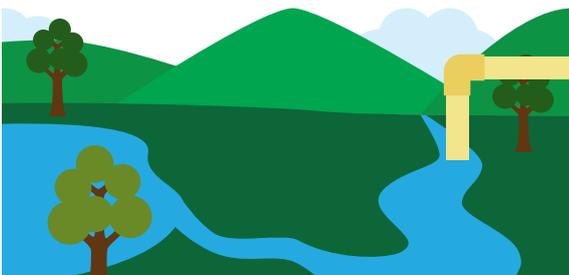


- Horizontal surface flow constructed wetlands.



- Horizontal subsurface flow constructed wetland, recommended for schools and locations with low temperature.

RECEIVING WATER BODIES: streams, rivers, lakes, lagoons or storage structures.



INSPECTION BOX: review and samples.



Both the water coming out of the units and the by-products (harvest from the plants) can be used for productive initiatives, offering new opportunities to the communities.



Birdlife on the shores of Chapala Lake.

CHAPALA LAKE

With a surface of 1,119 km² and a capacity of 7.3 millions of m³, the Chapala Lake is Mexico's largest natural lake and Latin America's third largest natural lake. It is one of the world's most important ancient lakes, since it is around 7 million years old. Most of the lakes today are considered "young" because they are 250,000 years old or younger.

In 2009, the lake was classified as a Ramsar Wetland of Importance for the high presence of indigenous fish (28) and bird (307 aquatic and terrestrial) species, which can reach the 50,000 spe-

cimens during the winter. Also, the Chapala lake is an important climate regulator in the region and provides around the 60% of water to Guadalajara, Mexico's second largest city.

The lake is part of the Lerma-Chapala basin, whose surface is 53,591.3 km² (an area greater than Costa Rica). This territory is characterized for its diversity of ecosystems and the wide variation of altitudes and climates, as well for its diverse geography (mountains, gaps, valleys and flatlands). These characteristics have developed a rich biodiversity and a series of environmental services of support, supply, regulation and culture. But, on the other hand, this territory has suffered the appropriation of its ecosystemic resources by the establishment of large areas destined to agriculture and cattle production (mainly areas of irrigation), changing its forestry purpose into agricultural production. In addition to this, nearly the 12% of Mexican industry is centered in this basin, which produces around the 13% of Mexico's GDP. Fifteen million people live in the basin's area, while ten million more, located outside the basin (Mexico City and Guadalajara's Metropolitan Zone), use its water.

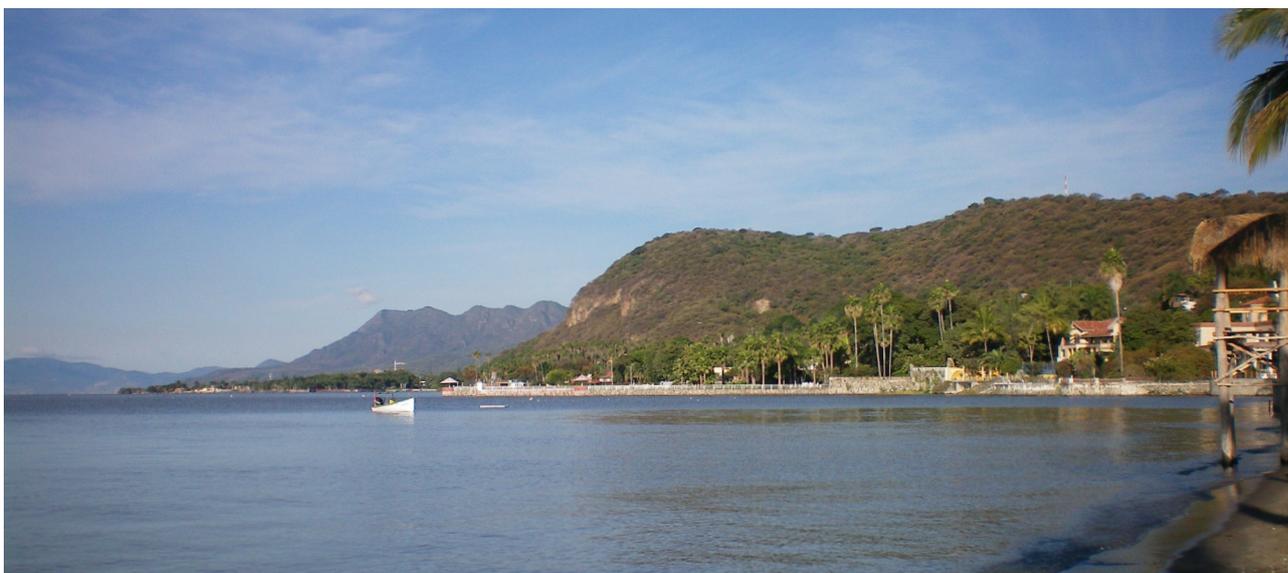
The lake and the basin's problems can be summarized in three main themes: deforestation, pressure upon water availability and contamination. Deforestation is mainly caused by the growth of agricultural activities and cattle over-herding. These activities take up to the 30% of the basin's area, taking place in irrigation areas (such as valleys) as well as in stormy areas. The main crops include grains (corn, wheat and sorghum), fruits (strawberries, cranberries and raspberries) and vegetables, even though it is more limited. The affected areas suffer wind and rain erosion that carry soil down to streams, dams and the Chapala Lake itself. For this reason, the lake suffers a high rate of sediment accumulation due

The lake and the basin's problems can be summarized in three main themes: deforestation, pressure upon water availability and contamination.

to the millions of tons of sediments that arrive each year. Furthermore, the illegal wood extraction, without silvicolous handle, is estimated in a 50% of the total wood extraction at the basin's area.

Due to the construction of various dams in the high and middle lands of the basin, the natural river flow has been reduced. The Lerma-Chapala basin has an annual deficiency of 677 km³ of water. This means that more water is consumed than that refilled by the rainfall. This shortage is dealt with over-exploitation of underground water resources, a situation that threatens to cause a strong middle-term crisis. This is worsened by the actual water misuse: it is estimated that up to 70% of irrigation water evaporates and the losses in the cities' piping systems is between the 30 and 40%.

Besides all the impacts already mentioned, the lake receives a large variety of farming, forest, cattle and domestic pollutants. A part remains dissolved in water, while the rest is accumulated in sediments. This accumulation means a critic risk to human health and productive activities. The pollutants affect fish population and increase disease and parasites proliferation. The main sources of nitrogen and phosphates in the lake's water are remainders of fertilizers, which are dragged into the lake and contribute to the growth of water hyacinth, a plant that in 1993 covered 135 km² (13% of the lake's area). Since 2006, algae bloom have been reported, this phenomenon reduces oxygen availability in the water abruptly. Another source of contamination is the raw sewage, its pollutants have been strongly reduced between 1980 and 2000, but it is still a problem to solve.



Views of the lake from the Chapala waterfront.

JUAN VENADO ISLAND NATURE RESERVE

The Juan Venado Island Nature Reserve is located in the northwest region of Nicaragua, in the town of León. It has a surface of 2,927.85 hectares and was declared protected area in 1983. The reserve is part of the National System of Protected Areas and of the Pacific Estuaries Biologic Corridor. With a length of 22 kilometers (from Las Penitas to Salinas Grandes), it is located on a sandy barrier along the Pacific coast.



Island landscape.

According to local history, its name is due to an ancient inhabitant who used the land to hunt deers and sell their meat. Nowadays, this is no longer a possibility. This area was also part of a settlement of an ancient indigenous culture: the Maribios, also called Sutibas. The reserve is considered the refuge to many endangered species of birds, mammals, reptiles, amphibians and aquatic fauna. The main forest found in the island is the mangrove.

The Chiquito River runs along León, crossing the Nature Reserve to flow into the Pacific Ocean. It is important to mention that it is part of a water network composed of several rivers and navigable estuaries during high tides.

Its area of influence is part of the chain of biological corridors of pacific estuaries that runs from the Chinandega Estuary (in the Northern Pacific

region of Nicaragua) down to Puerto Sandino and the south coasts of the Xolotlán Lake. This is the second bird migration route with most birds in the country, only beaten by the Caribbean route.

It is a zone of huge diversity, with 68 flower species among trees, bushes, weeds, cactuses and lianas. Besides, it has a great amount fauna, like birds, mammals, reptiles, amphibians, aquatic fauna, insects and spiders. A total of 77 bird species (18 migratory, 11 in the CITES list and 14 with special national regulation), 8 mammal species (among which 3 bat species can be found, which are very common in tropical forests since they are a main seed diffusor)

Even though the environmental importance of the Chiquito River basin due to its location and end in the Pacific Ocean, its waters have been affected for several years because of untreated household wastewater, toxic waste of the leather industry and solid waste.

and 10 reptile species (where Mexican spiny-tail iguana and the green iguana can be found, both hunted for their meat). Both species are in close seasons and are also sold as pets, because of there is need of a partial regulation of the species in the country.

Even though the environmental importance of the Chiquito River basin due to its location and end in the Pacific Ocean, its waters have been affected for several years because of untreated household wastewater, toxic waste of the leather industry and solid waste. This situation also affects the population of León, specially the riverside neighborhoods that have to deal with strong

smell and diseases risks. Thanks to systems like the green filters and the awareness of the communities, these ecosystems have still the chance to recover and become again the home of all those wonderful species.



Iguana iguana.



Mangrove at the island.



Sunset by the Magdalena River.

MAGDALENA RIVER

... water that unites the country. For the Colombian society, the Magdalena River is considered as the main hydric system. It guided, even before the Spanish conquest, the settling in the Colombian territory from the Caribbean coast uphill to the mountainous and fertile center. It was the main transportation and trade route, since it connected Cartagena de Indias with the Andean region through two main affluent branches that cover around a fourth of the continental territory (257,000 km²): the Magdalena River (with 1,528 km) and the Cauca River, its main affluent (with 1,350 km).

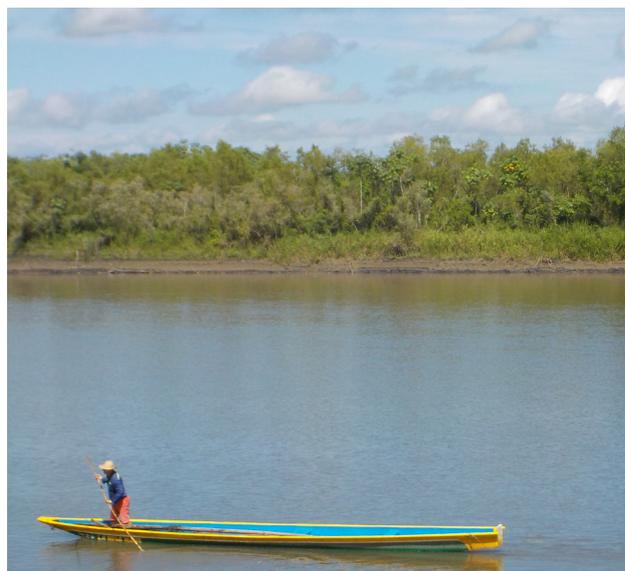
At 3,685 meters above sea level, between paramos and cloud forests, the Magdalena and Cauca rivers are born in the Southern Andes of Colombia and drain their way downhill through the main two inter-Andean valleys until reaching the Caribbean Sea. This wide distribution in space and altitudes has a rich diversity of ecosystems, of both the Andean and Caribbean regions, creating a complex and varied mosaic of biomes that are expressed in a wide range of environments that encouraged biodiversity. From the Caribbean savannahs up to the Andean mountain tops, an immense variety of fauna and plants inhabit. To picture it better¹, just in one part of the river's length, the middle Magdalena, more than 150 mammal species, 630 bird species, 120 reptile species, 50 amphibian species and 120 fish species and more than 4,000 plant species have been reported. Many of them are related to aquatic environments of an area greater than 5.7 million hectares², such as swamps, lakes, lagoons, basins, dams, canals and artificial superficial water bodies.

The Magdalena River basin is home of more than the 80% of Colombian population, and is where most of the urban centers of Colombia are located. Besides, almost all the Colombian industry is based on the basin and 58% of the basin's surface is used for agricultural production³. The soft and aromatic Colombian coffee is produced on the mountainsides at its valleys and savannahs. Its waters offer goods and services of immeasurable value for millions of Colombians that depend on the aquatic environments. For

This wide distribution in space and altitudes has a rich diversity of ecosystems, of both the Andean and Caribbean regions, creating a complex and varied mosaic of biomes that are expressed in a wide range of environments that encouraged bio diversity.



One of the busy harbours of the Magdalena River.



The Magdalena River, artery of life.

example, the fishing activities provide food and profits to more than 50,000 families, in addition to transportation, water supply, hydroelectric generation, tourism and other uses —biodiversity included. The mining industry has also been an ancient activities at the river's shores

and the most important oil refinery in the country is located at the riverbank in Barrancabermeja.

It is natural, then, that all these activities have consequences over the water quality, especially when it comes to its deterioration.

For this reason, the recovery of the river has to be faced with the most efficient and pertinent technologies, suited to the economic and technologic level of the country. If observed in detail, it is not a coincidence that water treatment plants are very scarce and, in case there are, their operation is very limited; this is a main challenge Colombia must face. More precisely, that is the challenge that we should be not only capable but also bold to solve, with the help of innovative and efficient technologies for water treatment and wastewater management. The benefit for many: this is the inspiration of Fundación Humedales, in collaboration with its allies, to undertake the following project: to supply clean water with easy and functional methods to protect vulnerable populations and strategic aquatic environments.

¹ WCS. Paisajes del Magdalena. [https:// Colombia.wcs.org/es-es/paisajes/andes/magdalena.aspx](https://Colombia.wcs.org/es-es/paisajes/andes/magdalena.aspx). 2019

² IAvH. Colombia anfibia. Un país de Humedales. Vol I. 2015

³ Restrepo y Restrepo. Instituto de Hidrología, Meteorología y Estudios Ambientales -IDEAM. 2005

MBARACAYÚ FOREST NATURAL RESERVE

The 64,405.7 hectares of the Mbaracayú Forest Natural Reserve (RNBM, for its name in Spanish), the center of the Mbaracayú Forest Biosphere Reserve, are situated at the northeast of eastern Paraguay, in the Canindeyú region. According to the eco-regional classification proposed by the Paraguayan Environment Department in 2015, the RNBM is inside a transition area between the Atlantic Forest of High Paraná and the Cerrado.

Since its creation in 1991, the surroundings at Mbaracayú have changed dramatically. Even though it is a protected area, the RNBM has not been unaffected by the new configuration of landscapes, the increasing demographics and economic activities. The management of this protected area has required the help of disciplines different to natural sciences. In order to protect Mbaracayú effectively, its surroundings had to be intervened. The main issues addressed have been: scientific research, environmental education, social investment and development in rural areas.

The Mbaracayú Forest Natural Reserve counts with a rich ecosystem and is one of the most biodiverse areas in Paraguay. Among the bodies of water present in the Reserve, the Jejuí'mi River stands out. It is the main river in the Reserve and it is part of the Paraguay River basin. The Jejuí'mi River runs west to unite with the Jejuí Guazú River to become the Jejuí River, just a few kilometers west Villa Ygatamí. For this reason, it can be said that the entire RNBM territory is contained in the Jejuí River basin.

Within the RNBM and its immediate influence zone, the Jejuí'mi River

has as tributary streams the Guazú, Opívo, Morití, Guyra Kíha, Pypukú and Bandera streams. The limits to northeast of the Reserve belong to the basin of the Karapá creek, which flows to the east and is tributary of the Paraná River. This is the only part of the RNBM that belongs to the Paraná River basin.

In addition to the rivers and streams mentioned above, the Reserve also counts with ponds and waterfalls as part of the landscape, the main touristic attractions at the Reserve. At this point, it is important to mention that these water bodies are funda-

mental for preserving the natural resources within the protected area for both the forest, and its inhabitants, who depend heavily on the Reserve.

Inside the Mbaracayú Forest Natural Reserve 19 different natural communities have been identified, among them we can find: forests of various altitudes and structures, closed fields, pastures, estuaries, lakes, caves, rivers and river sources. These ecosystems have a wide variety of animal and plant species.

Today, up to 1,018 plant species (among pteridophytes/ferns and



Jejuí'mi River, RNBM limit, aerial shot.



Lagunita, one of the most visited lagoons within the RNBM.



Surucuá (*Trogon surucua*), one of the RNBM species.

phanerogams/superior plants), 89 mammal species, 409 bird species (62 endemic species from the High Paraná Atlantic Forest), 22 amphibian species, 21 reptile species, 166 day lepidopterans (day butterflies), 42 coleopterans (beetles) and 146 hymenopterans (wasps and bees) are reported.

There are two species that have been historically classified as “endangered”; six species classified as “vulnerable”; and other eleven that are now classified as “almost endangered”; the most known of them is the jaguar, as well as the socially important tapir.

Compared to other areas in Paraguay similar in size, the RNBM is the site with the greatest number of endangered species (30) and is home of 50% of the total species present

in Paraguay. These species coexist due to the ideal conditions inside the RNBM, the thickness of the forest, the water sources and the different species that keep the natural biological control inside their habitats.

Compared to other areas in Paraguay similar in size, the RNBM is the site with the greatest number of endangered species (30) and is home of 50% of the total species present in Paraguay.

When it comes to infrastructure, thanks to the construction sites and the maintenance work carried out by local communities and NGO's in the territory, the roads and paths are conserved passable. Although, without rising awareness about water misuse and with no design of an action plan for sewage treatment at local and national levels, all the effort inside the RNBM as well as

in other preservation territories is in jeopardy. The water bodies accomplish a vital function in the Reserve. The pollution of water sources with nitrogen and phosphorus (resulting from human activities) cause eutro-

phication in these water bodies and, thus, affecting every species (vegetation and fauna) directly.

Some of its effects have been already observed within the RNBM, like dragonfly proliferation, changes in the intestinal flora of some animals due to polluted water consumption and the movement or disappearance of bird species.



THE PROJECT

The success of the operation and acceptance of the several communities and local agents of four green filters in Colombia, led several organizations of the Living Lakes Network to join the Green Filters Project Latin America, transferring this experience to seven rural communities.



OVERVIEW



Water before and after flowing through the green filter.

Pollution is a great threat to water bodies in Latin America and in the rest of the world. Almost in every developing country, an important amount of untreated wastewater is dumped into rivers, lakes and lagoons. This situation threatens the ecologic balance of aquatic ecosystems, and it is an important risk to life conditions of the affected communities. The rural areas that depend on the use of superficial water are specially vulnerable, since they are exposed to inadequate sanitary conditions due to the polluted wastewater.

As a solution for this, the successfully demonstrated efficiency of the green filters as an alternative technology for wastewater treatment adapted to the reality of rural Colombia attracted the attention of several allied organizations in the Living Lakes Network. With the common objectives of protecting water sources and improving the quality of life of thousands of people in Colombia, Nicaragua, Paraguay and Mexico, the project **Innovative Wetlands (Green Filters) as a Measure to improve the water quality and the life quality of rural populations in four countries of Latin America** officially started in September 2016, in collaboration with Global Nature Fund, Fundación Humedales, Fundación Moisés Bertoni, Fundar, Instituto Corazón de la Tierra and Fundación Cuenca Lerma.

The initiative was financed by the Ministry of Cooperation and Economic Development (BMZ) and the German and Swiss enterprises Kärcher GmbH & Co., KG GmbH and Sika. It has had the support

of local allies (local governments, public services enterprises and universities) as well as the community's involvement and participation in four different countries.

The main activities and impacts were:

- Construction of seven filters for the sustainable treatment of wastewater, based on natural degradation processes of pollutants and without the use of machinery or chemicals.
- Technical education on green filters and sustainable water treatment for 275 people.
- Environmental awareness and education of almost 4,000 inhabitants.
- Transference of knowledge, creation of networks and strengthening of political frameworks. Fundación Humedales (Colombia) has been the technical coordinator of the project and has trained all the other organizations in design, implementation and maintenance of this sustainable solution. Besides, several NGOs are interested in this technology and its potential has been

analyzed to be included in local and regional management plans.

- Latin American Conference of Green Filters.

The main results of the Green Filters Project Latin America have been:

- The consensus about the effectiveness and the great acceptance that green filters have had as a solution for the domestic and agricultural wastewater treatment.
- The green filter system improves the population's life quality, the water quality and helps to preserve biodiversity.
- It is fundamental to establish participative structures in order to enhance governance.
- The key actions for environmental conservation are: participative management, environmental education and the capacity building for the communities.
- The alliances networks are the main power force for the transference, replicability, improvement and dissemination of new sustainable technologies.



Inauguration: April 2018
Construction time: 10 months

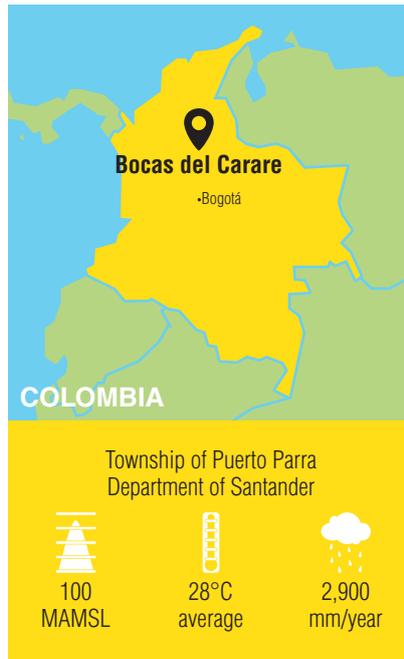
Executor: Fundación Humedales
Type of filter: Horizontal surface flow constructed wetlands

COLOMBIA

Bocas del Carare is a special place. Without a doubt, this place can represent one of the regions that suffered with great intensity the armed conflict in Colombia: the Magdalena River basin. Bocas del Carare belongs to the township of Puerto Parra in Santander.

Its population is made up of workers from all over the country, since many Colombians had to leave their natal towns due to violence in order to search for better conditions in the last sixty years. Nevertheless, in the 1980's, this populated area suffered the presence of members of two armies of the conflict, which resulted into the exodus of nearly the 100% of its population. The 1990's was a time of change at Bocas del Carare, most of its population returned and 40% was recognized by the Colombian Government as direct victims in the armed conflict.

Today, traditional fishermen and fisherwomen profit from the waters of the Carare River at the point where it joins the Magdalena River inhabit this riverside port. Most of the population at Bocas del Carare is made out of fishermen, farmers or employees at the local palm tree plantations that have found in this region an ideal site for palm oil production. Its 379 inhabitants are settled in some few streets barely



Today, traditional fishermen and fisherwomen profit from the waters of the Carare River at the point where it joins the Magdalena River inhabit this riverside port.

transited by kids enrolled at the local elementary school. They count with a fresh water supply system by pumping fresh but not-drinkable water from a superficial well into an elevated tank, from where it flows into the homes in Carare. As well, a system of collection and transportation of wastewater led the untreated sewage into a septic system that poorly treated the water before returning it to the Magdalena River.

In the last four years, the people of Carare has organized by establishing the Bocas del Carare Fishermen Association, the Entrepreneur Women Association of Bocas del Carare and by strengthening the Local Council. These organizations have become the perfect allies to promote sustainable development projects that can serve as an example to other riverside communities in the Magdalena River. Fundación Humedales worked with the associations and the Bocas del Carare's Local Council to create fruitful partnerships for projects like the green filter.



Kids from Bocas del Carare.



Fishing, the main source of income.

• In construction



• The green filter



 Inflow (water entrance) 1.5 L / seg.	 Canals: 14 Length: 445 m Width: 3.5 m Depth: 0.8 m
	
Used vegetation Flotant macrophytes, water hyacinth and water cabbage	

379 | beneficiaries

4.8 t / year | organic material removed

The filter was designed and built under strict sustainability criteria for its operation and implementation. Following previous experiences in Colombia, the almost exclusive use of local material and workforce was proposed in order to reduce energy consumption, waste and negative social and environmental impact during the execution and operation of the system.

A photovoltaic generator system was installed as well, so the hydraulic pump could be supplied with energy so it can automatically transport the poorly treated wastewater from the septic system into the green filter.

Not everything was easy. Due to the Magdalena River's influence, the soil at Bocas del Carare presents phreatic levels almost at its surface. Thus, even if the excavations for the green filter were not deep, water kept in the soil emerged in the lower territory of the area, damaging the



Launch event of the Green Filter in Bocas del Carare.

materials that waterproofed the channel. To control this, an additional pipeline for draining had to be installed, so the phreatic water excess could be returned to the Magdalena River.

After 10 months of intense work and after multiple climatic challenges, the filter was handed to the community of Bocas del Carare in April 2018, the same time of the 20th anniversary of the Living Lakes Network. The ceremony counted with the presence of several members of the community, the Local Council president, the president of the Fishermen Association, the president of the Women Association, the local authorities of Puerto Parra and members of the Town Council. Kärcher Colombia and Global Nature Fund were present too.

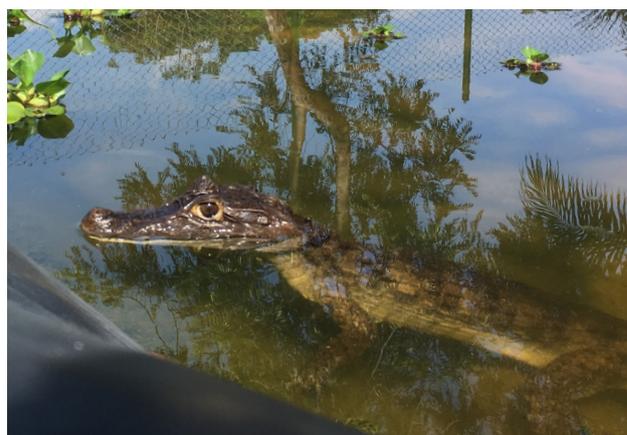
For being an extremely biodiverse area, the green filter receives visits from several species frequently. Colombian white-faced capuchin and howler monkeys (primates) swing in the palms at the filters site, while hundreds of birds spend the nights in the great grasses in the highest part of the territory. The water flows from the entrance to the exit, transforming and allowing insects, fishes and birds. The channels are seeded mainly with flotant macrophytes as water hyacinth (*Eichhornia crassipes*) and water cabbage (*Pistia stratiotes*) that attract amphibians and reptiles that can be seen among the macrophyte leaves.

As a result of the inauguration and with help from the different associations and the Local Council, the green filter has received visits of several leaders of different towns and national and regional media. Today, the filter is subject of community partners-

“It is not unusual to find yourself having a conversation with a local at Bocas del Carare and hear about the green filter. If you are lucky, they will invite you to meet the system and, as experts, they will show you how it works with professional precision.”

Felipe Valderrama Escallón, integral water management coordinator, Fundación Humedales.

hips with the local youth, which will take care of the operation and maintenance of the green filter in exchange of profiting from a productive project (production and commerce of eggs, for the local consumption) at the low territory of the filter.



Some visitors and inhabitants of the filter.

Fundación Humedales



It is a non-profit NGO dedicated to the conservation and restoration of wetlands at the Northern Andes. It has been the representative of the Fúquene Lagoon at the Living Lakes Network for 19 years. It has led processes to strengthen and make more dynamic different initiatives by local communities' organizations thus helping to manage a sustainable use of natural resources in Colombia. Fundación Humedales was in charge of the design and the technical supervision of the Green Filters Project Latin America and has worked together with GNF to transfer these technologies in Africa, the Middle East and Central America.

www.fundacionhumedales.org



Inauguration: November 2018
Construction time: 4.5 months

Executor: Instituto Corazón de la Tierra
Type of filter: Horizontal surface flow constructed wetlands

MEXICO

As a consequence of the big amount of pollutants in water bodies in Jalisco, several water treatment plants have been built. Nowadays, the local Government has 217 water treatment plants; from these, 131 are currently in use and only 81 fulfill the law standards.

This situation is very common in rural areas, due to the high costs of the operation of the plants, the lack of electricity and the absence of trained people for its proper maintenance. This context has led Instituto Corazón de la Tierra to analyze different alternatives to put an end to the problematic of poorly treated household wastewater that affects the population. As part of these projects, in September 2016, the Institute with cooperation of Global Nature Fund and the local government of Pihuamo to start a project to treat sewage through green filters, a very easy and low cost system to execute and maintain.



Socialization of the filter.

The project has been implemented in La Estrella, a small community of 223 homes at Pihuamo. The majority of the population is dedicated to rural activities and, if there is demand, to iron and other minerals production at the local mines or construction activities. They also practice fishing, but mainly to provide their own food.

La Estrella have had problems with untreated wastewater for decades, since it lacked of a water treatment system. The sewage was poured directly into the wild at the outskirts of the town, flowing freely into several water and fishing canals and Los Patos dam, which has a 3 million cubic meters capacity. This dam is vital for the local sugar cane producers and fishing. This situation led the community to ask several times their government to solve the problem that caused a negative impact on the population's health (gastrointestinal diseases were common, specially in children) and the environment.

The green filter was built 400 meters away from the community, in a property next to the dam. For its construction the land had to be

This context has led Instituto Corazón de la Tierra to analyze different alternatives to put an end to the problematic of poorly treated household wastewater that affects the population.



Capacity building with the community.

leveled with machinery, topographic measurements had to be done to determine the location of its components, water quality measurements and soil mechanics had to be done too, for the design of the pretreatment unities. Furthermore, it was necessary to protect the site from possible water overflow from the dam. More than 18 persons from the community helped leveling the soil, at the construction of the tanks, the installation of the geomembrane, the installation of the pipes and the

control valves, and the construction of the inspection boxes at the entrance and exit of the system. When the construction was over, the local Government personnel was trained on the proper operation and maintenance of the green filter.

In order to get the population involved, several meetings were held before starting the project with local adults, as well as successful education activities about environmental education at the elementary school.

• In construction



• The green filter



 Inflow (water entrance) 1.33 L / seg.	 Canals: 4 Length: 351 m Width: 3.5 m Depth: 0.8 m
	
Used vegetation Flotant macrophytes, water hyacinth <i>(Eichornia crassipes)</i>	

400 | beneficiaries

3.65 t / year | organic material removed

Once the filter started operations, a group of inhabitants visited the filter. The group was astonished by the correct operation of the system, since at the beginning they could not believe that wastewater treatment could be done without chemicals and machinery. In November 2018, the inauguration of the system took place, with the participation of the other Green Filters Project Latin America allies from Nicaragua, Paraguay, Colombia and Mexico, as well as some Global Nature Fund (Germany) and Kärcher enterprise representatives. At the ceremony, the town's mayor, local Government representatives and several inhabi-



Launch event in the Green Filter at La Estrella.



Ornamental plants, a productive project derived from the green filter.

tants were present. After the event, they all visited the green filter.

Without any doubts, one of the most important consequences of the project was its impact on local and national governance. Once the construction was over and the La Estrella population verified its proper operation and the improvements in their life quality, the deputies at the Congress of Jalisco State have asked to approve an agreement with the Environment and Local Development Office to include the implementation and maintenance of green filters and wetlands in the annual budgets to improve the water treatment at the municipalities and towns in Jalisco State.

The green filter has had a very positive impact in the town, that allowed to promote the construction of a second filter for the main area of Pihuamo, where 700 people live.

The green filter has had a very positive impact in the town, that allowed to promote the construction of a second filter to treat the wastewater of the main area of Pihuamo, where 700 people live. Today, this second treatment unity is under construction and will start operations in mid-May 2019. Besides, other neighboring towns have shown interest in using this method too.

The interest that other communities have shown on the green filter technologie, and the project itself, have

led to the interaction and collaboration with other regional and national agents concerned about the protection of the environment and the sustainable development of the Chapala Lake basin. For example, Instituto Corazón de la Tierra is already working with the Intermunicipal Association for the Environment Protection and Sustainable Development of the Chapala Lake basin (AIPROMADES), for the selection of possible communities where the green filter project can be replicated.

Instituto Corazón de la Tierra



Instituto Corazón de la Tierra is a non-profit institute that work recovering Mexican rivers and lakes. Its main objective is to preserve the environment through the development of ecological projects and technologies, through the education of rural and urban inhabitants on global environmental problems and the proper management of the water basins they benefit from. This consists of five main topics: participation (to strengthen local groups and other participation mechanisms for the inhabitants of the territory); ecosystem management (restoration and conservation of ecosystem by improving production techniques); ecofriendly technologies (for water and air treatment, to reduce the pressure on forests and be energetically more efficient); research; and environmental education. The institution has as priority site of action the Chapala Lake and its basin.

www.corazondelatierra.org.mx



Termination: January 2018
Construction time: 12 months

Executor: Fundar
Type of filter: Horizontal surface flow constructed wetlands

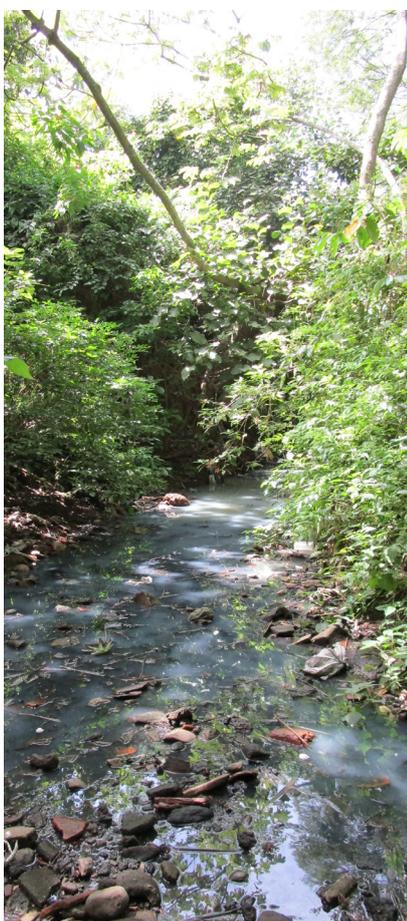
NICARAGUA

The Héroes y Mártires de Zaragoza neighborhood is located in León, a town at the northwest of Nicaragua. There, around 400 persons live. The economic activities of the inhabitants are diverse, they depend mainly on the maquila production, the activities related to the University and the soy, peanut, sugar cane and sesame production. In 2006, the Cathedral of León was declared Cultural World Heritage, making the city a main point of national and international tourism that has benefited many neighborhoods in the city.

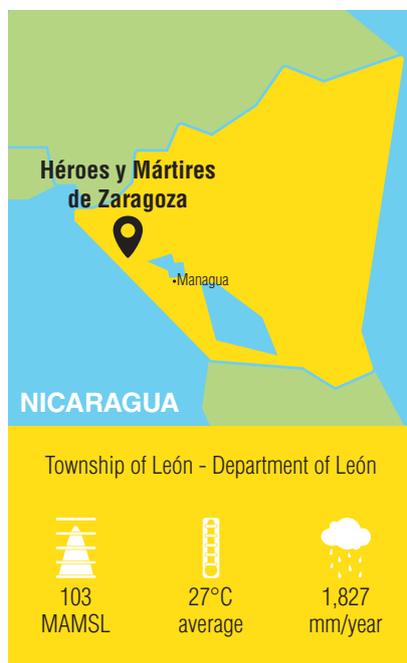
In Héroes y Mártires de Zaragoza case, the life conditions have always been hard due to, among others, the lack of infrastructure and economic resources of the local administration. The community counted with a conventional water treatment unit that was very expensive to operate and that did not work properly. An area of the neighborhood had become a dumpsite, since there was no infrastructure for the management of solid waste. The wastewater flowed directly into the river that carried the garbage leach. This situation affected the inhabitants of the neighborhood, damaging the quality of the superficial and underground water bodies in the Chiquito River basin. As a measure to solve this problem, Fundar, in collaboration with Global Nature Fund, has developed an innovative project in Nicaragua for the treatment of wastewater through the green filter method.

since the beginning, even if the technology was new for them and with which technical trainings were carried out for the future replication of green filters in other communities.

- Nicaraguan Enterprise of Water and Sewage (ENACAL). The enterprise that assumed the maintenance and follow-up of the infrastructure together with the community.
- Ministry of Education (MINED). A key agent in the process since has coordinated environmental education and awareness activities about the green filters and introduced them into the curriculum.
- León City Hall and BORDAS NGO. Both entities have developed activities to use the systems sub products (basically organic material collected from the canals) as humus and fertilizer.
- Freundskreis-Hamburg. They were in charge of the



Contaminated stream with wastewater.



The community counted with a conventional water treatment unit that was very expensive to operate and that didn't work properly.



Improvised dump.



Cleaning day at the community.

Besides the environmental benefits, the filter has become a real urban garden. The impact at community level is remarkable and several links with local agents have been established.

Several collaboration agreements and plans have been established with locals and national entities such as:

- León local Government. It has supported the project

conventional filters previously used by the community.

- Ministry of Health (MINSAs). Some cleaning activities were carried out at the Chiquito River at the same time some health and cleaning programs were promoted among the inhabitants.

This project adapted the previous system's infrastructure as a pretreatment and primary treatment facility before

the water flows into the five canals that complete the process. The works carried out included excavation and waterproof of the canals, the reinforcement of the walls (since the filter is on a downhill slope) and the swon of native macrophytes.

Finally the constructions ended on January 2018 with a fully operating filter, reaching removing levels higher than those established by the Nicaraguan law. Due to the political situation of the country in 2018, the inauguration of the project has been postponed, a new inauguration date is yet to be announced.

The impact at community level has been very strong, since it changed the quality of life of the neighborhood inhabitants. The community leaders in Héroes y Mártires de Zaragoza worked together to solve the problems



Previous unfunctional system of wastewater treatment.

• **Adaptation and construction**



• **The green filter**



 Inflow (water entrance) 2.5 L / seg.	 Canals: 5 Length: 743 m Width: 3,5 m Depth: 0.8 m
	
Used vegetation Flotant macrophytes, water hyacinth <i>(Eichhornia crassipes)</i>	

390 | beneficiaries

9.96 t / year | organic material removed

caused by pollution of water due to the bad operation of the previous systems, but no government agency took the responsibility. The green filter initiative has relieved the community, they feel someone has listened to them, there are no more bad smell and diseases. These changes have empowered the community so they can take charge or the filter maintenance in the long run.

In addition, thanks to the empowerment of the community, the safety has improved and 14 drug trafficking points have been shut down. Living together is now easier for the neighbors than before the project took place.

At last, one of the biggest problems faced by the inhabitants was the solid waste management, since it did not exist. The truck could not enter the neighborhood and the inhabitants had to move their waste from one place to the other or, in some cases, they just threw them in an area that became an improvised wasteland. Thanks to the project, now the truck has access to the neighborhood and the city hall has established a collection schedule.



Informative panel about the project for visitors.

As a conclusion, it is important to remark how this project has benefited the entire community, not only by managing waste but also by creating a sense of community among the inhabitants, giving them the necessary tools to be a real agent of change.



And after many months of work... the truck arrived.



Environmental education event at the House of Culture in León.

Fundar



Fundar is an NGO founded in 1998 in Nicaragua by a group of professionals of different disciplines. Their main goal is to support and promote social and environmental initiatives that

can contribute to the local management of natural resources in order to strengthen social and economic equity. Fundar cooperates with territorial coordinators, the Ministry of Natural Resources and the Environment, the Ministry of Education, and the National Autonomous University of Nicaragua, among other organizations that share their goals and mission.

www.fundar.org.ni



Inauguration: November 2017 and April 2018
Construction time: 12 months

Executor: Fundación Moisés Bertoni
Type of filter: Horizontal subsurface flow constructed wetland

PARAGUAY

Paraguay has a huge fresh water availability coming from rains, an important network of rivers and creeks (superficial water) and one of the biggest aquifers in the world (the Guarani Aquifer). Nevertheless, around 40% of its population has problems to access safe water, since there is no system or network that provides safely treated water for human consumption.

This unacceptable situation has motivated several leaders and organizations in order to put an end to the problem of access to safe water. Among them, Fundación Moisés Bertoni (FMB)

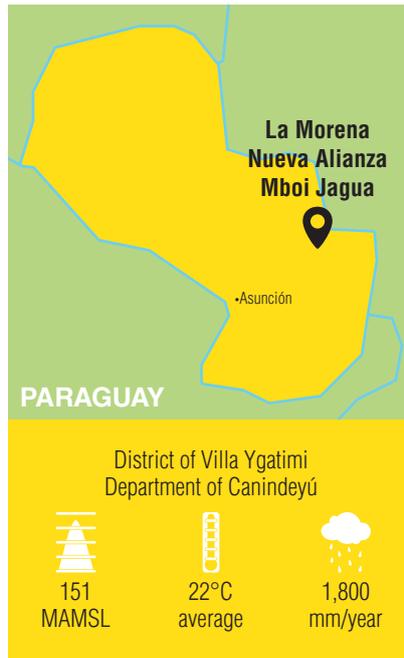
that believes this problem has huge environmental, social and economic consequences, and solving them is the first step towards a sustainable developed society. In order to face this situation, the FMB works

in different initiatives to tackle the complex problem that sustainable management of water is. One of this projects started in September 2016, in cooperation with Global Nature Fund, that aims to treat household

wastewater in three communities located within the buffer zone of the Nature Reserve Mbaracayú.

In the project's context, the FMB has built three green filter systems and three restroom batteries and have repaired two other restroom batteries in three schools in three communities in the Villa Ygatimí district, in Canindeyú. Such infrastructures have had a follow-up program for the beneficiary population.

The three rural schools are the beneficiaries of this project: the High School at Colonia Nueva Alianza, the High School at Colonia La Morena and the Elementary School Mboi Jagua. These schools are in three different communities with different origins and dynamics. The community at Nueva Alianza is a rural settlement in the district of Villa Ygatimí, located at 8 km from the nearest paved road and 18 km from Villa Ygatimí. This community was founded in 1995 and counts with 150 young families. The community of La Morena is Nueva Alianza, it is also located within the Villa Ygatimí district. It was founded in 1988 by 50 families. Mboi Jagua in an indigenous community located 17 km away from Villa Ygatimí and 5 km from the Reserve Mbaracayú, it was founded in 1968 and today has 246 families of the "Ava Guaraní" ethnicity. This community has roads that lead to the Reserve. The



Before the project, these communities had no sewage system, so most of them had latrines in their homes and institutions.

inhabitants, specially the elder, keep protecting their language, songs, customs and religion by organizing activities for the youth, so the "Ava Guaraní" values can be preserved despite the rampage of not sustainable development in their territory. All of the three communities are mainly dedicated to agriculture and cattle. In addition, by being next to the Jejui Guazú River and some

other streams and creeks, the families benefit from fishing. These are their main economic activities as well as the production of manioc starch. As in many other rural areas, the youth of Nueva Alianza, La Morena and Mboi Jagua have to travel great distances to reach the cities in order to get part-time or full-time jobs.

The infrastructure of these communities is scarce and basic. Besides the schools, none of them counts with public services, health centers or management of solid waste and wastewater. Before the project, these communities had no sewage system, so most of them had latrines in their homes and institutions.

The building process of the filter counted with the help from the communities. As being a project linked to the schools, the project had to be previously approved by the Ministry of Education and Science. In June 2017, the works started at the Nueva Alianza and La Morena, while the works in Mboi Jagua started in September of the same year. The process was the same in all three: excavations were carried out for the wastewater treatment canals, the toilets were built or rehabilitated and, connected to the new system of drainage and treatment.

Since the site of implementation were schools and, in order to avoid



School in La Morena.



School in Nueva Alianza.



School in Mboi Jagua.

• Construction and repair of the bathrooms



• Construction of the green filter



Canal: 1
Length: 9 m
Width: 3.5 m
Depth: 0.9 m



Canal: 1
Length: 12 m
Width: 4.5 m
Depth: 0.9 m



Canal: 1
Length: 10.5 m
Width: 5 m
Depth: 0.9 m

500 | students and teachers in total

accidents, the technical design of the filters was sub-superficial. This means that the canals run not deeply, filled with rocky material through which the wastewater is treated by the indigenous plants used for treating waters with high amount of organic waste. In this case, so the students could feel empowered by managing these systems, the plants were placed during the school year, to guarantee them daily care, especially during the first days, when there is not enough volum of water in the filters.

In the specific case of Mboi Jagua, the school did not have tap water, so

a tank of 1000 liters was provided, so the school could use water to start using the new restrooms.

The building stages were programmed with the community, most of the times through voting, especially among the school community. It is important to mention that during the year the works had to be suspended temporarily because of bad weather, the difficult access and, even more, because of the lack of qualified people for this construction.

The green filters and the new restrooms were inaugurated on November 23rd and 24th 2017 at La

Morena and Nueva Alianza. On the other hand, in April 18th 2018 was the inauguration of the Green Filter at Mboi Jagua. For this event, the mayor of Villa Ygatimí, the president of the Town Council, the local GNF coordinator of project and the technical coordinator from Fundación Humedales were present. During these events, the schools were supplied with all the materials needed for the maintenance of the filters, they were guided along the filters facilities and the system was explained to them.

The project has been widely spread. For this, FMB invited teachers from other schools to the workshops



Planting the macrophytes.



Launch event at the Mboi Jagua Green Filter.

about the filter and the management of wastewater. Some months before the end of 2018, many institutions got interested in the project and its replication, making the transmission of knowledge a reality. The design of the “Green Filters Project II” is on going, in addition to the identification of possible financing sources. Five new schools in Villa Ygatimí district (Chupapou school, a indigenous community, among them) are now included. By the hand of Fundación Moisés Bertoni, some agreements with the Villa Ygatimí local governments are discussed and approved. In these agreements, the local government commits to manage the resources for executing the project in at least two of the schools, while the FMB will carry out the design

and the management for reproducing the project in three more schools.

Even the students have had a positive impact on their behavior, now that they have started applying what they have learned at the workshops. The impact has been so positive that the students themselves have started an initiative to recycle materials that formerly had been burnt (plastic, tetrapack, etc.), thus creating some recollection points open to the entire community reducing its environmental impact.

On the other hand, thanks to the excellent results shown by the Green Filters Project Latin America at the Final Conference, held

on November 2018 in Mexico, the National Environmental Sanitary Service (SENASA) decided to build a sewage system centered in the green filters as the treatment method. It is important to remark that the SENASA is the institution in charge of sanitary infrastructure in communities smaller to 10,000 inhabitants. This process has already started, and the identification of the rural communities smaller to 1,000 inhabitants suitable for the project is undergoing. The selected community should be inside the “High risk of underground water pollution zone,” according to the studies carried out by the institution. Once the community is chosen, the work on the project design and the financing sources will start.

Fundación Moisés Bertoni



Fundación Moisés Bertoni (FMB) is a private non-profit association that invests in sustainable development understood as the process of creating environmental, social and economic value. The objective of FMB is to improve the life quality of people by preserving the biodiversity, the conservation of the environment and the promotion of the sustainable development for the benefit of future generations. To reach these goals, it works under a balanced, fair and inclusive model that brings together multiple elements and dimensions. For this reason, FMB prefers an integral approach that comprises the inhabitants needs, working as a mediator between the public sector, the private sector and society in order to find innovative solutions to complex social and environmental problems that must be faced together.

www.mbertoni.org.py

WORKING WITH THE COMMUNITIES

Any community project needs the involvement of the inhabitants and the local leaders for being successful. The Green Filters Project Latin America has been a clear example of international cooperation projects designed for and, even more important, with the local communities. The community's involvement in the execution of activities and, particularly, when taking decisions is the key for a real sustainable development of rural areas.

This is the reason why, when drawing attention to a project, identifying the local leaders that might have influence on the success of the project is the first task. After doing this, a plan for approaching to the community has to be designed, so the main characteristics of the initiative can be shared with the population in order to find an unanimous acceptance of the project. Once some agreements have been achieved with the community and authorities, it is important

to look for possible spaces to share the development of the project's execution. To inform the population in order to establish groups of community work and develop the technical capacities needed to make a proper use of the installed infrastructure and its maintenance. In that same sense, and aiming to involve every generation, workshops at schools with the youth should be carried out to ensure a long-term sustainability and community appropriation of the project.



Meeting of the Council of Puerto Parra (Colombia).



Visit of the municipality of Hamburgo (Nicaragua)

ENVIRONMENTAL EDUCATION

Education is an indispensable tool for changing society. We can not take care of something we do not know or we do not understand, this makes even more difficult to implement and maintain new systems and development models. For this reason, environmental education has played a key role in the sustainability and the appropriation of these new sewage treatment systems.

With the purpose of raising awareness about the impact of untreated sewage has on our health and environment,

the allied organizations from the four countries have carried out several socialization and education activities at all levels of the community. These have been very diverse and have taken place in city halls, schools, community centers and even main squares. Such has been the case of Nicaragua, where thanks the close work of Fundar with the Ministry of Education, some activities related to the green filters have joined their education programs, like the campaign "Safe, Clean, Beautiful School!"



Educational booklet "El agua y yo" (Colombia).



Activity with native animal masks (Mexico).



Aquifer simulator (Paraguay).



Theatre play (Nicaragua).

The activities have been focused on two target publics:

• **Adults:**

- Meetings and informative talks about the rational and sustainable use of water.
- Presentations and visits to the green filter areas.
- Educational material, such as flyers and stickers, promoting the proper use of sewage in a household.

• **Children:**

- Educational talks and visits to the green filters.
- Workshops at schools about water, recycling and other environmental topics.
- Educational material, like the handbooks and guides provided by Nicaraguan Ministry of Education.
- Games, masks, plays, costumes and other dynamics

emphasizing the importance of clean fresh water for human health and the ecosystem.

- Elaboration of model simulating wetlands, as the one made in Paraguay, to share the problems caused by dumping untreated wastewater.

In addition, each of the green filters installed have an information panel or desk where the visitors can find graphs and short texts explaining the filter's system and their social and environmental benefits. In Paraguay, even some educational posters have been installed inside the toilets.

Thanks to the hard work of Fundar in Nacaragua, Fundación Moisés Bertoni in Paraguay, Instituto Corazón de la Tierra in Mexico and Fundación Humedales in Colombia; 4,000 people have been reached.



Informative desk in the green filter (Paraguay).



Information desk in the green filter (Colombia)



Informative sign in the bathrooms (Paraguay).

TECHNICAL CAPACITATION AND CAPACITY BUILDING

A good knowledge on the operation and maintenance of the system is key on the long run. Even if the system is very simple at a technical level, it requires a basic, rigorous and constant maintenance, especially in warm weather areas, where the macrophytes grow very fast. This technical capacitation has the transmission of operative information for the right use of the filter as its main objective.

The technical training is focused in three groups:

- **Education for the execution organizations by the technical coordinator of the program (Fundación Humedales).** To start the Green Filters Project Latin America, the first meeting was held with participants organizations in Colombia. They visited one of the Green Filters in operation in the country so the participants could get their first general knowledge about the technology. The following technical trainings took place during the technical coordination visits to each of the countries where were the project has been implemented. They were focused in training the technical team of the implementing organisations in charge of construction and monitoring filter. In order to acknowledge the limits and characteristics of every filter, specific topics had

to be approached in every green filter site. The topics approached were such as the land slope, type of buildings, access control, volumes of water treatment, type of water to treat, etc.

In the case of Mexico, a follow-up by the technical coordinator has almost not been needed, since in that country there were previous experiences with this system of sewage treatment.

- **Technical training for the communities,** since they will be in charge of the maintenance of the system. In these meetings, topics related to the maintenance of the filters and tanks, the regularity of the maintenance, the type of maintenance required, the use of the filter's sub products (compost), the use of the treated water (irrigation), the operation of the connecting valves, the cleaning of the nearby areas, the protocol to take water samples for quality analysis and the information of the providers of equipment and materials that might be needed for keeping the filter for the following 15 years were approached.

In Colombia, the local workers visited a already installed green filter, so they could accept and promote this technology in their areas. Besides, the personnel



Group of women in La Estrella community (Mexico).



Training of last grade students (Paraguay).



Poster "Maintenance tasks of the Green Filters" (Colombia).



Workshop with teachers (Nicaragua).

in charge of the filter also learned about solar energy and batteries, since the system's pump is powered by solar energy.

In Nicaragua, together with the Ministry of Education, a learning program for school teachers was carried out, including site visits, so the school community could be open to the project and be in charge of it.

In Paraguay, the technical education was part of the curriculum in the three schools, since the filters were going to be kept by the last year students. This program consisted of three parts:

- Maintenance of the filter: Focused on the care of both plants, the planted in the filter and the ones watered with the treated water. Gardening, watering, summer schedules (since the filters have to be taken care of during holidays), seed production and recycling of school materials were some of the topics approached.
- How to build your own green filter: Focused on the knowledge about the parts and materials used in the filters and restrooms. Based on this, children could design their own filter, or at least their favorite part, and build a miniature with recycled materials.

- Monitoring the water quality: Topics related to water quality, the care and cleaning of septic tanks, and the sample taking procedures for the water entering and exiting the system in order to keep control of the depuration levels.

- Since one main objective of the program is to transfer the green filter technology to rural communities in order to improve their life, **technical education has taken place in every country for Government agencies, local Governments, Universities and others** in order to replicate this model as much as possible in communities that still do not count with safe water treatment systems.

In Nicaragua this part was fundamental. ENACAL and ALMA, the Government agencies in charge of sewage at national level, trained some of their personnel on the green filter technology. Due to this capacity building, both the ENACAL and León local government have identified a site to implement this model. This means that the technical team of both institutions understand the green filter circumstances and technology.

VOICES OF THE PROJECT

The citizen participation is a key factor for the autonomous development of rural communities. Its inclusion during decision-making and implementation phases is fundamental for appropriation of the infrastructure and its dynamics, assuring its sustainability and reproduction. This project is a real example of citizen empowerment, from the initial stages of the construction of the filter until the long-term maintenance. For many people it was a great surprise to see how a water treatment plant could look more like a floating garden than to a conventional structure, that at the same time eliminates bad smells and attracts species that were not seen in a while.



As municipality mayor during the inauguration of the green filter, Juan Alcaraz told us: “Before, in La Estrella we had problems repeatedly with diseases caused by the polluted drinking water. The green filter is of low-maintenance and improves the hygiene; and so, the life conditions of every person living in this community. We use now the treated sewage to water our ornamental plants (the ones of the women movement). We also realized that the water quality of the Los Patos lake has improved. This benefits the fishermen in the town. I hope other communities will follow our example.”

JUAN ALCARAZ VIRGEN, president of the Pihuamo municipality (Mexico).



“The green filters project in the Héroes y Mártires de Zaragoza neighborhood has been an efficient answer to our sewage problem. The green filters are the best project that could have been executed in our community since this is a place of difficult access. The project has proved to be ideal because of its simple techniques to get ecologically treated water, returning the clean water to our river with a low pollution levels, no colors and smells. The community is thankful with Fundar for the execution of this wonderful project that has taught us how to manage water.”

FRANCIS VALESSKA RODRÍGUEZ, neighbour of the green filter (Nicaragua).



María Elizabeth Alcaraz is deputy at the Jalisco Congress, and was mayor of the Pihuamo municipality during the implementation of the Green Filter at La Estrella. In one intervention at the Final Conference of the Green Filters Project Latin America, María Elizabeth shared her perspective: “I would like to share my experience about the project we implemented in Pihuamo. I’m talking about the installation of the green filters, as artificial wetlands, that help the treatment of the sewage at a low cost. In Pihuamo we carried out this project with help of Instituto Corazón de la Tierra and the economic aid of the German government; it has been a very fruitful and important initiative for the community. The project came along with a productive project, an association for the women of the La Estrella community, where the filter is installed. I invite everyone to transmit this type of technologies to their local communities; you can come to La Estrella too. These technologies are very efficient, very positive for the environment and at very low cost. When a mechanic water treatment plant is installed, the Government assumes the cost of the construction, but its maintenance is the city’s responsibility, and it’s very high. So high, that some towns of the region had abandoned their water treatment plants. It’s the opposite with the green filter; its operation is very cheap because it doesn’t need machinery, no pumping or chemical products. It’s very interesting and suitable for the environment. We have to promote this technology in other towns in Jalisco.”

MARÍA ELIZABETH ALCARAZ, deputy at the Jalisco Congress (Mexico).



During the inauguration, the director of the school stated one of his concerns about the project: “**the kids are not using the bathrooms**”. Worried about this problem, Fundación Moisés Bertoni team asked if there was any problem, to which he answered: “**No, the problems is that these bathrooms are too modern for them. They don’t know how to use them; they think the bathrooms are too neat and that they could break them**”. After this revealing conversation, some education workshops concerning the good use of the bathrooms took place in order to solve the problem.

ALTEMIO GÓMEZ LOZA, director of the school at the Mboi Jagua community (Paraguay).



“We are the only riverside community in the Magdalena River basin that returns clean water to the river. We help the water and we are an example to our neighboring communities.”

ALFREDO PALACIOS, local technician at Fundación Humedales and inhabitant of Bocas del Carare (Colombia).



As representative of Entrepreneur Women Association of Bocas del Carare, Kelly told us: “We take all the visitors at Bocas del Carare to the green filter. The filter is a proof of the town’s projects and can attract more support to our community.”

KELLY VANESSA CUERVO, ASOMUCARE representative (Colombia)



“I’m very happy that the project is being executed because it’s of great benefit for the communities where it’s taking place. It will be of great benefit for the children and the schools, there are a lot of them and the investment won’t be in vain. Here there is real need, they’re too many, and for this reason this project will benefit them.” Besides, he assures that this project has a great potential to be reproduced in other institutions, where there are huge necessities, as in the schools where the project has taken place, and where the education offered along with the project would be helpful for the communities.

ANÍBAL BENÍTEZ, local technician at Fundación Moisés Bertoni and neighbour of the communities (Paraguay).



“At the beginning people didn’t believe that it was going to work, but they supported the project because it was going to create new jobs. But, as soon as the works made progress, the people began to get curious about the project. Later, when they connected the pipes, they saw how the treatment works, through the channels and the wind and sun, and they were astonished. We are used to big machinery in order to clean water... and now there’s even people that come from other town to see how our filter works. This is very good!”

NOEL GARCÍA, inhabitant of La Estrella (Mexico).



“The water comes out so good that now fishes can grow! We have seen alligators and turtles. We are planning to exploit fishing bait for traditional fishing in the last canal, where the water is really clean.”

MARIO PARRA, inhabitant of Bocas del Carare (Colombia).

AN ENVIRONMENTAL AND SOCIAL COMMITMENT



The cleaning expert Kärcher and the Global Nature Fund build eco-friendly green filter plants worldwide to treat wastewater. A simple technology for a lot of clean water.

Water is one of the planet's most valuable resources. People's living conditions globally depend hugely on access to clean water. Working responsibly with water is very important, especially given the climate change. Under this belief, the cleaning appliance manufacturer Kärcher and the Global Nature Fund have been working together for 20 years now. In 2012, they both founded the initiative "Clean Water for the World" that seeks to build green filter plants to treat water ecologically, particularly in developing and emerging countries. "As an international company, we have been aware of our global responsibility for the environment for many years. Water protection is especially important to us," says Hartmut Jenner, Chief Executive Officer and Chairman of the Board of Management of the Alfred Kärcher SE & Co. KG.

The combination of technology and local networks has assured the initiative's success. The green filter plants are uncomplicated in operation, simple to set up, and achieve results that even exceed the expected indicators. Indigenous plants are used on-site to purify wastewater; they reinforce the biological processes



Visit of Johannes Kärcher to the Green Filter in Bocas del Carare (Colombia).

that already occur naturally. They are, thus, a cost-effective and environmentally friendly alternative to standard sewage treatment plants. People have little involvement in the process. This makes green filter plants a very good solution for small villages that only have low financial resources and technology available. Thanks to GNF's strong networks, plants can be built in these countries despite the lengthy and often

“As an international company, we have been aware of our global responsibility for the environment for many years. Water protection is especially important to us.”

Hartmut Jenner, Chief Executive Officer and Chairman of the Board of Management of the Alfred Kärcher SE & Co. KG.

difficult planning phases. To implement green technology sustainably, the environmental foundation works closely with the communities. This means having enough people locally who understand the plant from the outset.

Kärcher and GNF's goal is to raise awareness of sustainability further and implement follow-on projects in the regions. A total of 15 green filter plants have now been built worldwide, seven of them in four countries within the past year. For 2019, another plant is planned in Jordan, with both partners committed to continuing working together to treat water and supply drinking water.

EVENTS

Share experiences and knowledge with other actors and countries about results, strategies and difficulties for the implementation of alternative technologies and protection of water bodies is fundamental. In order to achieve this, throughout the development of the project, a series of events bringing together countless participants from different backgrounds and sectors have been carried out. Green filters as a solution to not treated domestic water that triggers water bodies and put riverine populations under serious risk.



Kick-off meeting.



Sustainability Forum.



Final Conference.

KICK-OFF MEETING

December 2016. Colombia



Visit to the Green Filter in Fúquene (Colombia).

In September 2016, the Green Filter Project Latin America started. The objective of this project was to transmit and replicate the good results obtained in Colombia after the implementation of this water treatment technology. The first activity took place in Colombia in December 2016: "The Kick-off Meeting Colombia"; coordinators of every country where present in this two-session starting meeting. The first session of the meeting was focused on strategic planning: definition of goals, duties of each organization, management and financial advice and brainstorming for the social component. The second session was focused on fieldwork and the first techni-

cal training. By the fact that only Instituto Corazón de la Tierra (Mexico) also had experience building green filters, an entire day was dedicated to give technical advice to the other organizations. This activity took place in the green filter site at Fúquene, this filter was built by the Fundación Humedales in 2015. This session was extremely important because the basic technical concepts were shared so the organizations could finish the design of their filters, define its components, the construction phases and learn how to perform an efficient maintenance to provide a long-term sustainability to the entire system. This was how the transmission of technology started to flow during these last three years between Colombia, Paraguay, Nicaragua and Mexico.



Brainstorming of implementing organizations.

FORUM: “Chapala in the 21st century... towards the sustainability”. Novembre 2017. Mexico



Marion Hammerl, president of Global Nature Fund.

In the context of the Green Filters Project Latin America in November 2017, Fundación Cuenca Lerma Chapala and the mayor of Chapala, Mexico, organized a forum about the future of the Chapala Lake and the sustainable management of the largest lake in Mexico. Marion Hammerl, president of the Nature Global Fund was present too. At that moment, the Chapala Lake has 57% of its “regular” volume. Marion highlighted it was comforting to see the lake in good conditions despite a long drought and a decrease of its surface in the recent years. However, this improvement was not due to a good management but to strong precipitations. Just the metropolitan area of Guadalajara has a 60% of illegal wells and there is no use of rainwater or awareness campaigns to reduce water misuse. The lake suffers another great problem: pollution. Heavy metals, arsenic, huge amounts of remainder nutrients from agriculture

and untreated wastewater from households reach the lake daily. More than the half of the water treatment plants in the basin do not work properly o do not work at all. But the lake is not alone, Manuel Villagómez, president of Fundación Cuenca Lerma Chapala, has been working for 40 years in its protection and finally gets some help. In May 2010, ten different towns around the lake created the Intermunicipal Association for the Protection of the Environment and Sustainable Development of the Chapala Lake (AIPROMADES). Besides the volume of the lake, the towns are promoting the creation of protected areas and reforestation areas to prevent the sedimentation of the lake and help to reestablish the hydrological balance of the basin. AIPROMADES is an excellent ally to inform the neighboring towns about the green filters as a practical and low-cost solution to treat wastewater.



Forum panelists.

FINAL CONFERENCE: Green Filters Project Latin America

Novembre 2018. Jalisco, Mexico

As closure of the project, a final conference was held in Jalisco. Instituto Corazón de la Tierra and GNF were in charge of leading the workshops during the three days. In addition to the coordinators of the organizations of the project, Udo Gattenlöhner, executive director at Global Nature Fund; María Magdalena Ruíz Mejía, head of the Office for the Environment and Territorial Development; Carlos Alberto Hernández Solís, general coordinator of projects at the State Commission for Water; Elizabeth Alcaraz Virgen, deputy at the Congress of Jalisco State; Abel Vargas, director of Public Works of Pihuamo; Juan Alcaraz Virgen, mayor of Pihuamo; J. Isabel Romero,

director of Ecology and Sergio Almazán representative of Kärcher México were present.

The conference was divided in several sessions. **A first one in Guadalajara** with the objective of informing about the functions and implementation of the green filter technology to treat wastewater, and the impact that Fundación Humedales, Fundación Moisés Bertoni, Fundar, Instituto Corazón de la Tierra and Fundación Cuenca Lerma Chapala have had in different communities in Colombia, Paraguay, Nicaragua and Mexico. During the first part of the event, the potential future



Shaping networks: Colombia, Nicaragua, Paraguay, Mexico and Germany together in the cleaning of wastewater.

for the green filter technologies at Latin American and global level were discussed, as well as the role of the international transboundary in the Integral Water Management.

A second part in Guzmán City, with the participation of different agents: local leaders, students, the public and private sectors and NGOs. Several discussion groups analyzed different synergies between the involved agents during the development of environmental projects. This, in order to identify the best interactions between science, the private sector, politics, civil society, the Government, international groups and financing agencies with the objective of give visibility and viability to sustainable technologies within the management plans of environmental authorities.



Brainstorming, creating new alliances.

A third part at the shores of Chapala Lake, where a conversation between all the assistants from the different organizations belonging to the Living Lakes International Network took place the guidelines for future projects as a network, seeking to enhance the work of each organization in their country and add them to

a joint effort of experiences and scopes. The following topics were approached: implementation areas, specific projects, allies and financing sources. In that session it was also discussed the main role of local governance, environmental education, and communication across borders for the conservation of ecosystems and replication of technologies. It is a difficult and challenging way, full of discoveries and fruitful alliances, just like the ones established during the Green Filters Project. This path generates strong synergies to continue working towards the improvement of the lakes around the world and set guidelines for the Living Lakes Network Latin America and the Caribbean.



Udo Gattenlöhner (GNF) hand over to Nell Orozco (Instituto Corazón de la Tierra) the certificate of new member of the Living Lakes Network.

At this event, the Green Filter at La Estrella was inaugurated. The local governments and authorities of Pihuamo and the community were present at the ceremony. In addition, Instituto Corazón de la Tierra was awarded with the certificate as new member of Living Lakes Network for his work at the Chapala Lake and the Allende Reservoir. Its in that area, the organization is carrying out a integral management of the basins, focusing strongly on local participation with the main agents, the public entities, the academy, the farmers, the fishermen, women and other groups that benefit from the basin.

Almost every one participating in some of the sessions of the Final Conference highlighted the importance to add up energies to keep raising environmental awareness. In addition to the need to share experiences, knowledge and strategies with agents and other countries, to protect the water bodies worldwide.

Saving lakes is not easy, but someone has to do it!

SUSTAINABILITY

Once the filters are handed to the communities, just after the transient joy of inaugurations and the project's closures, the real face of the technology transmission and its result show up. Long-term sustainability is the real challenge.

It is known that during the execution of the projects, while there are pending activities and the constant presence of all the local organizations involved its best, the public and private agents show a high interest in the initiatives. And, since these projects use unconventional technologies, there is a wide academic and media coverage too.

Along this period, the executive institution tries to invest such interest to penetrate into social and government structures so, once the project is finished and the trained staff leaves the sites, the infrastructure keeps operating in optimal conditions. However, no matter how much work is invested in awareness and education programs, the sustainability of the projects is extremely vulnerable to social and political changes.

Taking into account that the technology transmission's success depends on how social and political agents react in the long term and the undeniable political and social dynamism and instability in developing countries, we have identified a way to guarantee the stability of the project: to link the initiatives to productive projects led by community base organizations.

In the majority of the places where the Green Filters Project has been implemented, there are no institutions that might collect a fee for the

clean water supply and the sewage system and, in case there was, it would depend on the local government —often with a very scarce budget and staff— the assiduity and rigor of the maintenance scheme.

For this reason, during the construction of some filters, especially at Bocas del Carare (Colombia) and La Estrella (México), communitarian organization processes were encouraged. The goal was to link productive activities with the maintenance of the green filters; so alternative income activities would depend on the good operation of the installed infrastructure.

La Estrella, Mexico

The Intermunicipal Council of the Coahuayana River Basin (JIRCO) and the Office for Development and Social Integration (SEDIS) have financed a productive project for women entrepreneurship. A group of women living in La Estrella produces flowers that are watered with the treated water from the green filter. The team of 15 women received the

necessary education, equipment and materials, and today they have 2,000 adult plants and 4,000 flowers ready to sell.

Bocas del Carare, Colombia

Working together with the Entrepreneur Women Association of Bocas del Carare (ASOMUCARE), the Wildlife Conservation Society (WCS) under the projects "Wildlife" and "Green Filters Latin America", the Youth Group of Bocas del Carare is about to execute a project for chicken eggs production that will supply the local market. For this, the group counts with the technical aid of WCS (education on agricultural production and the equipment needed for the hens house), of Fundación Humedales (the land and the materials needed for the hen house), and of ASOMUCARE (management matters). In return, the Youth Group commits to build the hen house, manage the eggs productions and accomplish the green filter maintenance. The final agreement took place in April 2019, date from which activities started.





Mexico

Nicaragua

Colombia

Paraguay

Dominican Republic

Spain

FILTERS IN THE WORLD



Germany

Burundi

South Africa

Sri Lanka

Philippines





IN THE WORLD

The green filters experiences have reached Europe, Africa, Asia and America. It has been applied in different climate zones and diverse scenarios. The following texts present four successful examples in Spain, South Africa, Philippines and Burundi, each of them with its particular characteristics and contexts.





Inauguration: 2003

Developers: Confederación Hidrográfica del Júcar, ACUAMED

Executor: Fundación Global Nature

Sponsor: European Union

SPAIN



Fundación Global Nature develops activities throughout Spain, Sri Lanka, Paraguay, Dominican Republic, Philippines and Morocco. It is involved in several management projects of the Natura 2000 Network, the recovery of sustainable and traditional agriculture systems, the protection of indigenous species, the promotion of extensive cattle and the conservation and recovery of ecosystems.

Besides, it focuses on the conservation and recovery of wetlands inside and outside the Natura 2000 Network. It is also responsible for taking care of several lakes and wetlands. The organization is member of the International Living Lakes Network since 2009 and recently has joined the Wetlands International Network. For its work, it has received several prizes, among them the BBVA Prize to Biodiversity conservation in 2012 and the RAMSAR Prize for the sustainable use of wetlands in 2018.

The L'Albufera Lake (2,400 hectares) in Valencia is one of the most particular water bodies in Spain and is part of a National Park listed on the RAMSAR list of wetlands of international relevance. It is also a Site of Community Importance (LIC) and Zone of Special Bird Protection (ZEPA).

However, the water quality is deficient. For years, the riverside communities have poured their waste to the lake without any treatment and, even if this has change a bit recently,

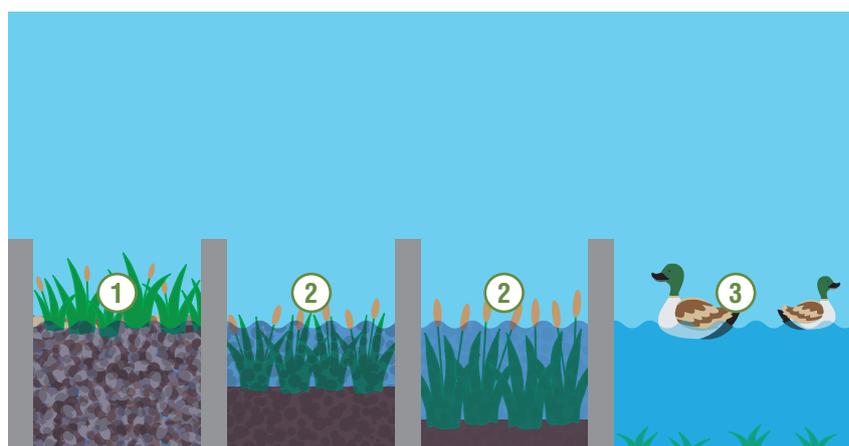
the eutrophication of the water is a reality. The quality of this water body is far from fulfilling the objectives established by the European Parliament Framework for Water, and its bad state is still affecting habitats and several species directly. The amount of migratory bird species and aquatic reproduction bird species has decreased in L'Albufera.

As a measure to recover the quality of water in L'Albufera and its ecological potential, former rice plantations have been transformed into three

artificial wetlands: the Tancat de Milia, the Tancat de l'Illa and the Tancat de la Pipa. This solution has been an innovative approach to these non-conventional systems of depuration because of their size and their huge capacity of water treatment. They have been designed to put the water of the lake in circulation, so they can reduce the amount of pollutants in the water and positively impact the water quality. The Tancat de Milia and the Tancat de Illa have a similar structure: a first area that works as an artificial wetland of sub superficial flow, a second area of artificial wetland of superficial flow with merging macrophytes, and a third lagoon-type wetland area with diverse macrophyte population of superficial flow. The Tancat de la Pipa does not count with sub superficial flow. In total, they sum up around 90 hectares.

These three wetlands were built by different entities; even they have been conceived to treat water from different sources. The two main promoting entities, the Hydrographic Confederation of Júcar and the Public Enterprise ACUAMED (Waters from the Mediterranean Basins S.A.), prioritized the acknowledgement of the potential that artificial wetlands have to improve water quality. Additionally, the work of several NGO's, focused on environmental and social causes, during the design of the project was vital, so the project could easily integrate to their surroundings. This better integration based a diversity of habitats that, together with the improvement of water quality, have transformed these three areas into key zones within the L'Albufera Natural Park, so nearly disappeared bird populations can develop and recover fully.

This three systems work as real wetlands that, besides treating water, work as a real biodiversity oasis. After three years, these systems



① Sub superficial flow ② Superficial flow ③ Lagoon-type wetland area

have demonstrated their multiple functions: they improve the water quality, they regenerate habitats and they compose a major natural reserve where biodiversity rises. Thus, in 2013, the project LIFE Albufera was launched by Institute of Water and Environment Engineering at the Universidad Politécnica de Valencia (IIAMA), in collaboration with Fundación Global Nature, Acció Ecologista Agró and SEO/Birdlife. The project was co-financed by ACUAMED, the Hydrographic Confederation of Júcar and the European Commission. This project aims to optimize the operations of the Tancats de Milia, Illa and Pipa; establish a joined management system to improve the water quality, the habitats and the biodiversity following the Guidelines for Water, Habitats and Birds; reestablish measurements for preserving the good state of the wetlands and reproduce it in other areas part of the Natura 2000 network; and provide recommendations to the competent entities for the development of management plans for the Natura 2000 Network areas and water management plans.

Some of the main results have been:

- **Water**
 - A better quality and an important

- ecological potential.
 - The sub superficial zones present good results in the studied areas. The superficial zone operates efficiently, cleaning all the suspending material and nutrients, and disposing of a large vegetal layer.
 - The concentration of zooplankton has increased throughout the artificial wetlands, specially the filtrating big organisms, which helps to return clear water full with helpful microorganisms back to the lake.

- **Birds**
 - The productivity, the survival rates and the distribution range of bird species directly or indirectly linked to the water quality has improved with the artificial wetlands; besides they serve as refuge in case of habitat loss.

- **Vegetation**
 - The creation of new ecosystems has favored the development of monocultives.
 - The best action for colonization and development of some plants, the activation of the seeds in the sediment, the reduction of the herbivory in aquatic bird species and the aeration of sediments is the drying.
 - The plant biomass harvested in the artificial wetlands has been an important sub product for production of biogas, bio construction materials and road pavement.



Inauguration: March 2016
Builders: Isidima Development & Design and Biomimicry SA

Executors: Wildlands Conservation Trust and GNF
Sponsors: Kärcher and SIKA

SOUTH AFRICA



Versatility is one of the many useful characteristics of the green filter. The green filter implemented by Wildlands is an out-of-stream installation, based on John Todd's Ecological Bioremediation principles, to naturally filter river water with indigenous plants in a series of water tanks.

Isidima Development & Design and Biomimicry S.A. built this ecological treatment facility in March 2016, with the financial support of The Global Nature Fund, SIKA and Kärcher S.A. This is the first initiative promoting low-cost sustainable technologies in South Africa.

This successful experience presented above had the following main objectives:

- To demonstrate and evaluate the performance of the green filter technology as a tool for restoring the rivers in the Plakenbrug River basin.
- To check and follow the different chemical parameters that measure water quality in order to improve the

green filter technology for its future applications in river restoration projects.

- To provide a new research opportunity by giving visibility to pollution of watercourses and showing new alternatives for restoring the water quality.

The site chosen for the filter installation was immediately situated out-of-stream next to the Plakenbrug River, in a public open space of approximately 150 m² in the Winelands District, under local government of the Stellenbosch Municipality. The Stellenbosch community comprises 155,000 inhabitants and it exhibits extremely affluent and extremely poor sectors. The main economic forces in town are the financial and banking sectors and technology development.

The area where the green filter was located at the Plankenbrug, Enkanini and Kayamandi neighborhoods a zone of a high unemployment rate, with informal housing structure and it lacks proper services such as water, electricity and cleaning. The Plakenbrug Industrial Estate surrounds this area. Thus, the Plakengrug River receives sewage, polluted rainwater, high loads of contaminated effluents from informal households and industrial wastewater, becoming an open drain line.

Under these circumstances, the Stellenbosch River Alliance identified the Plankenbrug River as priority for restoration due to the extremely bad conditions of its highly polluted waters. The Wildlands Conservation Trust, an organization that has several years of experience restoring river zones by eliminating invader plant species, collecting solid remains and restoring indigenous plant species, executed the green filter project in the Plakenbrug River.

The construction of the filter lasted only a month. Its design includes 14 aquatic cells with 3000 litre capacity each, connected in series with a hydraulic retention time of one day. The tanks are transparent and are fitted with plant racks which support the aquatic plants that grow on a coir bed. As plants settle in the coir bed, their roots grow deeper in the tank, serving as primary filters and, as the water flows from tank to tank, the vegetation present changes by adaptation to the nutrient concentration in the water. This creates a vegetation gradient along the entire system. In this case, location site in Stellenbosch did not allow gravity feed or in-river feed of the system, so a small submersible 11 W pump had to be installed to feed river water to the green filter.

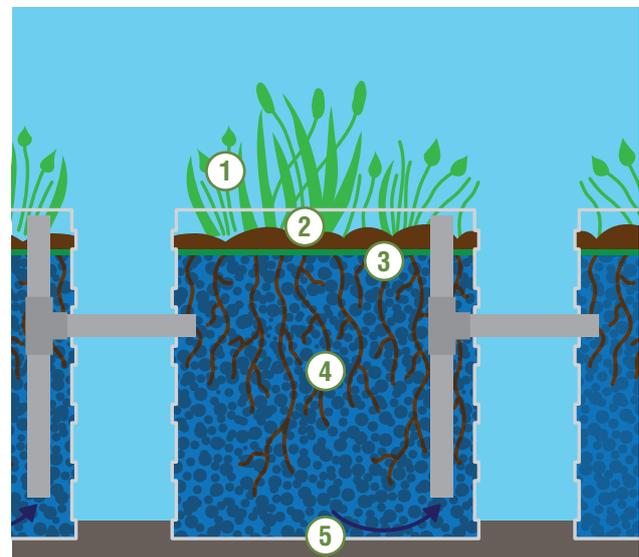
Only in a month the plant racks were built, the pipe system was assembled, the tanks were filled with polluted water and indigenous species were planted in coir beds on the racks. On March 16th 2016, the filter was officially inaugurated; for the occasion several agents involved in the development of the project were invited: Stellenbosch's mayor, Wildland's technical team, Isidima and a SIKA corporation representative.

Nethertheless the project faced some critical challenges: one year after the installation of the green filter, the implementation site next to the Plakenbrug River resulted difficult in terms of security and vandalism preventing an easy maintenance. So, the treatment cells had to be moved to a more secure site on Distell property, lower downstream. This new location site is next to the Eerste River, a river below the confluence of the Plakenbrug River and highly polluted too. Once the water of the Eerste River is treated, it is returned to

the mainstream, fulfilling the terms of the Department of Water and Sanitation.

From April 2018, Wildlands made an alliance with the Stellenbosch University Water Institute to undertake scientific monitoring and testing of the green filter technology with the assistance of post-graduate students.

The impact of this water treatment system has been very important, the successful and verified results of this innovative technology is providing enough proofs for restoration of polluted rivers in South Africa and positioning Stellenbosch as a pioneer. The fact that a well-renowned University, with the continued support of the Department of Water and Sanitation, has taken over the green filter for scientific research has scientifically proven the feasibility for larger scale application.



- ① **Aquatic plants:** indigenous vegetation as *Chondropetalum tectorum*, *Cyperus prolifer* and *Juncus capensis*.
- ② **Coir bed:** support the plants, which allow enough sunlight for good root development to aid ecological filtration and the development of natural biofilms.
- ③ **Plant racks:** support the coir bed and the aquatic plants.
- ④ **Roots:** as they grow they serve as primary filters.
- ⑤ **Tanks:** transparents, 3000 litre capacity, with hydraulic retention time of one day.

404,000 to 23 / mL | E. Coli bacterium

31 to 5 mg / L | solid remainders

8.2 to 0.32 mg / L | ammonium



Inauguration: 2017
Developers: SCPW and LP4Y

Executors: SCPW and GNF
Sponsors: Kärcher and SIKA

PHILIPPINES



The SCPW is an NGO that aims to promote the wise use of wetlands in the Philippines by networking, engaging in conservation activities, providing a forum and technical assistance, and complementing wetland activities through research, training and CEPA (communication, education, participation and awareness).

The project influence area is the water body of Laguna de Bay, the largest lake of the Philippines covering a surface of 900 km². The rivers flowing into Laguna de Bay serve as a waste dumps for 60% of the 8 million people living around the lake. Untreated sewage is a main cause of pollution. Approximately, 80% of the pollution in Laguna de Bay comes from untreated domestic wastewater causing health problems to the communities.

The green filter project is located in a resettlement area in Calauan, home for about 700 people. The community is located next to a creek that receives liquid and solid wastes from nearby residential houses and drains into an irrigation canal that flows to Laguna de Bay. The living conditions in this resettlement are extremely hard, with a young population lacking of opportunities. In this framework, the Green Village Project by the Life Project for Youth (LP4Y) envisions a training center

dedicated to social and professional integration for out-of-school youth in extreme poverty and exclusion conditions. In the Green Village, these young adults from cities of Makati and Manila are provided with relocation houses to improve their quality of life. The village is also a showcase of how a small community can demonstrate sustainability by using indigenous materials and environmentally friendly technologies in their operation. In order to create a self-sustained village, SCPW

together with GNF introduced sustainable technology for the villagers to treat their sewage, avoiding its impacts in the nearby water bodies and in the population health.

The green filter designed for the village is formed by five different units, representing a pilot initiative in terms of adapting the technology to different scenarios:

- Unit 1: Anaerobic baffled reactor.
- Unit 2: Vertical subsurface flow constructed wetlands (2 units).
- Unit 3: Horizontal subsurface flow constructed wetland.
- Unit 4: Horizontal subsurface flow constructed wetland.
- Unit 5: Biodiversity pond.

Today, the green filter is operating on a very light loading mode, since the dormitories in the Green Village are not yet fully occupied and the unit was designed to treat wastewater generated by 200-300 people. The filter is sustained and maintained between the LP4Y and the SCPW, LP4Y maintains the integrity of the Green Filters by ensuring that it is functioning as designed while SCPW monitors the facility.

Dissemination and awareness on the importance of water, sanitation and biodiversity were improved through learning visits, trainings and public activities conducted by LP4Y and SCPW with representatives from different sectors, including local and national government agencies, private corporations, NGO's, and the academy. One example was the presentation of the green filter during the World Water Day of 2017 with the theme "Water and Wastewater".

This initiative had a big impact at the local and national level in terms of governance. The Environmental Management Bureau showed high interest on this technology and organized a "Writershop" on Ecosystem-Based Wastewater Manage-



Entrance of the Green Village.



Horizontal subsurface flow constructed wetland.



Vertical subsurface flow constructed wetlands.



Guided visit to the Green Village.

ment for Local Government Units to development similar systems in other communities. The SCPW is already assisting two municipalities to replicate this technology. The Department of Environment and Natural Resources manifested its will to include the green filters in its Sustainable Integrated Area Development Program, as Laguna de Bay is one of their priority sites.

All in all, through presentations in international and local conferences

"I immediately saw the potential of Green Filters as an Ecosystem-Based Adaptation Strategy. This nature-based solution may be introduced in communities, particularly those near waterways."

Albert A. Magalang, chief of the Climate Change Division at the Environmental Management Bureau, Department of Environment and Natural Resources.

and forums, the green filter project showcases that nature-based solutions for sanitation and domestic wastewater treatment system can be implemented and adopted in the Philippines, improving public health and protecting water bodies from continuous degradation. Capacity of capacity building of the Local Government as well as the communities in Laguna de Bay are needed to establish green filters as nature-based solution to domestic wastewater pollution in the Philippines.



Inauguration: November 2018
Constructors: Biraturaba and the community

Executors: Biraturaba and GNF
Sponsors: Kärcher and SIKA

BURUNDI



The following project is the result of an experience of Biraturaba, a non-profit association that works for the rights of Burundian people. Its purpose is to support local communities to improve their standard of living and to fight against the indifference, ignorance and marginalization they face in order to reach “a united and peaceful Burundi where each actor understands and fully plays its role for an integral and sustainable development”.

The Tanganyika Lake is one of Africa's Great Lakes and many riverside communities with a long fishing tradition depend on it. This great lake, located at the border of the Democratic Republic of Congo with Tanzania, Burundi and Zambia, is an important source of water.

Unfortunately, this life source is at high risk. From the 200 m of depth, the Tanganyika Lake's water is almost anaerobic due to lack of water recirculation. This affects badly the lake's fauna, which counts with more than 280 endemic species, and more than 45,000 people that depend on the fishing industry as their food source. Often, the waterside communities find difficult the access to safe drinking water. There are very few wells around the Tanganyika Lake, so the people consume the untreated water from the lake or its tributary streams. Due to this unsafe consumption of contaminated water, outbreaks of diseases like cholera happen periodically.

This unhealthy estate of the Tanganyika Lake is mainly caused by the following three factors:

- The excessive amount of sediments and nutrients deposited in its basin due to erosion and industrial and urban waste.
- The intensive fishing with inappropriate methods.
- Human activities, such as construction and agriculture, near the lake shore that destroy the buffer and fish spawning zones.

Gitaza, a community at the Tanganyika Lake's shore, counts with 3,000 inhabitants and it is one of the many waterside communities that contaminate due to the lack of resources and opportunities. Gitaza lives from agriculture, fishing and some commerce and trade. This town lacks water purification systems, solid waste system and sewage treatment system. Biraturaba, with support from the Global Nature Fund and the experience and knowledge of the Living Lakes Network, is working in

this town in two different perspectives. One focused to raise the availability of drinking water for the communities by building tanks and public access points. And a second, designed to reduce the impact of human activities on the Tanganyika Lake and its water by raising awareness in the waterside communities. For this, Biraturaba executed a sustainable technology project for the sewage system at the Technical School of Management of Mutumba. The school is located uphill and it is surrounded by homes and other schools.

Located at northern Gitaza, the Technical School of Management of Mutumba is on a land of very steep slopes that end on a creek. This water source flows south from the school down to the neighboring households. The school has a permanent community of 555 students, most of them girls, and counts with kitchen facilities, two canteens, 24 semi-dry latrines, 14 restrooms and 20 showers. The three main points of sewage are the kitchen, the latrines and the bathrooms and showers. Until the project execution, the school sewage system counted only with septic tanks and cesspools, with no treatment. This raised the infection and diseases risk and generated strong and unpleasant smells that affected the life of the school residents and their neighbors. Due to this very basic design of sewage, very common in rural areas, the toilets suffered of overflow of fecal water more than once, sending all the waste downhill to the neighboring households. This affected the relationship between the school and its neighbors. All this waste finally ended up in the stream that runs into the Tanganyika Lake, causing direct contamination to this important water source.

To face this problem, the project consisted of the elaboration of a sewage system for the kitchen and the sanitary facilities connected to a water treatment system using the green filter technology. The green filter built for the school contains a series of pretreatment units at the entrance of the system and three canals that allow a slow and soft decaying of the organic material present in the water. From this last canal, the water is returned to the wild as less polluted water with no harmful effects. The canals were

protected with slopes in the inferior part of the retaining walls in order to prevent overflow damages.

Biraturaba carried out activities to promote and present the advantages of the sanitary and the green filter systems, and activities to raise environmental education and awareness. The compromise of the participants to take care of the environment and the filter were outstanding. The filter lifetime will depend on its maintenance. It is very positive that the entire community, the school authorities, the students and the school staff are aware of the need to protect the system and keep a good maintenance of it. The school's director is committed to keep the infrastructure in good conditions in order to allow a constant flow of water into the filter. Because this technology was new to the school and its neighbors, Biraturaba initially assisted the community in the maintenance of the system.

The school's director mentioned how important the green filter is for the treatment of sewage waters produced by the school and, even more important, for the students' and the staff's health. Furthermore, the director states that the problems with the neighbors due to the toilets overflow have disappeared, making better the relationship between them. Besides, many diseases caused by the constant overflow of the toilets have been eradicated. Now, the school does not need to invest big amounts of resources to empty the cesspools and can use those same resources for environmental awareness and education. And, of course, the Tanganyika Lake, this water source affected by the contaminating untreated sewage, now does not receive the waste anymore.



One of the canals of the filter.

Because of the great efficiency of the green filter to reduce the pollution, it is now proven that the filter is a viable option for schools and small communities that have no solid waste and sewage treatment systems. This is the case of several communities in Burundi and around the world. In order to make this possible, it is important to share experiences and knowledge so we can strengthen and adapt better the system to different cases for its implementation.

Imprint



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