Waste Management Blueprint Galapagos Islands

From Waste Management to Waste Prevention

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ORCATEC, May 2021

PACIFIC PLASTICS SCIENCE TO SOLUTIONS

GCRF Global Challenges Research Fund

Galapagos Conservation Trust

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EXECUTIVE SUMMARY

This report is an outcome of the *component III* of the *Pacific Plastics: from Science to Solutions Project* led by the University of Exeter and the Galapagos Conservation Trust. The project aims to identify and map the sources of plastic waste and distribution of marine debris, investigate its effects on marine species and generate solutions to reduce waste, leveraged by circular economy innovations.

This document describes the development of the integrated waste management system (WMS) on the Galapagos Islands (Ecuador) including regulations, processes and system developments. The report focuses on the island of Santa Cruz where more than 60% of the total waste is generated. Waste management is a matter of great concern in the Galapagos Islands because of the uniqueness and fragility of its natural ecosystem.

The Galapagos Islands are one of the best-conserved National Parks in the world. Due to its uniqueness the tourism grew steadily before the pandemic to up to 275.000 tourists a year. Tourism is the main economic driver for the inhabitants of the Galapagos Islands. This has led to both direct and indirect related migration from Ecuador´s mainland to the point that more than 33.000 inhabitants are permanently living on the islands. This development has also caused a steady rise in the generation of waste to currently around 17 tons a day on Santa Cruz Island, which are collected and treated by the local municipality.

Galapagos was the first province in Ecuador to have an integrated waste management separation system with separation at source. The waste is separated at source in organic, recyclable and non-recyclable materials. Since 2005, the waste management system has been improved steadily through strong support from NGO funding, but there are still several challenges to be solved.

Waste generation has increased from 18.8 tons/day in 2010 (Torsten, 2010) to 28.6 tons/day in 2019 (Veolia, 2019). In Santa Cruz, the amount of waste generated has nearly doubled in 10 years and landfill sites in the three inhabited islands are collapsing. At the same time regulations have been passed to reduce waste generation. In 2018, a law to prohibit the use of single use plastics was introduced. In 2020, Galapagos was declared “free of used tires”, 35.000 used tires were extracted from the Islands to be recycled in the mainland (MAE, 2020).

Whereas characterization studies conclude that the majority of generated waste is organic, the municipality has to deposit the major part of the collected waste as non-recyclable. Collected organic waste cannot be converted into compost as many single-used plastic bags within the organic waste prevent good compost quality. A possible solution is the already applied handover of organic waste to local pig farmers. Additionally household composting and gardening should be emphasized.

The amount of recyclable material has grown steadily even though it is labor intensive to separate the different waste materials and ship them back to the mainland. An important contribution has been the environmental campaigns led by NGO activities. Due to the cut down in funding in general, but specifically after the COVID pandemic, the municipalities lack support in environmental education and general technical assistance.

From the economic perspective, the cost of managing waste in Galapagos is comparably high with > 200 USD/ton treated waste. This is due to the isolated situation, expensive labor and logistics cost. These costs may include inversion and management, but exclude external costs, which might be much higher. These external costs can only be estimated. Due to the high cost of recycling practices the practicability on a global scale is highly doubtful. This leads to the conclusion that single-use plastics need to be prohibited and plastics products can be reused by applying circular economy principles.

Generally oil companies heavily promoted the concept of recycling since the 1970 as a solution to the lifecycle of plastics products. Unfortunately the practicability of recycling could be confirmed neither in developing countries

nor in developed countries. There are many obstacles to plastics recycling, a main one being the higher cost of recycled plastics compared to raw material.

As a consequence, global plastics pollution is threatening our natural habitat, human health and the livelihood of our entire human species. Beach litter on Galapagos is affecting local endemic species. However most of the litter is not generated directly on the Galapagos Islands, but has its origin on the continental mainland. In order to improve the situation, waste prevention on the mainland needs to be emphasized strongly as it is cheaper compared to introducing waste management separation facilities.

Within the mainland, the shopping malls have an important role within the consumption pattern in the big cities. Many Ecuadorians pass time with their family on the weekends and shop or buy food at the big food corners. The mall visitors can be seen as a melting pot in terms of their social background. So this is a perfect place to promote the use of circular economy products and show how avoiding single-use plastics is possible.

Two practical solutions with circular economy principles are described in detail. Iguana Cup as a reusable cup for hot and cold to-go beverages or as a constant companion during travels avoiding the need for single-use cups. The cup also has a strong linkage to nature and tells the story of the pink iguana which lives on a remote Volcano of Isabela Island where no plastics or marine debris are found. It implies the question “what else can we learn from nature to reduce waste generation?”.

Another solution, which is already carried out by Huella Verde in a shopping mall in Ambato, is the service of using returnable dishes within the food corner of a mall. This avoids single-use plastics, raises awareness amongst the mall visitors and gives a use to food leftovers as they are collected and passed to local pig farmers.

Pig farmers also may play an important role to solve the issue of organic waste since they are interested in acquiring organic waste for their pigs. So this may be a solution on a broader scale to reduce the cost of waste management. Also the promotion of compost solutions for households is presented as a way to promote circular economies and raise awareness amongst the users.

This document was created thanks to the support of Ing. Henry Bayas (Municipality of Santa Cruz), Ing. Alam Romero (Municipality of Isabela), Dr. Ulf Haerdter (Island Conservation), Jen Jones (Galapagos Conservation Trust), Andres Ordonez (Tourism Chamber Galapagos), Johanna Castaneda (Galapagos Governing Council), Diego Anazco (Education and Communication Consultant), Andrea Dahik (Orcatec), and all the local initiatives providing us with information and recommendations.

INTRODUCTION

The Galapagos Islands are undoubtedly one of the most exceptional and best-preserved natural places in the world. The importance of its biodiversity is recognized nationally and internationally through multiple protection figures: Galapagos National Park, Galapagos Marine Reserve, Natural Heritage of Humanity, Biosphere Reserve, Whale Sanctuary, RAMSAR Site (DPNG, 2014). Galapagos is also unique among oceanic islands as it was the last archipelago in the tropical zone to have its ecological isolation disrupted. It was not until the beginning of the 19th century that the archipelago became a geographic region used and later populated by humans (Grenier, 2010). In 1959 the Galapagos Islands were declared a protected area. The total land area is 788,200 square kilometers, of which 96.7% consists of the National Park, and the remaining 3.3% is made up of urban and agricultural areas, located on the islands of San Cristobal, Santa Cruz, Isabela and Floreana (DPNG, 2014). However, the creation of a national park would ultimately result in Galapagos becoming a centre for world tourism, accelerating its geographic opening (Grenier, 2010).

Today, Galapagos has a population of approximately 33,000 inhabitants (INEC, 2020). Around 20,000 people live in the main urban centre, Puerto Ayora, Santa Cruz. Population growth is a direct consequence of tourism growth, both leading to an increase in solid waste generation. Waste management is a matter of great concern in the Galapagos Islands because of its unique ecological, social, and economical characteristics. It is one of the most critical environmental threats affecting not only the terrestrial areas of the inhabited islands but also the unique ecosystems of non-inhabited islands and Galápagos' fragile marine ecosystems (Torsten, 2010).

Over the years, important steps have been taken to address the social and environmental problems related to waste generation and disposal in the Galapagos Islands. The present report reviews municipal solid waste management data and the developments in the three local municipalities, with a special focus on Santa Cruz Island. It is important to be able to go back in time and compare the different approaches, to better understand what has changed over the years and the key factors that influence or affect waste management practices, learn from the lessons of the past and adapt, like the species that Darwin described, to current changes and challenges.

The report is divided into six Sections:

Section 1, Objectives, Scope and Methodology; Section 2, provides a general context, and the evolution and dynamics of tourism and population. In Section 3 a historical overview of solid waste management especially in Santa Cruz is provided; key stakeholders and their roles and participation for sustainable waste management. In Section 4 the waste management system (WMS) on Galapagos is described, with data and statistics, main waste streams and key financial aspects; Section 5 focuses on best practices and key findings and also a selection of a number of local initiatives and interventions to reduce waste generation. Finally, in Section 6 the conclusions and recommendations are provided.

SECTION 1

1.1 OBJECTIVES

The report has the following objectives.

1. Develop an understanding of the challenges and best practices of the waste management system on the Galapagos Islands.
2. Describe the waste management system in place in Santa Cruz.
3. Estimate the tourism related waste generation in comparison with local population.
4. List existing local initiatives to reduce waste generation by prevention.

1.2 SCOPE & METHODOLOGY

The methodology is based on reviews of solid waste management data and interviews with the key stakeholders on the islands.

1. **Documentation review**

Various documents and literature related to waste management in the Galapagos Islands have been reviewed:

- Waste Characterization studies, carried out in 2008, 2015 and 2019 to understand the composition of the waste stream on each island.
- Population Statistics and Tourism data collected by the Galapagos National Park and the Galapagos Tourism Observatory.
- "Galapagos Report" published by *Fundación Natura,* WWF and Galapagos Conservancy.
- Cooperation reports of different organizations that have supported the implementation of the WMS in the islands: WWF, AECID, EUROPEAID, FUNDAR.
- Facility and Infrastructure Environmental Impact Assessments in Santa Cruz.
- List of documents referenced in the bibliography.

2. Interviews with local stakeholders

Interviews were conducted with the following key stakeholders:

- Henry Bayas, Director of the Environmental Department – Municipality of Santa Cruz;
- Alam Romero, Director of the Environmental Department – Municipality of Isabela;
- Johanna Castaneda, Environmental Analyst – Galapagos Governing Council;
- Diego Anazco, Education and Communication Consultant;
- Ulf Haerdter – Former Program Officer Waste Management Galápagos Program-WWF; and,
- various local initiatives to reduce waste generation.

3. Analysis of waste streams regarding type of waste

Analysis of the waste management system statistics collected from 2009-2020 by the Environmental Department of the Municipality of Santa Cruz. Sankey diagrams were developed to show the flow of major material categories. The reference units are tons/day and kg/per capita.

4. Estimation about tourism related waste

From the data obtained through the desk review and meetings, it was possible to estimate tourism related waste, considering data before and during COVID-19 pandemic.

5. Interviews with local initiatives to reduce single use plastics and barriers for implementation

There are a number of local initiatives to reduce single use plastics. The consultants conducted research and communicated with different groups and learned about their initiatives, strengths and barriers for implementation.

SECTION 2 GENERAL CONTEXT

According to the last census which was carried out in 2010, Galapagos had a population of 25,124 inhabitants, whereas 12,000 live in Puerto Ayora (Santa Cruz Island), 6,700 live in Puerto Baquerizo Moreno (San Cristobal Island), 2,000 live in Puerto Villamil (Isabela Island). Population annual growth rate from the previous census is estimated at 3.3%. Today, Galapagos has approximately 33.000 inhabitants. Both natural population growth and migration to the Islands have an impact on the population development on the Islands. The total population consists of permanent residents and a floating population. Permanent residents, in demographic terms, are people who have been living in a place for at least six months. The floating population consists of people who are in a place for vacation, business, family visits or other reasons, and do not plan to stay there for more than six months (Granda et al, 2012). In the last two decades annual tourism has quadrupled from 60.000 to 270.0000; meanwhile, the local population has nearly doubled (Figure 1). The significant increase of the population in the Galapagos Islands has resulted in a commensurate increase in solid waste generation. (Peñafiel et al, 2018).

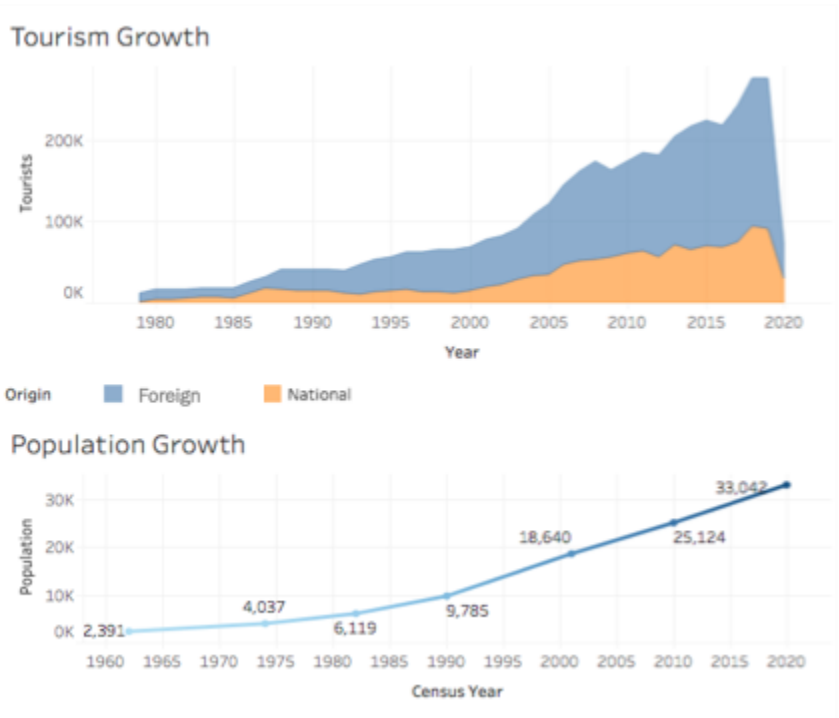


Figure 1 Tourism and Population Growth

Sources: Tourism Observatory Data and GNP Visitors Data 1979-2020. INEC Census 1962-2010. Projections 2020

This vertiginous tourism growth only dropped when tourism shut down in mid-march 2020 because of the global pandemic. Tourism is the main economic activity in Galapagos and contributes directly and indirectly to commercial development and population growth of the Islands (Epler & Proaño 2007). Tourism is a friend to conservation and an enemy at the same time; it has created economic and social development and a number of negative direct and indirect impacts.

To understand the tourism development on the archipelago, we will provide a brief summary over the last fifty years. Breaking down the numbers of tourism arrivals by modality, we could talk about three main periods that show the most predominant modality:

1***) The first one from the late 1970s to 2000 the Ship-based Tourism Model.*** This tourism model was designed in the late 1960s and used boats as hotels "floating hotels". This was the most popular way to explore the islands until 2000. The number of tourist boat permits grew over the years from 40 in 1980 to 80 in 2000 and the number of berths on board increased from 537 to 1773 (Epler & Proaño, 2007).

The ship-based tourism model is tightly controlled by the Galapagos National Park, it has fixed itineraries and boats visit only designated sites. There is a limit on the number of berths on board, which has remained stable in the last 15 years with 1798 berths (Galapagos Tourism Observatory, 2018). In this model tourists spend 4-7 days on board. Other than a one-morning-per-week visit to the Charles Darwin Station, usually followed by a brief stroll through Puerto Ayora, tourists on boats had only minimal impact on the local economy (Epler, 1993). Only fifteen per cent of the income generated by tourism entered directly to the islands (Epler, 1993). Concerns were raised among locals *"tourism only leaves garbage on the islands".* During this time there were a number of conflicts among sectors: conservation, fishing and tourism. A series of circumstances that arose during the 1980s and 1990s, such as social and political unrest, the heated debate over the use of entrance fees, and certain environmental issues, culminated in the 1998 approval of the Special Galapagos Law (Grenier, 2010). The Special Galapagos Law established a provincial autonomy, restricting migration and giving preference rights to the local population in employment and investments. It prohibited further settlement on the islands and set controls on tourism and fishing.

2) "Transition Period" from 2000-2010, where the industry made a transition from the original ship-based model to a land-based tourism model. The Galapagos Special Law officially named the population centers of the archipelago and protected areas as tourism "destinations". This resulted in the "locally based" tourism sector undergoing a period of rapid growth during this decade, surpassing the passenger capacity of the tour boat sector (Epler, 2007). Both sectors took advantage of the boom in tourism in Galapagos, which nearly tripled in ten years from 60,000 visitors in 1998 to 173,000 in 2008 (Grenier, 2010).

During this decade there were legal and institutional framework reforms. There were two important reforms: the Special Regulation for Tourism in Protected Natural Areas (RETANP) in 2002 and Galapagos National Park Administrative Statute both defined the scope of tourist operations and activities permitted in the Galapagos National Park. It is important to mention that, one of the management measures used by the Galapagos National Park Service (GNPS) to reduce the overexploitation of fish resources and to improve the socioeconomic situation of the fishermen was to provide economic incentives to encourage "alternative livelihoods" related to tourism. The measure was proposed at different times via two alternatives: Experiential Artisanal Fishing (EAF) beginning in 2005 and new Tourism Operation Permits (TOP) beginning in 2009 (Palacios & Shuhbauer, 2013). Another important reform that took place was the decentralization process promoted by the Ministry of Tourism, it transferred to Galapagos Local Governments the competences related to planning, promotion, management, organization and competitiveness of the local tourism activity and services. Local tourism companies started promoting land-based activities, less attention was given to planning and regulating and tourism services such as hotels, restaurants and tourism operators grew rapidly (Figure 2).

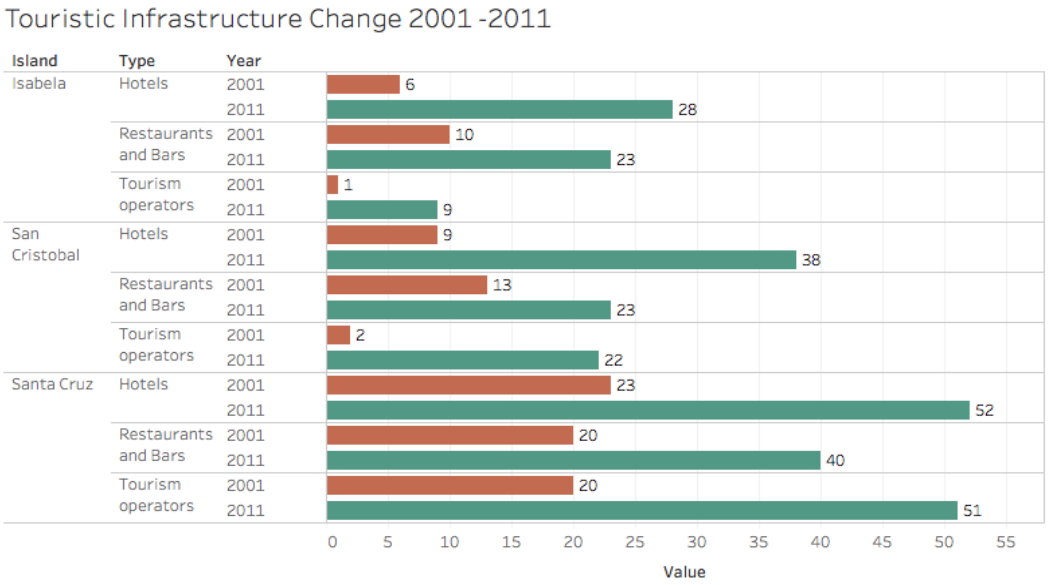


Figure 2 Touristic Infrastructure Change 2001-20011

Source: Municipalities Isabela, Santa Cruz, San Cristobal, Ordonez, 2002 in Estrella, 2012.

3) The third period 2010 – 2020 ***Land-based Tourism Model.*** Both models co-exist today, and are not mutually exclusive, in fact a number of tourists visit the islands using a combination of both, however it was precisely in 2010 when the "land-based model"[1] passed the 50%-50% threshold and became the most predominant modality of tourism to date (Figure 3).

Figure 3 Tourism on land and on-board 2007-2015 compound annual growth rate and forecasts[2]

Adapted from: Galapagos Tourism Observatory. 2018 Visitor Statistics Report. p. 9. 2019.

[1] Some values in land-based tourism may hide a percentage of "irregular immigrants", note the upward trend.

[2] From 2007 to 2015, statistics about tourists' accommodation during their stay in Galapagos were collected through the Transit Control Card (TCT). Since 2016 this data is not available.

As shown on the graph (Fig. 3), ship-based tourism has had a negative growth of 2%, while land-based tourism has an average annual growth rate of approximately 8%. Another important change occurred in this decade, the source of tourists shifted, with the largest group now arriving from Ecuador and the rest of Latin America. This is due in large part to aggressive promotions by LATAM Airlines advertising the Galapagos as an affordable destination (Lansdale et al, 2014). LATAM Airlines, former LAN Airlines began its operation in 2010.

The difference between land and boat-based tourists is highly relevant from the point of view of the impact on the social, terrestrial, and marine sub-systems, as land-based tourism implies greater urban development and supporting infrastructure, use of transportation, increased rate of exotic species introduction as a consequence of the import of most food and products from the mainland, depletion of drinking water reserves, consumption of energy, generation of waste, and the needs of an enhanced water and sanitation systems throughout the archipelago (Pizzitutti el al, 2014).

Rapid economic growth, urbanization and increasing population have caused (materially intensive) resource consumption to increase, and consequently, the release of large amounts of waste to the environment. (Singh et al, 2013). Solid waste management in touristic small island communities is often complicated by their isolated geographies and tourism dominated economies, resulting in even greater challenges for ensuring sustainable solid waste management (Willimot & Graci, 2012).

SUMMARY

- **Tourism is the main economic activity on the islands.**
- **Tourism grew steadily each year until the COVID pandemic to 275.000 tourists in 2019.**
- **Ultimately the tourism model changed from strongly regulated boat tourism to weakly regulated land-based tourism increasing pressure on the unique ecosystem and waste management infrastructure.**
- **The local population rose steadily to over 33.000 inhabitants in 2020. Main factors for immigration are directly and indirectly related to the tourism industry.**
- **After the COVID pandemic many challenges have arisen due to missing tourism income.**

SECTION 3 WASTE MANAGEMENT SYSTEM

3.1 HISTORY OF WMS

Galapagos was the first province in Ecuador to have an integrated waste management system. On the island of Santa Cruz the first waste management design and implementation by the municipality of Santa Cruz started in 2003. Thereafter, San Cristobal started the waste separation in 2007 and Isabela in 2011.

Apart from the waste management practices of the municipalities of the inhabited islands, the Galapagos National Park as part of the Environmental Ministry of Ecuador collaborates with provincial activities to reduce the waste on the islands. One example is the transportation of used tires to the mainland in 2019. Galapagos was declared "free of used tires" after 35.000 used tires were extracted from the Islands, which were recycled on the mainland (MAE, 2019). Also various beach cleanups were carried out through the local institutions, NGOs and the local community. First preliminary results show that only a fraction of 2% of the collected waste on the beaches originates from Galapagos whereas the majority are marine debris floating from the continent or from fisheries (Jones et al, 2021).

In 2018, Galapagos was also the first province in Ecuador to restrict single-used plastics. All public institutions and various NGOs and private actors worked on this ban, which had several stages of implementation. In 2015, a resolution promoted responsible consumption of plastics, however it did not restrict the commercialization and distribution of these plastics. In the 2018 resolution, single-use shopping bags, plastic straws, disposable cups, cutlery and disposable containers, expanded polystyrene products, and non-returnable soda bottles were banned from entering the Galapagos Islands. These new rules came into force a year later.

Even though the waste management systems were advancing and including more recycling materials during the last years, the waste generation rose parallel to the tourism and population growth. Waste generation on the four inhabited islands has increased from 18.8 tons/day in 2010 (Torsten, 2010) to 28.6 tons/day in 2019 (Veolia, 2019). On Santa Cruz, the amount of waste generated has nearly doubled in 10 years.

In the following, the WMS of the main inhabited islands of Santa Cruz, San Cristobal and Isabela will be described in more detail.

3.1.1 SANTA CRUZ

In 2003, the Galapagos National Park, through the Araucaria XXI Project financed by the Spanish Agency for International Development Cooperation (AECID), supported the local Municipalities, in the development of a proposal to implement an Environmental Management Unit (UGA) within the municipality.

From 2003 to 2006, the municipality had collaboration with funding from the European Union (URB-AL-Program). During this time the foundation of the WMS was built, and an independent consultant coordinated the project's launch and implementation working within the municipality. The project included the construction of a recycling plant and a composting area, the purchase of a waste compactor truck and the acquisition of waste bins. In 2006 Santa Cruz successfully upgraded the WMS requiring households to separate waste into three categories: recyclables, organics and non-recyclables.

In 2012, the municipality finally created the environmental department with a separate budget and also a separate Director´s position. This was a breakthrough as the environmental activities were scattered before and organized within the construction department.

The recycling centre "Fabricio Valverde" is located about 4 km from the town of Puerto Ayora on the road to the village of Bellavista. Within an area of 2 hectares the following facilities are located: a recycling plant with

manual separation, a composting area with composting piles, a hazardous waste incinerator, a truck scale and a packing shed; furthermore, in this space tires, scrap metal and weeds also accumulate so that the space is no longer sufficient in relation to the amount of waste that reaches the center (Caduceus, 2015).

WWF started to integrate waste management into their environmental activities in Santa Cruz from 2006 as the donor Toyota started to support the activities. Through the support of WWF, several improvements were possible such as the installation of a semi-automated composting machine for organic waste. Also, a more powerful waste compactor, a glass shredder, vehicles such as waste collectors, mini-loaders and more waste bins were acquired for the municipality. Various studies were conducted such as the expansion for the recycling center, the design for the sanitary landfill, a study about reutilization of shredded glass for construction, the potential of biological waste for biogas production, and various environmental impact assessments.

A very important complementary external activity by WWF was the steady environmental outreach campaign in schools and on public events to convince the population of their participation on the WMS.

Source: Collapsing Sanitary Landfill (2020), Recycling System and Recycling Center. Municipality of Santa Cruz, 2021

Since 2009, the Municipality of Santa Cruz has managed to monitor and evaluate the WMS through the implementation of a truck scale (Figure 4). It can be seen that the majority of waste is classified as non-recyclable, whereas the quantity of organic and recyclable material is very similar (approx. 20%).

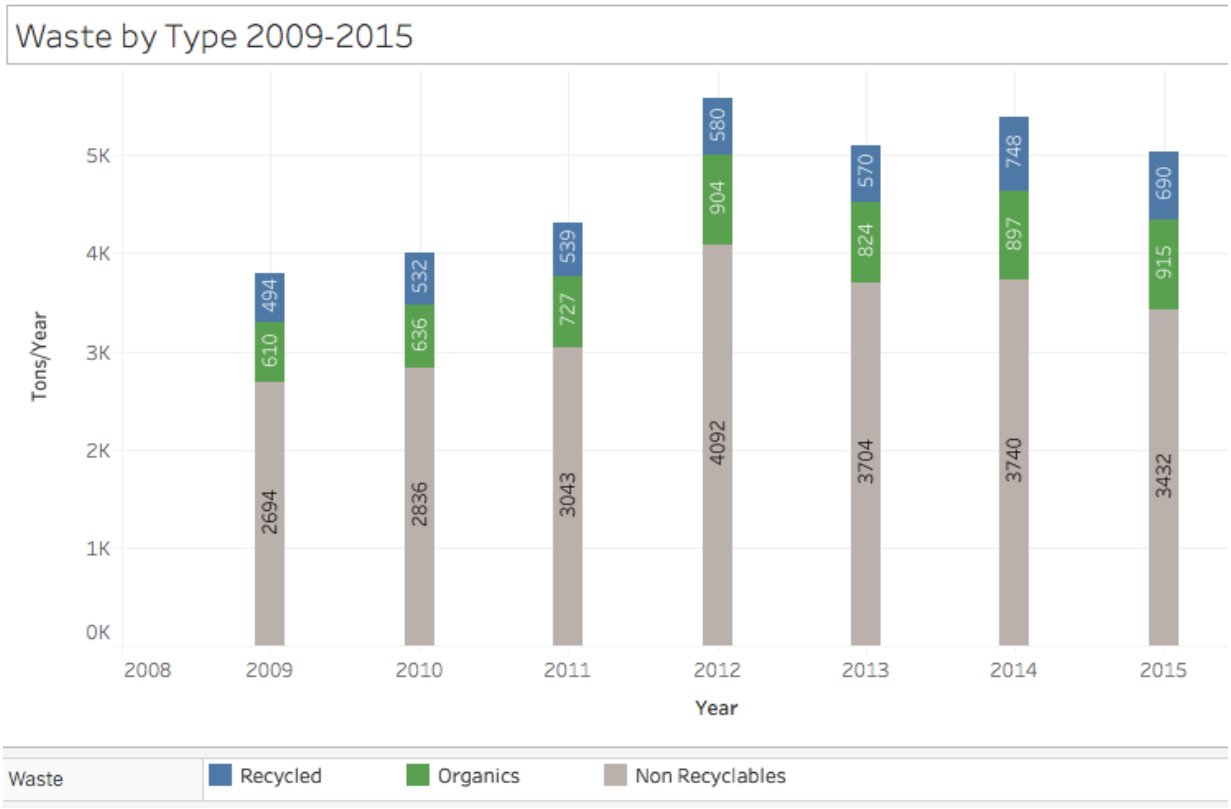


Figure 4 Waste By Type 2009-2015
Source: Environmental Management Department. Municipality of Santa Cruz. IWMS Statistics 2009-2015.

Until 2009 there was not a sanitary landfill on the island and the waste was deposited on a landfill 27 km away from Puerto Ayora on the North side of the island on the road to Baltra (where the primary airport is located). To mitigate the pollution of this area, a real landfill was finally built in 2013. The sanitary landfill has an area of 3.7 hectares. Originally the design would enable it to receive waste for at least 20 years, however at the moment it is already nearly collapsing.

3.1.2 SAN CRISTOBAL

In 2007, San Cristóbal started the implementation of a waste management system and required households to separate waste into organics, recyclables and no-recyclables. The Solid Waste Management Centre is located 4.5 km away from Puerto Baquerizo Moreno along the road to the village of El Progreso. This center occupies an area of 5 ha that has been divided into a classification zone, composting, incineration, leachate management, and waste disposal site for non-recyclables. With the support of "Fundacion IPADE" financed by the Spanish Cooperation Agency (AECID) the sanitary landfill was designed originally as a "dry landfill." The waste was disposed of in packed bales that were stored in layers. The sanitary landfill was built at level, since the rocky characteristics of the soil made the excavation of cells very expensive. For this reason, after a short time it was necessary to expand the space destined for the sanitary landfill and find a new place to build a sanitary landfill (Pazmiño, 2010). After more than 10 years, the Municipality commissioned the studies for the new sanitary landfill (CGREG, 2020).

Source: 1.Sanitary Landfill packed bales 2. Recycling Centre. Municipality of San Cristobal

3.1.3 ISABELA

Isabela was the last of the three municipalities to implement an integral waste management system. Characterization data in 2008 showed that organic materials account for 85.71%, cardboard 1.36%, glass 2.59% and plastics 2.99% and non-recyclables 7.35%. In 2008 per capita residential waste generation was 0.598kg/day. With the support from EUROPEAID, in 2009 started the implementation of a WMS Project. Through the funds, a local NGO, Fundar – Galapagos, the Municipality of Isabela, and the Galapagos National Park, started the planning of the WMS. Through this project, a waste collector truck and basic infrastructure for the recycling centre were acquired. A number of recycling stations were distributed in strategic points around the town of Puerto Villamil.

In 2011, WWF and Galapagos Conservation Trust (GCT) supported the project with a professional who gave technical assistance to the implementation. Since 2011 the Municipality has required households and touristic operators to separate waste. The processing of organic waste started in 2012. The environmental department of the municipality was created in 2012 with separate funding and staff. WWF supported the municipality with a skid steer for the landfill management, a second truck for waste recollection, waste bins and various studies until 2013. Through a support project with the Spanish development agency AECID a sanitary landfill was designed and constructed in 2013. AECID and WWF also designed and constructed an ecological model office for the administration of the environmental department in 2013.

An interesting project which is not directly related to waste management, but to sewage water treatment was also implemented on Isabela. Since sewage water was discharged without appropriate treatment into volcanic cracks or even directly into the ocean, a study was financed in 2012-13 to design a constructed wetland for the municipality of Isabela. The study was financed by WWF and with public funds from the Galapagos Government Council (CGREG) and the National Bank. The constructed wetland with a treatment area of around 6,000 m^2 was implemented and inaugurated in 2016. It is one of the biggest of its kind in all of Ecuador.

Photo: Sewage Water Treatment Plant of Puerto Villamil. Source Orcatec 2016.

From 2014-2018, the WMS did not receive support from the elected Mayor so that most of the WMS infrastructure was not maintained. During that time, waste was separated at source, but unfortunately all waste was dumped in the landfill. According to the present Environmental Department Director who was part of the WMS back in 2011, when he was appointed again by the new administration "*the WMS was largely moribund, there were damages in the infrastructure, the recycling centre was inoperable and the Environmental Department was non-existent; we had to start from scratch".* This is a compelling example of how important and critical the Mayor's involvement in environmental governance is and how politics can disrupt sustainable development. Since a new administration started in 2018, the WMS was reactivated. However, support is needed for all the different system components: waste separation, waste collection and waste treatment.

TABLE 1 GALAPAGOS WASTE MANAGEMENT OUTLINE

Facility and Equipment	System Introduction	Cooperation Project	Policy
1998 Fundacion Galapagos Recycling Centre "Fabricio Valverde" Santa Cruz	1990's First Recycling Initiatives – Fundacion Galapagos	1990's Fundacion Galapagos	
2000 Waste Collector Donated by GNP FUNDAR Santa Cruz	2000 Oil Collection System (RELUGAL) Santa Cruz		
2003 Waste Collector Composting and Recycling Area Santa Cruz	2003 Santa Cruz Pilot Separation Program in 3 neighbourhoods	2003-2006 Urbal- Project EU Santa Cruz	
2005 -2010 Expanded Recycling Centre. Mechanical Composter and containers, Truck Scale, GPS Monitoring. Incinerator Bio hazardous Waste 2013 First Sanitary Landfill Facility Santa Cruz	2006 Household Waste Separation Santa Cruz 2008 Expanded WMS rural areas and ships	2006-2014 WWF Toyota 2012-2016 WWF Helmsley	2006 Santa Cruz WMS Ordinance 2021 Santa Cruz WMS Ordinance Reform
2006 -2007 Colored containers. Recycling Centre, Composting area, Dry Landfill San Cristobal 2007 Equipment RELUSAN San Cristobal	2007 Household Waste Separation Santa Cruz 2007 Oil Collection System (RELUSAN)	2004-2007 San Cristobal Spanish Cooperation Project, Fundacion IPADE 2006-2014 WWF Toyota	2007 San Cristobal WMS Ordinance
2009-2011 Colored containers. Recycling Centre, Composting area Isabela	2011 Household Waste Separation Isabela	2009-2011 FUNDAR EU Waste Management Project Isabela 2011-2013 WWF GCT 2012-2016 WWF Helmsley	2011 Isabela WMS Ordinance
			2015 Galapagos Special Law Cargo Ships required to transport recyclables to mainland 3 times/year 2015 CGREG Resolution to promote responsible use of plastics (did not restrict)
	2019 Some single-use plastics products replaced by reusable or biodegradable.		2018 CGREG Resolution Reform to restrict the use of some plastics

Table 1 Galapagos Waste Management Outline

Santa Cruz San Cristobal Isabela

Source: Orcatec

3.2 KEY STAKEHOLDERS AND USER INTEGRATION

According to a regulation of the Organic Code of Land, Autonomy and Decentralization (COOTAD), Solid Waste Management is the responsibility of the municipalities. On the islands of Santa Cruz, San Cristobal and Isabela the municipality is responsible for the waste management system, in Floreana the Parish Council. Thus the implementation and success towards an integrated waste management system depends strongly on the commitment of the Mayor. This is the main reason why the WMS have developed at a different pace on the different islands.

Next to the public institutions there are several private service providers such as Don Yore, RELUGAL and RELUSAN for the collection of waste from ships and used oil. Also, various NGOs are key stakeholders as they have been supporting the municipalities over years in the implementation and improvement of their WMS.

A stakeholder analysis is a useful tool that allows the identification of different public, private and community actors that are related, either directly or indirectly, to the WMS in the Galapagos Islands.

KEY STAKEHOLDERS ANALYSIS FOR WMS IN THE GALAPAGOS ISLANDS

GOVERNMENT/POLICY MAKERS

STAKEHOLDER	TYPE/ Location	ROLE	INTEREST IN THE TOPIC
Municipality of Santa Cruz	Public / Santa Cruz	Provision of public solid waste management service Exclusive competence	The Mayor and the Environment Department are highly motivated to participate in the project and requested support in environmental education.
Municipality of San Cristobal	Public / San Cristobal	Provision of public solid waste management service Exclusive competence	San Cristobal has been slow to adopt the new regulations.
Municipality of Isabela	Public / Isabela	Provision of public solid waste management service Exclusive competence	They are highly motivated. It's a major concern to reduce waste. Landfill is collapsed. The system needs support in all the areas.
Parish of Floreana	Public / Floreana	Waste management service	
Galapagos Governing Council	Public	Planning, Public Policy and regional coordination	In 2018 passed a resolution to restrict single-use plastics in the Galapagos Islands. Their interest is to incentivize reusable items and channel resources to promote plastic use reduction.
Ministry of the Environment (ME)	Public	National Environmental Authority, responsible for the leadership, planning, regulation and coordination of the Decentralized National System of Environmental Management.	They are part of the Coastal Cleanup Initiative. As part of its competencies ME may determine products subject to Extensive Producer Responsibility (ERP), or specific prohibitions for National Park of Galapagos
Galapagos National Park Directorate	Public	Responsible for the conservation of the ecological integrity and biodiversity of the island and marine ecosystems of the protected areas of the archipelago, Environmental regularization and control of the projects that are being implemented or intend to be implemented in the province of Galapagos	They are part of the Coastal Cleanup Initiative. Environmental Education. Support the implementation and monitoring of the Resolution to restrict single-use plastics.

Source: Orcatec

PRIVATE AND INFORMAL WASTE MANAGEMENT COMPANIES

STAKEHOLDER	TYPE/ Location	ROLE
RELUGAL	Private / Santa Cruz	In charge of oil collection, Storage and transport of to the mainland to be sold to companies in charge of refining and reusing oils.
RELUSAL	Private / San Cristobal	In charge of oil collection, Storage and transport of to the mainland to be sold to companies in charge of refining and reusing oils.
DON YORE	Private/ Small Business/ Santa Cruz	Small boat collects and transports waste from tourist ships to the bay and then to the Recycling Centre.
INFORMAL FOOD WASTE COLLECTORS	Informal Santa Cruz San Cristobal	Small farmers collect food waste mainly from local restaurants to feed pigs.

Source: Orcatec

EXTERNAL STAKEHOLDERS

Source: Orcatec

STAKEHOLDER	TYPE/ Location	ROLE	INTEREST IN THE PROJECT
Galapagos Conservation Trust	NGO	Initiator of the Plastic Pollution Free Galapagos Programme. The project brings together an alliance of NGOs, local community and international scientists.	
Conservation International	NGO	Monitoring and evaluating the impact of ocean plastic and micro-plastic on marine fauna (trophic chain)	Partners Plastic Pollution Free Galapagos Programme
WWF	NGO	Supported the implementation of WMS in the Galapagos. WWF also helped the Galápagos government develop the provincial ordinance regulating single-use plastics. Member of the Plastics Management Committee of the archipelago.	
Charles Darwin Research Station	NGO	Conduct research to guide conservation efforts, run educational programs to increase local support for conservation. Risk assessment for Galapagos Wildlife and Plastic Pollution	They are part of the Coastal Cleanup Initiative. Partners Plastic Pollution Free Galapagos Programme
Galapagos Science Center USFQ	University/ Research Center	Since 2015 they have documented impacts of macroplastics on Galapagos wildlife. Research teams study macro and micro-plastics impacts on fauna and socioeconomic impacts of plastics on tourism and fisheries. Community outreach especially with local fisherman.	They are part of the Coastal Cleanup Initiative. Partners Plastic Pollution Free Galapagos Programme

3.2.2 ENVIRONMENTAL EDUCATION AND USER INTEGRATION

Because the effectiveness of the WMS depends strongly on the separation at source, it was very important to integrate the population since the beginning of the creation of the WMS. A crucial condition for successful waste separation at the source is active participation of citizens. Environmental education plays a very important role. To increase awareness on municipal waste separation and recycling, several educational campaigns were carried out, which were part-financed by WWF.

In Santa Cruz a long-term Environmental Education initiative was designed, and it included experts on education, communication and outreach. According to Diego Añazco, the communications consultant in charge of the campaign, there were a number of key elements that made it successful:

1. Planning: it involved the selection of age appropriate strategies directed for school children in the seventh and eighth grades. There was a pedagogical approach to environmental education in these years; children's brains are still developing and they have started to gain a sense of responsibility. They can bring the message into the households and help foster behavioral change.

2. The campaign consisted of various environmental activities, which were educational and fun and covered a number of topics. These activities included: lectures, excursions, competitions in waste separation, theater, and upon completion a *"Guardians of Galapagos"* Diploma. [3]

3. Material and activities were designed specially for children. An important part of the campaign was the creation of "Reciclaman": a recycling superhero who had 4 "weapons" Reduce, Reuse, Repair and Recycle. *Reciclaman* fought against *"Desechoide"* (Wasteman) and "*Puerca Mugre"* (Ugly Dirt). A number of communicational products were created, such as comics, jingles and a Reciclaman workbook.

Photos: Reciclaman Environmental Education Campaign Source: WWF, 2014

These educational campaigns reached 1,600 school children in 13 schools in Santa Cruz.

All the products that were produced during the project belong to the municipality. However, long-term outreach activities did not continue after the project ended. It is still necessary to generate continuous training activities

[3] Environmental Education Campaign Video. https://youtu.be/pIhTLRa7Kt4

to optimize the waste separation process at the source, in order to achieve a reduction of material sent to the landfill and, in turn, improve performance of the recycling process. At the moment, the Municipality´s Environmental Department has expressed the need to use all these materials and start a new campaign.

SUMMARY

- **Waste management is very complex and waste generation rose steadily.**
- **NGOs play a very important role in the development of the WMS on Galapagos.**
- **Even though many efforts are carried out to continually improve the WMS (from public policy to technical assistance), the majority of waste is disposed of in the sanitary landfill.**
- **Campaigns were important to include the population and tourism operators in the WMS.**
- **Even though many campaigns have been conducted, there is still need for more campaigning from the municipalities.**
- **Apart from the WMS on Galapagos, the majority of marine debris on the beaches comes from the continental mainland.**

SECTION 4: WASTE MANAGEMENT DATA & STATISTICS

Santa Cruz is the island that produces the largest amount of waste (more than 60% of the total), as previously mentioned it has the largest population - about 20,000 inhabitants (INEC, 2019). Santa Cruz is the hub of tourism, around 70% of the 271,238 tourists who visited Galapagos in 2019 entered through the Baltra airport that serves the island (Galapagos National Park and Galapagos Tourism Observatory, 2019). In this context, an efficient waste management system is a priority, thus it will be analyzed in further detail.

The WMS in the Galapagos Islands is in many ways different from mainland Ecuador for instance in the colors of waste bins. In Galapagos, the waste is separated at the source (private houses or tourism operators) in organic waste (green), recyclable waste (blue) and no-recyclable waste (black). The municipality collects separately voluminous garden waste (Table 2).

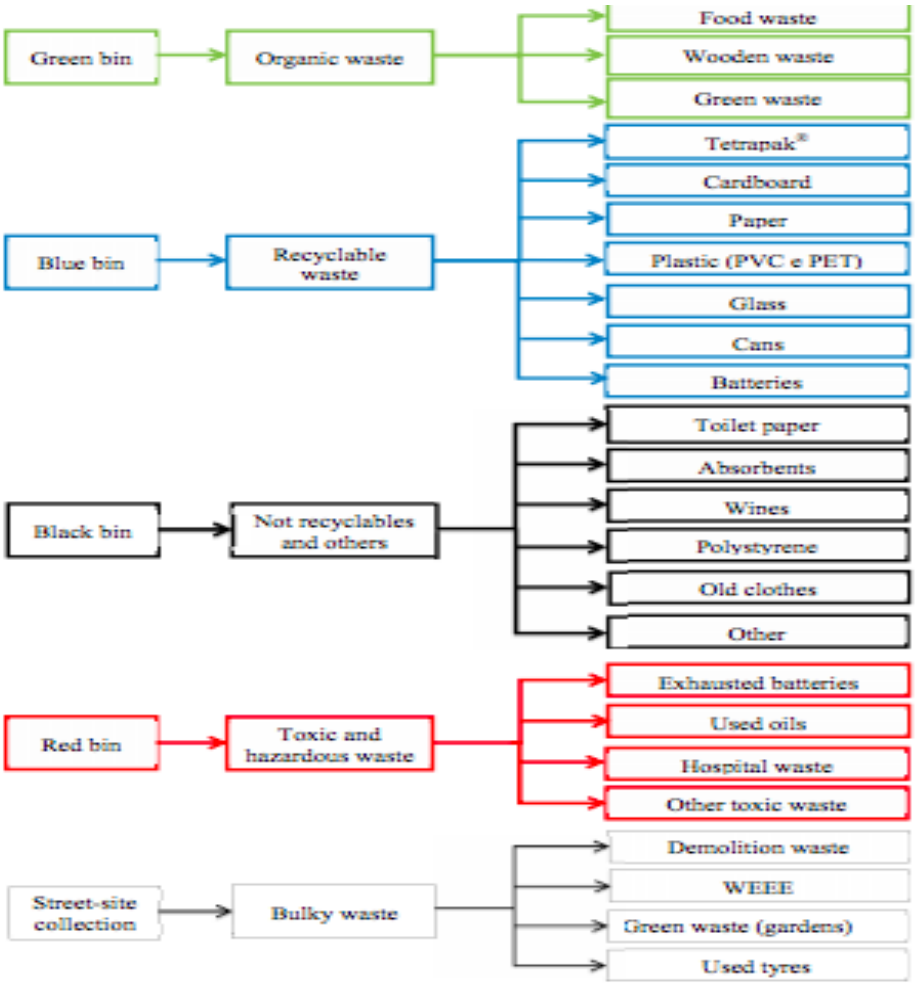


Table 2 Waste Collected

Taken from: Ragazzi et al 2014. Source: Municipality of Santa Cruz

A curbside collection system was developed; it includes more frequent waste collection in touristic or commercial areas and less collection in residential and rural areas. Each client is responsible to put the waste bin next to the public road before the collection and to store it afterwards on private ground. A specialty is the collection of organic waste early in the morning when the sun is low to avoid odor generation.

The organic waste is transported to a special composting area within the recycling centre of Fabricio Valverde, around 4 km inside the island. The organic waste is firstly cleaned from plastic bags, mixed with wood chips, and then stored on piles in the shape of a cone. The piles are moved and piled up every several weeks to generate fertile compost. The idea was to use the compost in public areas, in agriculture and within urban gardens. Unfortunately, the challenge from the beginning was a social factor. Since organic waste was stored in plastic bags, it is a high effort to separate all plastic bags in the composting area. Therefore, the final compost still includes plastic particles, which lead to a very low acceptance and usage of the compost. In 2017, Domski and Schryer (USFQ Scholars) evaluated a number of parameters: PH, temperature and humidity of a sample of composting piles. The results found that the average temperature was high, the mix was acidic and humidity was below 75%. Its nutritional value is compromised, besides some heavy metals and plastics are also present in the final compost.

Local pig farmers use about half of the organic waste that restaurants and hotels store separately in plastic barrels. Local pig farmers provide these barrels. The farmers are very interested in using food waste for feeding their pigs, so they take responsibility for the collection of filled plastic barrels and the return of empty and cleaned barrels to the restaurant. This practice helps to close the loop of organic waste.

At the recycling centre, recyclable waste is separated manually on an automatic belt. In the first step the main material groups are separated such as glass, cardboard, plastics, metals, paper, tetrapak and cans. The remaining material, which passes along the recycling belt, is transported to the landfill. In a second manual step each material group is separated again and compressible materials (paper, plastics, cardboard, metals) are compressed in a waste baler. The recycling material packages are stored in the recycling centre and transported to the mainland every several weeks. Due to a special regulation the cargo boats are obliged by law to transport recyclable waste to the mainland at no cost. Glass products are shredded to glass shards and used locally for souvenirs or for filling material on construction sites. Glass is the only material processed locally. The center has a glass crusher, which stopped operating in January 2017 due to wear and tear and machine problems. Since then, glass bottles have been deposited in two areas of the recycling center, which represents a problem due to the high flow of this material (Domski, 2017)

Non-recyclable waste is transported to the municipal landfill around 40 km inside the island. The main advantage of the site is its arid climate, due to orographic rainfall on the southern slope of Santa Cruz. This minimizes potential leachates in combination with lack of organic waste. In addition there are no freshwater layers on the Northern slope that could be contaminated. One disadvantage is the distance, which has to be covered by the waste collectors each day.

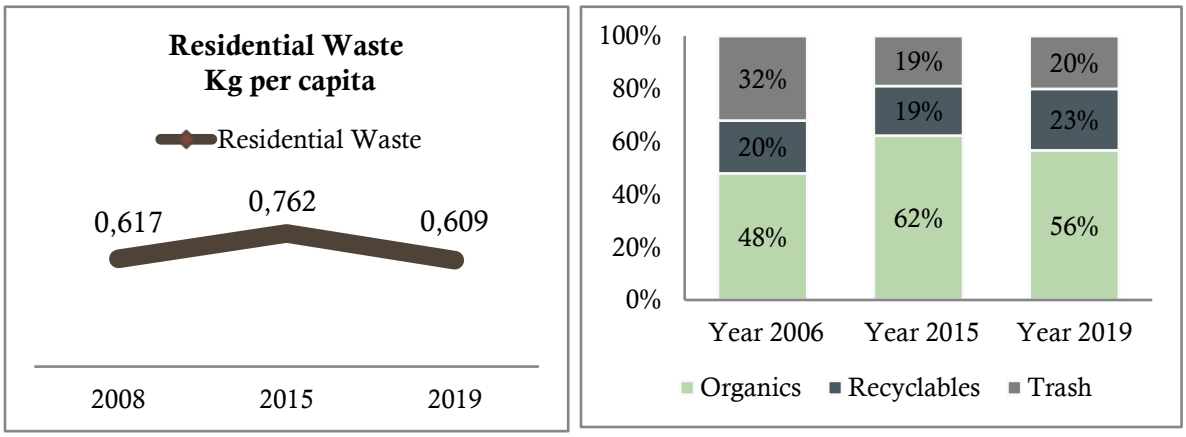
A private company, RELUGAL, collects burned oils from lubricators, mechanical workshops, restaurants, tourism and fishing boats. This company is in charge of collecting, storing and transporting this waste to the mainland to be sold to companies that are in charge of recycling the used oils. A certain part of the used oil enters in the cement factories near Guayaquil.

4.1 RESIDENTIAL WASTE CHARACTERIZATION

One of the first steps while starting to introduce WMS is waste characterization to understand the quality and the quantity of waste, which needs to be collected and treated. In Galapagos various characterization studies have been conducted by different institutions to calculate the waste streams as a basis for waste management for the municipalities (e.g. calculation of the sanitary landfill, personal needs for the recycling activities).

In the following, three waste characterization studies, which were carried out in 2006, 2015 and 2019, are compared. Since different methodologies were applied, the data cannot be compared completely, but several indications can be drawn.

The composition of the waste produced by households is summarized in Table 3. As shown on the graphic, the amount of organics produced by households generally is the highest throughout the studies and increased from 48% in 2006 to 56% in 2019; this may be due to an increase of cargo ships that transport organic products for the growing fluctuating population of the archipelago, and also an increase in local food production which means also more food waste. Recyclable materials also slightly rose from 20% to 23%. Whereas the amount of non-recyclable products reduced from 32% to 20%. This might be due to the fact that the waste management system changed between 2006 and 2019, which means that more materials are recyclable now, which have not been recyclable before.



Source: Veolia, 2019; Pazmino, 2015, De la Torre 2008.

Figure 5 Waste Characterization 2008-2019

The study gathered data on the composition of the Municipal Waste Management System. Table 3 shows the average physical composition of household solid waste. Results are presented in separate categories which reveal the most abundant materials, and the composition of the category "Plastics". Only a fraction of plastics can be recycled.

MATERIAL	SANTA CRUZ	ISABELA	SAN CRISTOBAL
ORGANICS	**56.45**	**59.99**	**35.29**
PAPER	**4.96**	**3.37**	**4.2**
PLASTICS	**12.04**	**10.19**	**20.83**
Low Density Plastic	5.3	3.75	11.98
HPDE	3.59	3.6	2.96
PET	1.19	1.28	3.85
Misc. Plastic	0.72	0.47	0.37
Tetrapak	1.24	1.09	1.67
GLASS	**3.74**	**4.44**	**10.39**
METAL	**1.93**	**1.6**	**3.34**
Ferrous Metals	0.38	0.3	1.54
Non-Ferrous Metals	1.55	1.3	1.8
NON RECYCLABLES	**20.79**	**20.33**	**25.82**
Rubber	1.73	2.83	3.75
Inerts & Other	4.48	1.98	7.12
Textiles	2.76	2.76	2.39
Diapers & Sanitary	10.83	8.4	11.57
Wood	0.99	4.36	0.99
Batteries	0.09	0.08	0.14
TOTAL	**100**	**100**	**100**

Table 3 Average physical composition of household solid waste, Source Veolia 2019

The results show that the biggest waste component is organic waste, whereas recyclable and non-recyclable waste have similar percentages. It is important to mention that despite the regional regulation to restrict plastics, only local governments have the capacity to enforce this regulation by passing local ordinances to restrict plastic use. This may explain the differences within the islands in terms of waste characterization.

Below is a graphic overlook at the results by material type for each Island (Figure 5) without organic waste. As shown on the graphics, diapers and sanitary products are the largest consumer items in landfills. They represent more than 40% of the non-recyclables category. Ecuador currently lacks any treatment and recovery options for diapers and sanitary products and there are not immediate plans of establishing recycling facilities. It is essential to find alternatives to prevent this emerging waste stream, as it will continue to grow.

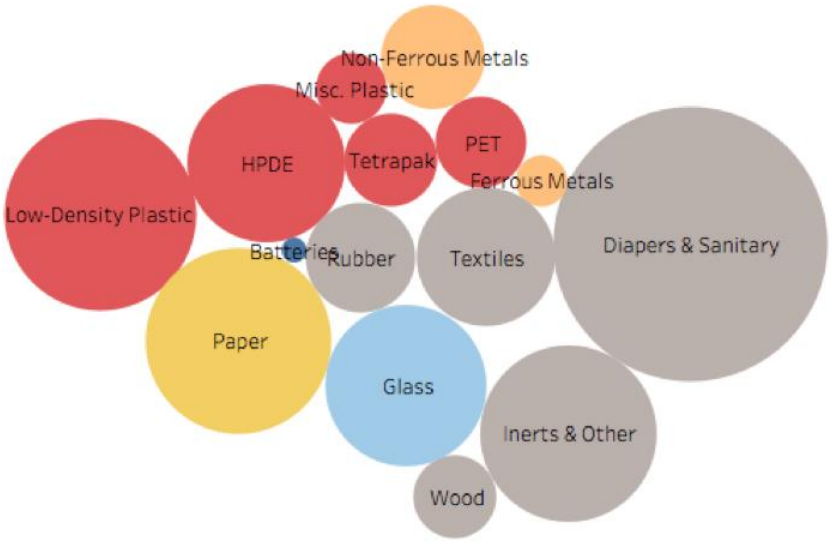


Figure 6 Non-organic Waste Characterization Santa Cruz

■Non Recyclables■ Plastics ■Paper ■Glass ■Metals ■Batteries
Source Veolia, 2019

4.2 MAIN WASTE STREAMS

Using a combination of waste generation and waste treatment statistics collected by the Municipal Environmental Department from 2009 to date, Sankey diagrams were created to show the waste flow for two different years with 5 year gap: 2014 and 2019. These diagrams provide a first overview of the waste management system and map the current flows of waste within the municipal solid waste management system.

Main Waste Streams by collection system in Santa Cruz 2014

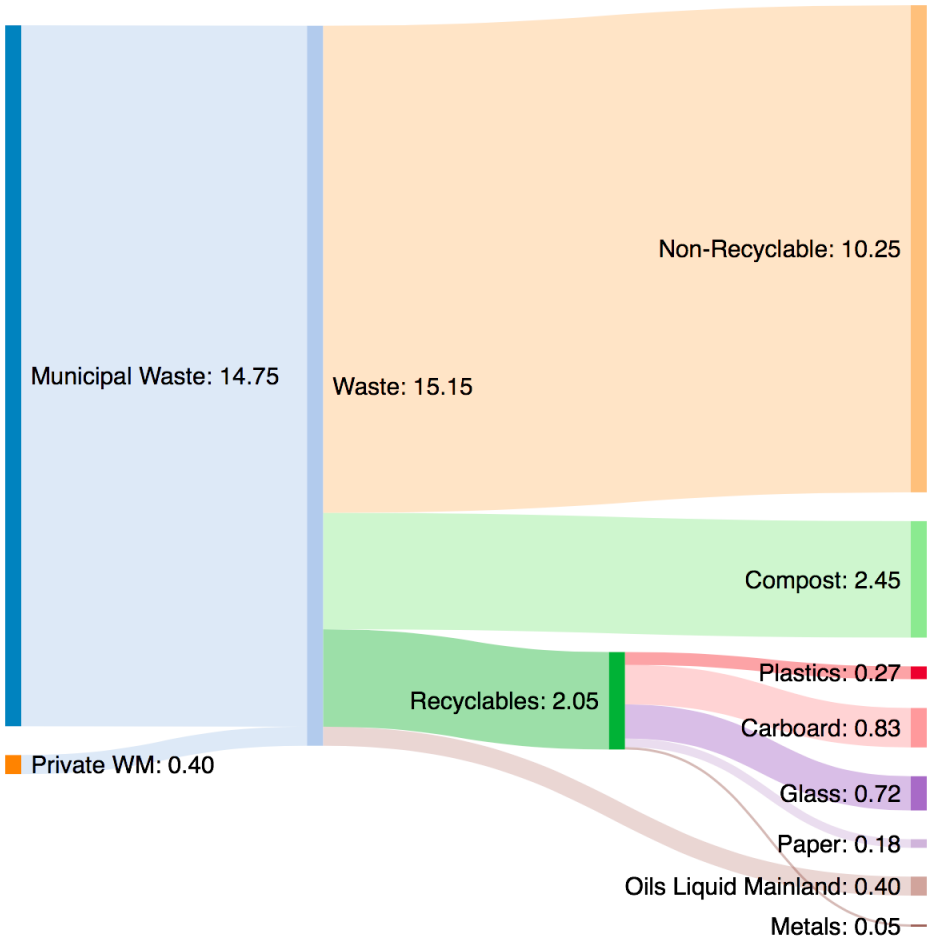


Figure 7 Main Waste streams by collection system

Source: Municipality of Santa Cruz Waste Management Data /WWF 2014. Data Tons/Day

The second Sankey Diagram (Figure 7) includes Municipal Solid Waste (generated by households, commercial premises, touristic infrastructure, institutions) and bulky waste (electrical appliances, old furniture, green waste, used tires) for the year 2019. The diagram shows how much of a material is being recovered. It uses the total recyclables in the garbage bin and the composition of the recycling stream by material. The capture rate for all the recyclables in 2014 was 64%.

Waste Streams treatment and disposal in Santa Cruz 2019

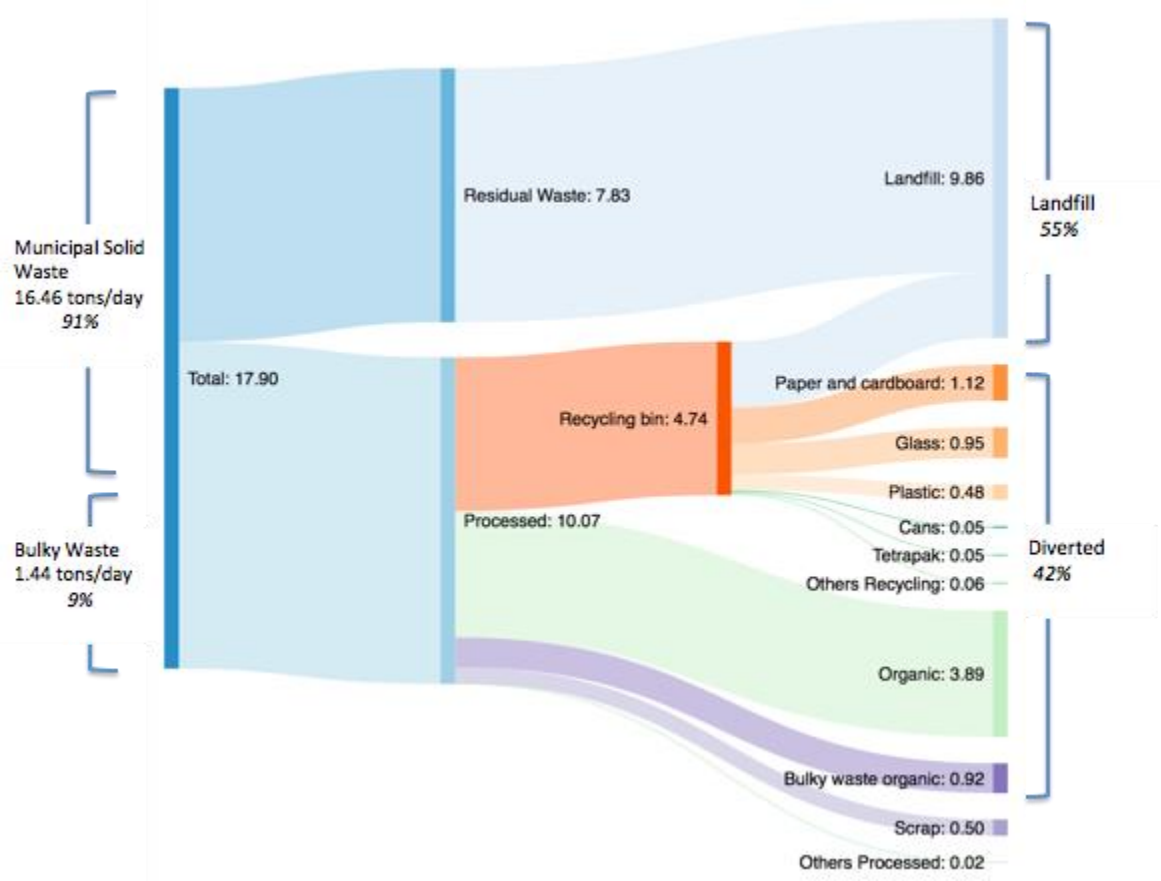


Figure 8 Main Waste Stream Treatment and disposal 2019

Source: Municipality of Santa Cruz Waste Management Data /WWF 2014.-2019 Data Tons/day

This data includes municipal waste and bulky waste.

4.3. ESTIMATION TOURISM RELATED WASTE

The impact of tourism on Municipal Solid Waste generation is large and increasing. Specifically, tourism pressure on waste management in island destinations is a major concern, as they are isolated from mainland recycling networks and facilities and landfilling prevails (Mohee et al., 2015). Islands all over the world exhibit the highest per capita waste indicators, not only because they keep a more complete account of waste generation but also because of their intensive tourism industries (Dias-Farina et al, 2020). Galapagos, as with many other islands, relies largely on imported products. In 2017, approximately 75% of the agricultural food supply was transported from the mainland (Sampedro et al, 2020). The per capita waste generation in the Galapagos Islands

in 2019 was 0.777 kg for the resident population and 0.850 kg for the floating population (visitors and tourists), these averages are well above the national average of 0.597kg/per person/day[4].

It is important to contextualize the contribution of tourism to mixed waste generation, to identify possible solutions at regional and local levels that would enable us to take action towards the overall challenge of waste management.

There are a number of methodologies to estimate tourism related waste. The most recent characterization study focused on a supply-side approach, to measure the waste generated by the main tourism activities, directly used by tourists. To determine this parameter, a survey was conducted in a representative number of generating sources for each category: bars, restaurants, hotels, cruise ships, tourism operators and airports; and on each island, Santa Cruz, San Cristobal and Isabela.

The results were categorized in land-based (0.883kg/tourist/day) and boat-based generation (0.778kg/tourist/day), as shown in Figure 8. Waste generation from the five tourism categories was assigned to each type of tourism. It is important to mention that a ship's food waste can be shredded and discharged in the sea, according to MARPOL and Galapagos National Park Regulations thus, that amount of organic waste has not been accounted for.

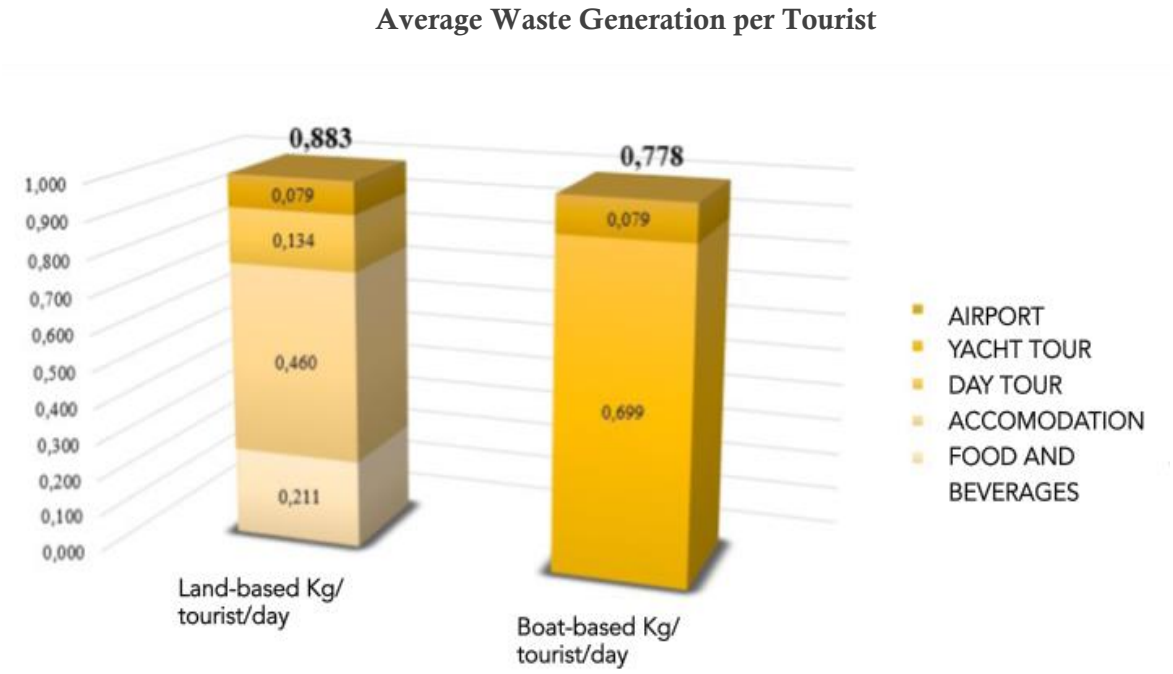


Figure 9 Average Waste Generation per Tourist
Adapted from: Galapagos Waste Characterization Study. Veolia, 2019

[4] According to Soliz 2020. In Ecuador, the per capita waste generation ranges widely from 0.22 to 1.8 kg / inhab / day, with a national average of 0.597 kg /inhab /day.

The characterization study of the garbage stream in tourism establishments indicated approximately 38% of organics; the second largest material is glass with approximately 17%, diapers & sanitary products accounted for 11% and low-density plastics for 10%. (Figure 9).

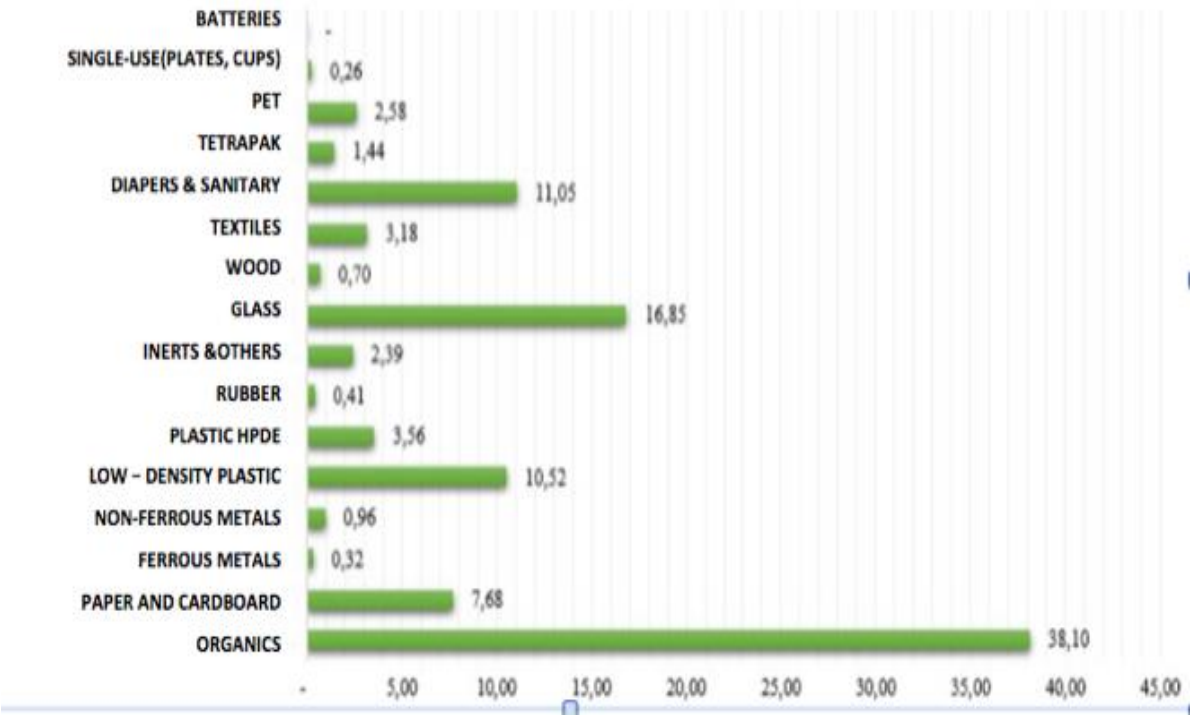
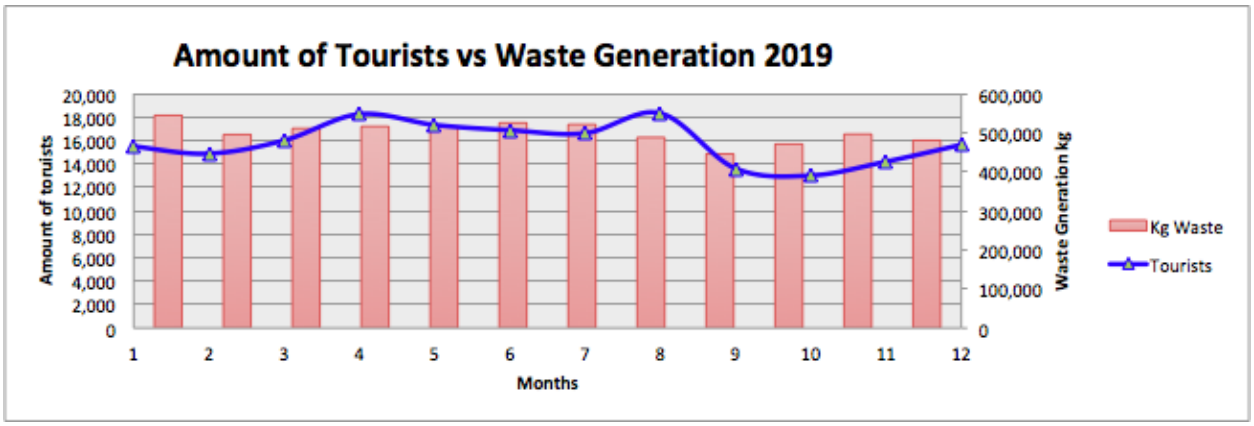


Figure 10 Tourism - Waste Characterization
Adapted from: Galapagos Waste Characterization Study. Veolia, 2019

One of the largest waste fractions generated by hotels, bars and restaurants is glass. Unfortunately, as mentioned before, in Santa Cruz, the glass crusher stopped working and glass is being collected and accumulated in the recycling center. Santa Cruz and Isabela mentioned the increasing amount of glass waste as a problem; it is difficult to process and recycle locally. In Isabela, the vast majority of glass is dumped in the landfill.

According to Veolia's 2019 report, the resident population generates 25.12 tons/day, in total, while the floating population generates approximately 3.53 tons per day, totaling 28.65 ton/day. It was estimated that tourism's waste contribution is 12.32% of the total solid waste generation in the Galapagos Islands.

The effect of tourism on the generation of waste is not constant along the year. In fact, the quantity of Municipal Waste is used as a proxy for calculating the seasonal population of different towns and regions with high amounts of tourists (Mateu-Sbert et al, 2013). Although Galapagos does not have very marked seasonal tourism rates, there is however, a high season in the summer months. 2019 and 2020 were chosen to illustrate the fluctuations of waste collection and tourism series along the year. There is a peak during the summer months for both Municipal Solid Waste and tourists, and during the low tourist season in September waste generation also drops.



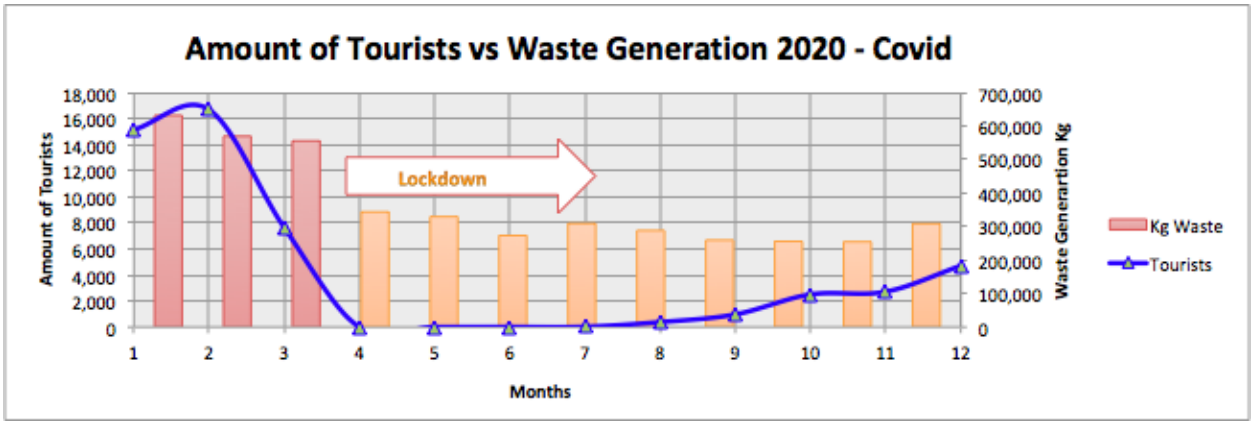


Figure 11 Tourism vs Waste Generation

Sources: Municipality of Santa Cruz Waste Management Data 2019-2020/ Tourism Observatory Data and GNP Visitors Data 2019-2020

Prior to the March 2020 lockdown, when tourism activities were at the peak in January, the Municipality collected 20 tons/day. When tourism activities shut down from April to July that number dropped all the way down to 10 tons/day, which is half of what it was before lockdown. In June 2020, 273 tons of municipal waste were generated in Santa Cruz, 48% less than in the same date the previous year (when 525 tons were collected). With the tourism closure, this is the first time that we can accurately measure the scale of the impact of tourism on municipal solid waste, which is dramatic. Nevertheless, other economic activities such as the closing of markets, retail and a general decrease in consumption contributed towards garbage reduction.

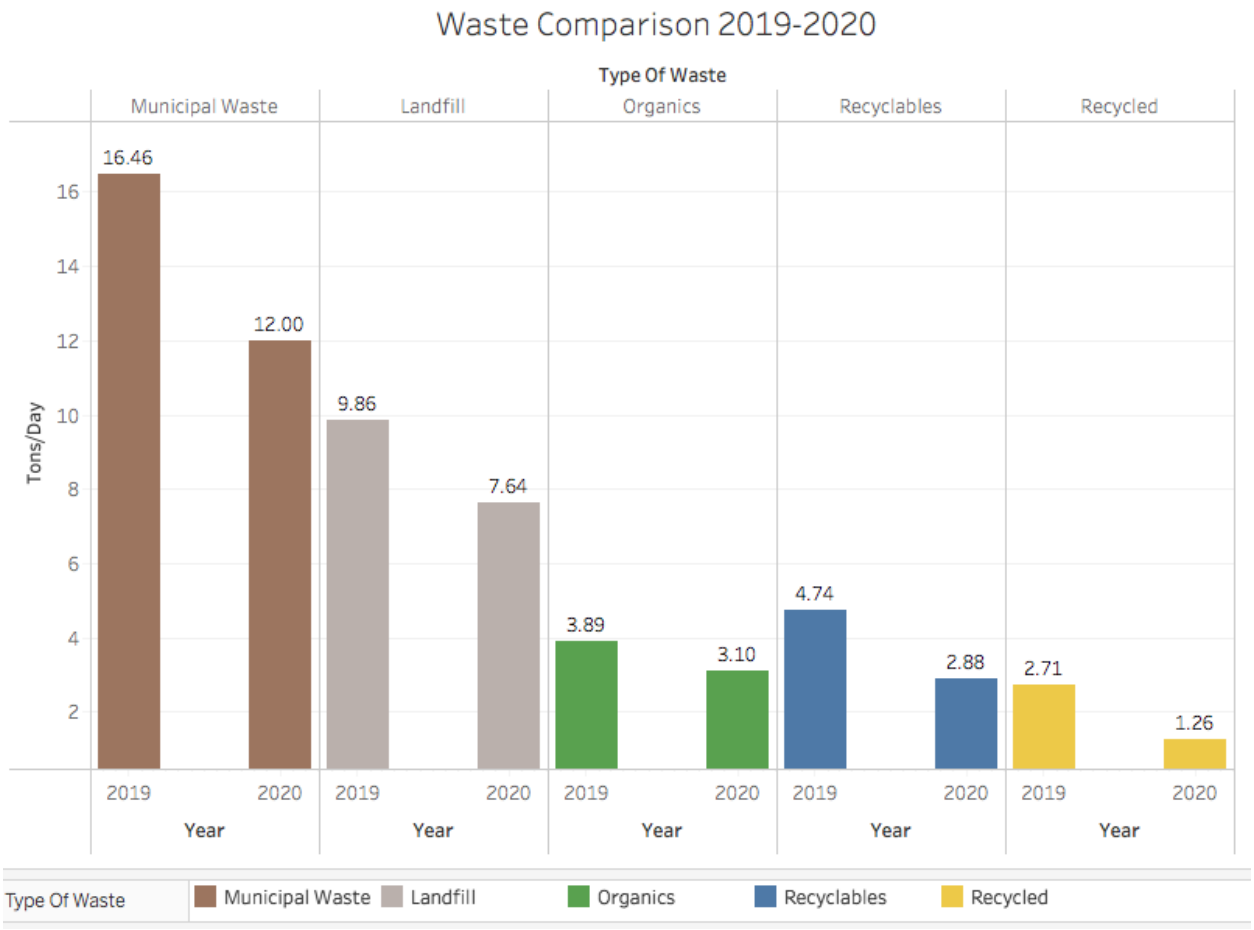


Figure 12 Waste by Type 2019-2020
Sources: Municipality of Santa Cruz Waste Management Data 2019-2020

4.4 FINANCIAL ASPECTS

Achieving financial sustainability of the solid waste management system is a major challenge for local municipalities. The costs to run the system represent a significant portion of their yearly budget. Additionally, the costs for investment have to be considered (construction of waste facilities, vehicles, etc.).

Currently the waste management fee is charged to the population through the electricity bill. This was a very innovative methodology, as the user needs to pay the electricity bill in order to have the service of electricity. The municipal waste fee is calculated based on a progressive waste tariff, which has a commercial, and a residential tariff. The objective is to raise the tariff consequently to achieve financial sustainability of the WMS. The theory behind the tariff is that a user with a higher electricity demand also accounts for higher waste generation.

At the moment a new financial model is being introduced in Santa Cruz, which is based on the "Swiss model". In this case the user does not pay a fee for the WMS as part of the electricity bill, instead the customer pays the actual WMS price for special waste bags, which have to be bought from legalized sellers. This means that a

customer is motivated to compact the waste as much as possible since the cost is no more related to the electrical consumption, but to the volume generated. Since the model is still in its pilot stage no analysis and recommendations can be derived at this stage.

It should be noted that the Municipal GADs subsidize 56.0% of the costs for providing the integral solid waste management service in their jurisdictions (PMRC, 2020), the difference is covered by the users. In the last years, the personal costs for administration, street cleaning, recollection and treatment have been between $1 and $1.7 Mio (2015-2019) for a total treatment of yearly average of 6.505 tons of waste. This means that the total waste management costs for the recollection, transport, treatment and ongoing investments of 1 ton of generic waste costs around $214.

Compared to other parts in the world this cost is very high. According to a study of the World Bank in 2015, the average costs for collection, transport and treatment (without investment) is around $100/ton for developed countries and around $35 per ton in less developed countries (Silpa et al 2018). These numbers are not static, they should just show that waste treatment is cost intensive, especially since externalized environmental costs from leachates, waste entering the environment, etc. are not included. So the actual cost actually is somehow higher.

SUMMARY

- **Due to a special regulation cargo boats are obliged by law to transport recyclable waste to mainland at no cost.**
- **No general reduction in waste management generation per capita has being observed.**
- **Diapers and sanitary products are one of the main components of landfill material.**
- **Low-density plastics are the most frequent plastic waste material.**
- **WMS is very cost intensive.**
- **The organic waste treatment is complex and the resulting compost has low quality and little acceptance.**
- **Pig farmers are collecting organic waste from restaurants and hotels.**
- **Informal waste stakeholders are complementing the WMS system taking advantage of the resources.**
- **A new business model is being piloted on Santa Cruz for which the customers buy special plastic bags from legal retailers.**

SECTION 5. INITIATIVES TO REDUCE WASTE GENERATION

The population of the Galapagos Islands has a comparably higher sensibility towards ecological topics in comparison to other parts of Latin America. This is due to their life within a natural protected area and to their dependency from tourism. Also, the municipality, the Galapagos National Park Directive and various NGOs have run various educational campaigns to raise environmental consciousness.

This could be the reason why many local initiatives have started to reuse waste and to reduce waste generation. In the following a list is presented with a short description of the focus of their activity and their geographical reference.

SANTA CRUZ

Name	Business	Description	Contact
Ginette Veas	Opuntia Galapagos Zero Waste	Sale of various products without plastic containers, including local organic drinks in returnable containers.	0969307768
Gustavo Daza	High tide	Sale of compostable products (mainly bags)	0983502051
Max Martin	Orcatec-Iguana Cup	Reduce the number of single-use plastic bottles and cups used unnecessarily	0989894526
Jeannet Garcia	Biocoral	Sale of biodegradable detergents with exchange of containers	0992048876
Teresa Barrera	Packaging	Sale of compostable and paper packaging.	0999414040
Rafaela Difazio	Packaging	Sale of compostable and paper packaging.	0993906097
Edwin Chillagana	Handicrafts	Elaboration of tiles, countertops, miscellaneous items with plastic and glass pieces. Recycled bags out of resistant cement bags.	0991657131
Vicente Berdonces	Retail	Drinking water vending machines	0992641056
Green Colony	Retail	Zero Waste Store Refill Station	
Darwin Ecogarden	Retail	Local production of organic food	
Carolina Proaño	Precious Plastic Galapagos	Plastic recycling with injection machines	0984494255

SAN CRISTOBAL

Name	Business	Description	Contact
Daniel Fraga	Endemica	Production of beer in returnable containers	0996524953
Dennis Garces	Cactus Shop	On-line store - sustainable and eco-friendly products, offering alternatives to avoid the use of plastic.	0989074161
Gaia Pack	Compostables	Sale of compostable packaging	0997761443
Organik	Zero Waste Shop	Sale of locally produced food without packaging.	0980125110

ISABELA

Name	Business	Description	Contact
Mayrita Solorzano	Evolution World	Sale of compostable cups with Galapagos designs	0997494222

Source: CGREG 2020 & Research

There is no general data available as of how these initiatives reduce the waste generation. Nonetheless it can be concluded that all initiatives have positive impacts on the waste reduction. Also they show a high degree of willingness to be active to confront the waste generation and invest their time to fight this issue.

On the other hand there are various challenges, which these initiatives have to face. Due to higher labor costs on the Galapagos Islands in comparison to mainland Ecuador, certain products made out of recycled material have a higher cost in comparison to products created on the mainland. This is a challenge since some recycled products are sold as if they would have been created on the Islands, but in reality they have been produced on the mainland and shipped to Galapagos. Also, initiatives to recycle waste may be seen as a justification for the creation of waste itself. Another challenge is that recycled products may not be recyclable because they are a mixture of different materials and end up on the landfill after use.

In order to reduce waste generation on a broader scale, it is necessary to focus on integral circular economy models, thus fully understanding the circular economy and the economic and social dynamics through which businesses create and implement solutions. This requires a transition to a systems perspective. (CRT, 2017).

5.1 WHY IS A ZERO WASTE APPROACH NEEDED?

If a plastic-free Galapagos should be achieved, the root of the problem must be tracked. Studies show that consumption patterns are responsible for an increase of waste generated per capita year by year.

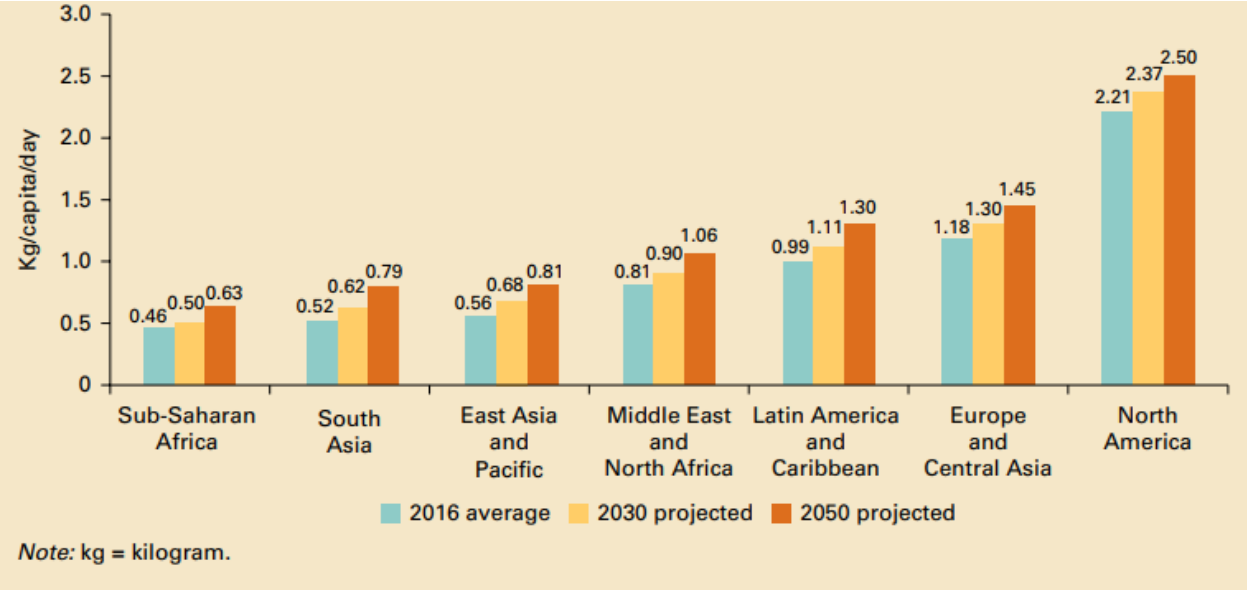


Figure 13 Projected Waste Generation per capita

(Projected waste generation per capita).
Source: Silpa et al, 2018. World Bank.

In the case of plastics, even if we could recover all plastic packaging and recycle it, we could not avoid many microplastics and it has even been proven that recycling is not the solution. Although the recycling of plastic has been promoted since the 70s, and huge investment has been put into recycling, its vast majority has ended up buried and, in some cases, in the ocean. Globally, only 14% of single-use plastic packaging is being collected for recycling and only 5% of it being successfully recycled into new plastic (Dauvergne, 2018). Reports have documented how the plastics industry has spent large sums of money promoting recycling although they knew that it was costly and even infeasible to do so. However, the strategy of holding consumers and municipalities responsible for recycling has continued strong in order to remove the pressure on the industry. (NPR, 2020). This has been a distraction from the real problem: single-use plastic. We can even say: producing, transporting items, like grocery bags, dishes, cutlery and several food containers that are going to be used only some minutes or weeks does not make any sense.

The impact of plastics on human health is another reason to focus on prevention rather than on remediation. To understand these impacts each stage of this lifecycle must be considered, and also all possible exposure pathways of the variety of substances used and released throughout the plastic lifecycle: inhalation, ingestion, and skin contact. The following graph shows the variety of toxic chemicals and microplastics that humans are exposed along the plastic lifecycle (CIEL, 2019).

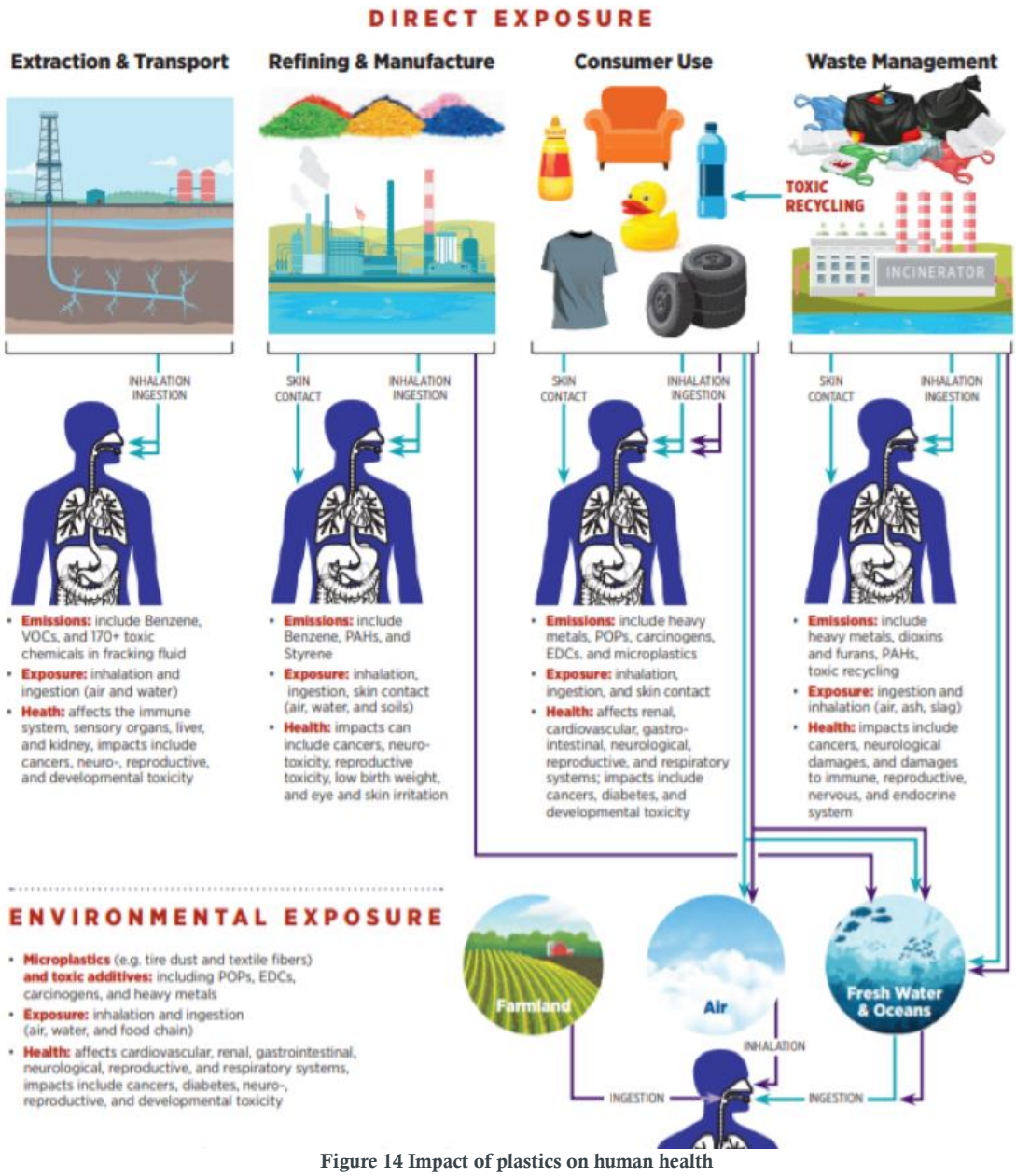


Figure 14 Impact of plastics on human health

Source: CEIL, 2109

With the COVID-19 pandemic, and taking advantage of the public's health anxieties, the plastic industry has taken the opportunity to promote its products, although health professionals reassured the public that reusables can be utilized safely by employing basic hygiene (Laville, 2020). On the other hand, disposable plastics such as expanded polystyrene, have already been declared by the WHO as "possibly carcinogenic".

Although it seems like a new issue in Ecuador, garbage has been a concern also for several decades now. In the 90s, organizations like *Fundación Natura* already carried out programs with schools, companies and governments to reduce and recycle garbage, but instead of reducing, each year each person produced more garbage. Only 30 years ago, Ecuadorians went shopping carrying their baskets, they had returnable crates and bottles of beer, soft drinks or mineral water and it did not occur to anyone to use disposable plates, cutlery or glasses for a celebration. They were used to *ReUse*. So why did they stop doing it? Perhaps the efforts of environmental organizations did not counterbalance the consumer trends and ease that were being implemented in the world.

5.2 REUSE AS PART OF A CIRCULAR ECONOMY

In response to an economy that generates more and more waste, the need has arisen to change its linear approach, produce-use-dispose, for a circular one rethink-reuse-return. The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In this sense, the model is more circular and more sustainable when the circle is smaller. The introduction of reusable items and systems has been shown to be highly effective and a key solution for replacing single-use plastics. Various studies have shown that Reuse is even much better than Recycle. While reusing a bag, a plate or any item requires only it to be washed, refilled or repaired, recycling involves dismantling, washing, melting, adding chemicals, re-manufacturing, among others. In this sense, reusing is better than recycling because it saves the energy and contamination from all these processes. For example, making a metal spoon uses only twice as much energy as a polystyrene spoon and washing the reusable spoon uses 1,000 times less energy than making a plastic spoon. However, the average restaurant uses its reusable tableware about 2,500 times (Deninson, 1998).

According to OCEANA (2020) of the 445 billion liters of beverages sold in PET bottles, between 21 and 34 billion PET bottles are converted into marine pollution every year. They also found that increasing the market share of returnable bottles in all countries` coastal areas by 20% and replacing disposable single-use PET bottles could reduce marine plastic pollution by 39%. This would prevent between 8,100 and 13,500 million of PET bottles ending up in the ocean every year (OCEANA, 2020). In this sense, the greatest impact can be achieved by avoiding the generation of waste, especially plastics, through reusable products.

The following selected initiatives are focused on solving the root problem and making structural changes that will gradually reduce the generation of waste. These solutions seek to avoid the generation of plastic waste and recover organic waste.

5.2.1. IGUANA CUP

IguanaCup is an initiative, which started in Galapagos in 2016. The idea was to give an alternative to single-use cups with a resistant, BPA-free, reusable cup made out of polypropylene. The concept of reusable cups has been viable in developed countries for years. Furthermore, there is data available on the reusability of these cups. According to German studies the cups are reused between 400 and 1000 times during their lifetime.

At the same time the concept is related to the endemic Galapagos species "*Conolophus martae*", the pink iguana which inhabits Wolf Volcano in the North of Isabela Island. This species may be one of the few Galapagos animals that may not have been in contact with plastics. Therefore, it was selected to motivate the user to observe nature, reduce waste generation and pass on the story about the pink iguana.

Source: Orcatec

The initiative started in 2016 and up to now around 3.200 cups are circulating on the Galapagos Islands, tourists have taken many of them as a souvenir. Calculating conservatively that one cup saves the production of 400 single-use plastic cups (each with a specific weight of 9g) means that each cup saves the collection and treatment of 3.6 kg of plastic waste. If the cups are used instead of paper cups (with a specific waste of 17g) a total of 6.8 kg of paper waste is avoided using one Iguana Cup during the life cycle. In total, the initiative has saved the generation of between 11.5 and 21.8 tons of waste theoretically. At the same time it is a motivation for the users to use more reusable products in their daily life. So it has an additional benefit, which is difficult to measure monetarily.

Before the pandemia more than 50 touristic operators used *Iguanacup* in their daily operation. The majority of these are coffee shops, restaurants and hotels. From a financial perspective the initiative has saved between $2,500 and $4,600, since the waste collection and final treatment of single-use cups has been avoided.[5] However, this cost does not reflect the external costs, which need to be considered. For example, the cost of environmental contamination of single-use plastics to wildlife and human health. So in the end the cost savings may be much higher.

The main challenge of the initiative is communication to and application within the tourism sector. While many tourists like to use it and take it as a souvenir, the integration of *Iguanacup* within the tourism sector on Galapagos has reduced drastically during the pandemia.

5.2.2. HUELLA VERDE

Much of the garbage that reaches the Galapagos coastline through ocean currents comes from mainland Ecuador. An important source of single use plastics is Ecuador's food courts since restaurants use single-use cutlery and tableware. In Ecuador there are at least 43 food courts where between 2.000 and 6.000 people eat a day, mostly on menus served on disposable plastic plates, cutlery and cups. This plastic garbage is mixed with food scraps, cardboard and bottles in garbage bags that are collected daily by the municipal entities in charge of cleaning. On average, each food court generates between 6 and 12 m^3 per day of this waste that ends up in municipal landfills.

[5] Based on the financial reports of the municipality of Santa Cruz (Chapter 4.4.)

Food Courts and Waste

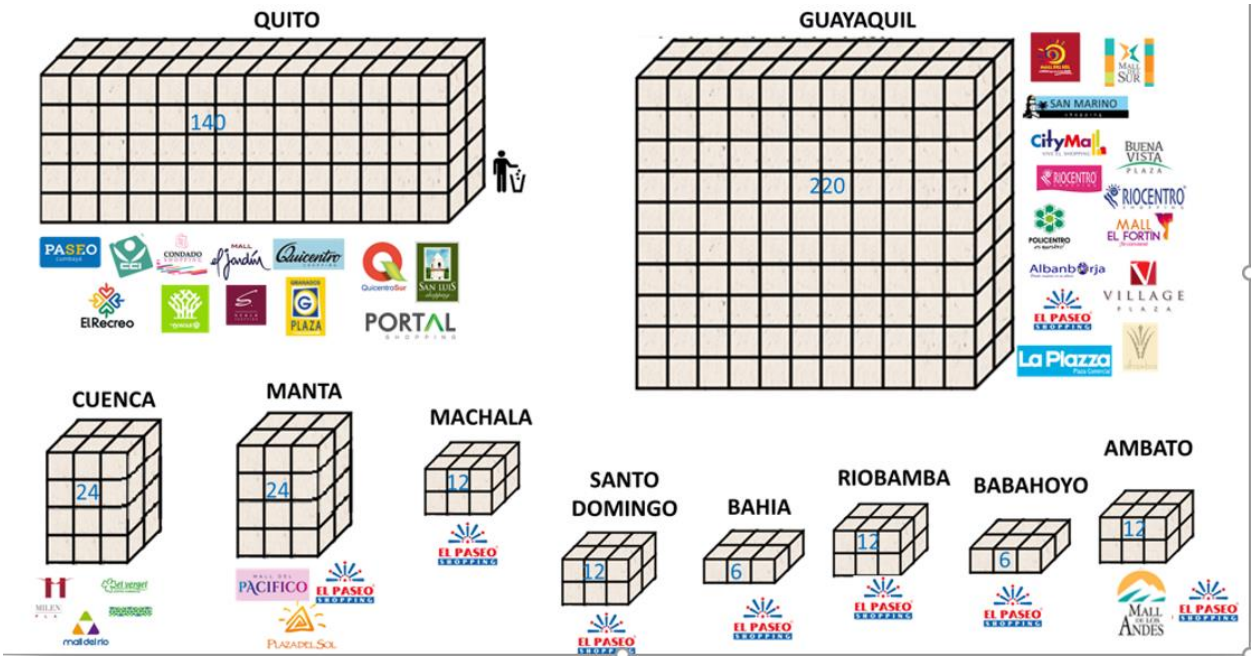


Figure 15 Food Courts and Waste Generation
43 medium to large food courts in Ecuador generate around 472 m3 of waste daily
Source: Huella Verde, 2020

Huella Verde developed and implements an innovative service that makes it possible for food court restaurants to replace the use of disposables with reusable plates, cutlery and glasses. A wide variety of models of ceramic plates, stainless steel cutlery and polycarbonate glasses are delivered every morning to the restaurants. During the day these reusable items are collected and washed in a washing station installed in the same food court.

Classification station in Mall de los Andes food court. Source: Huella Verde

The recovery of organic waste for animal feed is among the most sustainable options to reduce and take advantage of food waste and other organic waste (GAIA, 2018). To make this possible and also to recover other recyclable materials, *Huella Verde* developed collection stations that replace garbage cans in food courts and an innovative waste classification and management service.

Trays are received at the stations and the waste is classified into food scraps (organic); cardboard, paper, pet bottles, glass and aluminum (recyclable); and others. Organic waste is delivered daily to pig farmers and recyclable material to organizations that are dedicated to this work.

Huella Verde began operations in 2017 in the food court of the *Paseo San Francisco* shopping center located in Quito. In 2019 the improved model was replicated in the food court of the Mall de los Andes shopping center in the city of Ambato. Since *Huella Verde* started operations in the second food court, it avoided the generation of approximately 300,000 disposables per month, equivalent to 10,000 per day. During 2019, between the two food courts, 1,032,120 plates, 1,564,153 cutlery and 24,151 glasses and cups were washed. The total of disposables avoided in 2019 by *Huella Verde* were 2'620,424; 1'199,224 in the *Paseo San Francisco* and 1'421,200 in the Mall de los Andes.

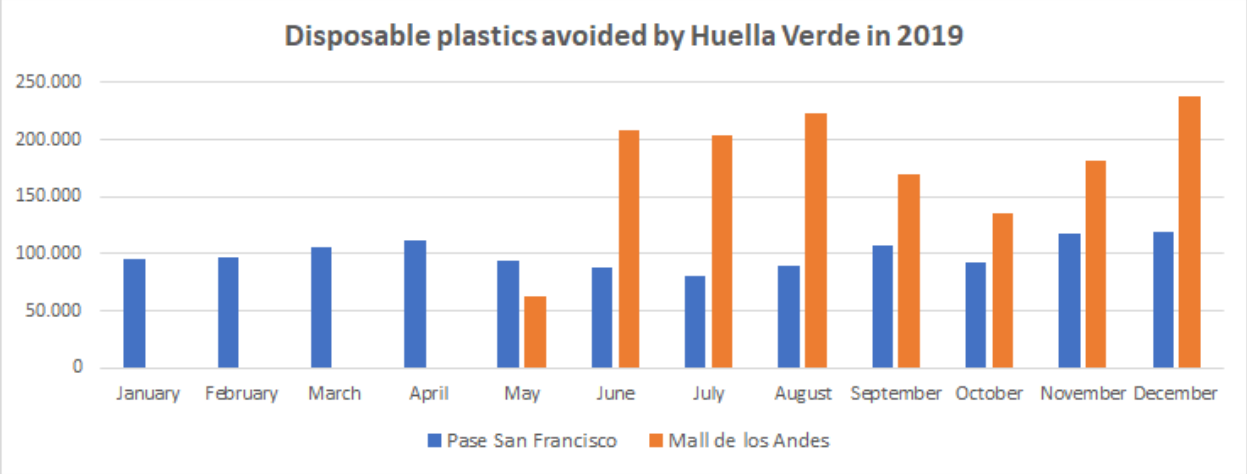


Figure 16 Disposable Plastics Avoided by Huella Verde, Source: Huella Verde

In addition to avoiding a huge amount of plastic garbage, in 2019 *Mall de los Andes*, 22,710 liters of food waste were recovered and 1,084 recyclable material bags were recovered.

With the amounts recorded daily by *Huella Verde*, it was determined that in 2019 902 kg or 1,963 m^3 of disposable tableware were avoided, 34,065 kg or 23 m^3 of organic waste was recovered, and 3,466 kg or 423 m^3 of recyclables were recovered. In conclusion, in 2019 *Huella Verde* prevented 38 tons and 2,409 m3 of garbage from going to the landfill. This garbage is equivalent in weight to 26 medium cars and in volume to an Olympic swimming pool. This avoids huge costs to municipalities and other institutions responsible for waste management, beach cleanups, and others.

The investment necessary to implement *Huella Verde* in a food court are: furniture for washing and storage of dishes, plates, cutlery and reusable glasses, industrial dishwashers, the adaptation of the food court for the new model and communication to achieve the change of habit in customers. The monthly operating costs are primarily labor and the replacement of broken or lost crockery. The project is sustainable over time, charging restaurants for the provision and washing of reusable dishes a value similar to that paid for acquiring disposable tableware.

5.3. SEPARATING AT SOURCE AND RECOVERING ORGANIC WASTE

Organic waste represents 53% of the world's municipal solid waste (Ricci-Jürgensen et al. 2020)[6]. 5% of global greenhouse gas emissions come from solid waste, excluding its transport (Silpa et al 2018). These emissions are mainly due to methane produced by the decomposition of organic waste. The non-separation and management of organic waste not only generates more emissions, but also prevents all these nutrients from being used again, replacing, for example, the use of petroleum-based fertilizers. Decomposition of organic waste generates biol, which, mixed with other waste in landfills, becomes leachate that is expensive to treat and toxic to the environment and human health.

Separating organic waste at source is the most effective way to recover and also makes it possible to recycle other material, such as paper or cardboard. According to United States Environmental Protection Agency (EPA), the most sustainable options to reduce of food scraps and other organic waste are (1) source reduction, (2) recovery of food for humans or animals, (3) composting, (4) biological treatment, and last (5) disposal in landfill (see graph below).

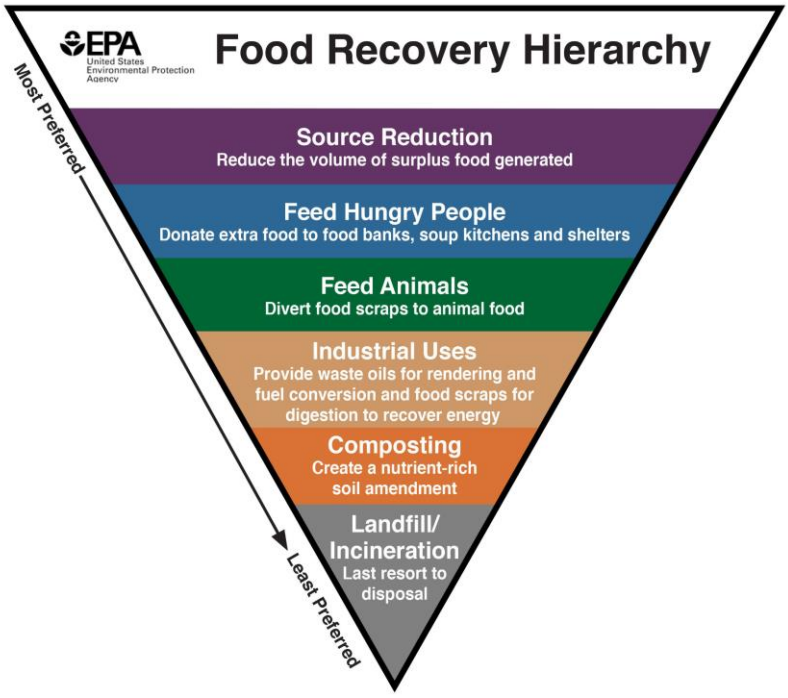


Figure 17 Food Recovery Hierachy

Source: EPA Food Recovery Hierarchy

[6] Ricci-Jürgensen M. et al. 2020. Global Assessment of Municipal Organic Waste Production and Recycling

Currently organic waste generated in Santa Cruz Island is collected separately and treated in a bio-stabilization plant and subsequently sent to a composting process. As mentioned in Section 4, there are some issues with the composting process and compost quality, furthermore with the new ordinance and pay-per bag fees, organic waste disposal will be charged. This opens an opportunity to promote composting at home to cut down food waste.

5.3.1. RESIDENTIAL COMPOST SOLUTIONS FOR PRIVATE HOUSEHOLDS

Composting is "the controlled aerobic, or oxygen-requiring, decomposition of organic materials by microorganisms, under controlled conditions. It reduces the volume and mass of the raw materials while transforming them into a valuable soil conditioner - compost" (ILSR, 2014). Composting is an efficient way to take advantage of organic waste that comes out of the kitchen, the pruning of gardens or crops, animal excrement, and other; and reduce the amount or waste managed and sent to landfills.

There are several levels of composting, for example by household, block, neighborhood, community or region. Large-scale centralized facilities require more logistics and investment; small-scale and locally based composting requires less or zero transportation and requires community participation and education. Composting systems need microorganisms to digest organic materials, adequate oxygen, adequate moisture, a balanced carbon to nitrogen ratio of food. Food scraps are materials high in nitrogen and pruning, sawdust and similar are carbon-rich materials.

According to ILSR (2014), among the most important reasons for composting are: to improve soils, protect watersheds, protect the climate, reduce waste, create jobs, and to build community. For example in the United States, by composting, 164 millions of tons of garbage disposed per year could be reduced by half.

In Ecuador there are a couple of initiatives that help people to compost. For example, Epicentre, which is a foundation in Quito that aims to establish composting as a solution to organic waste management, providing education to all its collaborators and users, contributing positively to the reduction of carbon footprint and increasing the fauna and flora of the place. To make composting of organics possible, Epicentre offers compost bins accompanied with training in their use. There are several options for composting bins depending on the number of people or families that will be using them. The smaller bin, 90 cm tall and 60 cm wide, is for two to five people and costs around $200.

Another example is Ayllu Recoleccion that provides the service of organic collection at home for $15 once a week or $7,50 twice a month; or people can deliver their organics at an address in Quito at no cost. Ayllu works with a community in the production of organic compost, and uses it to recover their lands and improve their production.

Figure 13: Compost solution by Epicentre

SECTION 6. CONCLUSIONS AND RECOMMENDATIONS

According to the interviews with key stakeholders, statistics provided by the municipality of Santa Cruz and the waste characterization studies various conclusions can be given based on the experiences of Galapagos and complementary information of mainland Ecuador:

1) The best waste is the waste prevented

   Nature teaches us that waste is a human phenomenon. In natural circumstances, "waste" of one species is the nutrition of another. Therefore, the general context has to be changed from a "throw-away culture" to a culture of circular economy which already was in place before the invention of single-used products.

2) Waste Management is expensive

   According to data from the municipality of Santa Cruz, the management of 1 ton of generic waste has a specific cost of $214. This cost does not include the external costs of waste, which was not collected and thus contaminates the environment or leachates from landfills. Also, the majority of waste collected is no recyclable and ends up in the landfill even though high efforts of environmental education took place through several years.

3) WMS has dependency on NGO activities

   Due to the complexity of waste management on Galapagos, the WMS was created with strong support from various NGOs. This dependency still is in place and can be seen as a challenge as the WMS gets more complex with more waste types (e.g. electronic waste).

4) Waste prevention is cheaper in comparison to waste treatment

   While much focus on environmental education has been put on the correct separation of waste and mitigation, the importance of waste prevention needs to be addressed strongly as it is the cheapest of all waste treatment solutions.

5) Waste generation in Galapagos has to be seen on a regional scale

   Recent studies detected that only a very small amount of waste (2%) collected on touristic and remote beaches around Galapagos actually originates from Galapagos. Most of the marine debris encountered has its probable origin on the continental mainland. This waste entered through rivers to the oceans or was disposed directly into the sea. This leads to the conclusion that more environmental awareness and waste mitigation needs to be realized on the continental mainland of Ecuador in order to protect the wildlife on the Galapagos Islands.

   Additionally, the consumption trends that reach Galapagos originate in continental Ecuador, where the companies that produce the majority of products consumed in Galapagos are located. So what is achieved to improve towards a culture that generates less waste in continental Ecuador will also impact what is done in Galapagos.

6) Law Enforcement

Even though the ordinance about waste separation defines clearly which type of waste must be put in the specific waste bin (organic, recyclable and non recyclable) there is a big difference between the waste characterization and the waste managed by the municipality.

Whereas most of the characterized waste is of organic origin (> 50%) and needs to be placed in the organic bin, most of the waste managed by the municipality is not recyclable (> 50%). Even though pig farmers use a certain part of organic waste, it leads to the conclusion that organic waste enters in the no-recyclable bin causing leachates on the landfill, which are toxic and very expensive to treat appropriately.

The municipal waste inspector issues fines if a client has not separated the waste of the organic or recyclable correctly, but more importantly is the control of the correct separation of the black bin/no-recyclable in order to reduce the amount of waste entering the sanitary landfill. In the waste characterization study 2016 in a random sample, around 22% of the no-recyclable waste was actually recyclable waste which was erroneously separated.

The same can be concluded from the provincial prohibition of single-used plastics. Apart from the legislation, law enforcement by the municipalities through local ordinances and control is very important to stop the use of single-use products on the islands.

7) Environmental Education

Parallel to the implementation and operation of the WMS on Galapagos, various educational campaigns with households and schools were conducted to include the users in the process and create environmental consciousness. Especially the information of the youth was very important to improve the user integration and waste separation at source. Nonetheless environmental education needs to be conducted continuously and the municipalities lack the funds for a steady campaign. This also leads to the conclusion that more focus has to be put on waste prevention to reduce the costs of operation of the WMS and the ability for the municipality to foster more environmental education around WMS and sound environmental practices in general.

Until now most education has focused on waste management instead of waste prevention. Environmental education content should delve deeper into the production, marketing and consumption habits that reduce the generation of non-organic waste, and promote alternatives for reuse and repair. It should also educate on the importance and alternatives to recover organics at home or locally, preventing it from ending up in landfills.

8) Potential for a best practice example in Santa Cruz

The municipality of Santa Cruz is redesigning a local food street called “the kiosks”. On this street various restaurants offer local food to tourists and the local population. In the past there were various environmental concerns such as missing sewage water facilities, exaggerated use of disposable take-away containers and single-used plastic bags to name some. Therefore the municipality is currently redesigning this area and would like to implement circular economy products. With the support and law enforcement of the municipality this site could be a best practice example on circular economy products.

9) Small scale treatment of organic waste at source

Due to the habit of storing organic waste in plastic bags, the municipality has difficulties to create compost in an acceptable quality. Therefore the informal organic waste collection by pig farmers should be enhanced and residential compost solutions promoted. This also helps to raise awareness that waste is a resource, which should be valued and reused.

10) Galapagos free from disposable bottles

Returnable bottles have various benefits and can be the next step to achieving a zero-waste culture in Galapagos. Even though there is a regulation for using returnable bottles, still many disposable beverage containers are used on Galapagos, especially for water, beer, hydrating drinks, juices and milk. Those are sold in disposable glass, plastic or tetrapak containers. Therefore, work should be done with the companies such as Coca Cola (Dasani water), and with the other large beverage companies in Ecuador: Cervecería Nacional and Tesalia CBC to achieve that all their beverages sold in Galapagos are in returnable containers (plastic or glass). In addition, a large part of the water is already sold in returnable large bottles. It could be encouraged that the rest of the water, even locally bottled, is only in returnable containers. It is important to find solutions together with the private sector, an approach that could even have more impact. A zero waste culture in drinks will promote zero waste in other areas and could make Galápagos an example for the rest of Ecuador and beyond.

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