

## Environmental education to mitigate marine and coastal plastic pollution



### Research Report final Thesis

Author: Valentin Janosch

Study programme: Delta Management

study year: 2017/2018, semester 2

School: HZ University of Applied Science

Organization: Coastal Conservation Institute  
(São Sebastião, Brazil)

# Environmental education to mitigate marine plastic pollution

Place: São Sebastião, Brazil

Date: 10.06.2018

Student number: 65746

Study year: 2017-2018

Semester 2

Final thesis research report

Supervisor: E. Geerling, Flavia Boffino

Version: 2

## Abstract

This final research is conducted as a bachelor thesis of the programme Delta Management at the HZ University of Applied Sciences in Vlissingen, Netherlands and is executed at the Coastal Conservation Institute (ICC) in the coastal municipality of São Sebastião in Brazil. The municipality is located on the southeast coast of Sao Paulo extending more than 100km along the coast including 33 smaller neighbourhoods and several small islands. 80% of the area is covered by the Atlantic forest with an extensive mangrove area. The area is vulnerable to landslides, flooding's, waste and oil spills which is threatening the more than 1,362 species in the area. Especially plastic trash has negative impacts on the area such as limiting mangrove growth needed for coastal safety as well as increasing health impacts like drinking water contamination or an increase in mosquito breeding. Most of the littered trash in coastal areas ends up in the ocean, affecting the marine environment and in return affecting the life of local people, their income depends on fishing and other products obtained from ecosystems. For this reason the objective in this research is to investigate solution that can help to raise the awareness of the local community on plastic litter and how their change in behaviour can increase community resilience while finding solution on how to recycle plastic to generate extra benefits for the local community. In order to start up the research, desk research was used to determine on how to develop educational programs which resulted in a 8 step approach. This 8 steps where then used to develop an educational program in Sao Sebastião. A focus location has been established through area analysis and important stakeholders have been identified in order to start up the program. Afterwards questionnaires have been carried out to get an insight in to the

perceived perception of the local people on plastic trash and the need to tackle this issue. The questionnaires also revealed that the local people are interested in learning about organic gardening and ideas on how to recycle plastic items to increase their income. Out of the questionnaires and by doing observation a 12 activity educational program was developed which had the big overall goal to build up a greenhouse made out of 1000 used PET bottles which can be used as a community hub and for growing organic vegetables. The program was developed around the topic of reuse, reduce, recycle and composting (organic gardening) and all of the materials used were either found in the natural environment or collected in the area with beach and mangrove area clean ups. After developing the program it was executed as a small scale pilot project in the neighbourhood of Baleia/sahy at the institute verdescola with 30 students from the local community. After 12 weeks the program was successfully finished with an greenhouse built up in the community of Baleia/sahy, which attracts a lot of attention from the local community about plastic waste and the need for reduction. The proposed solution furthermore provides social and local empowerment once the program is finished by providing food for the community and bringing the community together. Lastly the program was visualized in an implementation which can also be translated to other coastal and delta areas. The last part of the research shows extra recycling ideas which local people could sell in order to increase their income for them and their families.

<b>3 R`s</b>	Reduce, Reuse and Recycle
<b>APA</b>	Protected area in the municipality of São Sebastião
<b>Baleia-sahy</b>	Neighbourhood in São Sebastião- focus area in this research
<b>Caçara</b>	Traditional inhabitants of the coastal regions of the south-eastern Brazil. They are distinct group of people, descended from indigenous people, Europeans and Africans. Traditional way of life based on hunting and fishing.
<b>Composting</b>	Compost is organic matter that has been decomposed in a process called composting
<b>Entanglement</b>	Animals get trapped in plastic in the ocean
<b>Ghost fishing</b>	Lost nets by commercial fishing vessels, which float in the ocean and animals get entangled in them
<b>ICC</b>	Coastal Conservation Institute
<b>Ingestion</b>	Unintended consumption of plastic particles by animals
<b>Institute Verdescola</b>	Non-profit organization which promotes education, human and community development with socio-educational and socio-environmental activities.
<b>Macro plastic</b>	Relatively large particles of plastic more than 5mm in diameter
<b>Micro plastic</b>	Small pieces of plastic with less than 5mm in diameter
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>Upcycling</b>	Reuse material in such a way as to create a product of higher quality or value than the original
<b>UNEDP education</b>	United Nations Environmental Education Program
<b>MSW</b>	Municipal Solid Waste
<b>Waste hierarchy</b>	Tool used in the evaluation of processes that protect the environment alongside resource and energy consumption to most favourable to least favourable actions
<b>PET</b>	Polyethylene terephthalate, mostly used in single use plastic bottles
<b>UNEP</b>	United Nations Environment Program

## Table of Contents

Table of Contents .....	5	4.3.5 concluding remarks for the implementation research .....	30
1. Introduction.....	1	Sub question 4 .....	30
1.1 Problem statement.....	2	4.4.1 Recycled Greenhouse manual .....	31
1.2 Objectives .....	2	4.4.2. Reused 20L water gallons as compost design.....	32
2. Theoretical framework.....	3	4.4.3. Recycled plastic ideas to increase income .....	33
2.1. Plastic and Marine litter .....	3	5. Discussions.....	34
2.1.1 Sources of plastic and marine litter.....	3	6 . Conclusion.....	35
2.1.2 Behaviour of plastic in the ocean .....	4	7. Recommendations .....	38
2.2 Impacts of marine debris.....	5	Bibliography .....	39
2.2.1 Ecological impacts .....	5	Appendices .....	41
2.2.2 Social impacts .....	6		
2.2.3 Economic impacts.....	6		
2.3 Waste Management practices in Brazil....	6		
2.4 Marine plastic mitigation and prevention measures .....	7		
2.7 Conclusions.....	10		
3. Methodology .....	12		
3.1 Desk Research .....	12		
3.2 Survey & Questionnaire .....	13		
3.3 implementation research .....	13		
3.4 Observation .....	13		
4. Results .....	14		
4.1 Sub-question 1.....	14		
4.2 Sub-question 2.....	17		
4.2.1 Questionnaire .....	17		
4.2.2 Observation .....	20		
4.3 Sub-question 3.....	23		
4.3.1 Area analysis to determine location for pilot study.....	24		
4.3.2.1 Stakeholder analysis .....	25		
4.3.2.3 Target group .....	26		
4.3.3 12 Activities educational program ..	26		
4. 3.4. Implementation plan .....	28		

## 1. Introduction

Coastal and marine pollution is a growing worldwide problem affecting the environment, economies, human health and coastal safety. Typically plastic accounts to 75% of all marine litter, degrading slowly it persists in the marine environment for years (Barnes, 2009), harming marine and coastal ecosystems and their inhabitants. It is estimated that between 4.8 and 12.7 million metric tons of plastic finds their way into the oceans annually (UNEP, 2016). Plastic debris is then transported all around the globe by ocean currents and winds, even on the remotest and uninhabited island as well as in the arctic ice and the deep ocean plastic litter has been found. The main reason for this is due to anthropogenic issues such as poor waste management, littering, and illegal dumping or “leakage” of landfills. Most of the waste enters the oceans by rivers and streams coming from bigger cities. Especially coastal and delta areas and its inhabitants are affected by this the most and are the first ones to experience the negative impacts of plastic pollution in their environment. Ocean and beach clean up`s are already being successfully implemented and from great importance to reduce the current trash in the water, nevertheless the long-term goal is to have plastic free oceans and this can only be achieved by reducing the overall usage and improper disposal of plastics. Meaning to decrease the daily plastic usage and to create a change in behaviour towards reduce, reuse and recycling of plastic, as the annual plastic production and consumption has increased from around 50 million tons in 1950 to just under 300 million tons today with an extensive increase in single use disposable products (Löhr, Savelli, Beunen, Kalz, & Ragas, 2017). In developing countries the problem of improper waste management in coastal and rural areas add to the worldwide marine pollution, as well as those countries feel the effects of plastic pollution the most.



Figure 1: Litter on a beach in Brazil, (Smith, 2018)



Figure 2 & 3: Map of Brazil and municipality of litoral norte (Amaral & Nallin, 2011)

### 1.1 Problem statement

The municipality of São Sebastião (Figure 3), located on the southeast coast of Brazil in the state of São Paulo extends more than 100km along the coast including 33 neighbourhoods and several small islands. The coastal area is dominated by an extensive mangrove coverage and 80% of São Sebastião area is covered by the Atlantic forest, one of the richest biomes on the planet even surpassing the Amazon forest. The region is an important tourist and port region, as it is close to São Paulo City, but extremely susceptible to landslides, floods, waste and oil spills endangering the 1,362 species of Brazilian fauna. This highly biodiverse ecosystem is of great importance regarding coastal safety, food production and the overall resilience of the local community. Brazil produces 240 thousand tons of waste daily, mainly consisting of organic materials and plastics. Only 2 % of the whole waste is recycled, the rest is destined to landfills or littered otherwise (Corsten, 2012). The management and improper disposal of wastes cause environmental impacts such as soil degradation, impairment of water bodies, intensification of floods and water pollution. Although Brazil established laws and regulations for waste collection, only 62 % of the population has access to waste collection mostly in bigger cities. Rural and coastal areas where the population is mostly dominated by poorer inhabitants lack proper collection and recycling systems and are experiencing the impacts of plastic pollution the most. Oftentimes improper waste management is a result of a lack of education and the awareness what negative impacts plastic waste has on areas. Therefore finding a comprehensive solution on how to raise awareness of local people and how this can change their behaviour towards plastic waste which in return increase the overall resilience of the coastal area.

### 1.2 Objectives

The objectives regarding this research are to investigate solution/measures that can help to raise the awareness of local people (especially young pupils) on plastic litter and how their change in behaviour can increase community resilience while developing benefits for the whole community such as food production. Appendix 1 gives extra information for the research objective and the need for food security in São Sebastião. The results should end in an educational campaign where easy recycling methods can help raise awareness while getting benefits in form of food security. All materials used should derive from recycled waste or material found for free in the natural environment. The goal is to change the behaviour of the whole community regarding plastic waste by educating young people with easy recycling and reusing methods and using those for extra benefits. Considering the discussed problem the main research question was formulated:

*Which elements should be part of a community broad educational program in São Sebastião to raise awareness on effects of plastic products on marine environment and demonstrate examples of reduction and recycling of plastic goods?*

In order to answer the main research question several sub-questions have been formulated:

1. *How could a community broad educational program be developed for coastal areas?*
2. *Do the local inhabitants perceive plastic as a problem for São Sebastião??*
3. *How can the usage of plastic products be reduced for São Sebastião ?*
4. *How can plastic be recycled to generate additional positive impacts in the community of São Sebastião?*

## 2. Theoretical framework

In this chapter important themes related to the problem statement and research objectives will be analysed and described in more detail in order to gain in-depth knowledge about the subject.

### 2.1. Plastic and Marine litter

Plastic and marine litter (also called marine debris) is a local, regional and global pollutant of concern, developing to one of the most widespread pollution problems in the world's oceans and rivers. Marine debris is defined as "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes", according to the National Oceanic and Atmospheric Administration Marine Debris Program (NOAA, 2018). Plastics make up the largest part of marine debris, and is estimated to range from 60% up to 80% in some parts of the world (Derraik, 2002). Plastic usage has increased drastically in the last decades, replacing more traditional materials in the construction and transportation sector as well as household goods and packaging. The plastic market is dominated by a few types of plastic: Polyethylene (PE), Polyethylene terephthalate (PET), polypropylene (PP), polyvinyl chloride (PVC) and polystyrene (PS) all synthesised from fossil fuels. Whereat packaging makes up one third of global production and is mainly used for single use (UNEP, 2016). The reason why plastics are replacing other materials lays in the cheap production costs, its longevity, durability and it takes decades for it to degrade. Marine plastics can be categorised into macro- (over 20mm diameter), meso- (5-20mm diameter) and micro plastics (under 5mm diameter), while micro plastics pose the biggest challenges as it is difficult to monitor and many

species including fish, ingest micro plastic debris.

#### 2.1.1 Sources of plastic and marine litter

Trash and litter can travel long distances before being finally deposited on shorelines or till it settles to the ocean bottom, therefore determining the origin of the marine litter is not an easy task.

Researchers traditionally categorise marine debris sources as either land- or water based. According to Sheavly (2007) around 50% comes from land-based sources, while water-based sources only make up 18%, the rest 32 % could have come either from land or water-based sources (it has been too long in the water to determine). The most abundant types of marine debris are plastic straws, plastic bottles, plastic gabs and metal beverage cans.

Land-based litter blows, washes or is discharged into the ocean from land areas. Sources include materials manufacturers/processors/transporters, illegal dumping of waste, improper waste management and leakages from landfills. Another major factor how trash is transported from land into the oceans is by storm waters and heavy winds. Especially the lighter items such as plastic bags can be carried for kilometres until it reaches

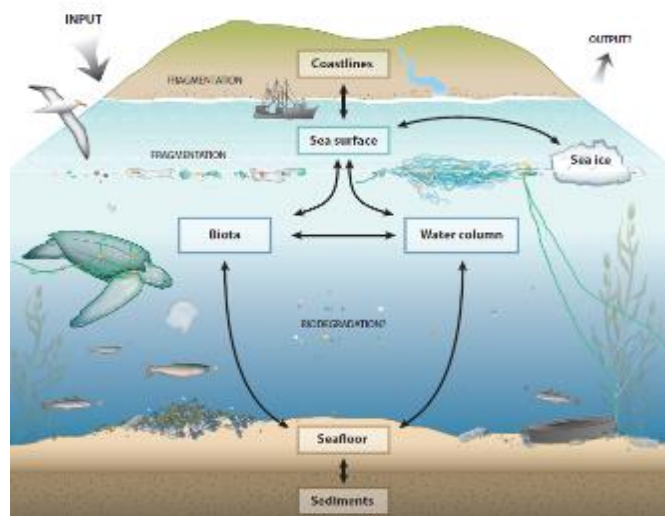


Figure4: flows of plastic, ( Law, 2016)

the ocean. Another major factor how plastic ends up in the marine waters is the behaviour of people, humans throwing plastic into the waters on purpose because of laziness or lack of awareness what their actions can impact. In many developing countries water ways are used as open sewage, where all the trash gets dumped. Water-based sources include commercial fishing vessels, merchant ships, cruise ships, petroleum rigs and drilling operations and naval vessels that illegally discharge waste and trash into coastal and offshore waters. Also pleasure boaters, yachtsmen and fisherman may also dump their wastes overboard. Such debris may consist of food packaging, water bottles as well as fishing lines and other related fishing gear.

Figure 4 the flows of plastic from land- or water based sources are shown, the large grey arrows indicate the fluxed into and out of the marine environment, potentially depredating the plastics. The boxes represent the reservoirs of plastic debris where they can accumulate and the black arrows indicate the potential pathways of plastic between the reservoirs. Fragmentation of plastics can occur in all reservoirs, especially when exposed to sunlight.

### 2.1.2 Behaviour of plastic in the ocean

Plastics in the ocean can either be found afloat or sunk to the bottom of the ocean, this depends on its density relative to that of seawater as well as other factors such as entrapped air, water currents and turbulence. After a certain time, which depends on the plastic, degradation sets in. Degradation is defined by (UNEP, 2016) as “the partial or complete breakdown of a polymer as a result of e.g. UV radiation, oxygen attack, biological attack. This implies alteration of the properties, such as discolouration, surface cracking and fragmentation”, meaning over time plastics are being broken down into smaller pieces

until it floats as micro plastics in the ocean or is being ingested by fish and other marine animals. In the ocean the principal weathering agent is UV radiation, mostly on shorelines and weathering is accelerated by physical abrasion due to wave action. Further degradation by microbial action is termed biodegradation “biological process of organic matter, which is completely or partially converted to water, CO<sub>2</sub>/methane, energy and new biomass by microorganism (bacteria and fungi”, (UNEP, 2016). Once biodegradation is complete plastic is said to have mineralized, meaning it got converted into carbon dioxide, water and other naturally occurring compounds. The extent to which biodegradation takes place in the ocean is difficult to estimate but is considered to be extremely slow. This process can take up to 500 years depending on the plastic and the environment it is in, as can be seen in Figure 5 Plastic bottles (PET) needs 450 years to degrade.



Figure 5: Estimated degradation rates of different items in the ocean, (wastefreeoceans, 2018)

## 2.2 Impacts of marine debris

Plastics in the marine environment directly and negatively impact coastal areas and marine species and their habitats as well as economic, social and health impacts. It is from importance to understand the impacts in order to develop strategies to lower the impacts on a region, country or area.

### 2.2.1 Ecological impacts

Ingestion of marine debris, mainly small or degraded plastic parts is a common problem for especially smaller animals and low trophic levels of organism as they recognize the small plastic parts as food source. The 1<sup>st</sup> level carnivorous consumers are then being eaten by 2<sup>nd</sup> level or top carnivores making it possible for plastic particles to be distributed through the whole food chain until humans consume the fish. Sheavly, Courtney & Parks (2011) are describing in their study of ingestion of marine debris, that 95% of 1295 dead northern fulmar (sea bird) collected from 2003 to 2007 contained plastic particles in their stomach, containing an average of 35 plastic items in their bodies (Sheavly, Courtney, & Parks, 2011).

Many forms of marine plastic debris poses threats to marine animals through entanglement, entanglement of animals means limited mobility and restricted movement which can lead to starvation, suffocation, infections, reproductive failure, internal injuries and possible mortality (Sheavly, Courtney, & Parks, 2011). Pieces such as packing bands and especially lost fishing items like nets, lines and traps are often responsible for entanglement and entrapment. According to Marine Mammal Commission, 136 marine species have been reported in entanglement accidents, including six out of seven species of sea turtles, 51 out of the world's 312 species of seabirds and 32 species of marine mammals.

Another negative impact plastic debris has

on the ecology is that it can lead to habitat alteration, degradation or even total destruction through physical interferences such as blockage of sunlight, surface scoring and abrasion. Particularly ecosystem engineers like coral reefs or mangroves are endangered, large and lost fishing nets and plastic bags can abrade coral reefs. Mangrove rehabilitation efforts are vulnerable as well, the young mangrove seedling can be covered and suffocated by plastic leading to death of the plants. Studies in Indonesia suggest that flora and fauna of sediment smothered by debris differed significantly from the structure of organisms in areas of the littoral zone that were free of debris.

Marine plastic debris has the ability to transport chemicals and concentration of pollutants that are present as environmental pollutants in the aquatic environment. Chemical contaminants can lead to immediate and chronic threats to both aquatic and terrestrial food webs, leading to irreversible effects on both wildlife and humans (Rios, 2007).

Furthermore marine plastic debris can lead to introduction and spread of invasive species as floating debris is recognized as a medium for long distance dispersion. (Barnes, 2009) estimates that plastics at seas have roughly doubled the proliferation of subtropical fauna and more than tripled the propagation of high- latitude fauna, speaking to the increased potential for alien species transport.



Figure 6: entangled sea turtle

### 2.2.2 Social impacts

Marine debris has several impacts on the society of a coastal or delta area as in intrinsic and social values associated with coastal and marine water are diminished by the existence of marine debris. Another social value affected is the aesthetic value, plastic litter reduces attractiveness of coastal areas which leads to lower beach user enjoyment and lowering the surrounding property values (Sheavly, Courtney, & Parks, 2011).

The biggest factor plastic has on a local society is probably health impacts associated with poorly regulated waste management. Litter is also able to block wastewater drains, which leads to sewage contamination of communities and areas of stagnant waters. Plastic in the environment unwantedly can collect rainwater becoming a vector for water-borne diseases and providing breeding sites for mosquitoes. The rapid spread of Zika in South America and especially in Brazil in 2015 and 2016 may have been exacerbated by a lack of effective waste collection and management (UNEP, 2016).

Another major health impact of plastic on humans is through micro plastics in seafood. Humans are being exposed to micro and Nano plastics through the consumption of marine food such as shellfish, shrimp and small fish species. Of great concern are compounds that can interfere with neurological development and the endocrine system, which can affect unborn foetus and children at early development stages.

### 2.2.3 Economic impacts

Marine plastic debris has numerous economic implications which can have negative effects throughout local economies. Marine debris can decrease the income and catch of aquaculture producers, as their fishing vessels and equipment can be damaged by floating

debris, entangled propellers and blocked intake pipes are the most common problems for aquaculture producers. It can also mean navigational problems, as nets, ropes and other objects can cause boats to have operational problems. Power stations can experience blockages of their cooling water intake resulting in additional removal and maintenance costs.

For coastal communities which depend on tourism as their income, the aesthetic impacts of plastic debris might be the most drastic. Plastic litter can deter visitors as cleanliness is the most important factor for beachgoers. A drop in beach users and tourists can result in less business and income for coastal communities (Sheavly, Courtney, & Parks, 2011).

The most obvious economic impact plastic has is represented by clean ups, for example to remove plastics from South Africa's wastewater streams is around 279 million US dollars per year (Lane et al. 2007).

## 2.3 Waste Management practices in Brazil

The Brazilian Association of Waste treatment, recovery and disposal companies reported that every year Brazil is generating nearly 2,9 million tons of Municipal solid waste (MSW) whereby 57,6% is collected in sanitary landfills (Corsten, 2012). Sanitary landfills have measures installed to minimize environmental impacts (leakage of leachate, contamination of groundwater and surrounding soil), the remaining 42,4% of MSW is disposed inadequately, including uncontrolled landfills and dumps. According to Corsten (2012) a majority of 61% of Brazilian municipalities still dispose their waste in an improper manner and don't have regulated waste management programs. The overall recycling rate of materials from Brazilian MSW is relatively low, around 4-11% of the total MSW

(Corsten, 2012), the lack of formal collection programs is currently one of the biggest obstacles for the growth of recycling in Brazil. Brazil is a developing country with a troubled economy and implementing separate collection systems would have 30% higher costs than landfills, as well as the absence of a recycling culture.

## 2.4 Marine plastic mitigation and prevention measures

When plastic production started in the 1950s, the production and consumption increased annually reaching over 300 million tonnes by 2015 with an annual increased rate of around 9% (Ogunola, Onada, & Falaye, 2018). Ogunola (2017) also states that in 2050 an extra 33 billion tonnes of plastic will be added to the planet and with increased human population it is estimated that by 2050 more plastic will be in the ocean than fish. Therefore immediate action is required to both limit the plastic production and consumption to reduce the plastic flow into the ocean while at the same time clean up the already existing marine debris. Preventive measures focus on the way of avoiding the generation of debris, or preventing it from entering the sea including source reduction, waste reuse, recycling and composting. As can be seen in Figure 4 the most preferred mitigation strategy is number 1 to reduce plastic

production, either industry or policy led or reducing the demand by changing the behaviour of consumers. A change in behaviour can be achieved by educational, outreach and public awareness programs aimed at local coastal communities. Ogunola (2017) is stating that targeting youth and children is seen as an effective way to promote positive behavioural changes in people and helps them in perusing marine related careers. He is also analysing the need for mandatory ocean and environmental courses for various levels of educations (primary, high schools and universities). For example native people of Hawaii showed a strong interest in adopting ocean conservation measures, this strong awareness and willingness of the citizens is traceable to their geographic location, cultural background, biodiversity and economy which depends on tourism (Ogunola, 2017). The second measure which will help mitigate plastic debris is green engineering or transforming to a circular economy where new biotechnologies could be used instead of crude oil. Litter capture and clean ups should be used to mitigate and reduce the current plastic which is already in the oceans. It is not only time and money consuming but also only small fractions of the overall debris is captured. All in all a combination of the strategies is needed to tackle the global marine debris problem. (NOAA, 2018) is also stating that “the education and outreach component of the



Figure 7: mitigation strategies for marine plastic debris

NOAA program is directed at the public and other stakeholders, and is designed to increase the understanding and awareness of the problems of marine debris and its negative effects”. (Ogunola, 2017) is concluding in his research that the issue of plastic pollution is increased escalating as a result of indiscriminate disposal practices by people and industries. Furthermore he discusses that from the strategies elaborated, a change in human behaviour is highly recommended as it will provide a long lasting solution to the environmental problem.

## 2.5. Marine plastic litter in the frame of the UN sustainable development goals

The 17 Sustainable development goals were set up by the UN summit in 2015 with the aim to promote sustainability in the most important issues for human life on earth. Sustainable development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their needs” (UN, 2018). Goal number 14: life under water includes the issue to combat marine litter. Target number 1 for the sustainable development goals of life under water is to prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities by 2025 (Lachmann, et al., 2017). A further goal is established for water under life and is defined by the UN that “by 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and taken action for their restoration in order to achieve healthy and productive oceans” as well as to increase economic benefits to developing countries from the sustainable use of marine resources (UN, 2018). The legal framework for preventing and managing marine plastic litter can be found

in multiple layers of governance, from international to national and local rules and legislations, although the execution oftentimes lacks successful implementation especially reaching local and more poorer communities. One advised way of reaching them by the UN is through environmental education as a pillar to the successful implementation of the sustainable development goals. The aim is to use the teaching of life sciences, environment and geology to raise student’s awareness and understanding of the goals (UN, 2018).

## 2.6 Environmental education as a tool for raising awareness (changing behaviour) towards marine and coastal litter

The United Nations sees education as essential for the advancement of sustainable development, therefore educating schoolchildren can be a tool to raise awareness and change behaviour towards plastic litter. Environmental education is defined as “the interdisciplinary processes of developing a citizenry that is knowledgeable about the total environment and its natural and built aspects and has the capacity and commitment to insure environmental quality by engaging in inquiry, problems solving, decision making and action” (Alici, 2013). Children can act as agents of change in a society, as they represent the next generation of consumers and decision-makers and can often inspire and influence directly the behaviour of their families and surrounding community. An enhanced awareness and deep knowledge of the issue of marine litter are crucial catalysing change in the perceptions and attitudes of coastal communities (Vaughan, 2003). Hoang and Kato (2016) executed a study in Da Nang city, Vietnam about environmental education for elementary schools with special emphasis on solid waste management and how in and out of class

activities can impact the students and parents behaviour towards waste and its impacts. Their results indicate that environmental education at elementary schools is an effective approach to raise awareness of sustainability issues and waste problems. They found out that after environmental education the students were adapted with concepts of recycling, reuse, organic and inorganic wastes. By teaching the students Hoang and Kato (2016) expected a change in parent's behaviour as well as other family members or members of the community. Another awareness and education campaign targeting schools and communities in Australia regarding marine debris found out that education helps to build knowledge and skills to change attitudes. Harding (2016) concludes in his findings that "building awareness and enabling behaviour change are particularly important in developing countries with remote coastal communities that have minimal infrastructure and capacity to manage waste at local level", he also stresses out that campaigns and outreach programmes implemented by local councils were found to be effective in reducing marine debris and may be more cost-effective than building waste management infrastructure. Explaining in further detail that "local authorities with insufficient capacity to deliver outreach and education programmes could work in partnership with NGOs and other expertise to focus on the issue of community based solid waste management practices that reduce land-based sources of marine litter". Important topics regarding education to prevent marine plastic pollution should include the concept of waste hierarchy (figure 8), showing that reducing plastic is the most favourable and disposing the least.

*Reduce* your plastic footprint. Cut down on your consumption of goods that contain excessive plastic packaging and parts. If it will leave behind plastic trash don't buy it. (wastefreeoceans, 2018).

*Reuse* durable, non-toxic straws, utensils, to-go containers, bottles, bags and other everyday items. Choose glass, paper, stainless steel, wood, ceramic and bamboo over plastic.

*Recycle* what you can't refuse, reduce or reuse. Treating or processing used or waste materials so as to make suitable for reuse (Cohen, 2018).



Figure 8: Waste pyramid of 3 R's

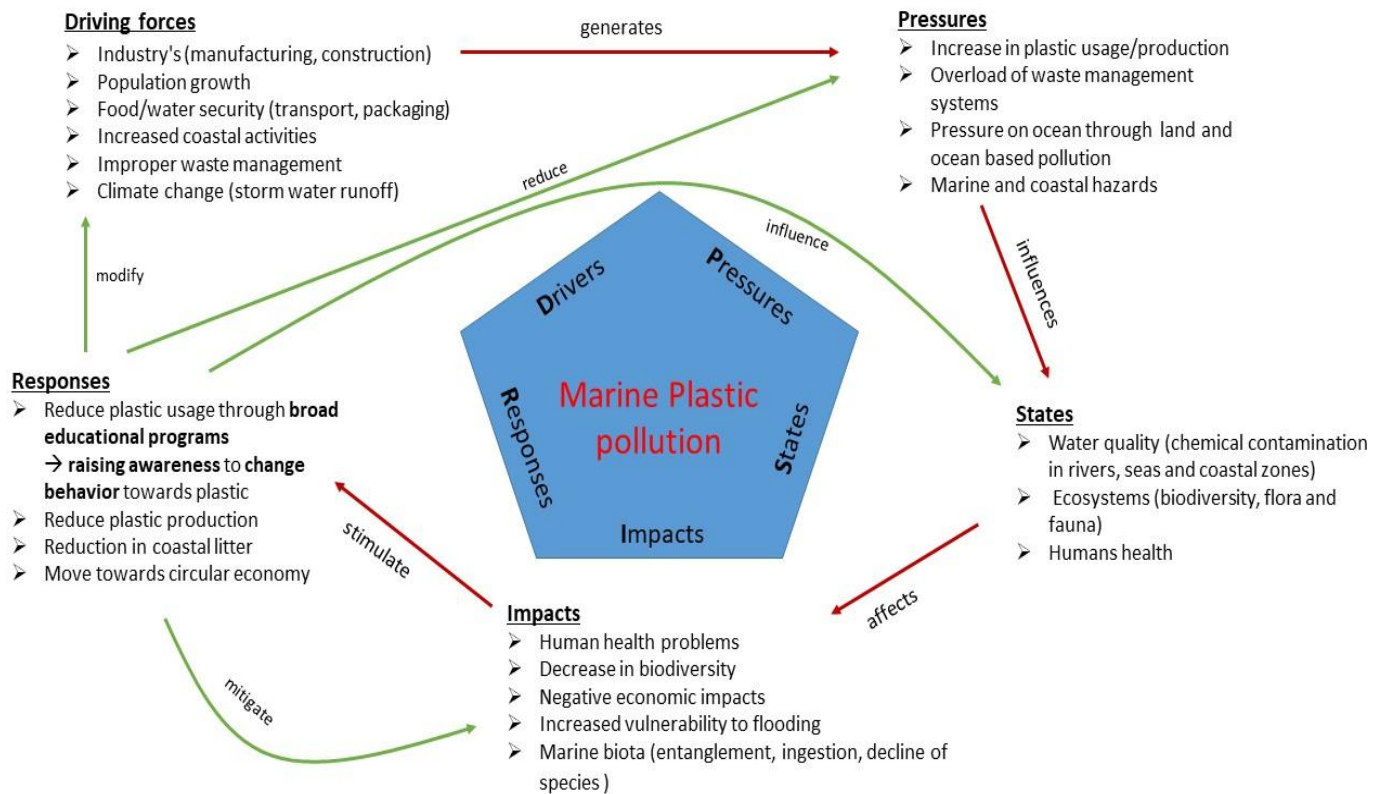


Figure 9: conceptual framework represented in the form of DPSIR-model (own archive)

## 2.7 Conclusions

To conclude the theoretical framework a conceptual framework in the form of a DPSIR model (Figure 9, DPSIR-model own archive) is established to describe the interaction between society and the environment. The framework is based on the concept that driving forces exert pressures, leading to changes in the state of the environment, which then leads to impacts on humans and ecosystems that requires in turn a societal response. The response can feed back to the driving forces, the pressures, the state or the impacts directly through adaptation or actions.

The increasing usage and production of plastics is a result of population growth and the cheap manufacturing of plastics through industries (manufacturing,

construction) and the need for food/water security (packaging, transport). This driving forces plus the issues of improper waste management and the effects of climate change (storm water runoff) generates pressure on the existing waste management systems and pressure on marine and coastal systems through land and ocean based pollution. The pressure on coastal systems influences the states of water quality by contaminating rivers, seas and coastal zones as well as it has influence on the state of ecosystems and human health's. Changes in the state have environmental, economic and health impacts. Plastic pollution affects the human health problems in form of chemical contamination, it decreased the biodiversity of local ecosystems which results in negative economic impacts. An increase in flood vulnerability through blockage of water ways affects coastal

safety as well as marine biota (entanglement and ingestions). Impacts in return can stimulate responses by society or policy makers to mitigate the usage and production of plastic. Responses to overproduction and single usage of plastics can be found in form of broad educational programs to raise awareness on the impacts of plastic has in order to change the behaviour. If the broad population is educated enough about the negative impacts plastic has on people and the environment it will limit the usage and purchase of plastic products and can therefore decrease the global plastic production. By investing in broad educational programs the pressure on coastal systems can be reduced and positively influence the states of the environment (increase in water quality, higher biodiversity) and mitigate the impacts plastic has on flora and fauna. Developing countries like Brazil have already incorporated laws and legislations for proper waste management and the protection of mangrove areas. However, the main problem is tough that laws and legislations are not translated to the poorer coastal communities and therefore are not being executed on a local level. As nearly 80% of marine plastic debris enters the oceans on a land-based way the first important step is to stop producing so much plastic and change the behaviour of people towards the usage of plastics. Environmental education as a tool to mitigate plastic pollution has been defined by the United Nations as one of the important pillars to reach the sustainable development goals of 2030. Important terms regarding the goals are the approaches of 3 R`s; reduce, reuse, recycle as well as composting.

### 3. Methodology

In order to answer the research question and its related sub-questions this chapter describes in detail the methods used for this research. The research focuses on the coastal zone of São Sebastião in Brazil and how an educational program can help to raise awareness on marine litter and its impacts. This research will be conducted as exploratory research, meaning to explore a problem that has not been studied more clearly. Trying to explore what kind of educational programs could contribute to the behavioural changes to plastic usage. Therefore the main research question is defined:

*Which elements should be part of a community broad educational program in São Sebastião to raise awareness on effects of plastic products on marine environment and demonstrate examples of reduction and recycling of plastic goods?*

In order to answer the main research question several sub-questions have been formulated:

- *How could a community broad educational program be developed for coastal areas?*
- *Do the local inhabitants perceive plastic as a problem for São Sebastião??*
- *How can the usage of plastic products be reduced for São Sebastião ?*
- *How can plastic be recycled to generate additional positive impacts in the community of São Sebastião?*

#### 3.1 Desk Research

Desk research is used to get an understanding on what marine plastic debris is and what the impacts are on coastal communities worldwide and the municipality of São Sebastião in Brazil. It

was done by means of literature analysis which resulted in the theoretical framework. Exploring a suitable area where the experiment is executed has been done by desk research. The goal of doing desk research is to gain an understanding on the researches already executed and terms and definitions related to the research question. The theoretical framework was divided into different topics:

- Marine plastic debris
- Impacts of plastic debris
- Waste management in Brazil
- Marine plastic mitigation and prevention measures
- Marine plastic in the frame of the UN sustainable goals
- Environmental education as a tool for awareness raising

The following websites have been used to gather information through literature research:

- Google scholar
- Google search
- Science direct
- Springer
- Elsevier

Sub-questions “How could a community broad educational program be developed for coastal areas?” (1) And “How can the usage of plastic products be reduced?” (3) And “How can plastic be recycled to generate additional positive impacts in the community of São Sebastião?” (4) will be answered by desk research. Sub-question 1 will examine different already executed researches about environmental education and how this can help to mitigate the plastic inflow into the ocean. Following by going more into detail with sub- question (4) about the solutions to recycle collected plastic. Desk research will also be used to find a right location for implementing the observation of recycling methods.

### 3.2 Survey & Questionnaire

Surveys and questionnaires will be used to determine if the local inhabitants perceive plastic litter as a problem for their community and if there are already impacts from on the environment of São Sebastião as well as it will indicate the already existing knowledge local inhabitants have on plastic waste. The results of the questionnaire will generate qualitative information as it should describe the problem or condition from the point of view of those experiencing it. The questions for the questionnaires were established by the student itself with the input of the theoretical framework and in relation to the research questions. First the questions were formulated in English and then translated to a more simple Portuguese which the local people understand and are not overwhelmed them. As the analysed community represent rather poor inhabitants the questionnaires were printed on paper and distributed inside the community, most of the inhabitants do not have an own computer or internet access at home. The questionnaires are then collected and translated again into English and afterwards the answers will be placed in a Excel file where graphs of the answers can be produced. In total 32 questionnaires will be analysed, trying to ask all sectors of the community from woman and men to young and older people.

### 3.3 implementation research

Raising awareness to pupils required Experimental research will be used to see how pupils can do easy recycling methods which are then used for an organic school garden usable for the whole community. 10-12 activities will be established related to plastic pollution in order to create an educational program to tackle those issues on a community base. Sub-question (4) “How can plastic be recycled to generate

additional positive impacts in the community of Sao Sebastião?” will be mainly answered by implementation research. Different materials and design will be analysed and based on the availability and easy implementation they will be integrated into the educational campaign. “How can the usage of plastic products be reduced?” will also be partly answered by experimenting different ideas of recycling and recycling. Furthermore area analysis and stakeholder analysis will be used to get an understanding of the area and its inhabitants.

### 3.4 Observation

Every project development is different on its own either the physical conditions change or the actors involved, therefore Observation will be used to get an insight about the area and local people and their behaviour and willingness towards plastic waste. The goal of the research is to change the behaviour towards plastic usage and try to show easy recycling techniques which will bring extra benefits to a coastal community. Observing them and analysing the recycling techniques can be then translated to other coastal areas. Observation is also used to get an insight into how much trash there is in the area and where the most problematic areas are, as well as prevailing materials. Observation takes place after the questionnaires were analysed to see with the own eyes how the area looks and how much trash is in it. Two observations will be used to get a better image and the fluctuations of litter in the area. The areas observed are the village centre, along roads and mangrove and coastal area. Materials used for observation are camera to take images of the area, notebook to note down how much and what materials can be found. Also observing the area gave input into the area analysis and possible locations for implementing the pilot educational program.

## 4. Results

In order to get an answer to the main research question the results chapter is organised by answering first the sub-questions which are then leading to answer the main question.

### 4.1 Sub-question 1

“How could a community broad educational program be developed for coastal areas?”

The first sub question has been answered by means of analysing existing literature about broad educational programs and what the best practices are to develop an educational program in the first place. A summary can be found in Appendix 2. The final 8 steps are a result of comparing existing programs and mind mapping techniques. Firstly the question arises if community education can be used to raise awareness on marine and coastal plastic pollution. People’s behaviour is generally responsible for the problems and it is people who want to find solutions to the problems, therefore community education is essential as most environmental and social problems arise as result of anthropogenic actions (Ford, 2000). Community education is a process which can be used to create awareness on an issue, enhance people’s knowledge and skills, influence peoples values and attitudes and encourage people for a more responsible behaviour. Collaboration is one of the most important aspects for successful community education projects, as most successful community projects are those which come from the community and therefore a bottom up rather than top-down approach is preferred. For developing a community educational project an 8 step approach is presented to see if the necessity is there and to see if the proposed project would work for the community. The 8 steps are separated into

3 phases: 1<sup>st</sup> phase to see if the preconditions for applying a project exist while 2<sup>nd</sup> phase focuses on the actual methods and how to implement the educational program in a community and the 3<sup>rd</sup> phase is about monitoring and evaluating them.

#### Step 1: identify the issue or problem

*“In relation to the area or socio economic problems”*

In order to establish a good design of a community educational program a clear understanding of the issue is essential. Getting a clear understanding can be done by breaking down the issue into its components. Components can be answered in separate questions for example: To what extent is this an issue of concern for our community? What are the reasons for this problem? What do we know about the issue? What has been done already? Is education the way to deal with the issue? What about other approaches such as laws and regulations?

Tools to help to identify the problem are:

- SWOT
- Area Analysis

#### **Step 2: Identify stakeholders and key players**

Successful community educational programs mean successful interactions with all involved stakeholders and already having an idea on how to approach each stakeholder group. By identifying “key players” and inviting those to be part of the project at an early stage the support for the project will increase. When all stakeholders are identified and it is clear what each stakeholder wants and how they stand in relation to the issue step 1 will be reviewed to see if it’s still the main problem which affects the main stakeholders. The key is to make important stakeholders your allies instead of having to work against them. Involving

stakeholders can be done by working groups, surveys, regular meetings. When the identified stakeholders fit within the problem analyzation the next step can be approached, namely the target group or for who the program should be developed in order to change plastic problems of an area. A useful tool is a stakeholder power/interest matrix, which already determines the position of each stakeholder.

### **Step 3: Know your target group**

Decide who you want to reach with the project by identifying, getting to know and involving the target group at an early stage of the project. To understand the current knowledge, attitudes and practices interviews and surveys can be used to gather insight information on the level of knowledge of the target group. This understanding of the characteristics of the target group makes it easier to select the appropriate method for achieving the educational goals. Defining the target group in terms of age, gender, culture, interest and occupation can make it easier identify similar skills, attitudes and behaviors. When the target group is defined it is important to look at it again in relation to the problem and if this target group will be able to solve it. Only if the first 3 steps are completed and revised accordingly the exact objectives and goals can be determined to reach the target group.

### **Step 4: determine objectives and desirable outcomes**

Define the educational objectives and goals in terms of knowledge, skills, values, beliefs and practices you want to achieve with the educational program. Define desired outcomes in terms of the effects and outputs. In step 1 a broad goal is established and after steps 2 and 3 a clearer understanding of the stakeholders

and target groups can be made which results in a revised goal.

After step 4 is completed, the preconditions for setting up a community educational project are met and phase 2 can be initialized. Phase 2 focuses on the actual design of the educational methods and how to get the program to be realized.

### **Step 5: Design the methods**

investigate the methods, tools and techniques which can be used to achieve the determined objectives and the desirable outcomes. Keeping in mind who the target group is can help in designing the right method, for example educating children a more playful methods would be considered to be more effective than giving only presentations where they listen. Also the availability of time and money influences the designated methods. Preliminary methods should be established to present to the stakeholder which can fund or support your project, if approved by them the methods can be finalized

### **Step 6: funding and support**

In order to develop projects even small ones need funding's to make them happen, so this step is from great importance as it can very quickly fail the whole project when no funds and no partners are available. The availability of money also influences in return the designed educational methods and the design of it. Identifying all possible funding and support opportunities influences in return the stakeholders and how to deal with them and who to focus on. Through stakeholder analysis the actors for funding have identified and need to be approached accordingly.

### **Step 7: action plan/implementation plan**

an implementation plan is useful to ensure you achieve the projects goals and objectives. An implementation plan identifies what has to be done by when and

what road to take if obstacles arrive. It also includes the needed resources and important milestones to keep the project on track. Important questions to be answered by the action/implementation plan are “Who, what, when, where and how?”

The implementation plan is a result of the problem definition, the target group and all involved stakeholders, the defined goals, methods and the support and funding. Before making the action plan all steps should be revised and reviewed. The final and last step ends in phase 3 which will be executed while the project is being implemented and after it is finished.

### Step 8: Monitor and evaluate

Monitoring and evaluating the project is considered the most difficult step in education project planning it is however from great importance if the project should be applied in different locations and situations and also to identify mistakes being made and how to fix them. It also

helps to identify strengths and weaknesses of the program and a determination of stakeholder and target group satisfaction can be made. For a community educational program two main types of evaluation should be considered:

1. Process evaluation- evaluates how successful the overall process where and involves examining, describing and documenting the activities and processes.

2. Impact evaluation- assess the overall effectiveness of the educational program. How much did the target group learn? Are all objectives and goals met?

Doing desk research it became clear that such as project for coastal areas which focuses on plastic waste and education is not implemented yet therefore the 8 Steps were used as a basis on how to develop the educational program. It was used to stay on track and to reach the established goals, for future implementations the 8 steps can be used to establish in different coastal or delta areas.

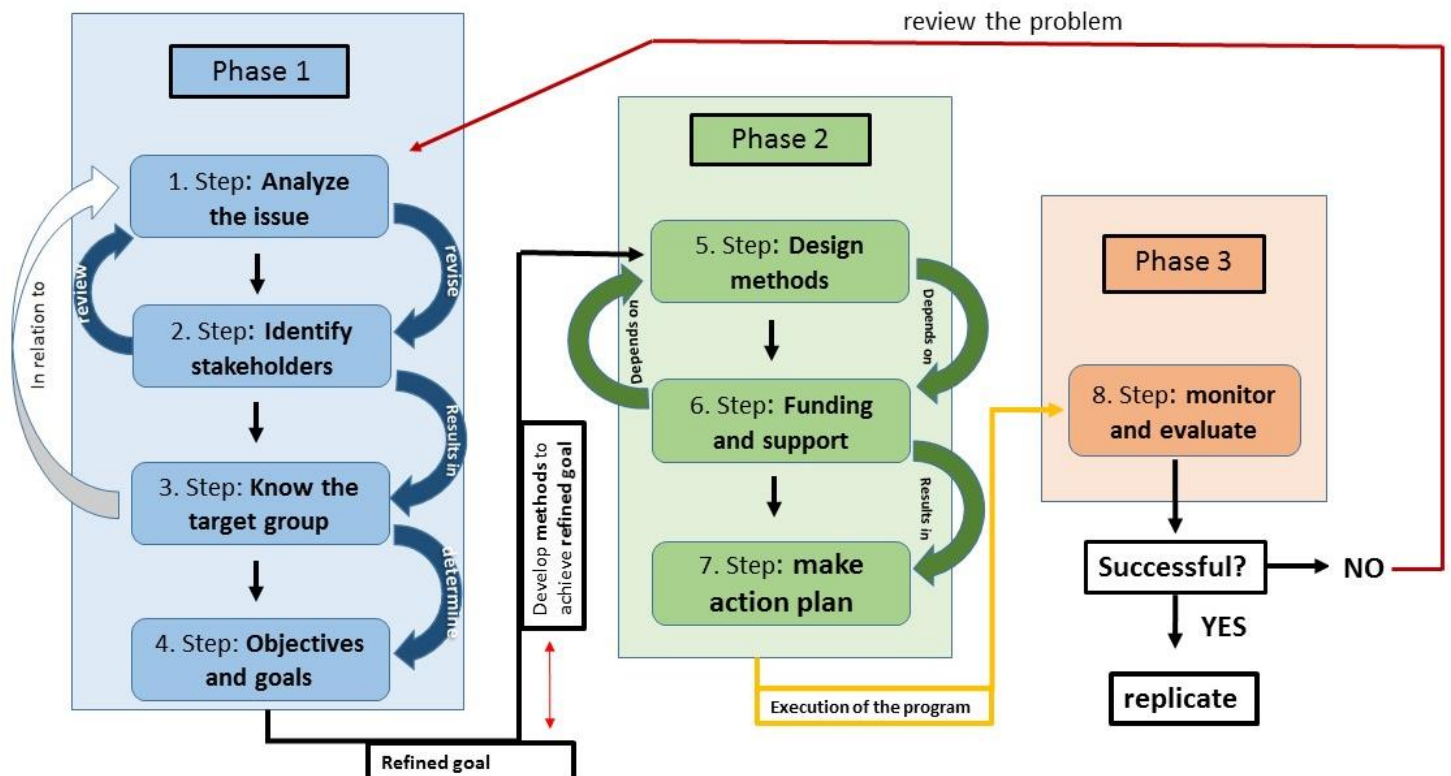


Figure 10: visualization of 8 steps on how to set up an educational program (own archive)

## 4.2 Sub-question 2

In order to develop an community based educational program and according to the 8 steps the problem needs to be identified. This was done by answering the sub question *Do the local inhabitants perceive plastic as a problem for Sao Sebastião?*. By means of questionnaire see Appendix 7,8 and 9. The response rate was higher than anticipated, previously 20 questionnaires were planned but while distributing them more inhabitants showed interest therefore in the end 32 questionnaires were distributed and analysed.

### 4.2.1 Questionnaire

To find out if a community educational program regarding plastic waste can be implemented in the municipality of Sao Sebastião, the first step is to figure out if the local inhabitants see plastic as a problem and if they are willing to participate in a community project. For this reason a survey was created and distributed in the focus neighbourhood of Baleia/Sahy. A total of 32 surveys were analysed, where 47% were males and 54% females. Two surveys were answered by the age group of 10 to 20 years, 12 persons answered the survey which are between 20 and 30 years old, 10 persons answered the

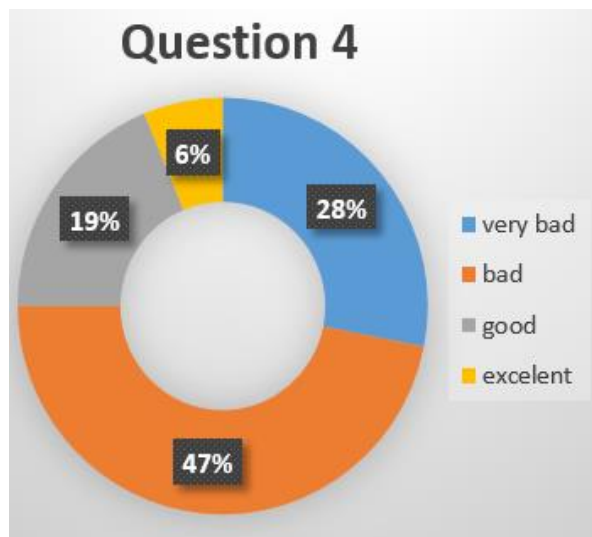


Figure 11: Answer to survey question 4: How would you describe the physical environment of your community regarding trash and litter?

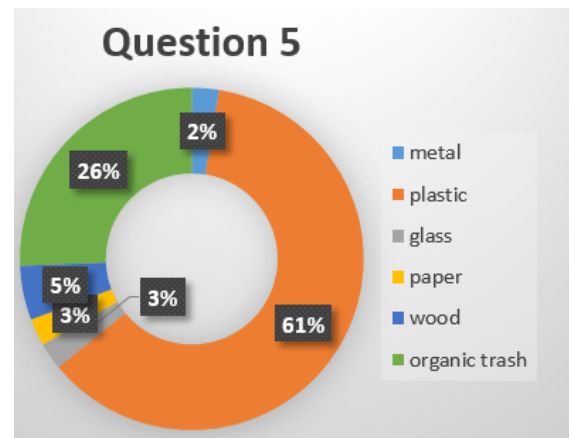


Figure 12: Answer to survey question 5: In your opinion what are the prevailing materials which can be found in your area?

survey which are between 30 and 40 years old and finally 8 persons answered the survey who are above 40 years old (questionnaire question 1-3.)

Figure 11 represents answers to question 4- where the inhabitants were asked to describe the physical environment of their community regarding littering and illegal waste dumping in public spaces. 75% described their environment as very bad or bad in relation to trash in the area. Followed by question number 5, in which the local people should indicate which materials are prevailing in their surroundings. 61% of the asked people gave plastic as the material which they see the most, followed by organic materials with 26%. Metal, glass, paper and wood are not being recognized and add up to 13%. This answer correlates with the findings made in the observation paragraph, where most of the found litter was either plastic bags or plastic bottles. Question 6 was asked to



Figure 13: Answer to survey question 6: In your opinion where can you find the most of the trash?

determine where most of the littered trash can be found. In this question the people who were asked should circle on a scale from 1 to 5 (5 being large amount of litter) how much and where they think most of the trash can be found. Figure 13 represents the answered surveys which indicated 4 or 5. 20 asked people said that there is large amount of trash in the village centre where most people live. 16 persons rated large amounts of trash alongside roads, while 18 stated that they see a lot of trash in the rivers and mangroves areas. Only 10 persons indicated that they can find large amounts of trash on the beach and only 4 stated that they see trash in the ocean. The next question was asked to find out if the inhabitants see plastic trash as a problem for their area. Figure 14 shows that 16 out of the 32 asked persons indicated that they see plastic trash as a problem for the municipality of Sao

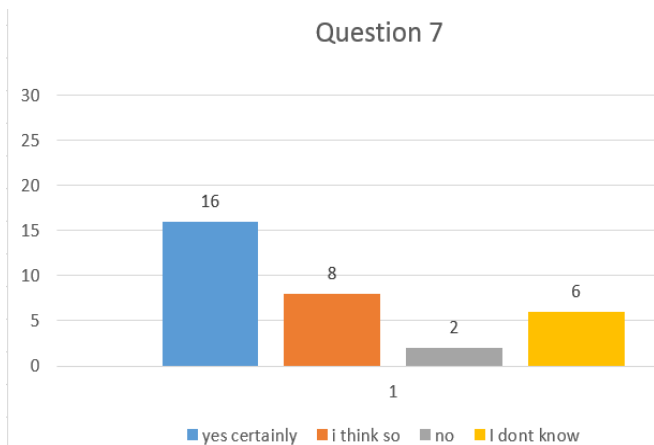


Figure 14: Answer to survey question 7: Do you think plastic litter is a problem for São Sebastião?

Sebastião. 8 people answered with I think so, while 6 were not sure and answered I don't know. Only 2 persons indicated that they don't see plastic trash as a problem for their community.

Question 8 was asked to find out where the inhabitants see the biggest threat plastic trash has on their area or community. Figure 15 shows that 36% of the asked people are concerned about their health in relation to plastic trash, most of them

indicated that mosquito impacts and chemical contamination worries them the most. Also 36 % indicated that plastic litter contributes to flooding/drainage problems of their area. Where 16% see the biggest impacts on the marine environment,

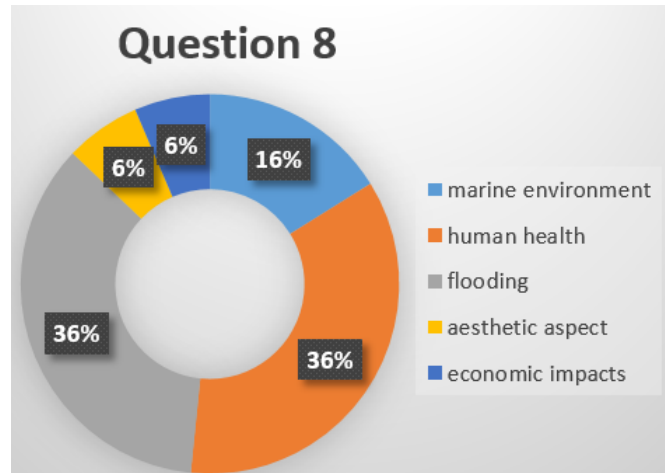


Figure 15: Answer to survey question 8: In your opinion, what do you think is the biggest threat plastic trash has on your area and community?

including habitat destruction and plastic ingestion and entanglement. 6% indicated that plastic has both aesthetic aspects and economic impacts.

Question 9 was an open question where the respondents could indicate if they ever had any negative experience regarding trash in their area. Most of the people left this question blank or indicated no, only 3 persons gave an answer. One person indicated that they got allergies and skin problems when being in contact to polluted water. The other two stated that they saw how plastic trash was blocking drainage systems which resulted in flooding's of their street in front of their houses. This statements fit in with the already executed research done by (Souza, 1998), where she states that one of the anthropogenic factors regarding flooding in Sao Sebastião is the obstruction of natural and artificial channels by litter.

Figure 16 show the answer to question number 10, where the asked people should

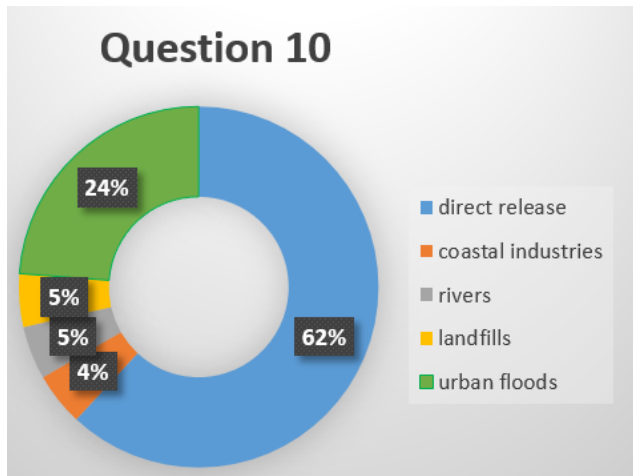


Figure 16: Answer to survey question 10: Where do you think most trash in the marine environment comes from?

indicate where they think most of the trash in the oceans and the marine environment comes from. 62 % stated that they think direct release (via beach-users, tourists) accounts for most of the plastic in the marine and coastal environments. 24 % indicated that they believe urban flooding's which will end up in the ocean accounts for the marine plastic problem. 5% filled in that they think inadequate landfills are responsible for the trash as well as the plastic flow from rivers into the ocean. Only 4 % thinks that coastal industries are responsible for it.

Question number 11 is about the perceived problems of marine and coastal pollution and if the inhabitants think immediate action is required to tackle this problem.

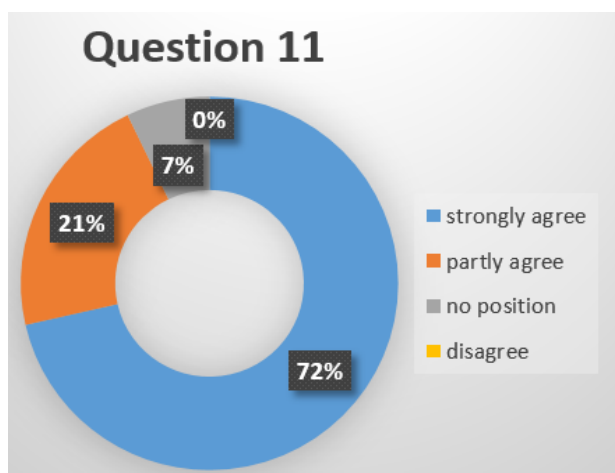


Figure 17: Answer to survey question 11: Is marine and coastal pollution important subject to tackle?

This question can also indicate if the local inhabitants see the need for a community program to tackle this issue. Figure 7 visualizes that out of the 32 analysed surveys 72% of the inhabitants strongly agree that action to tackle the plastic problems is needed quickly. 21% are partly agreeing while 7% indicated that they have no position to the subject. No body indicated that they disagree that marine and coastal trash is a problem which needs to be solved.

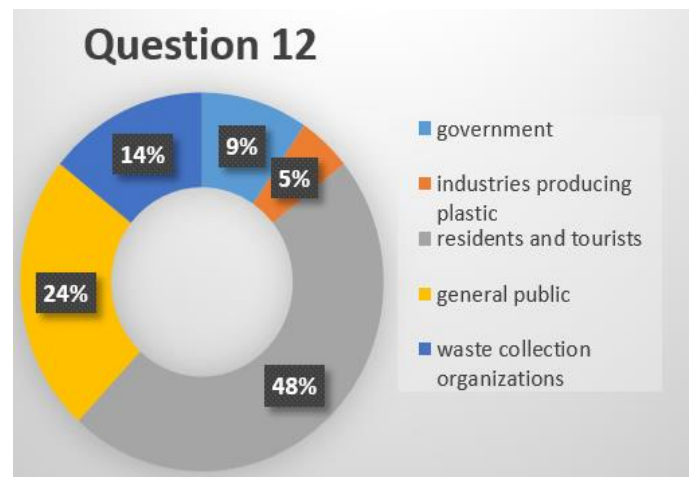


Figure 18: Answer to survey question 12: Who do you think is responsible for reducing marine and coastal trash?

In question the people were asked who they think is responsible for reducing marine and coastal litter. Figure 18 shows that 48% of the asked people think that residents and tourists are responsible for waste reduction. 24% indicated that they believe the general public should change their behaviour. 14% thinks that waste collection organizations should be responsible for reducing trash, 9 % states that it is the government's responsibility and only 5 % thinks that industries need to be responsible.

Question 13 "What actions do you think are the best to reduce marine and coastal litter?" have showed that 40% think that educating people is the best tool to tackle plastic trash in the long-term (Figure 19). 32% stated that a better recycling system



Figure: 19 Answer to survey question 13: What actions do you think are best to reduce marine and coastal litter?

can help to reduce plastic and trash, 12% of the asked people think that clean ups are a way to tackle the coastal pollution. 10 % indicate that a ban on plastic products can help to reduce the plastic in the waters. Only 2 % stated that they think there is nothing we can do about marine coastal plastic pollution.

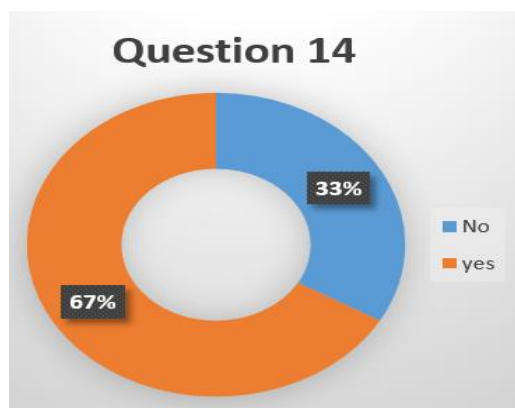


Figure: 20 Answer to survey question 14: Are you familiar with the concept of 3 R's?



Figure: 21 Answer to survey question 15: If familiar how often do you apply in your daily life?

In question 14 the inhabitants were asked if they are familiar with the concepts of Reduce, Re-use and Recycle of plastic products. Figure 20 shows that 67% are familiar with the concept of the 3 R's. Followed by question 15 (figure 21) where the people who answered yes were asked how often they apply it in their daily life's. 52% stated that always apply it, where 32 % stated that they sometimes follow it and only 13% said they apply it rarely.

In question 16 the inhabitants were asked if they think strengthening the community can help to tackle the trash problem. Figure 22 shows that 73% certainly agree that a strengthened community can solve the trash problem, where 20% said maybe and 7% don't agree with this statement.

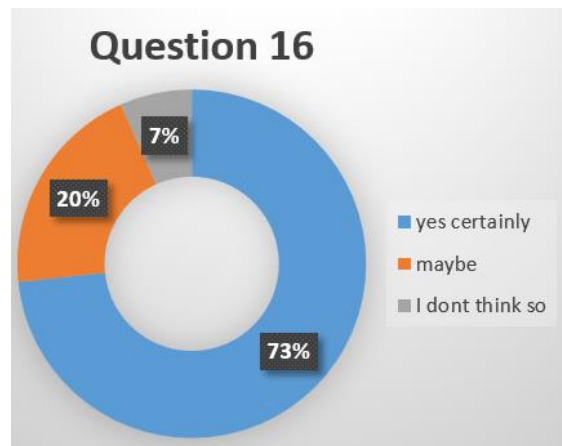


Figure 22: Answer question 16: Do you think strengthening the community can help to solve plastic problems?

#### 4.2.2 Observation

The area has been observed two times within three weeks for transparency and to compare amount and items found. While analysing the questionnaires a big percentage of the inhabitants stated that they can see most of the trash in the mangrove/river areas, alongside roads and in the village centre. As the received data from questionnaires give a more subjective insight based on people's perception on the

amount and problem of trash, observation was also used to underline the problem and identify areas with litter problems. Observation can be used when the topic is relatively unexplored and little data can be found. Physical observation was used to get a clear image of trash in the areas, where most of it accumulates and to give an indication what kind of items can be found the most. Observation is based on the questionnaires and therefore the focus was on trash inside the village centre, alongside roads and in coastal and mangrove areas. Walking through the village centre a lot of litter could be observed lying around, especially plastic single used PET bottles, plastic bags and used packaging. One thing that could be observed several times was that whole trash bags filled with different materials are thrown into the environment and gets picked up by birds and other animals spreading it even more around (Figure 29,). Figure 23 shows how much trash is being littered alongside the main road, this is just one example but most of the highway looks similar to this picture. Figure 32 gives an example on how long trash lays in the environment, as the bamboo plant grew already through the front part of the fan. Most of the trash could be observed in the mangrove area, where a big part of it consisted of empty bottles, plastic containers and plastic bags. Seen in figure 31 where plastic bag is suffocating new mangrove roots.



Figure 23: plastic litter along the road (own archive)



Figure 31: another plastic bag suffocating mangrove roots (own archive)



Figure 24: plastic litter in front of Verdescola



21 Figure 27: plastic in the city centre (own archive)



Figure 32: Litter in the natural environment, grown in trash in bamboo trees (own archive)



Figure 25: Plastic trash in mangrove area (own archive)



Figure 26: plastic along the roads (own archive)



Figure 28: plastic in the mangroves



Figure 29: full plastic bag in mangroves (own archive)



22Figure 30: mainly plastic bottles which could be found in the intertidal mangrove area

#### 4.3 Sub-question 3

The third sub question “How can usage of plastic in São Sebastião be reduced?” will be answered through implementing an educational program to change the behaviour of the local community regarding plastic waste.

By analysing the questionnaires and observation in the previous chapter it became clear that all the preconditions for implementing a pilot educational program to raise awareness about plastic waste are met for the municipality of São Sebastião. education to change behaviour of plastic waste. On the basis of the 8 steps a focus area for pilot project was defined in relation to the social-economic characteristics of the local community. A stakeholder analysis has been used to identify the most important stakeholders and how to approach them. Question 19 of the survey was “In what community activity would you be interested the most?”, 36% answered they would be interested in a community garden, while 27% stated they would be interested to learn methods of recycling to increase their income. Question 21 “Would you be interested in learning about organic gardening”?, 52% answered they would be very interested and 26% would participate.

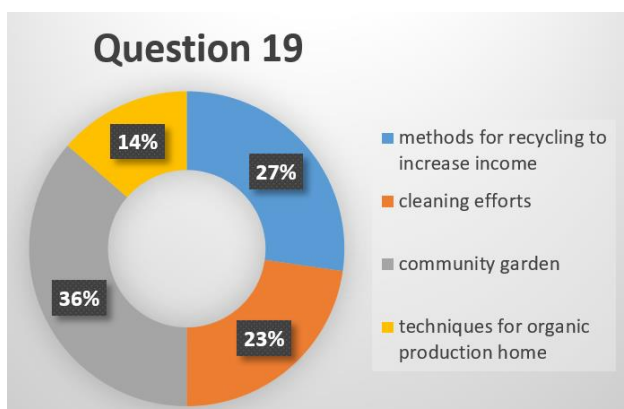


Figure 33: answers questionnaire question 19: What activities would interest you the most?

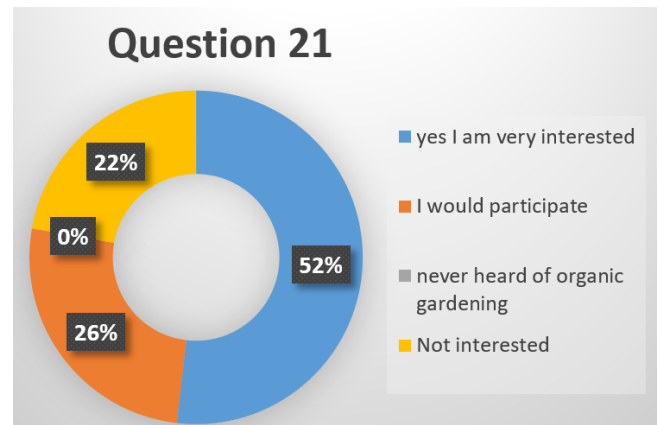


Figure 34: Answers to question 21: Would you be interested in learning about organic gardening techniques?

On the basis of the survey that a big percentage answered they would like to learn about organic gardening and in consideration of the abundance of agricultural area the activities designed were centred around the topic of plastic waste Reduction, Recycling, Reusing and organic gardening for food production. Important stakeholders have been identified and the resulting 12 activities to tackle plastic pollution. Followed by the theoretical planning of the educational program it was executed as implementation research. Focus on a small scale pilot study where the findings can be generalized to put into other coastal and delta areas.

#### 4.3.1 Area analysis to determine location for pilot study

An area analysis is conducted to gain understanding of the spatial patterns of the area of São Sebastião by using a layer analysis as well as looking into the social-demographic aspects of the municipality in order to find a suitable location to implement a pilot program in small scale. The complete area analysis can be found in Appendix 3. The main conclusions regarding focus area are:

A suitable focus location has been established in the Baleia/Sahy neighbourhood, seen in Figure 37 it is one of the most socio-economical vulnerable areas in the municipality. The protected area includes all types of vegetation which can be found in this region with an extensive protected mangrove area. Baleia/Sahy community consists of approximately 800 mostly poorer families, where only 2 % originally comes from this region the rest moved here because of job opportunities. The special aspect about this neighbourhood and the protected area is that it is managed by an NGO (ICC), which allows closer cooperation to the local people. The pilot program will be executed at the institute verdescola, located in between Baleia and Sahy and close to the local community. Verdescola promotes education, human and community development and is in cooperation with local schools. Having more than 3.500m<sup>2</sup> of built-up area, the institute offers facilities for community development and training of young adults and children. The already close cooperation with the local community makes it a perfect location to start up a pilot project to tackle plastic waste. The institute is also being supported by the ICC and a plastic waste reduction program fits within the pillars of the NGO to protect the area and invest in educating the local population.

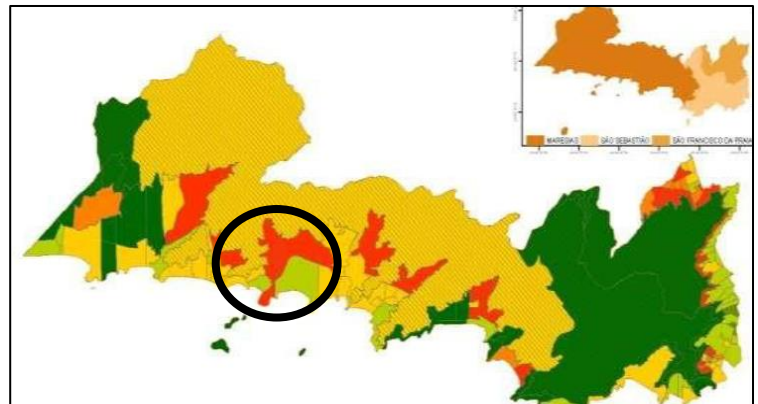


Figure 35: Municipality of São Sebastião, red area represent most socio-economical vulnerable neighborhoods where black circle is the area of Baleia/sahy, (Gil, 2016)



Figure 36: Focus area of Baleia/Sahy, green area is protected area, (Gil, 2016)

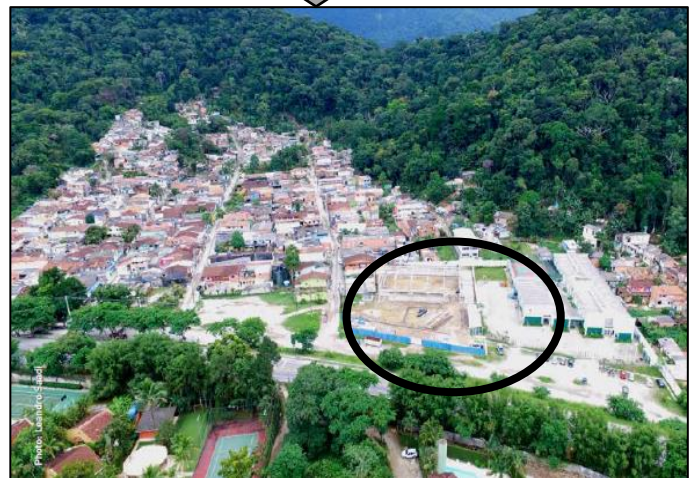


Figure 37: location for pilot program in Baleia/sahy

#### 4.3.2.1 Stakeholder analysis

Developing an educational program to tackle coastal and marine plastic pollution, a pilot study is being established. For this reason it is important to assess the position of all involved actors on how to involve them the best way. Each stakeholder group in the power/interest matrix has to be addressed differently in terms of intensity and the right timing to reach out to them. Extra information to the stakeholder can be found in Appendix 5.

##### 1. Monitor

The stakeholder group which needs the least close cooperation are the ones in the green column. Represented by tourists and local businesses like hotels, restaurants and little shops those actors need to be monitored and informed. Assessing their position at the beginning of the project can help to bring local business as partners for funding or support to gather materials (plastic bottles) and move them into the keep informed column.

##### 2. Keep informed

The group which should kept informed at all times is the column of showing

consideration. Those actors have a high Interest in the program but limited power. This group includes AMOVILA (residents association), local fisherman, institute capim santos and local waste collectors. Those stakeholders should kept informed and consulted, they could be potential supporter of the project. AMOVILA could help to get to know the community better and to receive contacts like community representatives. Waste pickers could be included in gathering enough plastic bottles for the greenhouse and the institute capim santo could use the produced vegetables from the greenhouse.

##### 3. Keep satisfied

The stakeholder group which is in the orange column has high power but medium to low interest. The stakeholders regarding this group are mainly to ensure funding and support of the program. They should especially be engaged in the planning of the project in order to make sure all the funding's are present when the program should start. Also trying to increase their level of interest can help to boost the program with the aim to implement it in more areas.

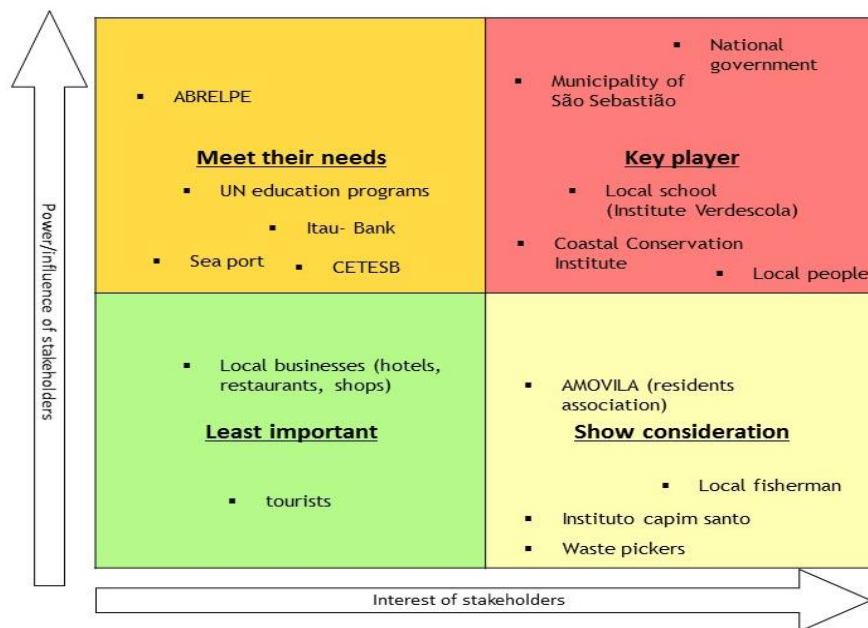


Figure38: Stakeholder power interest matrix

#### 4. Manage closely

The stakeholders which are represented by the quadrant of key players are central to the implementation and have the most power and interest in it. Managing them closely from the beginning is key to success as they can fail the project or put in a veto. The national government and the Municipality of Sao Sebastião as well as the local school are needed to legalize the program and give support for it, they need to be engaged in the very early stages of planning. As the project is mainly about changing the attitude of local people the main stakeholders are the local community as the program is made for them and to continue after it is finished. For this reason they need to be engaged in the very early stages of the planning and being monitored or having regular meetings after the program is finished.

##### 4.3.2.3 Target group

The educational program is aimed to teach kids in the age of 8-10 about plastic waste and its impacts on the environment and society. The program is being developed to be implemented by woman with low incomes in coastal communities in order to empower them and give them the opportunity to gain extra income by growing food or selling recycled art. The implementation research executed in baleia/sahy used around 25 students to execute the program.

##### 4.3.3 12 Activities educational program

After finding a suitable location to implement the project and analysing the stakeholders of the area, 12 activities have been developed to teach children of baleia/sahy in the age group between 8-12. The 12 activities were designed with the input of the surveys where most of the participant stated they would be interested in learning about recycling techniques and organic gardening. The table below is a summary of the activities which have been

executed at baleia/sahy community, Appendix 6 extensive descriptions of each activity can be found where objective, preparation/materials and a short description of each activity can be found. The pilot program had a duration of 12 weeks having each week one activity, one activity took around 1,5 hours to complete. The program has been developed around the topic of 3 R's (reduce, reuse, recycle and organic gardening), whereby building up a the recycled Greenhouse made out of PET single used plastic bottles is the main activity and should be worked on every week. The first week was used as introduction, where the whole educational program was explained and the first steps on the Greenhouse were executed. The second activity had the topic of Reusing non-organics, the students made a home recycling bin to collect plastic bottles which are used for the Greenhouse. The third activity was beach clean-up, to show how much plastic is in the environment as well as collecting more materials for the program. Activity four was about composting and how to reuse 20L water gallons as a compost. Activity 5 and 6 had the topics of landfills and plastic degradation, soil textures and plastic soil and water pollution. Activity 7 was about entanglement and ingestion, while activity 8 was about germinating of seeds. Activity 9 was about reducing and reusing of organic waste, where in activity 10 upcycling ideas to generate a mother's day gift were used. In all activities some time was used to work on the recycled Greenhouse, so in activity 11 the actual Greenhouse was constructed. Activity number 12 was used to close the cycle of plastic waste and organic gardening by planting the plants inside the greenhouse. A question and answer round where the students could tell what they learned and what they liked about the program finished the project. Description is in Appendix 6.

Activity		Objective	Materials/ preparation
<u>1.</u>	Introduction to the Greenhouse educational program	Need for plastic reduction worldwide	- find suitable location for the greenhouse+ activities
<u>2.</u>	My home recycling bin: Importance of <b>Reusing</b> non-organic – incentive collect bottles for the Greenhouse+ Introduce the concept of <b>3 R`s</b> and <b>composting</b>	Students get familiar with 3 R`s + composting	- old paper cartoons + newspaper to cut out pictures
<u>3.</u>	beach/ mangrove clean up + collect materials for the greenhouse ( <b>Reuse, Recycle</b> )	To show where the problem of plastic waste is in their local area	trash bags, notebook, gloves...
<u>4.</u>	<b>Composting</b> : a way of recycling organic waste + <b>reuse</b> 20l water gallon to make a compost	What goes in a compost bin and how to use 20l water gallon to make a compost	2x20l water gallons, potato bag, rope
<u>5.</u>	Landfills and degradation time: importance of <b>reducing</b> and <b>recycling</b> non-organic waste	Show how long items need to degraded	5x 5liter water container, sand, soil, water, organic, non-organic materials
<u>6.</u>	Water filter, soil morphology ( <b>recycling</b> )	Different soil types, water retention and percolation, blockage of waterflow by plastic	2xPET bottles, charcoal, gravel, sand, coffee filter
<u>7.</u>	Plastic impacts on flora and fauna, entanglement and ingestion game (need to <b>reduction</b> )	Show the impacts plastic has on environment and animals by entanglement and ingestion	30x elastics, pictures of local animals, cardboard, M&Ms, plastic pieces, tape
<u>8.</u>	Organic gardening as a way of reducing pollution+ germinating of seeds ( <b>recycle</b> )	Food production without the usage of pesticide, how to germinate seeds	PET bottle bottoms, seeds, other plastic items, ice cream sticks
<u>9.</u>	Replanting food: <b>reducing</b> and <b>reusing</b> organic waste	What plants can be replanted to not generate waste	Several different vegetables, soil, knife, plastic cups
<u>10.</u>	<b>Upcycled</b> mother's day gift	Introduce the concept of upcycling	Plastic lids, PET bottles, paper, cartoon, (all materials which haven't been used so far)
<u>11.</u>	Assembling the Greenhouse	Finalize the Greenhouse	Cable ties, rope, knife, bamboo sticks...
<u>12.</u>	Planting of the plants in the greenhouse to close the cycle + solution to world problems to close the	Close the cycle of plastic waste and food production	Soil, germinated seeds and plants, water, shovel...

#### 4.3.4. Implementation plan

The educational program with its 12 activities related to plastic trash and organic gardening was set up as a pilot implementation research. For this reason an implementation plan is used to show how the pilot program has been developed and how it could be replicated in other and more neighbourhoods around São Sebastião or worldwide in coastal areas. The implementation plan in Figure 33 starts with the orange box where the preconditions for an educational program regarding plastic waste are listed. By preconditions it is meant if there is a plastic litter problem, if local communities or environment is suffering from the problem, if the local people are willing to participate (see the need to tackle this problem) and if the aerial conditions apply for implementing it. The orange boxes represent external factors which cannot be influenced. The preconditions were analysed by the methods which are presented in the blue box, desk research was used to get an understanding of the global plastic problem and what actions are needed to solve this. Furthermore Desk Research was also used to find the most vulnerable areas and communities of São Sebastião. Questionnaire were used to get an insight into how the local people see litter and its impacts as a problem, where they see the biggest problems as well as to get an indication what prevailing materials can be found in the area. Questionnaire were also used to find out the communities interests, for example most of them were interested in learning about organic gardening or how upcycling can help to increase their income. All the preconditions for implementing an educational program were answered with yes by using the methods in the blue box, then it is possible to implement and pilot educational program. If not all preconditions were answered with yes, then the research methods should be analysed

again or the precondition itself, for example is the problem really necessary for the community to be solved. Once the preconditions were proven to enough for an implementation the design of the 12 activities could be made. With input from the questionnaire and observation most inhabitants answered the prevailing materials are plastic bottles, plastic bags and organic trash. The community stated in the questionnaire that they would be interested in learning about organic gardening and ideas on how recycling of trash can increase their income. Based on this inputs the 12 activities were established with the focus on 3 R's and composting with the goal of raising awareness about plastic litter and its impacts. The 12 activities were executed in 12 weeks with the big overall activity of building up a recycled PET bottle Greenhouse. The implementation of the activities were monitored at all times for future replication in other areas as well as assessing how successful each activity was, showed in red arrows and red box. Once the program is finished successfully, the end product is a Recycled Greenhouse which can function as community hub for upcycling activities and to produce organic fruits and vegetable which can either be used for the local community itself or sold to generate extra income. If the program has been assessed not successful the preconditions and/or methods need to be assessed again. If successful, the program could be also applied to other neighbourhoods in São Sebastião as well as other coastal and delta areas all over the globe because marine and coastal plastic litter also doesn't concentrate on one area. Monitoring the whole program is from great importance as it was a pilot project and there is always room for improvements, also other communities perceive the problem maybe different or are not as willing to participate as in baleia/sahy.

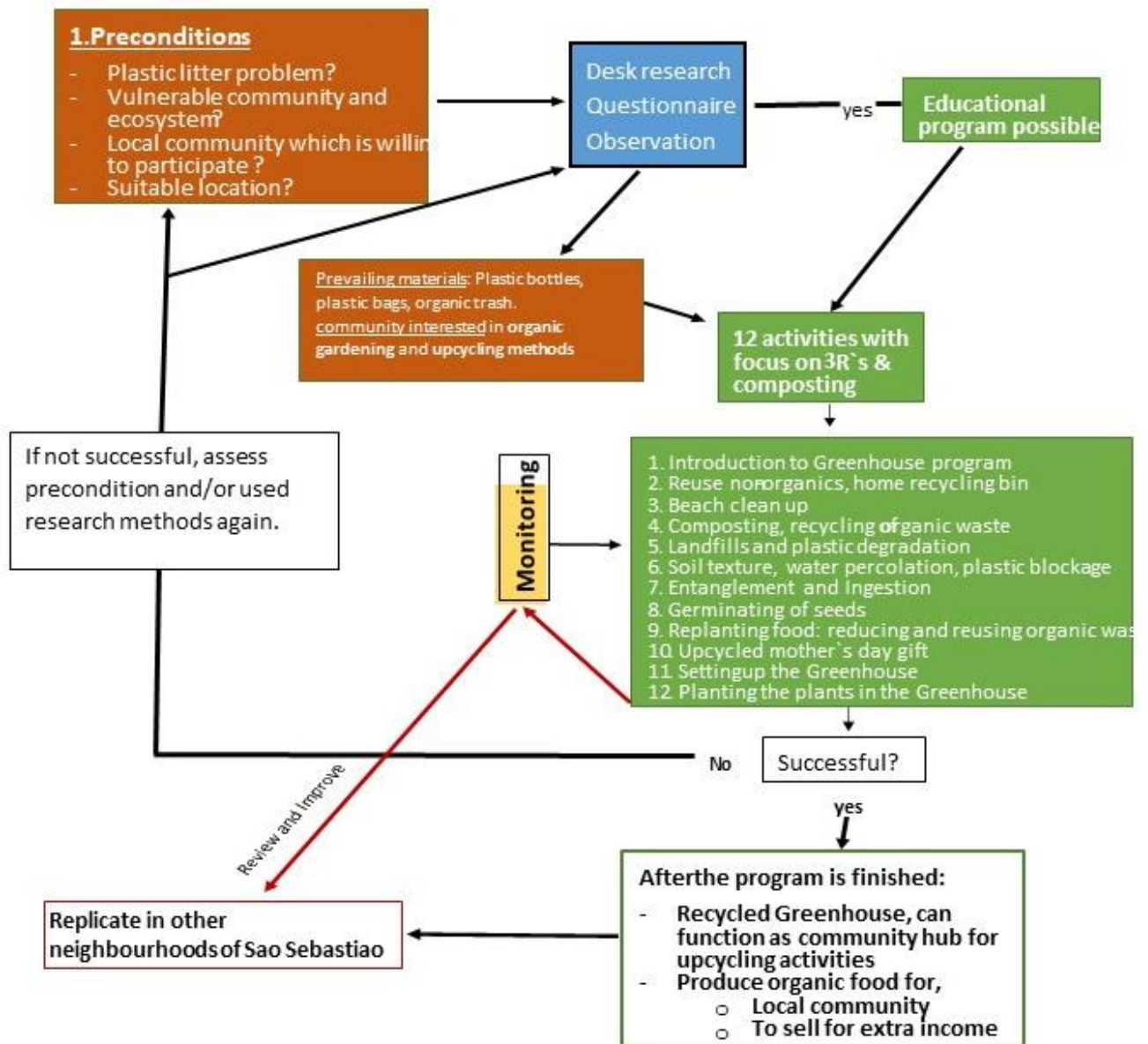


Figure39: Implementation Plan of the Greenhouse educational program in the neighborhood of baleia/sahy, Sao Sebastião, (own archive)

#### 4.3.5 concluding remarks for the implementation research

By implementing the proposed educational program in a small scale pilot, good insight into the planning and execution processes could be made and what to adapt to continue in different locations. Having a partner organisation like Verdescola was from great advantage as all the legal aspects of starting up the project as well as finding a suitable location were made easier. Also having a local school/ institute as partner made it easier to approach the local community, most of the educators and parents came from the community. Also the location of Verdescola made it easier to implement, being located directly next to the community where many people pass by. The local people were really interested in the project and a lot of questions have been asked. Initially the questionnaire was supposed to be handed to 20 people, although so many others showed interest that 32 were collected and analysed in the end. This gave a good indication that the community was really willing to help and saw the plastic problem as important to solve. The initial group size of participants was 30 students, although for future implementations it is recommended that the group size should not exceed 20 students. Depending on who participates in the program the activities can be adapted, for this pilot program children with an age from 8-10 were selected so a more playful approach was used and the theoretical part was shortened and presented with games and visual tools. The response from the students itself was also positive, for example students came up with ideas of recycling plastic and how even to improve some of the activities.

#### Sub question 4

The last sub question “*How can retrieved plastic be recycled to generate additional positive impacts in the community of Sao Sebastião?*” includes the design manual for the recycled Greenhouse, compost and other upcycling ideas which came out of the project in order to have additional benefits for the local community.

Once the actual 12 week program is finished the goal is to establish a community hub/garden around the recycled greenhouse, where organic fruits and vegetables can be grown and sold as well as using it for upcycling of plastic trash into art to sell. The produced organic food could either be used for the local school kitchen or the communities itself could consume it. The idea is that unemployed mothers/woman could organize the community garden and be responsible to further collect plastic litter which can be upcycled into handcrafts. The Greenhouse can be still used after to program to raise awareness about plastic problem, for example to notify people when to make a beach clean-up.

The Design of the Greenhouse was based on the availability of local materials, bamboo is growing in a lot of places and regrows fast so for this design all wooden parts were made out of bamboo. In other areas where there is no bamboo available normal wooden planks can be used as well. Figure 40 shows the adapted design of the Greenhouse and what kind of materials and steps were used to build it up. Followed by the instruction on how to build up a compost bin made out of two 20L water gallons.

#### 4.4.1 Recycled Greenhouse manual

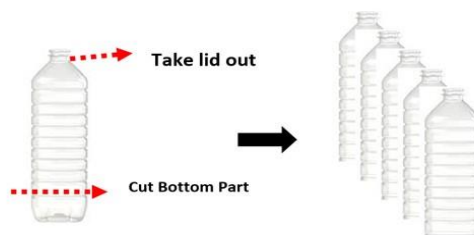
##### 1. Materials:

- 1000 x 2L PET Bottles
- Bamboos:
  - 18 x bamboos of 2.5m long with thickness 5-10 cm (roof)
  - 26 x bamboos of 2m long with thickness 5-10cm (walls and roof frame)
  - 80 x bamboos of 2m with thickness of < 3cm (bottles support) + 20 x with length of 2.5m for the roof
- Rope, screws, cable ties, machete and electric or manual saw



##### 2. Methods

###### Step 1: wash the bottles and cut them



###### Step 2: cut bamboos in the right sizes

- Cut thin bamboos in 2m for the bottle support. These should have a diameter smaller than the outlet of the bottle
- Cut thicker bamboos (26) in 2m and around 5-10cm of diameter should provide better support for the greenhouse structure
- Cut thicker bamboos (18) in 2.5m for the roof
- Cut thinner bamboos (20) in 2.5 with diameter of <3cm for the roof

Figure 40: manual and materials for Greenhouse design (own archive)

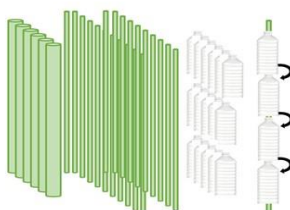
###### Step 3: Assembling of one pillar of bottles for the wall

- 1x thin bamboo of 2m length
- 10-11 x 2L PET bottles



###### Step 4: Assembling of one wall

- 20 x pillars of bottles
- The bamboo is connected with rope to each other



**TIP:** The frame structure requires only 4 thick bamboos although for better stability one or two extra bamboos can be placed horizontally to strengthen the frame. This step is optional.



###### Step 5: Assembling the front frame

- Instead of placing horizontal bamboos place them vertically to leave an opening for the greenhouse



###### Step 6: Putting the walls together

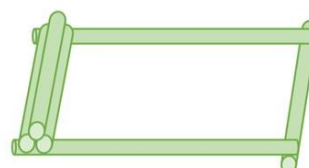
- Assemble the walls to each other
- To connect them cable ties and rope was used



###### Step 7: Assembling the roof

- 6 x thick 2m long bamboo for the frame
- 18 x thick 2.5m long
- 8 bottle pillars

**TIP:** Before start the assembly cut all 18 bamboos of 2.5 meters in half for the rooftop. Like this only half of the bamboos is needed for the roof



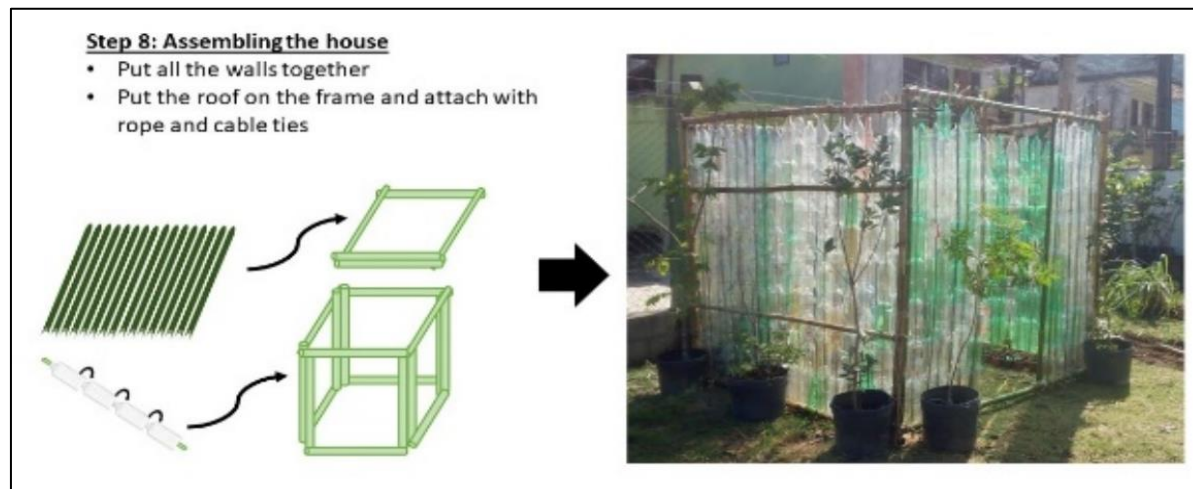


Figure 41: Finished Greenhouse made out of more than 1000 PET bottles, (own archive)

#### 4.4.2. Reused 20L water gallons as compost design

##### 1. Materials

- 2 x 20L water gallons
- 1 x rope
- 1 x potato bag (something to filter big solids)



**Step 2:** Place the filtering cloth in the top part for both gallons and secure it well with the rope

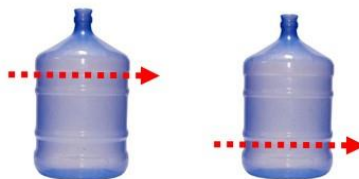


**Step 3:** Assemble as the image indicates



##### 2. Method

**Step 1:** cut gallons as indicated in the Picture



**Step 4:** Add water and turn the upper gallon one a week for a better compost quality.

#### 4.4.3. Recycled plastic ideas to increase income

A big part of São Sebastião economy depends on tourisms, especially poorer people oftentimes sell different items along the roads or directly at the beach to generate an extra income. For this reason some ideas which are easy to reproduce and only with plastic trash items made are presented. Next to the community garden a community shop could be opened where all these upcycled items as well as the fruits or vegetables could be sold.

Figure 42 shows a cell phone holder which can easily be upcycled by using bottle lids, this idea was actually presented by one of the students who took part in the greenhouse program. Figure 43 shows a upcycled spice rack made out of 5L bottles, this spice racks could be produced within the greenhouse community garden. Figure 44 shows a lamp made out of the PET bottle lids, the lids are glued onto each other and a normal bulb is placed inside. By integrating bamboo into the plastic trash the aesthetic of the upcycled item can also be increased. Or lastly as seen in figure 45, where 0.5L bottles and 1L bottles were used to organise kitchen tools and cutlery.



Figure42: plastic bottle lid used as cell phone holder (own archive)



Figure 43: 5L water bottle upcycled as a spice rack (own archive)



Figure 44: bottle lids used for a upcycled lamp (own archive)



Figure45: PET bottles used to organize kitchen tools

## 5. Discussions

This chapter will discuss the proposed solution, which is presented in the previous chapter of results. Coastal and marine litter is a result of overproduction and over usage of plastics and missing waste recycling systems. This research investigated solutions where the awareness of local and mostly poor communities on plastic waste and its impacts can be raised and how this plastic waste can generate extra benefits for the community.

This research is focused on community based educational programs, where a pilot program was designed for Sao Sebastião, for this reason the needs and wishes of the local people were taken into account. To get an idea what the local population thinks and feels about the need for plastic waste reduction program questionnaires were established. Of course the questionnaires only represents a small percentage of the whole community but it was tried to ask people from all genders and ages to get a representative image of what the community needs. Surprisingly the questionnaires results showed that most people really know the problems of plastic waste and the impacts but also understood the relation to flooding problems in the area as well as human health impacts. Also most of the people answered that they would like to have extra income for them and their families, this emphasizes the findings from socio-economic analysis as well as most of the people in this area moved there from other areas to seek job opportunities. Furthermore most of the inhabitants stated that they are interested in learning about organic gardening, this could be because of several reasons, one that the area is limited in agricultural area and most of the fruits and vegetables have to be imported from other states making them vulnerable to any disruption in the system. But also

represent that the country's economy is in recession and small bottom up initiatives are needed for the people to generate income.

Implementing the proposed educational program in a small scale pilot program gave a lot of valuable information on the effectiveness of the program and shows how easy it was to implement. One point which could influence the effectiveness of the program is the group size of the target group, younger children are losing their focus very fast and with more people sometimes children had to wait till it was their turn. Also the time frame of one week between the activities might have been too long as children forgot to bring their homework and sometimes couldn't remember what the topic of the previous week was. When the activity was presented in a more playful way or in a way where the pupils could actually do something with their hands they were more interested and showed more initiative of doing things themselves. In general the designed educational program could be applied in other coastal and delta areas especially in more poorer and remote areas where the current waste collecting systems are failing and the local population is suffering from its impacts. Of course the activities have to be adapted to the areal specific conditions as well as the wishes from local communities can differ but in general this program could help to raise the awareness of plastic products and its impacts and show solutions to tackle this in most coastal areas. It is an easy and simple solution and not only professionals could executed the program but also local people could take initiative and implement it and then train other people to reproduce it in other areas.

## 6 . Conclusion

The chapter of conclusion is structured how the main research question was tried to answer by first answering the sub questions which then lead to answering the main question.

### 1. Sub-question

The first sub question “How could a community broad educational program be developed for coastal areas”? was mainly included because the subject of raising awareness through community education has been very new to myself and to get a starting point on how to start up. The sub question has been mostly answered by using desk research and mind mapping techniques. This first sub question was set to be the basis for developing an pilot educational program for Sao Sebastião region, following the 8 Steps in the coming chapters it was easier to keep on track and to get to the refined goal of the community and what the programs objectives are. Since the long-term goal is to establish an educational program regarding plastic waste in more areas and around the globe this 8 step approach is useful to start up programs in more areas with slightly different problems or willingness to cooperate from the local communities.

### 2. Sub-question

A community based educational program really depends on the willingness of the local community to participate and a precondition for this is that they perceive plastic litter in their area as a problem. For this reason questionnaires were distributed around the proposed community to see if they see trash as a problem. The questionnaire itself have been translated into Portuguese and after collecting the answers were noted in an Excel file. One remark which could be made was that the first translated questionnaire had to many technical terms in it and had to be revised to an easier Portuguese which the local

community could be easier to understand. It was tried to ask people from different age groups and genders with the focus on the poorer inhabitants. Based on the questionnaire the preconditions for a pilot educational program were met, inhabitants perceive plastic as a problem and are willing to participate in community activities. As the answers to the questionnaires are rather subjective, observation of the area was also used to get an insight into the problem of trash and the area in general. The results of the observation match with the results obtained from the questionnaire, where most litter consisted of plastic waste, especially PET bottles and plastic bags. A big part of the observed plastic is single used plastic, meaning there is hardly a market to melt it and produce new products from it. Also the location where most of the litter can be found coincided with the questionnaire, where most of it can be found inside the village centre, along roads and in the river and mangrove area. The trash in the mangrove and river area heavily depended on tidal and rain influences, after big storms with heavy rains more trash could be observed in the mangrove area. A lot of people who answered the questionnaire really knew the relation of plastic waste and flooding's in their area and this was also one aspect which a lot of people mentioned while talking to them about the area. So sub-question 2 was mainly according to the first 3 steps of the previous chapter, where the issue was analysed. Stakeholders were asked and an idea of a target group formed. One aspects

### 3 Sub-question

The previous two sub-question were the preconditions for implementing a pilot educational program in an area in Sao Sebastião. To design the program in relation to the area and on the wishes of its inhabitants where executed in the 3<sup>rd</sup> sub

question. Part of the questionnaire was also asked what the local people would be interested in learning in a community program. Most of them stated they would be interested in a community garden or learn about organic gardening as well as methods for recycling to increase their income. With this input and the information learned in the theoretical framework the 12 activities were planned around the topics of Reduce, Reuse, Recycle and composting (organic gardening). To implement a small scale pilot program, a suitable location has to be found. This was done by means of an area analysis where a focus area resulted. It was chosen to be the best location to execute in the baleia-sahy community as for one point it was one of the most socio-economic vulnerable areas of the municipality. As well as the protected areas where reaching from the mountains to the coast with many important ecosystems. The area is managed by an NGO (ICC) and therefore the relation to the local community is very close. Also the Institute Verdescola is located in this neighbourhood, giving a perfect location to implement the pilot program. After the area has been chosen a stakeholder analysis has been conducted to understand the most important stakeholders in this area and how they can help or be partners in the project. Most important ones where the Institute Verdescola as the program should be implemented on their ground, the local people as the program was established for them and the support of the Municipality or in this case the Coastal Conservation Institute (ICC). As one benefit to the program should include food production, the idea was that the big overall activity will be to establish a recycled Greenhouse made out of PET bottles which can function in the end as a community hub for organic gardening or for local people to upcycle plastic trash in

order to gain extra income. After the pilot program was established it was executed as a small scale implementation research with 30 students (age from 8-10) from baleia-sahy community. It became clear that 30 students are too much for one group and sometimes they did not pay attention at all especially in more theoretical parts. One activity was executed per week and took about 1,5 hours. Every activity ended with the last 20min working on the Greenhouse. As the pilot programs group of choice were children because they could easily influence their parents or other close members of their family and their behaviour is still able to change easily. Sometimes The actual implementation gave a lot of insight into the processes of each activity and how to change them before replicating them. For children the activities were more arranged in a playful way, with games and activities where they could handcraft plastic themselves and bring home to show their parents. As the pilot program was executed on a small scale and the limitation of time, it was hard to access how much the behaviour of the kids changed, more small scale programs are probably needed to get reliably data. Although by implementing the program it became clear the students really understood the topic, as for example students came after the activity with ideas on how to recycle different items for example use parts of the bottles to hold a cell phone. Students were also telling how they saw older people litter and then going to them and asking them to pick it up.

#### 4. Sub question

The last sub question was “How can retrieved plastic be recycled to generate additional positive impacts in the local community”? This questions has been answered by the design of the recycled greenhouse which could once the program is finished, function as a community hub

for producing organic food or for recycling activities which can then be sold to tourist. The greenhouse design was established on the basis of the available materials in the area. Prevailing plastic items were PET bottles and bamboo grows as a natural material in a lot of places. The design is easy to assemble and easy to be reproduced. As organic gardening uses no artificial fertilizers and pesticides a design of an easy recycled compost bin is also presented. Followed by more ideas for recycling, the ideas came out of the left over materials for example bottle lids couldn't be used for the greenhouse but for a homemade lamp it could be used. The actual assembling of the greenhouse was rather simple, the only thing which took more time than planned was to collect more than 1000 plastic bottles. Furthermore while building up the greenhouse a lot of people came by and where interested in the project, so having the greenhouse in a really centred point where many people pass by is from great importance to influence the whole community.

### To conclude

By answering all the sub question the main research question could be answered, how to start an educational program for coastal areas has been established with the 1<sup>st</sup> sub question, while 2<sup>nd</sup> question analysed the preconditions and problems of the area and of the local population. Sub question 3 included the theoretical planning of the program as well as implementing it and sub question 4 gave an idea how recycled plastic can be used to generate extra income. This educational program could be translated to most of the coastal areas where vulnerable local people are suffering from the impacts of plastic waste. Apart from a few materials the whole program can be executed without much monetary resources making it suitable for developing countries where funding seems problematic. Also is the program designed in a way activities can be adapted to local circumstances or be extended or shortened. The solution itself might not reduce the existing plastic items in the marine and coastal environment but will provide long- term impacts on the behaviour of people which in return will hopefully reduce the plastic usage and give incentive to young people to solve this issue. This educational program could be one part of a bigger project regarding the circularity of plastic waste systems on a community level, for example by including waste collectors, waste banks and recycling and upcycling companies into it which could bring additional benefits to an area.

## 7. Recommendations

### **Project oriented recommendations**

Developing the educational program for the area of Sao Sebastião

For implementing the program in other areas or to scale it up it is recommended to follow the steps which lead to the main problem of an area. For the long- term if this program really helps to change the behaviour of people towards plastic waste, more pilot programs need to be established and the monitoring activity needs to be extended and the participants awareness should be assessed after some time. It also recommended to really design the activities regarding to the focus group, in the pilot in baleia-sahy children were used so a more playful methods has been established. The goal is that in the future the program can be executed by local woman and mothers who are unemployed or who want to increase their income. One further recommendation could be that the educational program is part of a bigger plastic waste program of a community, including waste pickers and collectors as well as projects to catch plastic trash from rivers could be part of it. By using this bottom up approach governments and municipalities might see the need to change laws and regulations regarding plastic waste and give incentives for green businesses or sustainable waste models. The design of the greenhouse was based on the availability of the materials in the area, bamboo is growing in a lot of places and the plastic bottles were collected via beach clean-up or collected from the students at home. To further up scale the program different materials which can be found in different places can be used, it is therefore recommended to really asses the prevailing materials before designing the program. Also the group size should not exceed 15-20 people and for future implementations local adults could be

included in the project as well, it could become a program which empowers woman and children in poorer communities. The finished community hub (greenhouse) could be used after the project to further educate the local people about plastic waste and could function as a place for innovation and community development. To further research the effectiveness in the long- term more and longer programs need to be established and the results need to be compared.

### **Process oriented recommendations**

It is crucial in the planning process to look for partners or collaborations as the program needs to be established without many monetary resources. A local institute or school seemed to be one of the easiest ways to get to know the local population as well as it could provide a good location for the implementation. Also having the support from the local municipality is from great importance and it is recommended to include them very early in the planning process. Also that the program fits within the overall vision of an area should be considered and that the program answers the needs and wishes from the local people, for this reason it is recommended to assess the views from the local people in a very early stage of the process. Establishing relationships with local people is also recommended to ensure that the program will continue after the activities have been finished. Being related to an institute (for example institute verdescola) or coming from a university makes it easier to get into contact with local people and gives people more incentive to participate. It is also recommended to further monitor the project once it is finished, to ensure further successfulness but also to get feedback on how to adapt the program for different areas or what could be improved to make a long- term impact.

## Bibliography

- Alici, S. (2013). *Recycle, Reduce, Reuse education for Kindergarten children*. Ankara: Graduate School of social Sciences of Middle east technical University.
- Amaral, A. C., & Nallin, S. A. (2011). *Marine Benthic Biodiveristy and Ecosystems from the Norhtern coast of the State of Sao Paulo, Southeastern Brazil*. Campinas: Apoio Institucional.
- Barnes, D. K. (2009). Accumulation and fragmentation of plastic debris in global environments. *The royal society*, 1985-1998.
- Cohen, D. (2018, march 12). *take the 4rs pledge*. Retrieved from plastic pollution coalition : <http://www.plasticpollutioncoalition.org/the-4-rs/>
- Commission, M. M. (1999). Annual Report to Congress 1998. *Marine Mammal commission*, 236.
- Corsten. (2012). *The potential for waste management in brazil to minimize GHG emissions and maximize re-use of materials*. Arnhem: Ministry of Infrastructure and the Environment.
- Derraik, J. G. (2002). *The pollution of the marine environment by plastic debris: a review*. Wellington: elsevier.
- Estatistica, I. B. (2018, May 12). *citypopulation*. Retrieved from citypopulation: <https://www.citypopulation.de/php/brazil-regiaosudeste-admin.php?adm2id=3550704>
- Ford, C. (2000). *What we need is... A community Education Project*. Sidney: Environment Protection Authority.
- Gil, E. R. (2016). *Diagnostico socioeconomico APA Baleia-sahy*. Sao Sebastiao: Municipio de Sao Sebastiao .
- Harding, S. (2016). *Marine debris: understanding, preventing and mitigating the significant adverse impacts on marine and coastal biodiversity*. Montreal: Secretariat of the Convention on Biological Diversity.
- Hoang, L. T., & Kato, T. (2016). Measuring the effect of environmental education for sustainable development at elementary schools: A case study in Da Nang city Vietnam. *Sustainable Environment Research*, 274-286.
- Lachmann, Almroth, Baumann, Brostrom, Corvellec, Gipperth, & Hasselov. (2017). *Marine plastic litter on small island developing states (SIDS): Impacts and measures*. Gothenburg: Swedish institute for the marine environment.
- Law, K. L. (2016). Plastics in the Marine Environment. *The Annual Review of Marine Science*, 1-29.
- Löhr, A., Savelli, H., Beunen, R., Kalz, M., & Ragas, A. (2017). Solutions for global marine litter pollution. *Current Opinion in Environmental Sustainability*, 90-99.
- NOAA. (2018, 03 06). *Marine Debris Program*. Retrieved from Marinedebris.noaa: <https://marinedebris.noaa.gov/discover-issue>

- Ogunola. (2017). current advances in strategies to mitigate the impacts of micro/nano plastics. *journal of environmental and analytical toxicology*, 1-4.
- Ogunola, O., Onada, O., & Falaye, A. (2018). Mitigation measures to avert the impacts of plastics and microplastic in the marine environment. *Environmental Science and Pollution Research*, 1-18.
- Oliveira, A., & Turra, A. (2015). Solid waste management in coastal cities: where are the gaps? Case study of the north coast of Sao Paulo, Brazil. *Journal of Integrated Coastal Zone Management*, 453-465.
- Rios, M. J. (2007). Persisten organic pollutants carried by synthetic polymers in the ocean environment. *Marine Pollution Bulletin*, 1230-1237.
- Sheavly. (2007). National Marine Debris Monitoring Program: Final Program Report, Data, Analysis and Summary. *Prepared for U.S. Environmental Protection Agency by Ocean Conservancy*, 76.
- Sheavly, S., Courtney, K., & Parks, J. (2011). *Honolulu strategy, A global framework for prevention and management of marine debris*. Honolulu: UNEP and NOAA.
- Smith. (2018, March 10). *pghenvironmental*. Retrieved from pghenvironmental.wordpress: <https://pghenvironmental.wordpress.com/2016/02/18/cholera-dysentery-hepatitis-a-and-typhoid-oregon-trail-or-the-brazil-olympics/>
- UN. (2018, March 12). *sustainable development goals*. Retrieved from goal 14: conserve and sustainably use the oceans, seas and marine resources: <http://www.un.org/sustainabledevelopment/oceans/>
- UNEP. (2016). *Marine plastic debris and microplastics- global lessons and research to inspire action guide policy change*. Nairobi: Nations Environment Programme.
- Van den Brink, N., Franeker, v., Riddle, & Heuvel-Grevel, v. (2011). contrasting time trends of organic contaminants in Antarctic pelagic and benthic food webs. *Marine Pollution Bulletin* , 128-132.
- Vaughan, C. (2003). The effect of environmental education on schoolchildren, their parents, and community members: a study of intergenerational and intercommunity learning. *Journal of Environmental Education*, 12-21.
- wastefreeoceans. (2018, 03 07). *wastefreeoceans*. Retrieved from wastefreeoceans: <https://www.wastefreeoceans.org/infohub>

## Appendices

### Appendix 1: extra information for research objective

The two biggest consumers of plastic usage in Brazil are the construction industry and the food industry. Whereby in the food industry most of plastic is used for packaging and transportation of goods. The educational program has therefore the extra benefits of food production which in return means less plastic used for packaging and bringing food security to remote areas like São Sebastião. Food production for São Sebastião is limited as well due to current land use of the area, most of the land being used for constructions of holiday homes. Establishing a program which not only tackles the UN sustainable goals of Quality Education (goal number 4), responsible consumption and production (goal 12), life below water (goal 14) but also goal number 2 of Zero Hunger the resilience of the local community can be increased. Furthermore the decision to educate local pupils has been made because of several reasons, first they represent the future local population of the area and they will be the people to take care of it. Also young pupils mind can still be influenced and form long lasting behaviour changes, as well as children are influencing their close relatives with ideas and solutions. Lastly Brazil's population is young and oftentimes younger people struggle in finding jobs, therefore the focus on young people was also made to give them the opportunity to learn something new for their future and maybe use this incentive to create job opportunities.

#### Market Segmentation

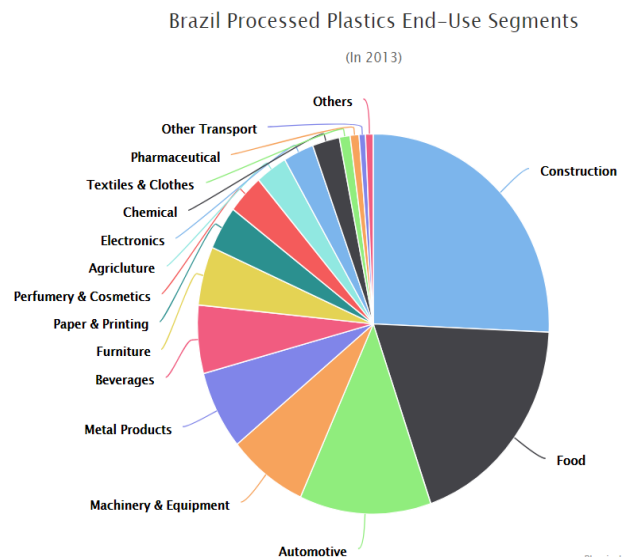


Figure46: Brazil processed Plastics, (Plasticsinsight, 2016)

### Appendix 2: Summary of 8 steps

To be cited as: Ford, C. (2000). *What we need is ...A community Education Project*. Sidney: Environment Protection Authority.

In order to solve environmental and in particular plastic pollution problems which arise as a result of people's actions, the behaviour of people needs to be changed. One way of changing people's behaviour is through community education, which is considered one of the mechanisms to address anthropogenic problems. Other mechanisms for change are enforcement of policies and regulations, give monetary incentives and disincentives and through science and technology. Community education can be a process to create awareness of an issue or to enhance people's knowledge, understanding and skills as well as encourage people to more responsible behaviour. Community education includes the aspects of involving the general public via adult education, school and tertiary education, community

development and communications or social marketing. To make effective community education projects an involvement of all kind of stakeholders is from great importance in the planning, execution and monitoring process. This can support and strengthen the existing community networks and can help to create new ones. A key factor for successful community education is collaboration, meaning a more bottom up approach. The most effective community education projects are those arising from the community itself, the community knows best their needs and wishes and is connected to people in order to find solutions for the problems. Before planning an educational program the issue or problem needs to be analysed (First step) in order to establish a good design of a project. This can be done by looking into already executed similar projects via literature research as well as formulating a broad goal which will be defined in a later step to the refined goal. Analysing the issues can only be done when including the wishes and needs of all involved stakeholder therefore step two consists of identifying stakeholders and in light of those review the issue or problem again. It is from importance to identify the stakeholders, involve them and find out where they stand in relation to the issue. This can be done by identifying key players and make those to your allies as well as trying to set up partnerships and collaborations. The next step (third step) is to identify the target group, so to who the projects is created for. This step is in close relation to identifying stakeholders and form the target group, it is from importance to understand the characteristics of the target group making it easier to select the appropriate method for achieving the objectives which are the next step in developing an educational program. Determining the results which should be included in the educational program in terms of goal, educational objectives and the desired outcomes can be concluded as step 4. After this step the preconditions for an educational program are established and the next step is to actually design the methods how to achieve the goals and objectives stated in the previous steps. The first four steps resulted in a broad goal which can now be defined into a refined goal in light of the objectives and inputs of the stakeholders. The next step is how to find support and funding for the program which is in return again in relation to the stakeholders. This steps includes an estimation of total costs of the projects, location of the projects and eventually partners which can help the program. After funding and support is established an action or implementation plan can be used to help to organize the projects and set deadlines when and where to start with. The plan should include the “Who, what, when, where and how?” which results in a project plan with important milestones. After the implementation plan is formulated the actual implementation can take place of the project. The last step includes monitoring and evaluating the program and tell people about it, this helps to make decisions and recommendations for future programs and can identify the strengths and weaknesses of it. For a community education program there are two types of evaluation: First process evaluation, meaning to assess the processes of the entire program how everything worked out and what to do better next time. The second one is impact evaluation, meaning to assess the overall effectiveness of a project in achieving its defined goals and objectives. The last section of the report gives useful education methods such as audio visual tools (video, audio, photos), case studies, demonstrations, focus group, peer education, posters, presentations, games and plays, workshops and many more.

## Appendix 3: Area analysis and study location

### 1. Underground layer

The municipality of São Sebastião has a coastline of more than 100km with 36 separated neighbourhoods and a total area of 400km<sup>2</sup>. The city is located between the Atlantic Ocean and mountains covered with Atlantic forest, the plains measure from 3km to 6km in width. The mean elevation of the area is 6m, where low lying lands are dominant in the mangrove areas. The area is characterized by rich and diverse ecosystems, fore dunes and beaches as well as rocky shores and several uninhabited islands. The overall sedimentation rates are low and erosional processes are prevailing. As the area is dominated by mangroves coverage, the soil is also composed mainly of sand, silt and clay. Soils are of marine alluvium, transported as sediment and deposited by rivers and sea being rich in organic matter. Soils below the surface are typically waterlogged and have the presence of hydrogen sulphide resulting strong odour and a colour of grey or black. The climate is a humid subtropical climate with a dry and rain season, receiving up to 3000mm of precipitation per year mostly in the hot summer months.

### 2. Network layer

The road network in São Sebastião is mainly dominated by the BR-101 also called the Trans coastal highway, being nearly 4,800km in length and crossing 12 states it is heavily used by trucks. The highway connects the city from north to south and regular bus line running through it. In the smaller communities most of the roads are still made up to dirt roads and the usage of bicycles are dominant. Train lines and airports are not present in the municipality of São Sebastião, the nearest ones are



Figure 47: location of the municipality of São Sebastião in the state of São Paulo, (wikipedia, 2018)



Figure 48 São Sebastião area of whole municipality, ( Gil, 2016)

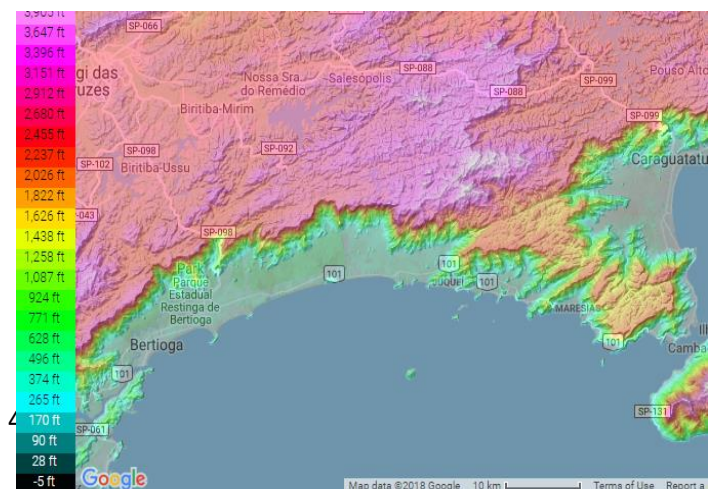


Figure 49 Elevation map of São Sebastião, (topographicmap.com, 2018)

located in the city of Santos or Sao Paulo which are only accessible via roads. Electricity is mainly coming from hydroelectricity, which makes the country also vulnerable to power supply shortages in times of drought. The area is dominated by mangrove forests which have small rivers and creeks within them, as can be seen in figure 4. In the rain season those small rivers exceed their water carrying capacity and overflow of water and flooding is a result.

### 3. Occupation layer

The occupation layer describes the built-up area and the land uses of an area. The municipality has a population of 85,538 where 50.1% are females and 49.9% are males (Estatística, 2018). The area experiences a population growth of +2.13% per year. The dark red area in the east part of the municipality is the Port of Sao Sebastião and is functioning as a multipurpose port handling steel, vehicles and sodium sulphate as well as diesel, gasoline and crude oil. In the surrounding areas in light red, industries and more urban area can be found. The purple area is occupied land whereby some of the areas are illegally built in protected areas. The light green area is land which was planned for housing and constructions but has been either abandoned because of economic reasons or because of improper planning. Dark green area is the Atlantic forest and the brown area in the west is land from the indigenous people. Blue area is the protected marine environment with its protected and mostly uninhabited islands. In total 607.93 ha are protected area in Sao Sebastião, most of it being mangrove forests. Regarding the waste system, most of it ends up in landfills although they are classified as inadequate. Exporting waste to other cities is a common solution to get rid of the trash, sometimes exporting to other landfills which are up 200km away. As the municipality is influenced by tourists the amount of generated waste differs, on a normal day 116 tons of waste are produced while on holidays around 250 tons per day are produced, which is more than the already existing waste collection system can bare (Oliveira & Turra, 2015).



Figure 504: main roads at the coast of Sao Paulo

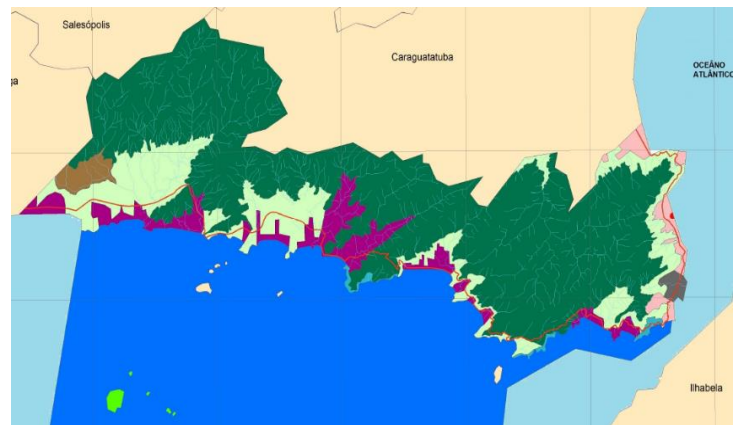


Figure 51 land usage ( Gil, 2016)

#### Appendix 4: Location for pilot project

Going more into detail, it became clear that each neighbourhood in Sao Sebastião differs from each other in terms of socio-economic situation as well as the physical conditions. The product of this research will be pilot project where an educational program is developed, therefore a smaller target community/ target locations was established.

#### Selection of area of Baleia-Sahy

The Baleia-Sahy community is one of the most vulnerable areas regarding socio-economic risk as well as the physical conditions, figure 52 show the areas of socio-economic risk in Sao Sebastião. Being the red indicated areas the most vulnerable ones. The black circle indicates the location of the neighbourhood baleia/sahy. The green area indicates the least vulnerable areas in regard to socio-economy and community vulnerability. It is also the only protected area which covers all types of vegetation that occurs in the region, ombrophylous forest, restinga forest (distinct type of coastal tropical and subtropical moist broadleaf forest), várzea (seasonal floodplain forest inundated by Whitewater Rivers), jundu (coastal vegetation that grows in non- flooded areas with bushland up to 1,5m) and an extensive mangrove ecosystem. The total protected area in Baleia-Sahy has 100,345 ha and is an important ecological corridor that runs from the seafront to the mountains, sheltering the important ecosystems and habitats. In Figure 53, the green and red area is the protected area (APA) of baleia-sahy community, where most of it is located in mangrove area with muddy and wet soils. The yellow line indicates the whole area which belongs to baleia-sahy with its catchment zone. The uninhabited island (las Islas) in front of the area attracts many tourists on holidays and on weekends.

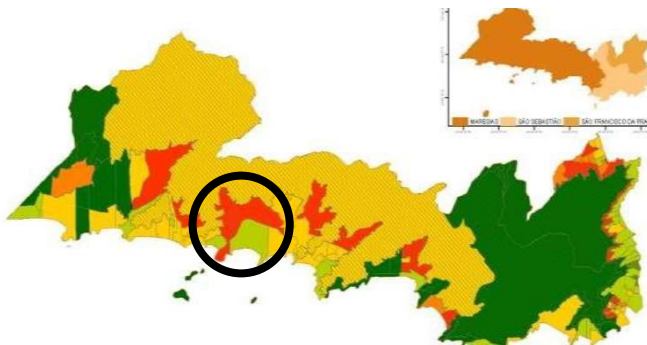


Figure52: areas of social-economic risk, (Gil, 2016)



Figure53: shows the river system+ protected areas ( Gil, 2016)

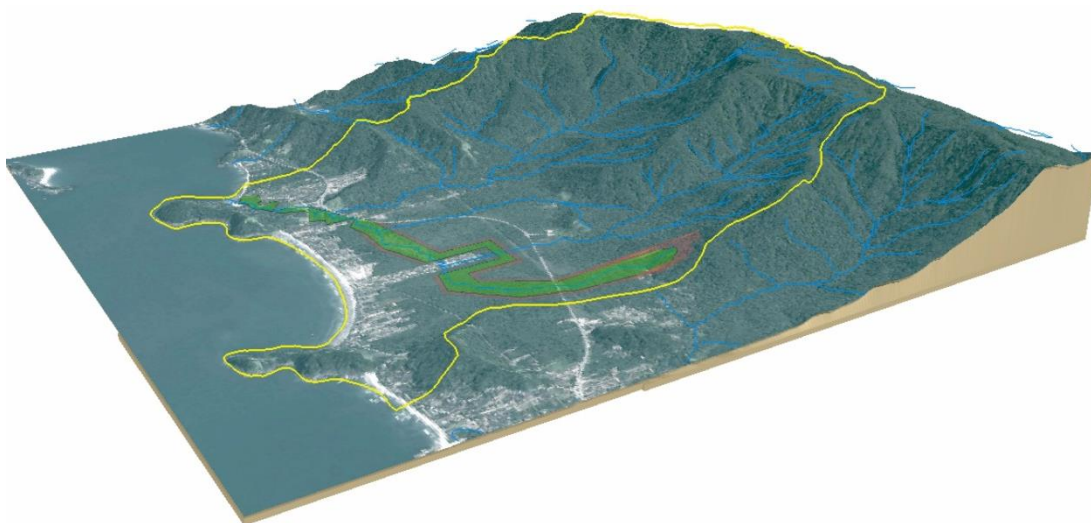


Figure54: topographic image of baleia-sahy area ( Gil, 2016).

### **Social-demographic**

Historically the area has undergone transformations when the highway Rio-Santos was built in the 80s, bringing tourists and as a result more construction workers. The local people living in this area for centuries were forced to move more land inwards as big investors bought the land at the seafront for developments of resorts and hotels. Moving more onto the slopes and hills which are often in geological risk areas, local and often poorer people are affected by landslides, flooding's and improper sewage and waste systems. Figure 37 shows the focus area of Baleia-sahy, with its river and creek system, as well as how steep the terrain becomes to the mountains. Approximately 20% of the constructed houses are built on protected areas, resulting in land subsidence and destruction of habitats and to more flooding's as waterways and flood areas are blocked

Baleia- Sahy community consist of approximately 800 families in 648 houses accounting to a total community population of about 3300 people. This officials numbers are very likely to be higher in reality as a lot of people are not registered at the town hall and many poor people live in buildings which are not official.

Only 2% of the local population comes originally from this area, the so called caiçara were mainly fisherman and lived from the natural ecosystems. The main population moved there because of job opportunities, adding to the problem of behaviour of waste as they are not emotionally connected to the area. Once they earned enough money most of them leave this area again. 79% of the workers are working in the labour market or tourist industry and the unemployment rate is around 20% in this area. The families living in this area have on average 5 to 6 people depending on one income. And 14% of the population has some kind of health treatment (diabetes, HIV, alcoholism) (Gil, 2016). Regarding the educational level of the resident population, the majority did not complete the Elementary school representing more than half of the population. The illiteracy rate is relatively high compared to the other areas in the municipality. Furthermore about 41% of the population does not use treated water and if treated it is done by chlorination or boiling (Gil, 2016). The difference of this protected area is that it is managed by an NGO (ICC) and not by governmental organizations as in other areas, allowing greater participation of the local community.

### Institute Verdescola

Located in between to the community of balea-sahy is the institute verdescola, an institute which promotes education, human and community development with socio-educational and socio-environmental activities. The institute is in partnership with local public schools and is offering full time schooling for kids with social disadvantages or from troubled families. Having more than 3.500m<sup>2</sup> of built area, the institute offers facilities for community development, coaching of students, training for young adults and adults (computer skills, languages).

The location and the already existing close cooperation with the local community makes the institute of verdescola a perfect location for a pilot project to implement the educational program to tackle plastic waste. Being related to the ICC the Greenhouse plastic education program fits within the pillar of environmental education which is one focus area of the institute Verdescola.



Figure 55: Location Verdescola and protected area of baleia-sahy , ( Gil, 2016)

## Appendix 5: stakeholder analysis

Developing an educational project to raise awareness about plastic litter focuses on changing the behaviour of people, therefore identifying and engaging stakeholders is from great importance for a successful program implementation.

**Primary stakeholders** are stakeholders that are directly affected by the realization of a project/program and should be kept informed and kept satisfied during every stage of the process. They also should have the opportunity to give feedback and information throughout the process. The most important primary stakeholder for developing an educational program for São Sebastião is the local community (local people), which is also the target group, as the whole project evolves around them. Amovila, which is a residents association is another primary stakeholder group representing the local inhabitants. Another primary stakeholder is the local school (Institute Verdescola) where the program will be implemented. Besides the target group (local inhabitants) and place of implementation (local school) the last primary stakeholders are related to funding and support of the program. National Banks (Itau), sea port in São Sebastião, CETESB (Environmental sanitation Technology Company of the state of São Paulo) and the UN Educational programs belong to the group of stakeholders who can fund or support the project.

**Secondary stakeholders** are those stakeholders that are indirectly affected by the realization of the project. It is from importance to give secondary stakeholders the chance to gain information about the realization of the project, but it is not necessary to actively inform them in every step of the process. Secondary stakeholders in the Sao Sebastião project are tourists as they benefit from a cleaner and more aesthetic environment. Local businesses (hotels, restaurants, shops) as a cleaner area attracts more customers to them as well as being able to give materials for the implementation. Local indigenous people mainly depend on ecosystems services for their income and food production, by having less trash in the mangroves more fish and shrimps will be there for them to catch. Waste pickers as they could be incorporated into gathering plastic products which could be recycled as well as they are part of the system. Waste collection Association (ABRELPE), which are struggling to collect all the waste especially in high season times. The coastal conservation institute (ICC), as this program would support their pillar of environmental education. Also organizations which could use the produced vegetables in the community organic garden for example Institute cappim santo- where poor people get educated in gastronomy and organic cooking.

**Key players** are those stakeholders focusing on legal aspects involving governance, laws and legislations and they can be critical as they can make a project successful or failure. Actors in this group are the National government as well as the Ministry of education (secretaria da Educacao) and the Municipality of Sao Sebastião.

To further visualize the stake of each stakeholder a power/interest matrix was developed. A power/interest matrix is a tool that helps to visualize and categorize stakeholders in a project, it helps to identify key stakeholders and narrow down the target group as well as developing a plan on how to engage with all involved actors.

## Appendix 6: Summary of all activities

### Educational program to reduce plastic pollution

#### ACTIVITIES

1. Introduction to the Greenhouse educational concept
2. My home recycling bin: Importance of Reusing non-organic - incentive collect bottles for the Greenhouse+ Introduce the concept of 3 R's and composting
3. Beach clean up to visualize how much trash and plastic is in the environment + collection of materials for the greenhouse
4. Composting: A way of recycling organic waste + reuse 20l water gallons to make a compost
5. Landfills and plastic degradation: importance of reducing and recycling of non-organic waste.
6. Soil textures and plastic pollution for gardening: percolating water and ground water supply
7. Plastic impacts on flora and fauna (entanglement and ingestion game)
8. Organic gardening as a way of reducing pollution+ germinating of seeds
9. Replanting food: reducing and reusing organic waste+ mixing cultures
10. Upcycled mother's day gift
11. Setting up the greenhouse
12. Planting of the plants in the greenhouse+ solutions to world problems

#### 1. Activity: Introduction to the Greenhouse educational program

##### OBJECTIVE

- Make the students or target group familiar with the whole educational program
- Explanation on what to expect from the program
- Introduce the problem of global marine and coastal plastic pollution

##### PREPARING ACTIVITY

- Make a plan for construction of the greenhouse
- Select target group, in this case pupils age from 8-10
- Select group size: 30 children
- Start collecting materials

##### SUMMARY OF ACTIVITY

The first activity is the introduction to the whole Greenhouse educational program, the students get an introduction why it is an important topic to tackle and why immediate action is required, as well as what to expect in the next three months. Furthermore through an easy question and answer round the knowledge of the participants will be examined to see what their level of knowledge is on the topic. Also setting up bottle collection station next to the school, where everybody from the community can put their bottles.

To finish the introduction activity students were asked to write down how much and what types of trash they can find on their way home from school.



## 2. Activity: My home recycling bin: Importance of Reusing non-organic + Introduce the concept of 3 R's and composting

### OBJECTIVE

- This activity is used to teach the concept of reusing materials (plastic, paper, glass..)
- Important for gathering PET bottles
- Introduce the concept of Reduce, Reuse, Recycle and composting. Make them familiar with the terms and explain what is the difference.
- Concept of waste Hierarchy

### PREPARING ACTIVITY

- Old paper cartoons which can be used to prepare homemade recycling bins for the students
- Newspapers, magazines to cut out pictures which can be glued at the recycling bin to show what goes in and what doesn't.

### SUMMARY OF ACTIVITY

The activity started with a small theoretical part about the concept of Reduce, Reuse, Recycle and composting. The reused old paper cartoons are then used to make homemade recycling bins for each student to collect PET bottles at home which are then used for the Greenhouse in total 1000 to 1500 bottles are needed.



3. **Activity:** Beach clean up to visualize how much trash and plastic is in the environment + collection of materials for the greenhouse

OBJECTIVE
<ul style="list-style-type: none"><li>→ To show the students how much plastic trash there is in the natural environment</li><li>→ Cleaning up the area</li><li>→ Gather materials for the program (PET bottles...)</li></ul>
PREPARING ACTIVITY
<ul style="list-style-type: none"><li>→ To prepare a beach clean up the area which has to be cleaned is established: in this case the focus was on beach and mangrove area</li><li>→ Two or three different colours of plastic bags</li></ul>
SUMMARY OF ACTIVITY
<p>The beach and mangrove clean-up was established to actually clean up the area and to gather materials for the educational program and for the PET Greenhouse. The group was divided into three smaller teams, each team had one hour to collect as much trash as they could find. After the hour was finished each team had to count their items found and separate them in plastic, aluminium, paper, glass.... After that each team calculated how long their items would have been in the environment, for example a PET single used bottle takes up to 450 years. So if they found 10 PET bottles their total years would add up to 4500 years. In the end the team with the most collected years wins.</p>



#### 4. Activity: Composting: A way of recycling organic waste + reuse 20l water gallons to make a compost

##### OBJECTIVE

- The main objective of this activity is to introduce the theme of composting and teach the students by doing it. Approaching in two ways the topic of composting should have theory on recycling of organic waste and the application step on constructing and maintaining a compost bin that will feed their organic garden.
- This activity should already refer to the plastic waste aiming on the employment of such kind of waste on organic gardening. This should provide the students a different view on the reuse and recycling of plastic waste.

##### PREPARING ACTIVITY

- Three weeks before activity start to prepare some compost at home to be showed as final product to the kids on activity day.
- 2x gallons of 20L of water;
- 1x potato sack (filter);
- 1m of rope;
- Small tools for digging;
- Organic compost (fruit and vegetable remnants);
- Dry leaves;
- 2L of water;
- 2x cardboards (1x poster, 1x drawings)



##### SUMMARY OF ACTIVITY

The composting activity, to be understood and appreciated by the target public, was divided into two parts aiming on transmitting knowledge throughout interactive methodology (theory and game).

→ Part 1: Theoretical. Assembly of composting poster for greenhouse. These poster should contain information of the kind of food that may or may not go to compost bin.



→ Part 2: Practical. Build up the compost bin with two 20L water gallons.



Fertilize the soil with pre-done compost and plant some trees in the garden. The planted trees are also part of the design of final



organic garden as natural shade for the seedlings.

##### 5. Activity: Landfills and plastic degradation: importance of reducing and recycling of non-organic waste.

###### OBJECTIVE

- The activity of the week of Landfill theme has as main goal to make students aware of the time of degradation of each type of waste kind and consequently how long they remain polluting and damaging nature. The most common household wastes were identified and divided among the five main classes (Plastic, Metal, Glass, Paper and Organic) to analyse the respective degradation times. Greater focus was given to plastic waste as these present greater threat to the coastal ecosystems representing more than 70% of the residues found in this region.
- Thus at the end of the week the students should be able to distinguish and classify the types of domestic waste in order to destine them to the right places be these recycling or direct reuse.

###### PREPARING ACTIVITY

- 1x cardboard to make posted to the exposed in the garden;
- 20x solid household CLEAN waste. Among plastic, metal, glass, paper and wood. (Ex: Yogurt cup, Ice cream stick, wafer pack, etc.)
- 20x cards with periods of degradation of the selected waste in nature;
- Adhesive tape;
- 5x gallon of water of 5L;
- Aluminum foil or any material to coat the sides of the gallon preventing light from entering its sides, leaving only the upper part in contact with natural light;

###### SUMMARY OF ACTIVITY

Part 1: Degradation poster: Theory.

GOAL: Familiarize the group with the high numbers of years for degradation of solid waste in nature.

We only worked with non-organic waste, however, since organic recycling was a topic from the previous week (composting). In addition, this activity will have as physical product a table of materials and their respective periods of degradation to be exposed in the Sahy Community Garden.

The activity was passed in game form, dividing the class into two large groups. For each group, a table was given with 10 recyclable solid waste and 10 cards with different degradation periods. The proposal was that they discuss among themselves where each card fits to their respective material.



## Part 2: Mini landfill: Practical

**GOAL:** Observe the response to the middle of each of the household waste components. However, the conclusion of such an activity should be drawn around organic waste and paper, showing that these two types have extremely faster degradation time than the other 3 types. This activity demonstrates the immutability of plastic and glass and therefore the extreme need to deal better with the disposal of such waste this practice the class was divided into 5 groups and each group was assigned a type of residue; Plastic, Metal, Glass, Paper and Organic. A 5L gallon per group was also distributed with the aim of simulating the conditions that the residues are subjected to in a sanitary landfill. So it was necessary to cover up the sides of the gallops with something that would prevent sunlight from penetrating the sides.

The week Landfill was intended to introduce the students to the topic of non-organic solid waste degradation, presenting them with a visual example representing this differential response of each material to the middle of the dumps. This task was completed successfully, because not only were the activities carried out but the students reacted to the task with comments and new ideas for reusing plastic waste mainly as the tips of the plastic bottles. For example one student had the idea of making the support of fingers for the mobile phone with lids of PET bottles.





## 6. Activity: Soil textures and plastic pollution for gardening: percolating water and ground water supply

### OBJECTIVE

- Learn about different soil types
- How plastic can block the water flowing through the soil
- Water retention and percolation
- Easy DIY water filter

### PREPARING ACTIVITY

DIY water filter:

- 2x 2liter water PET bottles
- 1x Coffee filter
- Charcoal
- Sand
- Gravel
- Different sizes of rocks



### SUMMARY OF ACTIVITY

1<sup>st</sup> part of the activity was to make a easy water filtration system, to show how water travels through soil as well as how important clean water is. The filters were made by cutting open two 2liter PET bottles and closing one end with the coffee filter. After it is closed first charcoal will be put into it, then sand, gravel and smaller rocks and on the top the biggest rocks will be placed. After that mix some dirt into water and pour the dirty water through the filter. Measure how fast it goes and compare the colour of the water afterwards. To show how plastic influences the water flow through soil, plastic parts can be placed in the filter and the time will be stopped again. The filter with the plastic inside will flow way slower than the ones without. 2<sup>nd</sup> part of the activity involved the same topic the water flow through the soil and how plastic can block it. This was visualized by involving the students in a game. The students were grouped in different soil particles, clay, sand and mud and another group was the water. The first round the water children (particles) had to try to move through the different soils.



Clay pupils were sitting at the floor with less space between them, and sand and mud were crouching with little more space between. In the second round another group of children were placed in between and acted as plastic particles which were not be able to move and were sitting very close to



each other. Now the water particles had a harder time to pass the other kids.

## 7. Activity: Plastic impacts on flora and fauna (entanglement and ingestion game)

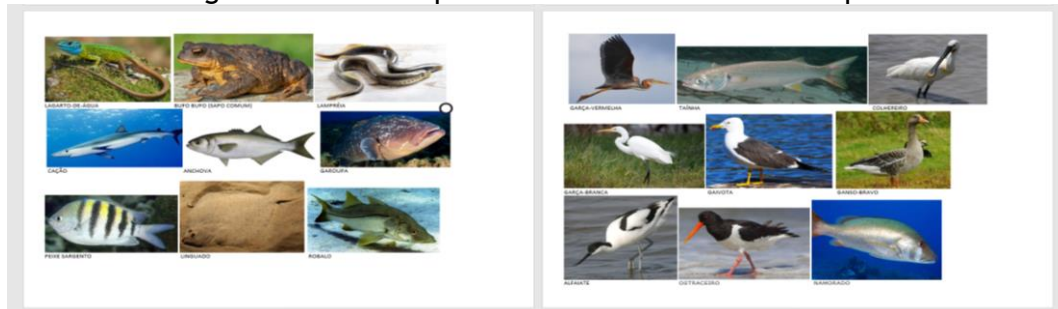
### OBJECTIVE

- Objective of this week's activity is to raise awareness about the damage that inorganic waste improperly discarded in nature causes to the fauna of the coastal regions. This activity is directly related to the topic discussed in the previous week about the time of degradation of domestic waste, dealing with the damage that inorganic waste causes to the local flora when incorrectly discarded in nature. Together with the activity performed in the form of a game, the children took home a task to do such reflection.

### PREPARING ACTIVITY

#### First part:

- 30x elastic to put in the hand. Animal simulation stuck in the trash.
- Print 30 animals of the local fauna of the coastal region of São Sebastião. One animal per pupil, so that they feel closer to them, °Our Neighbors.
- Show pictures of entangled animals and pictures of birds which died of plastic in the stomach



#### Second part:

- Two cardboards or crepe tape on the floor or any other way to demarcate two regions for feeding the animals.



- A package of M&M (or any small food eg. seeds).
- Plastic pieces in the same M & Ms tanham.
- A white tape to cover small plastic pieces and M&Ms. The idea behind the coating is to make it impossible for children to identify the difference.

### SUMMARY OF ACTIVITY

**First part:** In the Skin of Animals

To simulate the despair and struggle of animals accidentally trapped in the solid inorganic wastes, the students each received an elastic to be placed in the hand, attaching the thumb and thumb. The game begins by dividing students into groups of approximately 5 people. So taking advantage of the distribution of the students in the classroom, with 6 per table and one table at a time they should go to the front of the room and for 30 seconds strive to release the hand of the elastic. However, some rules must be followed in order to bring the simulation to the maximum of reality, such as not using the other hand for assistance in the removal of the elastic band, nor any other part of the body (eg. mouth)



**Second part: Game I ran from what I saw, I took what I did not see**

The objective of this game is to collect the largest amount of food, exposed on the boards on the floor, in the stipulated time of 1 min and 30 seconds (the time must depend on the number of students per group). The small pieces of food, among them M & Ms and plastics, should be deposited on the cartolines. Once the groups are separated one on each side, the game begins in the form of competition, and each student must run to the cardboard of his group, collect only a small piece of food and rush back to make room for the next.

The round ends when everyone in the group has fed once and at first this group is given as the winner. However, this status is in doubt when we reveal that everything was not food. So we opened the envelopes and counted the amount of plastic and food that each group collected. The winning group was the one who collected less plastic and could survive on that day. The groups 1 and 2 respectively collected 7 and 9 plastic pieces, thus group 1 the survivors of the day.



The second round counts on the knowledge of the students in the content of the food exposed in the cardboard, but still in the same exercise of competition they had to run and make a quick choice to win. This time however one of the fathoms must remain behind the back and the elastic of the first activity turns the hands to identify the disability of the animal that feeds on plastic, so everyone became ill. The final result of the second round of the activity counts with a smaller number of pieces of food collected in general, but smaller was also the amount of plastic collected, being that group 1 collected 5 and group 2 only 3 pieces. This result directly demonstrates the care the children had in choosing their food better. Rushing to choose the best group 2 did not collect enough of feed and did not survive. Group 1 in turn who collected more food but more plastic also did not survive by having too much plastic food.



This game reproduces faithfully the current situation of the reality of competition in the marine environment for food, where being fast does not mean surviving anymore. By instinct the marine animals in search of food feed on small pieces of plastic and die of hunger, in the nursery competing children do not have time to identify what they are choosing as food and end up also feeding on plastic and this has consequences for their health

## 8. Activity: Organic gardening as a way of reducing pollution+ germinating of seeds

### OBJECTIVE

- Students learn how to germinate seeds with and without soil
- What plants need to start germinating
- What are the differences between organic farming and regular ones

### PREPARING ACTIVITY

- For this activity the cut end of the PET bottles used for the greenhouse can be used again for germinating of seeds, each pupil get one
- Different plastic or other materials to personalize the germinating pot

### SUMMARY OF ACTIVITY

This activity combines recycling of plastic with organic gardening. The goal of this activity was to show the pupils how to germinate seeds. First of all each student received one cut bottom part of bottle to take home to germinate different kind of seeds. Different items are used to make it look nicer for example wooden ice cream sticks or colourful plastics can be used. After the pupils make their own germinating pot they receive seeds, now planting several seeds inside paper and wet it with water. The pupils take their individual germinating pot home and note daily how it changed. After 7 days they bring back their germinated plants and compare their



diaries.



## 9. Activity: Replanting food: reducing and reusing organic waste + greenhouse

### OBJECTIVE

- Learn how to reduce and reuse organic waste
- Learn what fruits and vegetables can be regrown by itself

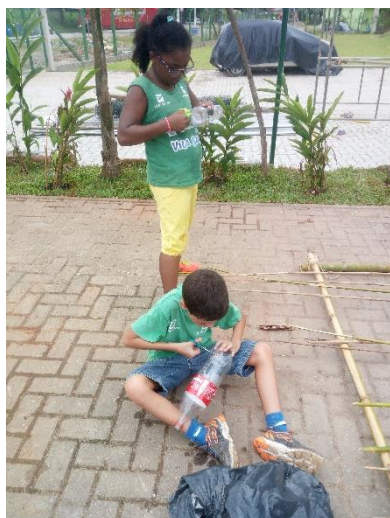
### PREPARING ACTIVITY

- Choose different types of vegetable which can regrow: for example potato, carrots, onion, ginger, garlic....

### SUMMARY OF ACTIVITY

This activity was used to show how to reduce and reuse organic waste, several different vegetables were chosen for example carrots and potatoes and cut in half. Students were divided into groups and each group received a different vegetable, some had to be planted directly into the soil while other like carrots can stay in water for a few days to start sprouting again. The second part of the activity was used to work on the Greenhouse and putting together the walls.





## 10. Activity: Upcycled mother's day gift

### OBJECTIVE

- Demonstrate how easy and cheap plastic can be upcycled to make something new

### PREPARING ACTIVITY

- Plastic lids, PET bottoms
- Paper or cartoon
- Other plastic items which can be used to design a mother's day card

### SUMMARY OF ACTIVITY

This activity was prepared before mother's day and to show how easy the children can do upcycling methods. The activity resulted in a mothers' day card which each student made individually for their mother. The only items used were either found in trash or in the surroundings as well as natural products like bamboo. Each kid was also asked to bring some things they think could be used for easy upcycling methods.



## 11. Activity: setting up the greenhouse

### OBJECTIVE

→ Finish the greenhouse

### PREPARING ACTIVITY

→ Cable ties, rope, knife, scissors, bamboo sticks, tape ....

### SUMMARY OF ACTIVITY

This activity was used to finish up the recycled greenhouse



12. Activity: Planting of the plants in the greenhouse+ solutions to world problems

**OBJECTIVE**

→ Close the cycle of plastic and organic gardening

**PREPARING ACTIVITY**

→ Bring all germinated plants

→ Soil, shovels, gloves, water, compost

**SUMMARY OF ACTIVITY**

The last and final activity was used to close the cycle of plastic waste and organic food production. For this last activity the germinated seeds will be plant into the Greenhouse. Each student could bring their germinated plants which the prepared at home to the Greenhouse to plant it, the greenhouse will be then used for the seedling of the plans and if they are strong enough the can be replanted next to the greenhouse in the organic garden.

Solutions to the world game was the last game carried out. The students were presented actual and relevant problems and had to come up with own ideas. The first problem was the actual one they had in brazil where the truck drivers went on a strike and the supermarkets and trash trucks didn't come anymore. Some students answered that they would grow their food and make other things out of their trash, so basically what they learned in the program. Another question was about water scarcity and one student answer he would build a water filter like in the program where you could filter the salt out of the water and use for drinking.



Appendix 7: Questionnaire - the questions regarding the questionnaire were established by the student itself with the input of the literature and on the basis of area and socio-demographic analysis.

1. What is your gender?

- ☐ Male
- ☐ Female

2. How old are you?

- ☐ 10-20
- ☐ 20-30
- ☐ 30-40
- ☐ 40-60
- ☐ Above 60

3. Are you currently employed?

- ☐ Full time
- ☐ Part time
- ☐ Not at the moment

4. How would you describe the physical environment of your community regarding trash and litter?

- ☐ Poor
- ☐ Below average
- ☐ Average
- ☐ Good
- ☐ Excellent

5. What is in your opinion the prevailing materials which can be found in your area?

- ☐ Metal
- ☐ Plastic
- ☐ Glass
- ☐ Paper
- ☐ Wood
- ☐ Organic trash
- ☐ Others, \_\_\_\_\_

6. In your opinion where can you find most of the trash?

Please indicate on a scale from 1 (no trash) to 5 (big amount of trash)

	none				Large amount
In the city	1	2	3	4	5
At the beach	1	2	3	4	5
Along roads	1	2	3	4	5
Rivers/mangroves	1	2	3	4	5
In the ocean	1	2	3	4	5

7. Do you think plastic trash is a problem for São Sebastião?

- ☐ Yes
- ☐ No
- ☐ Maybe

8. In your opinion, what do you think is the biggest threat plastic trash has on your area and community?

- ☐ Marine environment (animals, habitat destruction)
- ☐ Human health (mosquitos, chemical contamination)
- ☐ Flooding (blockage of waterways)
- ☐ Aesthetic aspects
- ☐ Economic aspects

9. Have you experienced any negative impacts yourself and if so please describe them?

- ☐ Yes \_\_\_\_\_  
\_\_\_\_\_
- ☐ No

10. Where do you think most trash in the marine environment come from?

- ☐ Direct release onto the coast (beach-users, tourists)
- ☐ Direct release in the sea (fishing vessels, industries)
- ☐ Through waterways (rivers)
- ☐ Litter leaked from landfills

☐ Intensive rain flooding's

11. Some people think marine and coastal pollution is an important issue, do you think it is important subject to tackle and immediate action is needed?

- ☐ Strongly agree
- ☐ Partly agree
- ☐ No position
- ☐ Partly disagree
- ☐ Strongly disagree

12. Who do you think is responsible for reducing marine and coastal trash?

- ☐ Government
- ☐ Industries producing plastic products
- ☐ Local residents
- ☐ General public
- ☐ Organizations that collect waste (recycling companies, landfill operators)

13. What actions do you think are best to reduce marine and coastal litter?

- ☐ Educating people
- ☐ Community beach and river clean ups
- ☐ Ban plastic products
- ☐ Recycling of plastic products
- ☐ There is nothing we can do about it

14. Are you familiar with the concept of Reduce, Re-use and Recycle?

- ☐ If yes, where did you hear about it \_\_\_\_\_  
\_\_\_\_\_
- ☐ No

15. If you are familiar with the concept do you apply them in your daily life?

- ☐ Often
- ☐ Sometimes
- ☐ Rarely
- ☐ Never

16. Do you think strengthening the community can help to tackle trash problems?

- ☐ Yes
- ☐ No

17. Are you participating in any school or community organization?

- ☐ Yes, which ones?

---

---

- ☐ No

18. If your answer is No would you be interested in participating in a community project?

- ☐ Yes
- ☐ Maybe
- ☐ No

19. If yes what activities would interest you the most?

- ☐ Recycling and upcycling of plastic trash (Art, Greenhouse)
- ☐ Clean up events
- ☐ Community organic garden
- ☐ Techniques for organic food production at home
- ☐ Others, \_\_\_\_\_

20. Do you have a garden at home?


- ☐ Yes
- ☐ No

21. Would you be interested in learning about organic gardening techniques to reproduce at home?

- ☐ Yes
- ☐ Maybe
- ☐ No

## Appendix 8: example of translated questionnaire to Portuguese


2

 INSTITUTO  
CONSERVAÇÃO  
COSTEIRA

**Questionário sobre poluição no Sahy**

Este questionário foi desenvolvido pelos pesquisadores do Instituto de Conservação Costeira em parceria com o Verdescola para avaliar a satisfação dos moradores da comunidade do Sahy quanto a sustentabilidade da comunidade e possíveis melhorias. Assim este questionário oferece ao morador uma chance de expor sua opinião sobre problemas ambientais enfrentados pela comunidade tais como, poluição nas praias e alagamentos e especialmente sobre o interesse dos moradores em melhorias tais como, cursos de jardinagem orgânica e reutilização de materiais para venda de artesanato reciclável.

- Sexo?
  - ☐ Masculino
  - ☒ Feminino
- Sua idade?
  - ☐ 10-20 anos
  - ☒ 20-30 anos
  - ☐ 30-40 anos
  - ☐ 40-60 anos
  - ☐ + 60 anos
- Emprego no momento?
  - ☒ Sim, integral
  - ☐ Sim, meio período
  - ☐ Não
- Como você descreveria a limpeza das ruas da Vila e Barra no Sahy em relação a quantidade de lixo nas ruas?
  - ☐ Muito ruim
  - ☐ Ruim
  - ☒ Boa
  - ☐ Excelente
- Na sua opinião qual o tipo de material MAIS encontrado nas ruas ao redor da sua casa?
  - ☐ Metal
  - ☒ Plástico
  - ☐ Vidro
  - ☐ Papel
  - ☐ Madeira
  - ☐ Lixo orgânico
  - ☐ Outros, \_\_\_\_\_
- Onde você acredita que a poluição do lixo está pior? (Por favor, indique abaixo em uma escala de 1 para sem lixo a 5 para muito poluído)

 INSTITUTO  
CONSERVAÇÃO  
COSTEIRA

Nada 1 2 3 4 5 Muito Lixo

Na Vila 1 2 3 4 5

Na Barra 1 2 3 4 5


Na praia 1 2 3 4 5

Nas estradas 1 2 3 4 5

Nos rios e mangues 1 2 3 4 5


No mar 1 2 3 4 5

- Você acha que a poluição plástica é um problema no Sahy?
  - ☒ Com certeza
  - ☐ Acho que sim
  - ☐ Não
  - ☐ Não sei
- Na sua opinião qual é a maior ameaça ambiental causada pelos resíduos plásticos ao bem estar e futuro da comunidade do Sahy? (Assinale mais de uma opção se achar necessário)
  - ☒ À vida marinha
  - ☒ À saúde dos moradores (aumento de mosquitos e contaminação química da água)
  - ☒ Enchentes
  - ☐ Aspectos estéticos da paisagem perdidos
  - ☐ Ao desenvolvimento econômico da região.
- Você ou algum membro de sua família já foi prejudicado por algum destes impactos negativos no meio ambiente do Sahy?
  - ☐ Sim, \_\_\_\_\_
  - ☒ Não
- De onde você acha que este lixo marinho está vindo?
  - ☒ Dos usuários da praia, turistas e barcos de pesca (descarte direto na costa)
  - ☐ Das indústrias costeiras (descarte direto no oceano)
  - ☐ Dos rios e afluentes.
  - ☒ Do vazamentos dos aterros sanitários
  - ☒ Das frequentes enchentes enfrentadas pela comunidade.
- Algumas pessoas acreditam que a poluição marinha e das regiões costeiras é um dos maiores problemas ambientais a serem enfrentados na atualidade para garantir um futuro seguro as comunidades costeiras e vida nos oceanos. O quanto você compartilha da opinião acima, principalmente sobre a necessidade de ação imediata para garantir segurança a comunidade?
  - ☐ Sim, quais? \_\_\_\_\_
  - ☒ Não, mas tenho vontade.

 INSTITUTO  
CONSERVAÇÃO  
COSTEIRA

- ☐ Concordo em parte
- ☐ Nunca pensei nisso
- ☐ Discordo em parte
- ☐ Discordo completamente

- Quem você acha que é responsável pela redução desse lixo nas costas e oceanos? (Assinale mais de uma opção se necessário)
  - ☐ Governo
  - ☐ Indústrias produtoras de produtos em embalagens plásticas
  - ☒ Moradores e turistas
  - ☐ Cíveis no geral
  - ☐ Organizações de coleta de lixo.
- Quais das ações abaixo na sua opinião são as melhores para reduzir lixo nas regiões costeiras?
  - ☒ Educação ambiental e cívica
  - ☒ Mutirões de limpeza das praias e mangues
  - ☐ Proibição de produtos e embalagens plásticas.
  - ☒ Reciclagem
  - ☐ Leis de incentivo a empresas verdes e punição a empresas poluidoras
  - ☐ Não há nada que pode ser feito
- Você já ouviu sobre os três R's (Reduzir, Reciclar e Reutilizar)?
  - ☒ Se sim, onde você ouviu sobre? na Verdescola
  - ☐ Não
- Se você já estava familiarizado com o conceito, você os aplica no seu dia-a-dia?
  - ☒ Sempre
  - ☐ Às vezes
  - ☐ Quando eu lembro, mas nem sempre
  - ☐ Raramente
  - ☐ Nunca
- Você acredita que educando mais a população local ajudará a resolver o problema do lixo na natureza?
  - ☒ Com certeza
  - ☐ Pode ser que sim, pode ser que não
  - ☐ Não
- Você faz parte de alguma organização, escola ou grupo de moradores com projetos para melhoria da comunidade?

 INSTITUTO  
CONSERVAÇÃO  
COSTEIRA

- ☐ Sim, quais? \_\_\_\_\_
- ☒ Não, mas tenho vontade.

- Se você respondeu não na pergunta anterior, você estaria interessado em participar de projetos para benefício da comunidade?
  - ☒ Sim
  - ☐ Não
- Você teria interesse em algumas das atividades abaixo para serem oferecidas à comunidade Sahy em formato de cursos e workshops?
  - ☒ Métodos para reciclagem e reuso de reciclados para aumento da renda doméstica (fabricação de artesanato de matéria reciclável)
  - ☒ Mutirões de limpeza (Na vila, na praia, no mangue...)
  - ☒ Jardim orgânico comunitário
  - ☐ Técnicas para alimentos orgânica em casa
  - ☐ Outras ideias para cursos e projetos comunitários, \_\_\_\_\_
- Você tem jardim em casa?
  - ☒ Yes
  - ☐ No
- Você teria interesse em aprender a produzir seu próprio alimento de forma orgânica?
  - ☒ Sim, tenho muito interesse
  - ☐ Se tiver eu participo
  - ☐ Nunca ouvi falar de jardinagem orgânica
  - ☐ Não tenho interesse

**Espaço para nota final (se quiser)**

Espero que todos estejam unidos com a Verdescola para começar a organizar trabalhos voluntários e cursos para a comunidade. Com bons trabalhos de voluntários para disponibilizar para todos. Um grande obrigado, boa sorte!

Muito obrigado pela participação, a sua opinião é extremamente importante para nós!

## Appendix 9: Answers to the questionnaire shown in Excel table

[illegible]

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	
28	Q6: Where can you find most of the trash?	city	1	x																	x															
29			2																																	
30			3																																	
31			4			x				x	x			x			x					x											x			
32			5			x		x		x	x	x		x	x		x				x											x	x		x	
33		bay	1	x	x											x					x	x											x			
34			2																																	
35			3																																	
36			4																																	
37			5			x				x	x	x			x						x													x	x	
38		beach	1																																	
39			2																																	
40			3																																	
41			4																																	
42			5																																	
43		roads	1																																	
44			2																																	
45			3																																	
46			4																																	
47			5			x																														
48		rivers/mangroves	1																																	
49			2																																	
50			3			x																														
51			4			x	x			x	x																									
52			5							x																										
53		rivers/mangroves	1																																	
54			2																																	
55			3				x																													
56			4					x	x	x	x	x																								
57			5																																	
58		ocean	1																																	
59			2																																	
60			3				x																													
61			4																																	
62			5																																	
63																																				
64																																				
65	Q7: Do you think plastic is a problem for Sao Sebastiao?	yes certainly		x	x																															
66		I think so						x	x	x	x		x																							
67		no																																		
68		I dont know																																		
69																																				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI		
70	Q8: What is the biggest threat plastic has on the area ?	marine environment		x	x	x	x								x					x	x	x	x														
71		human health		x	x	x				x	x	x	x	x	x	x	x	x	x								x	x		x	x	x	x	x	x		
72		flooding		x	x			x	x	x			x	x	x	x	x			x	x								x	x	x	x	x	x			
73		aesthetic aspect													x		x																			x	
74		economic impacts													x		x															x					
75																																					
76	Q9: Did you or your family experience an negative impacts of plastic?	yes															x											x	x							x	
77		no		x	x	x	x	x		x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x			x			x	x	x		
78																																					
79	Q10: Where do you think most trash in the marine environment come from?	direct release (beach users)		x	x	x		x	x	x	x	x	x		x	x	x			x	x	x					x	x					x	x	x		
80		coastal industries									x																										
81		rivers													x																						
82		landfills		x																	x																
83		rain floods		x										x	x	x				x	x									x	x	x				x	
84																																					
85	Q11: important issue to tacke (marine and coastal pollution)?	strongly agree		x	x	x	x	x	x	x		x							x	x	x	x	x	x	x	x	x		x						x	x	
86		partly agree										x			x	x				x									x				x	x			
87		no position															x																				
88		partly disagree																																		x	
89		strongly disagree																																			
90																																					
91	Q12: Who do you think is responsible for reducing marine trash?	government														x	x																		x	x	
92		industries producing plastic																																		x	
93		residents and tourists															x	x	x	x	x	x	x				x	x	x		x	x		x	x	x	
94		general public																																			
95		waste collection organizations															x		x																	x	
96																																					
97	Q13: What actions do you think can reduce marine and coastal trash?	educating people		x	x	x	x								x	x	x	x	x	x	x	x	x							x	x	x	x	x			
98		beach clean ups		x											x	x	x	x																	x		
99		ban plastic products																			x																
100		recycling		x	x		x								x	x	x	x	x	x	x	x															
101		encourage green companies																																			
102		there is nothing we can do																			x															x	
103																																					
104	Q14: Are you familiar with the concept of 3Rs?	yes		x	x	x		x							x	x	x	x	x	x	x	x							x	x	x	x	x			x	
105		No																																			
106																																					
107	Q15: If familiar do you apply in your daily life?	always		x	x			x							x	x	x	x	x	x	x								x	x	x	x				x	
108		sometimes																																			
109		when i remember																																			
110		rarely																																			
111		never																																			
112																																					

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	
113 Q16: Do you think educating public helps to tackle trash problem?	yes certainly				x	x	x		x		x	x	x	x	x	x		x	x	x	x	x		x		x	x		x	x	x		x	x	
114	maybe																																		
115	I dont think so																																		
116																																			
117 Q17: Do you participate in any school or community organization?	Yes																																		
118	No																																		
119																																			
120 Q18: If no, would you be interested in a community project?	yes																																		
121	No																																		
122																																			
123 Q19: If yes what activiteis would interest you the most?	methods for recycling to increase income																																		
124	cleaning efforts																																		
125	community garden																																		
126	techniques for organic production home																																		
127	others																																		
128																																			
129 Q20: Do you have a garden in your home?	Yes																																		
130	No																																		
131																																			
132 Q21: Are you interested in learning about organic gardening?	yes I am very interested																																		
133	I would participate																																		
134	never heard of organic gardening																																		
135	Not interested																																		