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Analysis of the correlation between the tourism industry and municipal solid waste (MSW) on small islands with a case study of Corsica, France

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Author's declaration

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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ABSTRACT OF THESIS submitted by: Vanya ILIEVA for the degree of Master of Science and entitled: **Analysis of the correlation between the tourism industry and municipal solid waste (MSW) on small islands with a case study of Corsica, France.**

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The tourism industry has been one of the most rapidly growing industries in recent years, with leading destinations islands and coastal regions. Today, the evolution of global tourism and the impacts created by its development are a topical issue. One of the negative impacts discussed in this thesis is the generation of waste. Municipal solid waste is a world-wide problem and its management is a burning dilemma for many societies. For small islands this is a major problem due to the limited options for waste treatment and the large number of tourists' arrivals, which leads to higher waste generation. The aim of this study is to show the relationship between tourism and waste in small islands and especially in the island of Corsica. Corsica is the least densely populated of all islands in the Mediterranean and is also the island with the least polluted environment and still not reached carrying capacity. However, the population significantly increases during the summer with about 2 million tourist arrivals, a figure which is expected to double within the next 30 years. Therefore, the least actions for managing the increasing amount of MSW while keeping the tourism industry growing and at the same time preserving the environment and natural resources are needed. The Syndicate for the Recovery of Household Waste in Corsica (Syvadec) is trying to develop long-term, integrated waste management plans for waste treatment options such as waste reduction at source, reuse and recycle, waste-to-energy recovery and composting in order to arrive at the best possible mix of solutions.

Keywords: tourism development, impacts, MSW, islands, Corsica, 3Rs strategy, Syvadec

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List of Abbreviations

ACRR	Association of Cities and Regions for Recycling
ADEC	*Agence de Developpement Economique de la Corse* – Agency of the Economic Development of Corsica
ADEME	*Agence de l'Environnement et de la Maîtrise de l'Energie* – French Agency for Environment and Energy Control
ATC	*Agence du Tourisme de la Corse* – Agency of Tourism of Corsica
BAT	Best Available Technique
CJEC	Court of Justice of the European Communities
CTC	*Collectivite Territoriale de Corse* – Territorial Community of Corsica
DOCUP	*Document Unique de Programmation* – Unique Programming Document
EC	European Council
EPA	Environmental Protection Agency
EU	European Union
Europa EC	Europa European Commission
FCMGD	*Le Fonds Corse pour la Modernisation de la Gestion des Déchets* – The Fund of Corsica for Waste Modernization and Management
FEDER	*Fonds Européen de Developpement Régional* – European Funds for Regional Development
INSEE	*Institut national de la statistique et des études économiques* – French National Institute of Statistics and Economic Studies
MSW	Municipal Solid Waste
MSWLFs	Municipal Solid Waste Landfills
MSWM	Municipal Solid Waste Management
NGOs	Non-Governmental Organizations
NIMBY	Not In My Back Yard
OEC	*Office de l'Environnement de la Corse* – Office of the Environment of Corsica
OECD	Organization for Economic Co-operation and Development
OEHC	*Office Hydraulique de la Corse* – Hydraulic Office of Corsica
ORARC	*Office de Developpement Agricole et Rural de Corse* – Office of Agricultural and Rural Development of Corsica
OTC	*Office des Transports de la Corse* – Office of the Transport of Corsica

PIEDMA	*Plan Interdépartemental d'Elimination des Déchets Ménagers et Assimilés* – Interdepartmental Plan for the Elimination of Municipal Waste
PPP	Polluter Pays Principle
PREDIS	*Plan Régional d'Elimination des Déchets Industriels Spéciaux de Corse* – Regional Plan for the Elimination of Special Industrial Waste of Corsica
3 Rs	Reduce, Re-use, Recycling
SPREP	South Pacific Regional Environment Programme
SYVADEC	*Syndicat de Valorisation des Déchets Ménagers de Corse* – Syndicate for the Recovery of Household Waste in Corsica
TOC	Total Organic Carbon CO
UK	United Kingdom
UN	United Nations
US EPA	United States Environmental Protection Agency
USA	United States of America
VOCs	Volatile Organic Chemicals
WTO	World Tourism Organization
WWF	World Wildlife Fund

1 Motivation, aim and objectives of the present study

1.1 Introduction

The tourism industry has been one of the most rapidly growing industries in recent years within Europe, with leading destinations, especially the islands and coastal regions of the Mediterranean (Manera and Taberner 2006). Today, the evolution of global tourism and the problems created by its development as well as its economic, socio-cultural and environmental impacts are a topical issue (Nagle 1999).

One of the so called "fundamental truths" about tourism is that it consumes resources and **generates waste** (McKercher 1993). Usually, these resources are natural, human-made or cultural, and are often disturbed by the tourism industry, which is considered to be an insatiable consumer of all these resources (Mason 2003).

Municipal solid waste is a world-wide problem and its management is a burning dilemma for many societies (Chen *et al.* 2005; SPREP 1999). For small islands this is a major problem due to the limited options for waste management systems and the large number of tourists' arrivals, which leads to higher waste generation (Chen *et al.* 2005). Furthermore, inadequate management of waste disposal can affect people's health, damage the environment and interfere with an island's economic development.

Islands need to develop long-term, integrated waste management plans, which should include waste treatment options such as waste reduction at source, reuse and recycle, waste-to-energy recovery, composting, etc. in order to arrive at the best possible mix (WTE - ISLE 2002).

1.2 Motivation for the present study

While the tourism industry does constitute a main share of income for many islands' economies, it also brings a range of negative impacts (Priestley *et al.* 1996). As already mentioned MSW generation is a major impact from the development of tourism on islands and is constantly increasing over the years. According to WTE - ISLE (2002) waste management and related problems are challenges for many communities whether insular or not. However, islands have some specific and unique characteristics, which make the choice of waste treatment methods more difficult. Some of these characteristics are as follows:

- Municipalities of small islands have limited waste disposal options
- The land available for landfills is limited as well
- Due to islands' isolation from the mainland, self-sufficient solutions for insular waste management and energy supply are needed
- The increase in population due to seasonal fluctuations based on tourism affects waste management
- Due to the small size of the islands, usually there is no market for recycled materials and thus recovery and recycling are often impracticable

The choice of the most appropriate MSWM treatment methods depends largely on the characteristics of the island's area. According to White *et al.* (1999) no single MSWM system is optimal for all regions, where the area characteristics are decisive.

Corsica is a small French island situated in the Mediterranean Sea as shown in figures 1 and 2, with rich historical and cultural background, unique ecological and geographic characteristics, wonderful nature, great beaches and important marine and natural resources (Corsica 2009).

Figure 1 The island of Corsica (lonelyplanet 2009)

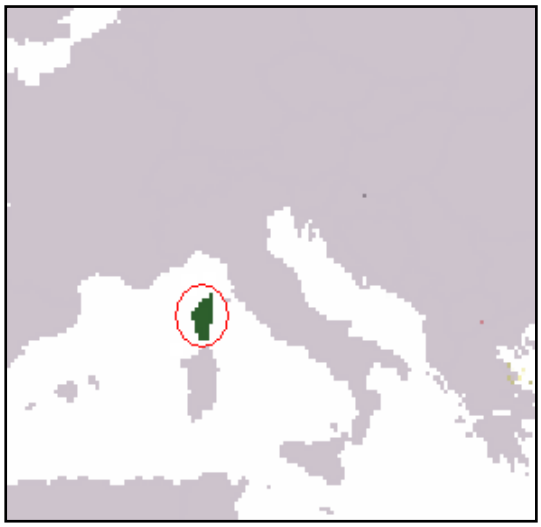

Figure 2 A view of Corsica (wikimedia 2009)

The area of the island is 8,682 km² with a population of 275, 000 people. The island is the least densely populated of all islands in the Mediterranean with 30 people per square kilometre and 60 people per square kilometre in regions situated on the sea coast (Corsica 2009). Estimates made by the French National Institute of Statistics and Economic Studies (*Institut national de la statistique et des études économiques* – INSEE) (2009) show that the population significantly increases during the summer with about 2 million tourist arrivals, a figure which is expected to double within the next 30 years. During the summer season, usually the months from April till September, the weather is wonderful and thus the hotel trade makes a lot of money with occupancy rates from 60% in April to 90% in August (Corsica 2009).

Considering that Corsica is the island with the least polluted environment in the Mediterranean (picture 1) and its carrying capacity has still not been reached (Corsica 2009; Manera and Taberner 2006), the least actions for managing the increasing amount of MSW (picture 2), while keeping the tourism industry growing and at the same time preserving the environment and natural resources, are needed.

Picture 1 The Beautiful Corsican Landscape (own-made)

Picture 2 The "Beautiful" Corsican Landscape (amateur photo)

1.3 Aim and objectives

The aim of this paper is to find the best strategy in order to manage MSW in small islands and especially in the island of Corsica; a strategy consistent with the development of the tourism industry, bearing in mind that the tourism is bringing the highest revenue to the island's economy.

The objectives of the thesis are:

- to define what are the positive and negative effects of the increase in tourism industry on islands
- to identify the main problems of municipal solid waste management (MSWM) on small islands
- to provide statistical data about the relationship between the tourism and the local economy in the island of Corsica
- to identify how the tourism industry is influencing waste generation on islands and the island of Corsica

- to describe how the MSWM system in Corsica has developed over the years
- to assess which waste management treatment methods are most appropriate for Corsica

2 Overview of the tourism industry and its impacts on the environment, with a focus on municipal solid waste (MSW)

2.1 Introduction

In the following literature review the main issues concerning the growth of the tourism industry on islands and related municipal solid waste management problems are presented and discussed. A variety of literatures are consulted, with specific case studies from different islands, which however face the same problem of the increase in tourist flows and therefore increasing amounts and complexity of waste generated.

First, a general description of the global tourism industry and its development during recent years in coastal and island areas is given. The main positive and negative impacts of mass tourism are identified and more attention is paid on the increased amount of municipal solid waste due to the high number of tourists in the desired vacational locations (Nagle 1999).

The general characteristics of MSW are discussed together with all possible treatment methods and technologies. Problems faced while dealing with municipal solid waste management on islands are described during the search for the best option of MSWM methods.

2.2 World tourism industry: an overview

One of today's most dynamic economic activities worldwide is tourism. Over the past decades tourism has spectacularly developed and become a global industry, considered as one of the fastest growing trades (Nagle 1999; CoastLearn 2009). Manera and Taberner (2006)

show a record of 703 million international tourist journeys around the globe for the year of 2002. The World Trade Organization statistics for 2002 estimated approximately the same number of 693 million tourist arrivals worldwide and predicted over one billion till the year of 2010 (CoastLearn 2009). Defined by the United Nations, tourism is "a sum of the phenomena and relationships arising from the interaction of tourists, business suppliers, host governments and the host communities in the process of attracting and hosting these tourist and other visitors" (Ellul 1996).

The world's leading destination is Europe recording 500 million arrivals, which is estimated as constituting 53% of the world's total influxes (WTO 2009; Ellul 1996). The WTO statistics show that 2/3 of global tourism involves European destinations and this is predicted to double by 2025 (CoastLearn 2009). Some statistics of tourist destinations are shown in figure 3.

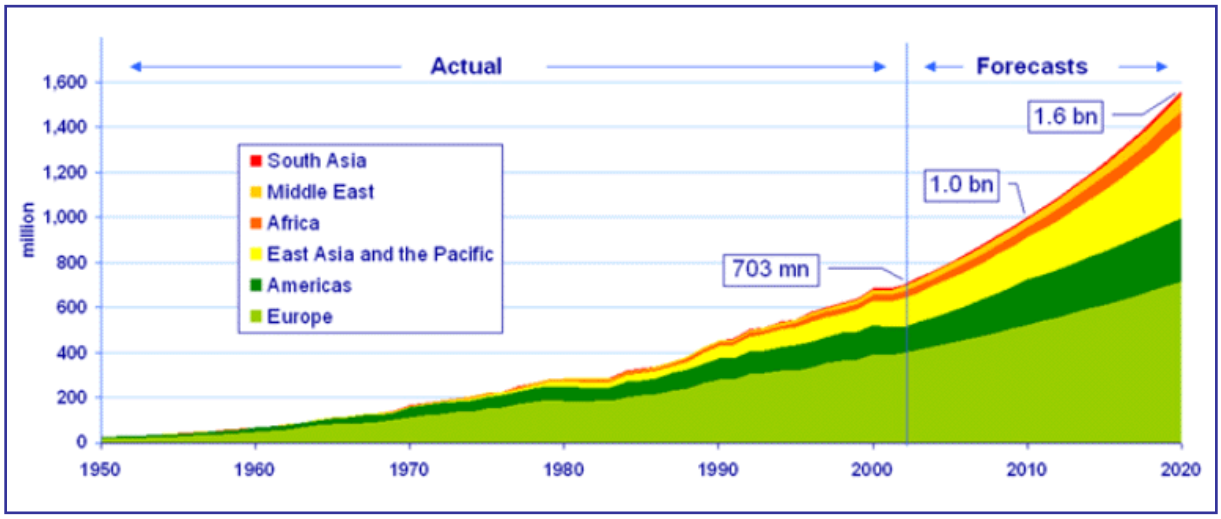

Figure 3 Actual and forecast tourist destinations (CoastLearn 2009)

The world's number one tourist target and one of the key areas is the Mediterranean Sea. This preferable destination with plenty of wonderful islands generates 1/3 of the world's tourist revenues (Manera and Taberner 2006; CoastLearn 2009). The World Trade Organization (2004) also confirms that the leading tourist destination is the Mediterranean,

stating that the number of tourists visiting the sea will increase from 220 million to 350 million by 2020. The majority of the visitors (84%) come from Europe, with Germany as a leading country, followed by the United Kingdom, France and Netherlands (Ellul 1996). The target places chosen for stay are usually Spain, France, Italy or Greece (WTO 2004). France is at the top regarding world tourist arrivals, followed by the USA, Spain, Italy and Hungary (Ellul 1996). The length of stay by international tourists in France for the year of 2005 is shown in figure 4 (Tourism Directorate 2006).

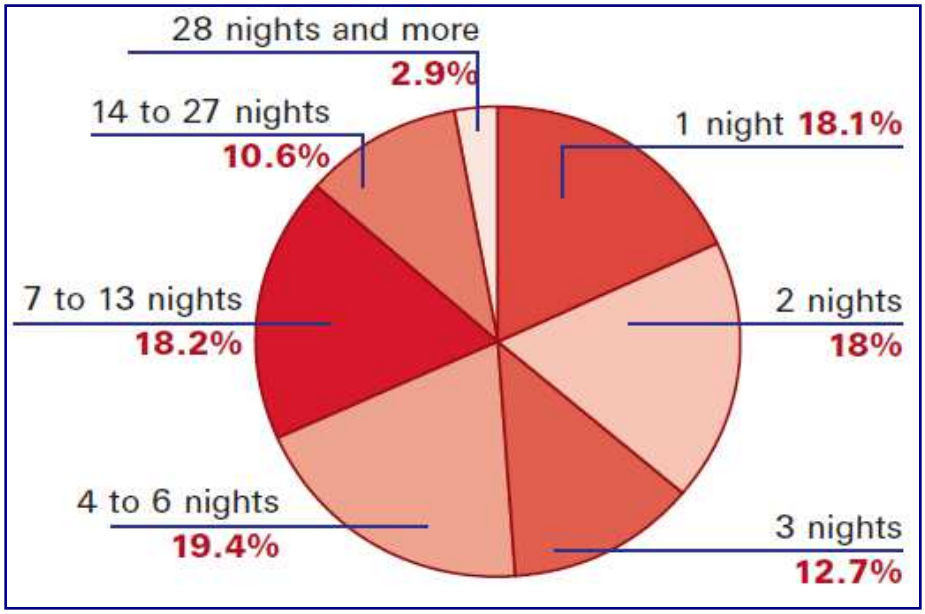

Figure 4 International arrivals in France by length of stay (Tourism Directorate 2006)

According to statistics of the French Tourism Directorate for the year 2005, France had 76 million tourist arrivals with at least one overnight, and 107 million visitors coming to France for a shorter stay without spending the night in the country. Another important issue to consider is the difference between winter and summer seasons. For December the average number of visitors is recorded at 600 000 and for August 4 000 000. The average daily rate for the whole year is 1 600 000 (Tourism Directorate 2006).

The most popular destinations in France for 2005 are shown in figure 5 below, where the area of each semi-circle is proportional to the overnight stays in the region and the

numbers show the percentage of the regional overnight stays from the French total (Tourism Directorate 2006).

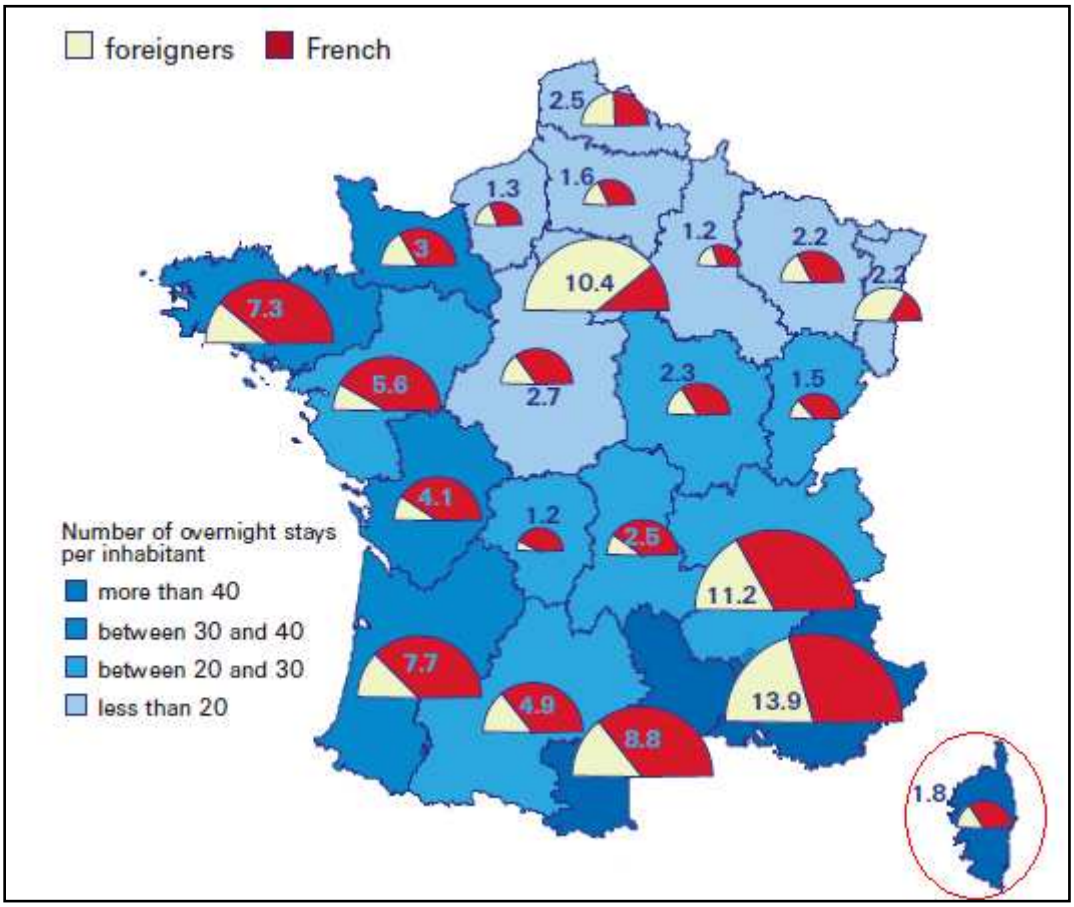

Figure 5 Most popular destinations in France (Tourism Directorate 2006)

Regarding the number of overnight stays per resident, the island of Corsica records the highest ratio of 95 overnight stays per inhabitant (Tourism Directorate 2006).

According to CoastLearn (2009) the population of Europe over the age of 65 will increase by 17 million in the next 20 years. This is a significant fact for the tourism industry and much more attention should be paid to it, considering that this group of people demands different forms of tourism such as trips related to natural and cultural heritage. Several statistics show that this type of tourism is the fastest growing in Europe (CoastLearn 2009).

The statistics, however, also reveal that most European tourists (63%) prefer the sea, 25% love the mountains, another 25% like big cities and the rest (23%) the countryside (Ellul 1996).

Having in mind that the island of Corsica is an island combining wonderful nature, sea, coastlines and mountains as well as natural reserves and cultural heritage, it is obvious that the demand for visiting that island will continue to increase in the coming years and the percentage of the visitors can be assumed as a sum of all the forms of tourism mentioned above.

2.2.1 Tourism industry on islands

Tourism is considered as an integral part of the island and coastal economy (Inskeep 1991; Davenport and Davenport 2005). Coastal and island tourism has became one of the most popular and desired forms during recent decades. The unique environment with a combination of land and sea, sun, water, long coastlines and beaches as well as good sea food and scenic views were the initial attractions (Nagle 1999). Over the years more attractions have been developed based on these resources: diving, trips to adventurous areas, observation of wildlife (corals, dolphins, birds) and boat-trips, which have made the coastal destinations even more attractive (Davenport and Davenport 2005; CoastLearn 2009). Coastal and island tourism became a mass tourism industry in the middle of the 20th century and has become an affordable option for almost everyone (Davenport and Davenport 2005). Davenport and Davenport also estimate that every year around 60% of European holidaymakers prefer the coast and sea as a vocational destination. Furthermore, coastal and island tourism is becoming more and more competitive which leads to tourists expecting a higher quality of performance for lower prices (Davenport and Davenport 2005).

The development of the transport industry throughout the last few centuries has also influenced the expansion of tourism on islands, having in mind the creation of more means and easier ways to reach the desired destinations (Davenport and Davenport 2005). Today, travel and tourism, combined are worth approximately 3.5 trillion US dollars per annum and employ more than 200 million people (Nagle 1999; Gormsen 1997). Many small islands in developing countries get a significant, even prevailing income from the tourism and travel industries (Davenport and Davenport 2005). This is true for most of the places where the tourism industry is playing a significant role for the economy of the country with a significant share of GDP (Gormsen 1997).

After 20 years of conflicts regarding the development of the tourism industry in Corsica between 1970 and 1990, tourism has now become the major activity existing on the island, and thus the most important one for the economic growth (Priestley *et al.* 1996). Estimates made by INSEE (the French National Institute of Statistics and Economic Studies), show that in 1987 tourism contributed 33 million French francs to the island economy and provided more than 10 000 seasonal jobs for the local population. Furthermore, an increase is expected over the next few years (Priestley *et al.* 1996).

Tourism as seen in the paragraphs above brings economic benefits for all coastal and island areas. However, most of the time this activity is associated with substantial socio-economic and environmental costs (Davenport and Davenport 2005). Davenport and Davenport also explain that such costs can affect even larger areas that usually do not seem vulnerable and may be devastating for small island resorts.

Holder (1988) proposes a theory of "self-destructive tourism", which states that an attractive natural area might become a place for the development of low-density and higher-price tourism. However, the problem is the rapid appearance of other developers on the market, which offer the same quality of performance at lower prices and therefore creating

competition. In order to reach the available number of bed places, the standards and prices decrease and in this way mass tourism appears on the scene (Holder 1988).

Nowadays, however, people do not expect just sun and sand when going on vacation. They are looking for a wide range of leisure activities, extreme sports, and traditional cuisine as well as natural and cultural attractions (Davenport and Davenport 2005). However, this brings also anxiety for the local people who want to preserve their identity, environment and historical heritage from negative impacts (CoastLearn 2009).

2.2.2 Island carrying capacity

Defined by Coccossis and Mexa (2004), the carrying capacity is the maximum amount of people, visiting a tourist destination at the same time without causing any deterioration of the area, affecting in any way the local population or providing a lower quality of visitor's satisfaction. However, the carrying capacity is a much more complicated concept. In tourism, the carrying capacity has been approached from a range of different perspectives: biological and ecological, physical, sociological as well as behavioural, planning, design and policy (Priestley *et al.* 1996). In coastal and island areas, biological and ecological impacts of tourism are usually considered. The behaviour perspective studies the tourist's satisfaction as well as the opinion of the local population about the visitors (Parpairis 1992). The latter, leads indirectly to the theory of social carrying capacity of a region, where the social disturbance afterwards brings negative consequences for both visitors and residents. However, much more efforts and concentration are needed to define the environmental carrying capacity in order to plan tourism development so that it is in harmony with its surrounding environment (Coccossis and Parpairis 1992). In recent years, the issue of the environmental carrying capacity has been growing in importance and most of the time is related to the perception of

sustainable development, emphasizing that there are certain capacity limits that should not be broken thinking not only for present, but also for future generations (Priestley *et al.* 1996).

2.2.3 Impacts of tourism on coastal and island environment

Tourism in itself is considered as a positive activity having in mind that the major goal of every holidaymaker is to receive a positive experience and spend a pleasant time (Ellul 1996). However, Ellul also considers that increasing tourism creates a certain level of impacts to the environment and based on how the receiving country is managing and planning them, these impacts can be either positive or negative. Cooper *et al.* (2008), before dividing the impacts into positive and negative, group them into three main categories: economic, socio-cultural and environmental. They also, like Ellul, agree that for managing the development of tourism, all factors related to its impacts and resources should be considered and well-planned. To this definition, Mason (2003) adds that the tourism impacts are difficult to plan and manage because of their multi-faceted nature. The nature of many tourism impacts is usually influenced by some of the following factors: what type of tourism is taking place and where it is happening, as well as the seasonality, the tourism infrastructure, and the origin of the visitors (Mason 2003).

The economic impacts are those affecting income and employment. They can be both positive and negative, like all other types of impacts (Mason 2003). Cooper *et al.* (2008) also define tourism as an important developing industry for the earnings and employment of the destination countries. An industry that creates working places for many people both experienced and inexperienced: cleaners, waiters, maids and porters as well as accountants and managers (Nagle 1999). The Tourism Directorate (2006) records that in France in 2005, there were c. 894,000 wage-earners fully connected to the tourism industry with a minimum of 686 000 in January and a maximum of 1 184 000 in August. Employment in the

commercial sector (hotels, restaurants and cafes) for 2005 shows an increase compared to 2004 and accounts for 828 000 employees as well as an additional 170 000 self-employed workers (Tourism Directorate 2006). Nagel (1999) however, defines some problems that usually may occur due to the seasonality of the available working places which consequently leads to seasonal unemployment and instability.

For many island and coastal areas, indeed, tourism industry is the major activity responsible for generation of income, employment and foreign exchange earnings (WTO 2004). Most islands depend heavily on income from tourism based on the island's attractiveness (Inskeep 1991). However, the small size of the islands usually makes them vulnerable to the socio-cultural, environmental and economic impacts that the tourism industry may cause (WTO 2004). Besides the increase in income and employment, the tourism industry has many other positive impacts such as conservation of important natural areas, improvement of environmental quality, improvement of infrastructure etc. (Inskeep 1991).

However, this rapid economic growth and rising population density also contributes to the burden of many negative impacts, which can vary based on the kind of tourism developed, the specific area and the tourism scale regarding the carrying capacity of the environment (Bai and Sutanto 2002). The main negative impacts are air, water, noise, and visual pollution as well as land use problems and **waste disposal** (Inskeep 1991).

Regarding the negative impacts of tourism in coastal and island areas, Nagel (1999) defines the Mediterranean Sea as the most influenced region. As already mentioned the Mediterranean coast is one of the most attractive tourist destinations and predictions show that the number of tourists will further increase within the coming years (Manera and Taberner 2006). Nagel (1999) identifies the high concentration of tourist, infrastructure developments as well as the traffic and **waste generation** as some of the most significant adverse impacts

that cause intense problems for both environment and residents. A clear classification of the tourism impacts on the Mediterranean is shown in table 1 (Nagel 1999).

Table 1 Impacts of tourism in the Mediterranean (Data source: Nagel 1999)

Overdevelopment	Unplanned growth of hotels and tourism facilities with little regard to visual impact or local architecture has led to visual degradation over vast areas. Land has been used for recreational facilities such as golf courses and theme parks. Major roads and airports encroach on protected areas.
Visitor related development pressure	For example, agricultural development aimed at meeting tourists or catering needs around National Park in Southern Spain at places such as Coto Donana, where wetlands are threatened by water abstraction and pesticide run off.
Loss of habitat and loss of biodiversity	Over 75% of the sand dune systems from Gibraltar to Sicily have been lost since 1960. This has led to the loss of breeding grounds for species such as the Loggerhead Turtle. Over 500 Mediterranean plant species are threatened with extinction. In France alone, 145 species are on the verge of extinction or have already disappeared.
Species impact	Tourism pressure on nesting sites of the Loggerhead Turtle and Green Turtle led to a curtailing of the building of a hotel at Dalyan in Turkey in 1986. However, the very act of protecting the turtles has led to an increased influx of tourists, 5000 every summer, creating other environmental pressures such as **waste dumps**.
Lack of sewage and effluent treatment and disposal	Only 30% of municipal waste water from Mediterranean coastal towns receives any treatment before being discharged. As a result, some Mediterranean beaches fail the EU bathing water quality tests. For example, in 1992, 7% of Spanish beaches and 13% of French beaches failed the test. The total cost of developing the necessary level of sewage treatment is over 6 billion pounds. Spillages from pleasure boats were also a major source of pollution.
Unsustainable exploitation of natural resources	This includes excessive abstraction of drinking water and exploitation of fisheries resources. Over-abstraction of water for drinking, bathing, golf courses and water theme parks has led to increased forest fires.
Traffic congestion	On coastal roads traffic congestion, and the associated problems of noise and air pollution, are becoming an increasing problem.
Change in traditional lifestyle	Where local populations are outnumbered by tourists, such as in the poorer regions of the Balearics, Turkey, Croatia and Cyprus, over-dependence on tourism threatens traditional lifestyles.

Besides all tourism's impacts mentioned in table 1, WWF has recognized 200 regions in the world with crucial status for the conservation of biodiversity called eco-regions. One of the most important and most endangered is the region of the Mediterranean Sea including the island of Corsica (CoastLearn 2009).

Cruise ships are also a source of negative impacts and specifically **waste generation** (US EPA 2000). Considering that the largest cruise ship can carry more than 5000 passengers and is kind of a small village, the amount of **waste generated** is significant (Davenport and Davenport 2005). The sewage, garbage and wastewater produced are most of the time freely released into the marine environment. It is estimated that each passenger produces approximately 3.5kg of solid waste per day and one million litres of sewage ('black water') are discharged during a week of travel of a standard cruise ship (US EPA 2000). Another problem created due to the existence of the cruise ships is that they can bring a high number of tourists to remote and vulnerable areas that cannot be reached by any other means of transport (Davenport and Davenport 2005) and in this way the wildlife and marine habitats can be devastated. Davenport and Davenport describe one more negative impact caused by cruise ships. Having in mind that the legal dumping of solid waste generated on ships is no longer allowed in the seas, the solid waste is often dumped into island landfills, thereby contributing to habitat losses as well as pollution and much faster use of the island landfill capacity (Davenport and Davenport 2005).

As already seen, tourism is playing a considerable role in the development of small islands. The increasing demand for tourism is bringing many opportunities for the improvement of small and isolated places, contributing to the income and employment of local population (Priestley *et al.* 1996). However, the tourism activity creates also direct and indirect impacts on the unique and vulnerable environmental resources (Coccossis 1987). People's local awareness of environmental issues has already been influenced by such

problems, especially in places where tourism's growth appears very rapidly and intensively (Priestley *et al.* 1996). Priestley *et al.* agree with the fact that tourism's attractiveness depends on an island's natural landscape, plant and animal life as well as cultural and social attractions. They also highlight the need for resource protection, but illustrate also the fact that tourism's development may come in direct conflict with the protection of the island habitat, since it involves a high level of modernization, improvement in infrastructure, cultural change and over-exploitation of resources. For example, in many seaside regions, landscapes and coastlines have been affected by road constructions, and the creation of new hotels and infrastructure. Furthermore, the consequent environmental degradation, due to uncontrolled and intensive generation of mass tourism, is bringing negative impacts on tourism itself, while affecting the vulnerable island ecosystem and its resources on which tourism's attractiveness is based (Priestley *et al.* 1996). In order to prevent such problems and deal with them, special emphasis should be made regarding issues, such as coastline, fresh air, water quality, marine resources, agricultural land and **waste disposal** (Priestley *et al.* 1996).

During its development as already seen in the above paragraphs tourism industry creates positive and negative impacts. One of the negative impacts further discussed in this paper is the generation of waste and more specifically the municipal solid waste (MSW) generation on islands.

2.3 Municipal solid waste (MSW)

Many experts agree with the fact that municipal and household wastes are rapidly growing worldwide and appear to be more than one billion tonnes per year (Seager 1990). Municipal solid waste (MSW) is defined as the "waste collected by private or pubic authorities from domestic, commercial and some industrial (non-hazardous) sources" (Kiely 1997). To this definition Eurostat (2002) adds also the waste from small businesses, offices,

hotels and restaurants, schools, hospitals as well as waste from parks and street cleaning. According to Kiely (1997) there are not even two similar wastes considering that the solid waste is not standard. Domestic wastes might vary from week to week, season to season and even from one household to another. Seager (1990) estimates that there is also difference in the garbage thrown by people from rich and poor countries, where rich countries generate more paper, plastic, glass, metal and other durable wastes and poor ones produce more organic materials. Kiely (1997) agrees with this stating that waste can vary from country to country and between socio-economic groups. He also mentions that the wastes generated within community can vary also based on the community's level of commercialism and industrialism. Regarding differences in waste based on seasonal variations a typical example is the ashes produced by households during winter and no ashes during summer. Another point to consider for small tourist islands is the presence of tourist during summer, which leads to increase in waste quantities as well as waste complexity comparing to the waste generated during the winter season. Different types of solid waste generated from different sources are shown in table 2.

Table 2 Sources and types of solid waste (Kiely 1997)

Source	**Facility**	**Type of waste**
Domestic	Single family dwelling multifamily dwelling low, medium and high-rise apartments	Food, paper, packagings, glass, metals, ashes, bulky household waste, hazardous household waste
Commercial	Shops, restaurants, markets, offices, buildings, hotels, institutions	Food, paper, packagings, glass, metals, ashes, bulky household waste, hazardous household waste
Industrial	Fabrication, light and heavy manufacturing, refineries, chemical plants, mining, power generation	Industrial process wastes, metals, lumber, plastics, oils, hazardous wastes
Construction and demolition	-	Soil, concrete, timber, steel, plastics, glass, vegetation

The sources and types of waste shown in the table above encompass all the categories of solid waste. However, in this paper the concentration is on the waste produced by domestic and commercial sources i.e. the municipal solid waste (MSW). If we are to categorize it by material as illustrated by Kiely (1997) as well as Georgieva (2007) the municipal solid waste consists of paper, glass, plastics, metals, food wastes, textiles, wood and others. In the following table the detailed composition of different waste categories is described (Georgieva 2007).

Table 3 Material classification of MSW (Georgieva 2007)

Paper	Newspapers, magazine, junk mail, catalogues, books, office waste paper, cardboard, etc.
Glass	Green bottles, amber bottles, clear bottles, other glass, etc.
Plastic	Beverage bottles, carrier bags, PE and PP sheets, polystyrene packaging, PVC, rubber, tires, polyurethane mats, etc.
Metal	Ferrous cans, other scrap, aluminum cans and foils, batteries and accumulators, electronic waste, etc
Organics	Food, other kitchen waste, garden plants and wood, etc.
Textiles	Used clothes/bedding, carpets, etc.

The percentage composition of the wastes mentioned above differs from country to country. The country of our interest is France and especially the island of Corsica. In the following chart the composition of the MSW in France for the year of 2005 is illustrated (OECD 2008).

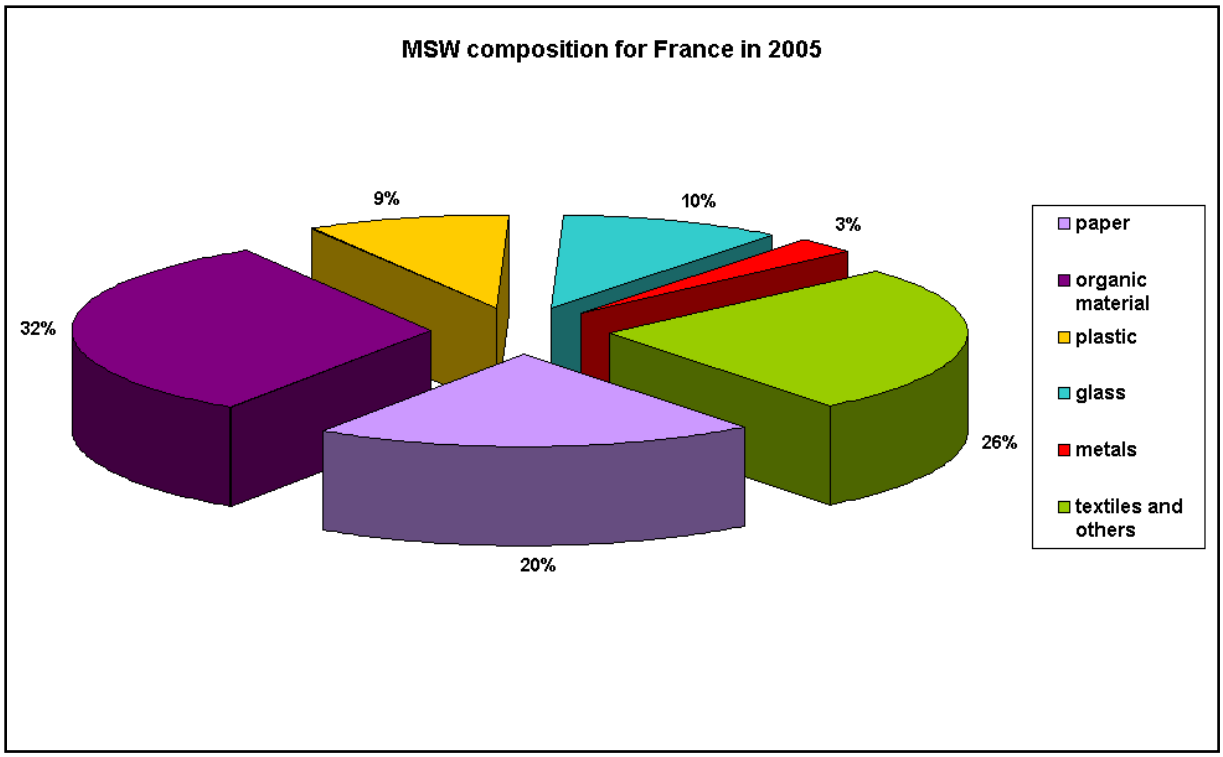

Figure 6 Composition of MSW in France (data source: OECD 2008)

According to Eurostat (2003) municipal waste in Western Europe consists mainly of organic materials (27%) and paper (26%). The figure above confirms this statement showing similar percentages also for France (32% of organic material and 20% of paper) and additional to the Eurostat statistics 26% of textiles and other wastes (OECD 2008). There are lower percentages for glass, plastic and metal products. Even though the percentage of the least disposable of any waste (plastics) is less than any other wastes except metals, this is not encouraging news having in mind the statistics given by the French National Institute of Statistics and Economic Studies. INSEE (2008) defines France as a producer of municipal waste far beyond the EU average, recording the amount of 553 kilograms of MSW collected in 2006 per inhabitant. Household wastes are 3/4 of the refuses mentioned above. If comparing to other countries, a French resident generates two times more waste than a Polish citizen, but a bit less than Spanish and German ones. Since 1995, the waste per inhabitant in

France has increased by 7 kilograms per year which is much more than the EU average rate (INSEE 2008).

Estimates from Syvadec (Syndicate for the Recovery of Household Waste in Corsica), show that in 2008 the population of 360 000 people in Corsica generated 315 000 tonnes household wastes and similar to waste materials (Syvadec 2009j). The municipal waste in Corsica consists of domestic waste, sludge from industrial wastewater, waste from small enterprises, bulky and commercial waste, and green waste, as shown in figure 7 (Syvadec 2009j).

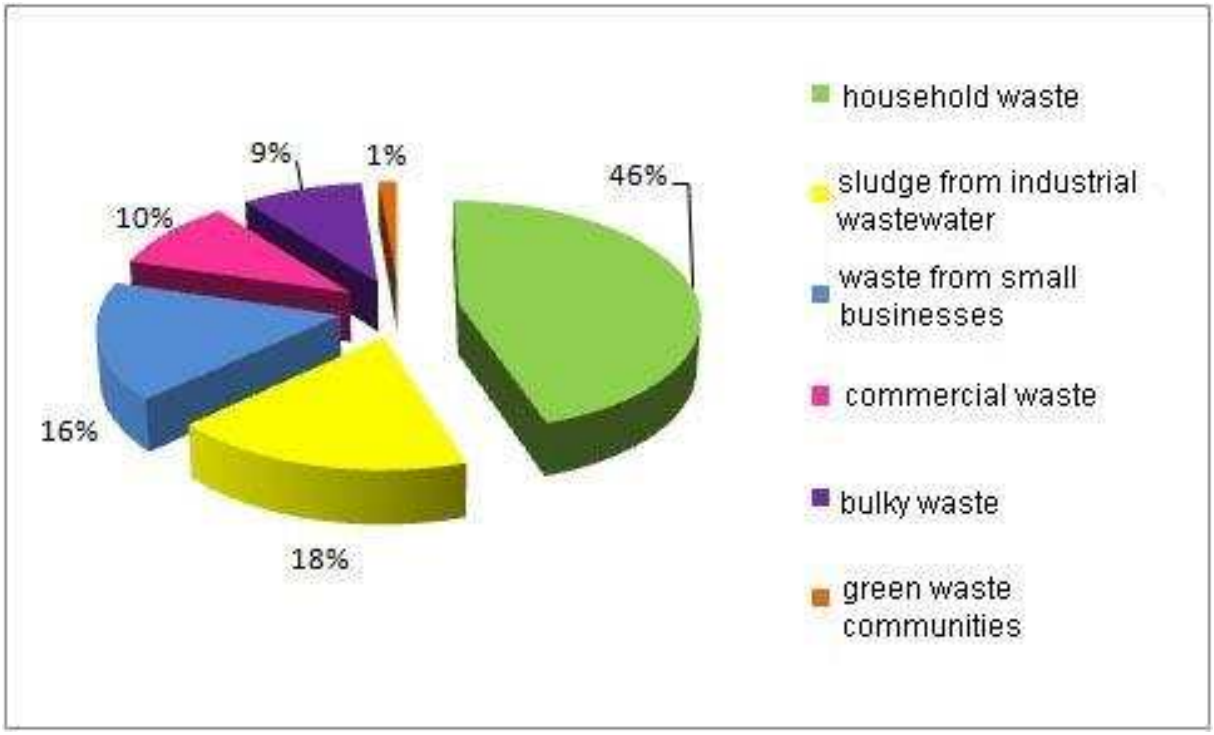

Figure 7 Municipal Waste in Corsica (Syvadec 2009j)

The biggest share (46%) goes to the household waste which is approximately 145 000 tonnes of waste equal to 402 kilograms per inhabitant for a year. This amount exceeds the national average of 360 kilograms per inhabitant per year (Syvadec 2009j).

The composition of waste is an essential and important step to be considered before starting any treatment of municipal solid waste. Kiely (1997) states that most of the time the

domestic and commercial wastes are collected and transported by the same authorities and they have similar compositions. However, a key point is to identify the waste as organic or non-organic, combustible and non-combustible etc. and based on that to choose the appropriate treatment method (Kiely 1997).

2.3.1 Management of MSW: treatment methods

Defined by Eurostat (2002) municipal solid waste management (MSWM) is the generation, separation, collection, transfer, transportation and disposal of waste while taking into account different factors such as public health, environment, economics, conservation, aesthetics, etc. Dubois *et al.* (2004) conclude that if waste cannot be eliminated it can be at least minimized and reduced whenever possible. The European Commission Directorate on the Environment (DG Env 1999) showing the statistics for the increased amount of waste during the last years and its rapid growth also concludes , that to reduce waste generation is not an easy task. The reduction, re-use and recycle of waste is known as the 'waste hierarchy' or the '3Rs' and is considered as the most favorable waste treatment option (Dubois *et al.* 2004). For the achieving of more environmentally-sound MSWM, the US Environmental Protection Agency (US EPA) also promotes the same order of treatment: source reduction as first option, recycling and composting as a second and waste burning and disposal in landfills as a last choice (US EPA 2008).

Unfortunately, most of the European Union (EU)'s municipal waste is still disposed of in landfills or incinerated even though these are the least preferable options for waste trearment according to the EU waste management framework directive (EC 2006) and the waste hierarhy as shown in figure 8.

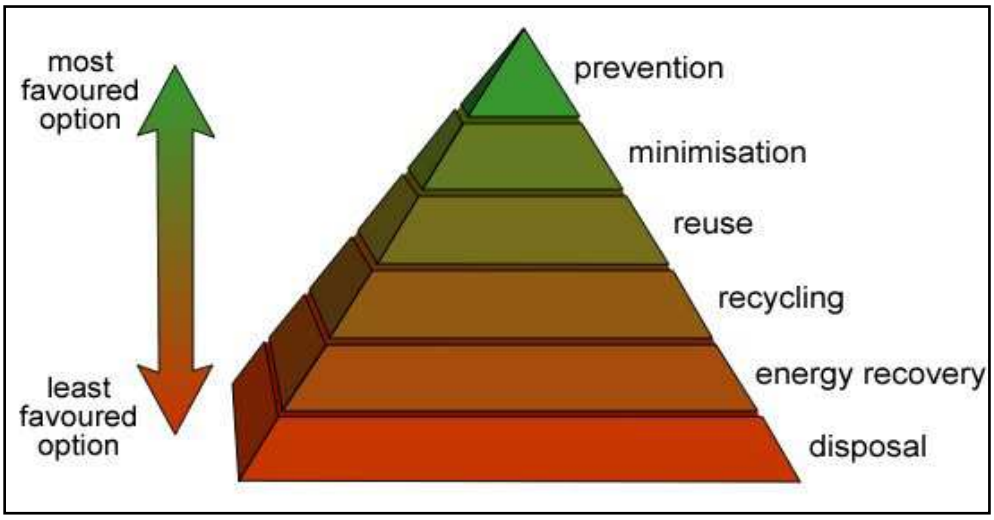

Figure 8 Waste hierarchy (Wikipedia 2009)

The last two methods might cause also severe impacts to human health and the environment (DG Env 1999). Environmental harm as well as operational costs can be reduced by using the 3Rs practices. This is another advantage that makes them the most desirable among the other waste management treatment alternatives (Dubois *et al.* 2004).

2.3.1.1 Waste prevention

Defined by Mazzanti and Montini (2009) waste prevention, also known as source reduction, is the designing, manufacturing, purchasing and using materials in a way to reduce or remove pollution at the source as well as waste amount and waste toxicity. US EPA (2009) describes that the reuse of materials is a method of reducing waste at source because it stops or postpones the entrance of the items into the waste collection cycle and disposal.

Waste prevention is the first option of the waste hierarchy, because it does not affect the environment in negative way (pollution, green house gases etc.), conserves resources and energy and reduces production and disposal costs. Furthermore, there is no need of new facilities (Dubois *et al.* 2004). Dubois *et al.* identify some ways of waste prevention such as:

- Using packaging as less as possible or using reusable ones
- Using durable equipment and supplies and reusing them when appropriate

- Using supplies and equipments more efficiently

Reusing items and materials is a way of reducing waste and it is even preferable than recycling, because there is no need to reprocess items before they can be used again (US EPA 2009).

2.3.1.2 Recycling

Recycling turns materials that otherwise will be considered as waste into valuable resources and creates environmental, social and economic benefits (Dubois *et al.* 2004). Recycling covers some general steps such as: collection of recyclable materials, sorting and processing them into raw materials, which are further manufactured into new products ready to be purchased (US EPA 2008). All these steps create a cycle that guarantees the general success and value of recycling. Dubois *et al.* (2004) describe some more positive aspects of recycling:

- Recycling decreases the use of incineration and landfilling
- Recycling decreases the need of extracting and using virgin materials which pollutes soil, water and air
- Recycling saves energy

According to the Association of Cities and Regions for Recycling (ACRR) (2006) for the production of new materials, recycling can save from 1.5 to 5 times more energy than the energy generated by incineration. After being collected, the recyclables (paper, glass, aluminum, plastics etc.) are separated and transported to treatment plants where they are further processed and turned into new products (Mazzanti and Montini 2009).

The ACRR's (2006) estimations showed that aluminum and paper give the best profits from recycling per tonne of MSW and the glass offers the least. Aluminum is used in many branches as a scrap metal, beverage cans, foils etc. Furthermore, if recycled aluminum saves

95% energy than if it is produced from raw materials. It also generates approximately 95% less air and water pollution (ACRR 2006). Regarding paper recycling, ACRR (2006) records 40% of energy savings if one tonne of paper is recycled instead of produced from virgin materials. Glass recycling saves between 4% and 32% of the energy required for its production from raw materials and generate 20% less air pollution and 50% less water pollution. Recycling of plastics is also preferable comparing to a new production, because it requires only 2/3 of the energy used to manufacture plastics from raw materials (Dubois *et al.* 2004). However, it must be considered that there are different types of plastics, which cannot be recycled together and additional separation beforehand is needed. Dubois *et al.* (2004) describe another concern that must be taken into account. The recycling market is not stable when it comes to prices. If they are too low for particular materials, the communities have to spend more money for collecting, separating and selling the products than if they send them to the landfill.

2.3.1.3 Composting

According to Dubois *et al*. (2004) there are different techniques for treating biodegradable waste. However, the main one is composting. Composting is another type of recycling, where decomposition of organic matter takes place (US EPA 2008). Tammemagi (1999) defines composting as an aerobic process, where biologically degradable waste are broken down with the help of micro-organisms in order to form a stable material called compost. The micro-organisms that are involved into this complex interaction can be categorized into three main groups: bacteria, fungi and actinomycetes (Dubois *et al*. 2004). The compost itself is an organic matter that can be used as soil modification or product for growing plants (US EPA 2008). It provides humus and nutrients for more healthy and productive soil (Tammemagi 1999). Other positive returns of composting defined by US EPA (2008) are:

- Decrease in plant diseases and pests
- Minimization or removal of chemical fertilizers
- Higher production of agriculture crops
- Restoration of wetlands, reforestation and habitat recovery with the improvement of contaminated, compacted and marginal soils
- Removal of grease, oil, solid particles and heavy metals from stormwater run off
- Destruction of approximately 99% industrial volatile organic chemicals (VOCs) in polluted air
- More than 50% savings over the use of conventional technologies for the remediation of soil, water and air pollution

Dubois *et al.* (2004) describe different methods of composting based on materials used and time needed for processing. They stress that the most common method of composting depends on the oxygen supply and therefore all equipments designed should be concentrated on the efficient transfer of oxygen to all parts of the composting matter.

Both US EPA (2008) and Dubois *et al.* (2004) agree that in order to reduce the waste that goes to landfills and benefit from resource efficiency, an increase in composting practices should be required. Dubois *et al.* (2004) also illustrate some main factors that should be considered while introducing the subject of costs. Composting costs consist of costs for site development and acquisition, regulatory agreements, facility operations and marketing of the final products. An approval from the local health department is also needed. Further regulations may require buffer zones around the composting facility, site preparation as well as equipment for controlling the odours, leachate and run off from the compost processes (Tammemagi 1999).

2.3.1.4 Landfills

Although landfills are the worst option according to the waste hierarchy, it has been and still is the most common used MSW disposal method in Europe (Seager 1990). Today new EU directives and regulations force municipalities to find new practices for waste disposal because of the negative impacts that old landfills cause on the environment as well as the scarcity of land available for landfills due to fast population growth, tourism and increase in waste generation (Dubois *et al.* 2004). Defined by US EPA (2008) landfilling is a process of waste disposal into the land and further spread, compacted and covered by soil or ash. Dubois *et al.* (2004) describe the importance of landfill site's design. A landfill must be planned in a way to prevent surface and groundwater contamination, reduce all possible impacts on the environment as well as assist the closure and post-closure processes of the site. There are number of factors that have to be considered and examined when preparing the report of the site's design. Some of them are illustrated by Davis and Masten (2003) as follows:

- Proposal of site boundaries and buffer zones
- Control of surface water and landfill gas
- Road and transport structures
- Planning of final cover system
- Monitoring facilities

Another important issue added by Dubois *et al*. (2004) is the characteristics of the site proposed for a landfill. Before starting any construction, the geology and hydrogeology, topography, drainage, soil permeability as well as the transportation facilities must be taken into consideration.

Described by US EPA (2008) the modern landfills or the so called sanitary landfills are the sites which are well-engineered, designed, operated and monitored in a way to meet

the federal regulations and protect the environment from contaminants. Domestic waste as well as non-hazardous sludge, industrial solid waste, construction and demolition materials are delivered to municipal solid waste landfills (MSWLFs). All MSWLFs must follow federal standards or equivalent state regulations. Some of them are defined below by US EPA (2008):

- Location limits – landfill sites must be built in a suitable geological area, far from lakes, wetlands, rivers and other restricted regions. Buffer zones must be considered as well
- Composite linear requirements – includes all membrane and layers required to protect the groundwater and underlying soil from release of leachate
- Leachate collection and removal technologies – removal of leachate for treatment and disposal
- Groundwater monitoring facilities – groundwater sampling and analysis for determining any presence of wastes escaped from the landfill
- Closure and post-closure requirements – comprises landfill closure, post-closure care and restoration of the closed site
- Financial provision – assures financial aid for environmental protection during and after the closure of the landfill

Even though landfilling is the last preferable method for waste disposal, its advantages are based on its simple technology and low infrastructure costs. However, most of the time the closure, post-closure and restoration costs are not taken into account (Davis and Masten 2003). Regarding landfill costs, Dubois *et al.* (2004) explain that they can vary due to the regulate standards in different countries. In general, landfill costs include all costs for engineering, operating, monitoring and leachate treatment, installations for landfill gas collection, energy generation etc. Davis and Masten (2003) add that the geological characteristic can also affect the costs as well as that the landfill size determines the prices

charged for waste disposal. Estimates also show that the landfill costs are highly dependent on how the EU landfill directive is implemented in different countries (Dubois *et al.* 2004).

2.3.1.5 Incineration

Every year more and more countries are running out of available for landfill sites space and therefore the growing amount of waste generated had become a key problem for many communities (Seager 1990; Rowat 1999). The landfill crisis brought more attention to the process of incineration, which involves the burning of waste with or without energy recovery (Georgieva 2007) and in this way minimizing significantly the waste volume (Dubois *et al.* 2004). However, Seager (1990) describes incineration as a process that besides the high costs of waste treatment facilities, it generates air pollution and toxic residue that itself needs further disposal. Dubois *et al.* (2004) agree with this fact and add that before using the combustion as a waste management method, there are many environmental problems that have to be surmounted.

Much more modern definition of incinerators or combustors is given by the US EPA (2008). Waste incineration is considered as a process, controlled by local governments or private operators, of burning MSW at a high temperature, while reducing waste volume and producing energy. US EPA (2008) also describes that if well-equipped, incinerators can convert water into steam and thus to fuel heating systems or electricity generation. More benefits are added by Georgieva (2007), explaining that incineration facilities decrease waste amount by approximately 90% and thus less need for landfilling is required; the income from incineration increases over time, while landfill costs become higher etc. Destruction of chemical compounds and disease-causing bacteria are also consequences of burning waste at very high temperatures (US EPA 2008). Regular testing shows that the lasting ash is non-hazardous before going to the landfill. Furthermore, about 10% of it can be used for road construction or daily cover layer in landfill sites (US EPA 2008). Dubois *et al*. (2004)

conclude that waste incineration is a subject of high public concern, because if effective control measures are not taken into consideration, harmful contaminants can be released into the air, land and water and thus influence human health and the environment. It is widely recognized that waste-to-energy incineration can take a significant place into the waste management system, but if only strict controls are established to prevent adverse environmental impacts (Dubois *et al.* 2004).

Dubois *et al.* give additional information regarding incineration costs. They can vary based on different incineration techniques that have been applied as well as the degree to which the emissions are controlled. Different countries have different standards and therefore the costs and investments are different depending on how strict the standards are.

US EPA (2008) describes another issue concerning waste burning – the **backyard burning**. People in USA and not only, are burning domestic waste on their own property. Most of the time the waste materials are paper, cardboard, plastics, and food scraps. There are many reasons explaining this behaviour: people want to avoid and reduce expenses for collection services, hauling efforts and waste of time. Backyard burning has been a common method in many rural areas years ago. Nowadays, however, there is a variety of alternatives for waste collection and transportation. Despite this fact and the state and local governmental restrictions and prohibitions, there are still people that burn wastes illegally and release air pollutants directly to the atmosphere (US EPA 2008).

2.3.1.6 Transfer stations

Defined by US EPA (2008) waste transfer stations are places where municipal solid waste can be stored after collection and held until its further reload to lond-distant transport vehicles for shipment to landfills or other treatment operations. Advantage of the waste transfer stations is that communities can save money from labour, operating and transportation costs while combing several loads of waste collection. Trips from and to

disposal sites are also reduced, but traffic can be created near the areas where the transfer station are located. If a proper design, operation and control are not implemented, waste transfer stations can affect the nearby environment and residents living there (US EPA 2008).

Seager (1990) explains another type of waste disposal problems. Many countries such as France, Belgium, UK and West Germany are burning some of their wastes on incinerator ships in the sea even thought this is very dangerous and extremely polluting alternative of waste disposal. He further continues with more pessimistic facts of other countries that are simply dumping their municipal waste in the sea, which leads to marine species illnesses and incidents as well as garbage washed up from the sea on coastlines as shown in picture 3.

Picture 3 Waste washed up from the sea (amateur photo)

It is difficult to derive a general conclusion on which disposal method is better than the others due to the highly diverse waste management in Europe. Major disposal methods as well as recycling and recovery rates vary from country to country (Dubois *et al*. 2004).

A report made by the European Commission on landfilling and incineration externalities concludes that "there is no easy and straightforward answer as to whether incineration or landfill disposal is preferable from the point of view of external effects" (DG

Env 2000). Therefore, the report recommends that any choice should be made based on options' impacts on the environment and associated costs.

Dubois *et al.* (2004) define that France, Germany, Denmark, Sweden and Luxembourg are relying mostly on incinerating their municipal solid waste. Countries like Portugal, Spain, Greece and UK are landfilling almost all their MSW. Most of the Central and Eastern European countries are also disposing their waste to landfills even thought the waste amount and kind of technology used can vary due to different economic conditions (Dubois *et al.* 2004). The percentage of different waste treatment methods in France is illustrated by Eurostat (2003) in figure 9.

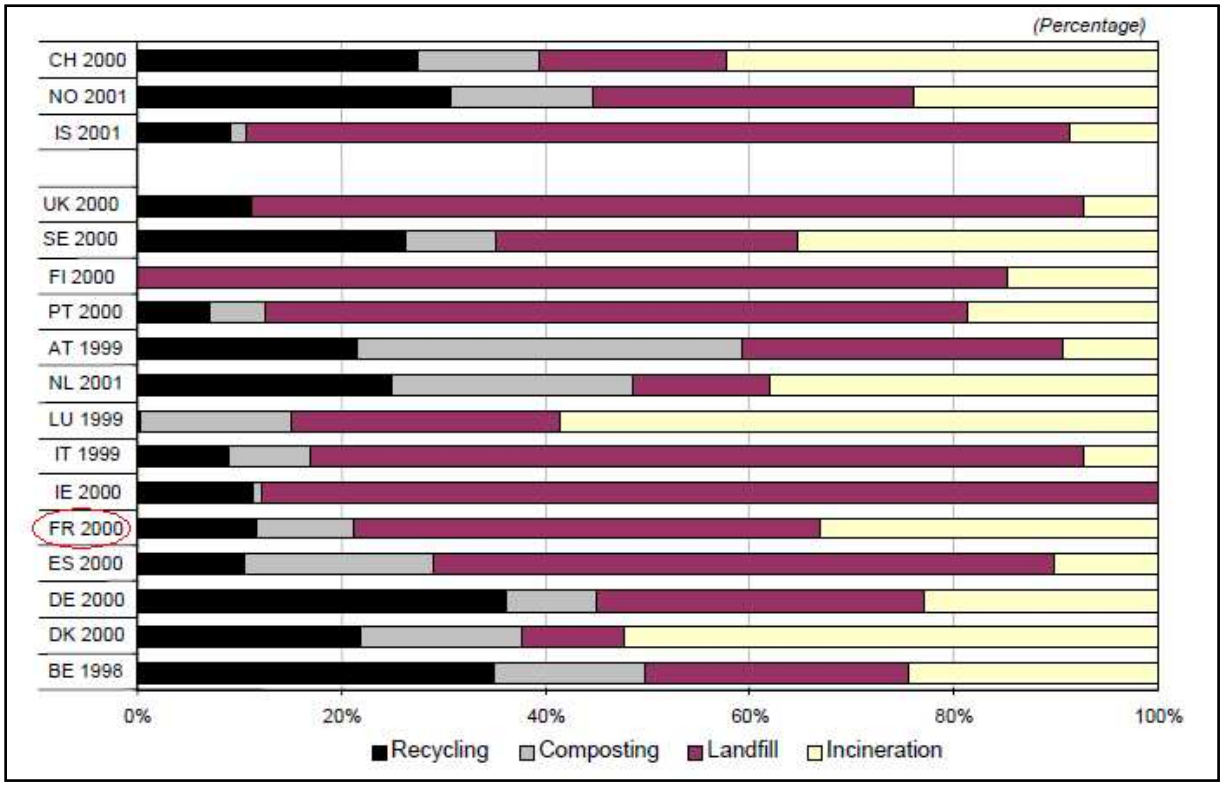

Figure 9 Treatment options of MSW in Western Europe (Eurostat 2003)

As it can be seen, in France a lower percentage goes to recycling and composting and an almost equal share is given to landfilling and incineration (Eurostat 2003).

Despite some improvements regarding collection and treatment of the MSW on the island of Corsica in recent years, which will be further discussed in this paper, there are still many significant factors that need more development due to geographic and demographic particularities as well as seasonality, structure and equipment innovation. Syvadec (2009j) illustrates the most common MSW treatment methods of Corsica in the figure below.

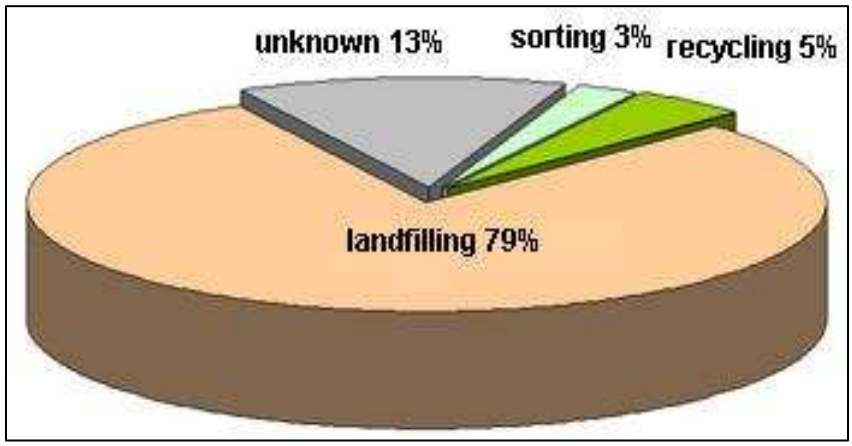

Figure 10 MSW treatment methods in Corsica (Syvadec 2009j)

Syvadec estimations show that of all MSW only 8% are recovered, for 13% information is not available and the remaining 79% are landfilled (Syvadec 2009j).

2.3.2 Waste management on islands

Waste problems on islands are based on the increase in the number of tourists and improper disposal of solid waste from hotels, restaurants and resorts. Waste can produce both litter and health problems as well as pollution and unattractiveness (Inskeep 1991).

Chen *et al.* (2005) consider the management of municipal solid waste as a great problem for many societies. The waste must be collected, transported, processed and afterwards disposed of. For small islands that is not an easy task. As already mentioned, the consequence of the large numbers of tourist is the relatively high waste generation, while on islands, options of alternative waste management are limited (Inskeep 1991). The option of

landfills may not be viable, because of the limited area suitable for such sites and can also cause indirect costs (reduction of tourism, loss of environmental quality, pollution) (Seager 1990). Incineration may also not be the economically efficient choice (Chen *et al*. 2005).

Sakai *et al.* (1996) suggest an effective strategy for minimization, recovery and transformation of the waste, similar to the 3Rs method: a strategy adopted by many industrialized societies as a model of solid waste management. However, the extent to which each of the hierarchy components are used varies based on many external factors such as topography, population density, environmental and socio-economic regulations (Sakai *et al.* 1996).

As a final alternative Chen *et al.* (2005) propose the option of shipping waste to the mainland even if it is very costly, but it remains the only feasible decision when all other alternatives are depleted (Chen *et al.* 2005).

2.4 Summary

Even though the tourism industry has negative impacts, it is one of the most important industries for island and coastal regions. On the World Tourism Organization's meeting in Baku, Azerbaijan, held on 29th of March 2009, European member states concluded that the tourism is one of the most resistant industries to the deteriorating global economic conditions today and can be supportive in overcoming the national economic crisis situation, especially in Europe (WTO 2009) with the support of long-term, key policy issues (WTO 2004).

Regarding the above paragraphs it could be also concluded that municipal solid waste management is one of the main problems that most 'tourist islands' face nowadays (Priestley *et al.* 1996). Furthermore, considering that the carrying capacity of Corsica has still not been reached, the tourist flow will continue to increase within the next few years (Manera and Taberner 2006) and thus will increase the municipal solid waste of the island as well.

In the following table Dubois *et al.* (2004) summarize the advantages and disadvantages of the MSW treatment methods mentioned in this section.

Table 4 Pros & cons of waste management techniques (data source: Dubois *et al.* 2004)

Techniques	Advantages	Disadvantages
Recycling	• conserves natural resources • reduces the amount of waste that requires disposal and saves on the associated costs • provides a raw material for new industries	• costs and the energy used for collecting, transporting and reprocessing of recyclables are high • fluctuations in the prices paid for collected recyclables • unless there is a suitable market for them, some compounds are not recycled
Composting	• removes organic waste from landfill providing organic materials on the soils and reducing methane emissions • provides a useful compost which improves soil properties for agriculture. It replaces other soil improvers and conditioners and protects against erosion	• can produce unpleasant odours, spores and fungi and possibly polluting liquid effluence if not properly processed • problems with contamination of the final product can arise in largescale composition operations • large-scale composting requires a good quality feedstock, therefore, separation costs can be high
Incineration	• energy production from waste reduces the use of fossil fuels such as oil and coal • reduces the weight of waste requiring disposal to landfill by 70% • reduces the volume up to 90% • energy generated is 5 times more effective than from landfill • Over 80 % of ashes can be recycled	• costs are much higher than landfill • emissions contain persistent pollutants which must be controlled to minimise harm to health • the remaining ash still requires disposal. The toxins in the waste are concentrated in the fly ash. This material requires very careful disposal • Incineration sites are difficult to find (NIMBY)
Landfilling	• relatively low costs • suitable for the reclamation of land for agriculture, wildlife or leisure uses • landfill gas is a suitable fuel for heat and power generation • suitable for disposing a wide variety of wastes	• emits greenhouse gases: especially the emissions of methane are important • Unavoidable long term emission risks • Landfill sites are difficult to find (NIMBY) • Landfill without energy recovery is the least sustainable disposal option

The choice of the waste management methods varies considerably from country to country due to specific characteristics of the region, legal standards and regulations as well as associated costs for construction, operation and maintenance (Dubois *et al.* 2004). Considering islands' unique environment, land scarcity and other specific characteristics, it is difficult to define which waste management method is the most appropriate one. Even though some improvements have been recorded in Corsica in recent years, there is still a long way to go in order to decrease the 79% of landfilled waste and introduce waste reduction, composting and recycling as the most appropriate waste management treatment alternatives.

3 Methodology

In order to develop a good thesis, every researcher should be familiar with the precise approach for conducting qualitative and quantitative research. The research road is based on variety of components the combination of which leads to the desired results at the end. Based on the thesis topic, however, one research method could be enough to achieve the desired outcomes, even though a combination of both gives better results.

As stated by Ritchie and Lewis (2003), the most important point is to understand that there is no single way of doing a research. The research is always depending on many factors such as: ontology (the nature of the social world and what can be known about it) and epistemology (the nature of knowledge and how it can be obtained), as well as the aims and objectives of the researcher and the main audience of the research. In order to address the research question in this thesis, both qualitative and quantitative methods are used.

3.1 Overall research design and methods used

The thesis research question as stated already in the introduction is focused on the relationship between the tourism industry and municipal solid waste management in tourism-affected islands such as Corsica. It has been explained in the literature review how the development of tourism industry is bringing positive and negative impacts on the environment and how the increase in MSW is related to the raise in the number of tourists every year. In order to get good results supporting the objectives of the research, a combination of both qualitative and quantitative research methods is needed. To identify the pros and cons of tourism development on islands as well as the main problems of island's waste management system, general literature (books, articles, and internet sources) and legislative documents are

revealed. For the understanding of the MSWM policies in Corsica, particular articles as well as official papers and information provided from regional municipalities and the Syndicate for the Recovery of Household Waste in Corsica *(Syndicat de Valorisation des Déchets Ménagers de Corse – Syvadec)* were consulted and a personal interview with a member from Syvadec was conducted. In order to attain better understanding of the current situation in Corsica and collect more specific information regarding the MSWM, qualitative methods like interviews, archival research and field notes, and quantitative method (Stella Modeling) are used.

3.1.1 Interviews

Interviews are used in order to answer some particular questions difficult to find out with an archival research as well as to clarify some doubts and confirm information based on articles and media.

As stated by Kvale (1996), an interview tries to "understand the world from the subjects' point of view" and in this way explains the meaning of certain hidden actions and situations. Rubin and Rubin (1995) classify three different types of interviews: semi-structured - for events when more particular information is needed; topical - when the concentration is focused on specific events and processes and evaluation interviews - when the purpose is to find out what are the initiatives, projects and programs planned as future actions.

A combination of all interview types is used for the thesis research. The interview questions are prepared based on information found out during the preparation of the literature review, which helps to identify the main actors and organizations contacted as well as the choice and range of questions. Interviews were held within different public groups and organizations: starting from the level of service to the local municipalities and ending up with the key organizations managing the municipal solid waste in the island of Corsica.

The first step in order to decide where to go and who to interview was to follow some acquaintances' advice and speak with people they know from local environmental NGOs and municipalities. The talks with these people were informal without any questions prepared, asking basic information about: which associations are dealing with the tourism and MSWM problems in Corsica; where these organizations are located and who are the people responsible for the information I was interested in. This was the start which led to the interviews with the participants illustrated in the following table.

Table 5 Interview respondents

Date	Name	Position
30/04/2009	Mr. Charles Pinelli	Association "Les amis des Agriates" (Friends of the Agriates), St. Florent, Corsica
04/05/2009	Mrs. Stephanie Marchetti	Conseil general, Conservatoire du Littoral, Bastia, Corsica
11/05/2009	Mr. Patrick Saliceti	An officer from the Municipality of Oletta (Mairie d'Oletta), Corsica
25/05/2009	Mrs. Marie-Emmanuelle Arrighi	Chargée de Prévention, Syvadec (in charge for the Prevention, Syndicate for the Recovery of Household Waste in Corsica), Corte, Corsica

It must be considered that the number of the conducted interviews must be at least double in order to get better understanding of the stated problem. However, due to time limitations and other barriers further discussed in the thesis limitation section, four personal interviews were considered as enough at this stage.

Meanwhile, a lot of information was received via e-mail communications from professors from the University of Corte, Environmental Sciences Department: Prof. Sauveur Giannoni and Prof. Eric Leoni as well as Mr. Christophe Paoli from the Department of Sciences and Techniques. Two more interviews with Prof. Giannoni and Mr. Talloni from Syvadec were planned for the end of June, but did not take place.

The length of personal interview was approximately one hour with a range of 15-20 mainly open-ended questions, separated in two sections regarding tourism development and

MSWM. A detailed list of the questions used is included in Appendix I. Usually when answered, the first one or two questions asking general information about the tourism development or MSWM, had given information that covered some of the next questions prepared.

Due to the open-ended type of majority of the questions prepared, often, some answers were leading to questions out of the pre-prepared list, which is considered as a positive effect, because in this way more detailed information has been collected. For example during the interview with Mrs. Marie-Emmanuelle Arrighi, a question regarding initiatives and projects already planned or carried out provided information about a project for an incineration plant, which had been rejected by the local population. This naturally led to some more questions of the type 'why?', 'what were the reasons?' etc.

Both interview types (personal or via e-mail) have their advantages and disadvantages. If comparing the e-mail and personal interviews, the personal ones were considered as a better option, even though the results reached at the end were quite satisfactory from both kind of interviews. The analysis of the interviews are further discussed in chapter 5.

3.1.2 Archival research

The archival research is based on a selection of relevant books and articles investigating existing data regarding world tourism and especially the tourism in the Mediterranean Sea as well as in island and coastal regions. Further, books and articles containing general information for MSWM as well as waste management on islands and island's carrying capacity are revealed.

The correlation between MSW and the development of tourism in Corsica has not previously been investigated and analyzed due to the increase in tourism development in Corsica occurring only during the last 20 years. Until now nobody has paid specific attention

to the relationship between those two issues. This makes this thesis research more difficult and leads to some limitations.

Internet sources and important web sites of governmental and non-governmental organizations (NGOs) are consulted as well as several sites giving reliable statistic information. Most of the sites are subject of often updates regarding current news for the municipal solid waste and projects related to its management and system improvements. Therefore, such web pages were constantly examined.

3.1.3 Field notes

Defined by Silverman (2000) field notes are remarks on personal ideas that somebody have came up with while doing a fieldwork. For the research of this thesis field notes were taken during landfill visits, interviews and personal observations in order to complete the data collection. Field trips to some landfill sites were undertaken, but on own initiative without any special appointments due to, as already mentioned, time and language restrictions. Teghime, an active site near Bastia, and two closed dumping sites (closed because of the new EU directive on waste management) near Calvi and St. Florent were visited to see personally how the work is arranged and make some amateur photos of the closed sites, left without any post closure and restoration care.

3.1.4 STELLA modeling

The description and understanding of complex environmental systems such as those used in environmental sciences are simplified throughout an application of modeling tools. STELLA is one of the most commonly used languages for facilitating and presenting environmental systems into computer models. It enables the visual performance of environmental systems, the correlation between variables, flows and factors showing changes under specific conditions (Beltramo *et al.* n. d.). In this case, the aim of the STELLA model is

to show how the rapid increase in tourists' flows during summer influences the MSW generation in the island of Corsica and therefore creates future problems, having in mind that the carrying capacity of the island is limited.

The conceptual idea of the model is shown in figure 11**,** where the main relations further illustrated in the STELLA model are pointed out. The idea as already mentioned is to show how the increase of the tourists' arrivals during the summer season (approximately 5 months) influences the MSW generation as well as the increase in its amount. Local people are included in the model, because they also generate waste throughout the whole year, even though the amount of waste they generate is quite low comparing to the waste generated during the summer.

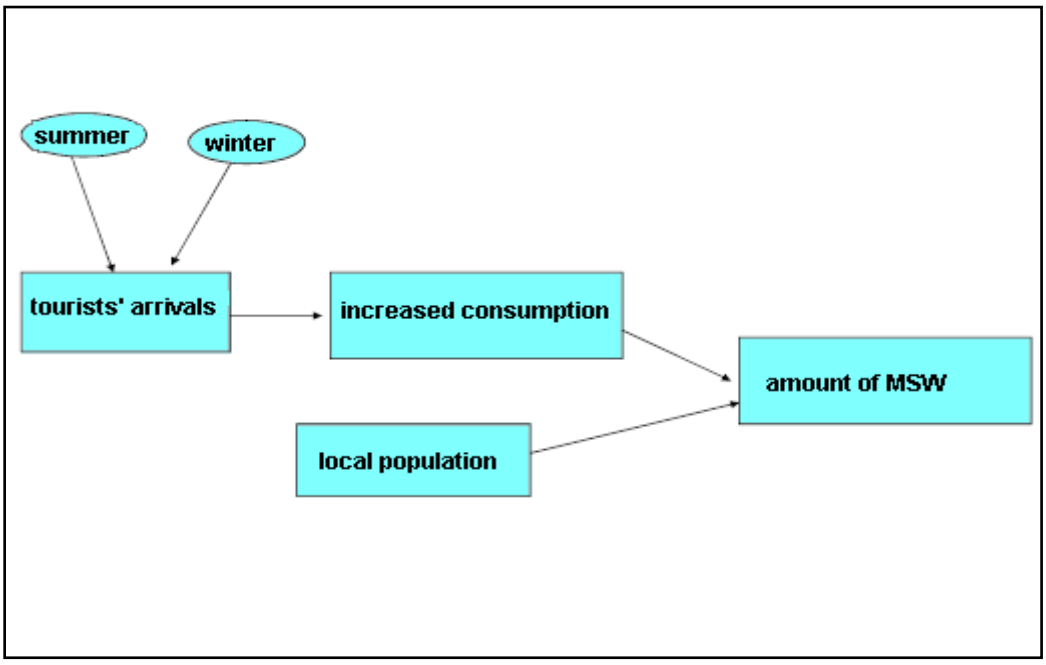

Figure 11 Conceptual idea of Tourist's flow & MSW model (own-made)

The same idea, but transferred in a STELLA model has more complicated look including a range of variables, factors and rates as shown in figure 12.

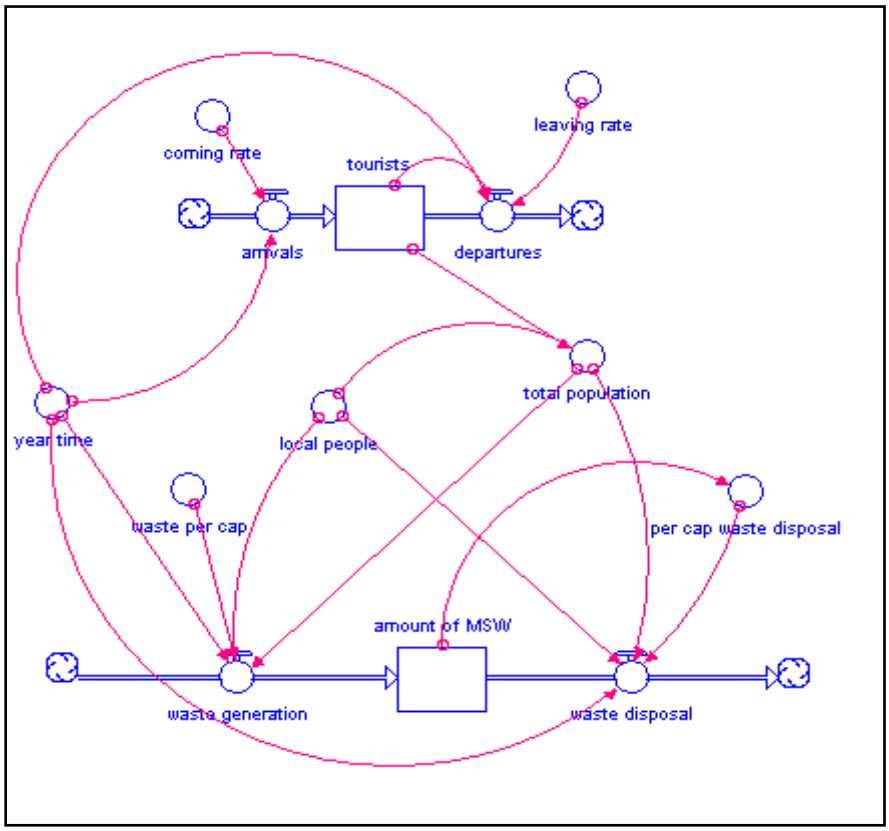

Figure 12 STELLA Model of Tourist's flow & MSW generation (own-made)

Variables, such as number of tourists, year time, coming and leaving rates, waste generation and disposal are factors that make the model work. The local population is considered as more than doubling during the summer season and thus the MSW generated is consequently doubled. For the provision of statistical data regarding the increased number of tourists and MSW generated during the last years in Corsica, the official web site of the French National Institute of Statistics and Economic Studies (INSEE) has been consulted and the attained data has been applied to the Stella model in order to create a graph illustrating the correlation between increased tourist numbers and MSW generation. The results and analysis of the STELLA model will be discussed later in section 5.3.2.

3.2 Data analysis

The data derived from the interviews was recorded and further transcript and analyzed. The observations and information collected gave enough data for describing and analysing the current situation and problems of the Corsica Island. These analyses enable the provision of some recommendations for further development, improvement and implementation of best strategies for managing the MSW on the island. More time and further research is needed in order to make more specific conclusions. Proposals and recommendations for future researchers could be outlined as well.

3.3 Limitations of the research

The main limitation comes from the fact that up to date nobody has done any research regarding the municipal solid waste management in Corsica, neither the impacts from the development of the tourism industry nor the correlation between both of the issues. Therefore, relevant case studies from different coastal regions and islands facing the same problem of fast tourism growth and waste generation problems were investigated and compared to the island of Corsica.

Time and language barriers have been considered as another limitation encountered during the conduct of the research.

Considering the interviews, both of them (personal and via e-mail) had the limitation concerning time and language barriers. In some cases, more time was needed to get an appointment and conduct a personal interview than the e-mail communication. On the other hand, the communication via e-mail did not always bring the desired answers, so further e-mails had to be written and thus more time was needed. Furthermore, nobody guarantees that the e-mail questions will be answered the next day. Therefore, the time limitation is

applicable for the e-mail communication as well and nobody can assure which method will be faster. Considering the language barriers, most of the time people that have been contacted, were speaking French and a little bit of Italian or English. There were also cases when people do speak fluently many languages. The advantage of the personal interviews, however, was the constant presence of a French speaking person, who was always ready to translate if necessary.

4 EU Legislation

National waste policies are usually strongly influenced by European legislation. EU directives are always compromises between countries that want to have higher standards and those who prefer to avoid any obligations regarding the management of waste. Binding targets directives are the ones under constant debates but also with the strongest impact (Dubois *et al.* 2004). New EU directives now require that all Member States are introducing legislation regarding collection, reuse, recycle as well as waste disposal methods. In 2006 directives on waste and shipments of waste were adopted by the European Parliament and the Council in order to strengthen and facilitate the control of waste disposal and waste shipments (Eurostat 2008). The most relevant for MSW directives are discussed below.

4.1 Waste disposal directive

Directive 2006/12/EC of the European Parliament and the Council is the EU framework directive for the limitation of waste generation and control on waste treatment and disposal methods (Europa 2007). The Commission has also published guidelines based particularly on the case law of the Court of Justice of the European Communities (CJEC) to assist the responsible authorities and the private sector in establishing which product is defined as waste or not (Europa 2007). Dubois *et al.* (2004) describe some main principles of the directive:

- The waste management hierarchy: prevention, reuse and recycle of the waste as well as waste-to-energy recovery
- The Best Available Technology (BAT) principle: all disposal facilities have to be equipped with the best available technology. Member States should establish an

integrated and adequate system of disposal installations. The BAT is selected based on three major criteria: technological, economical and environmental

- Self-sufficient principle: every country and every community is responsible for its own waste production
- Proximity principle: waste should be treated as close as possible to the place of its production and collection in order to guarantee less environmental damage
- Polluter pays principle(PPP): the taxes for waste disposal facilities are paid by the polluter rather than the money from tax payers

Beside these principles Europa (2007) explains that before the promotion of the waste management hierarchy, the EU framework directive first prohibits all kind of abandonment, dumping and uncontrolled disposal of waste. The EU Memebr States are required to submit a draft rules concering any difficulties faced during the treatment of waste. Member States are also obligated to ensure corporate governance (Dubois *et al.* 2004). The directive obligates every state to make a waste management plan on local, regional and national level. Every state is considered responsible for the control of its disposal facilities. In accordance with the European guidelines every Member State should also install a monitoring and reporting system as well as introduce a system of licenses (Dubois *et al.* 2004).

4.2 Landfill directive

In order to reduce as much as possible the negative impacts on the environment and on human health, the EU has laid down strict regulations considering the waste disposed to landfills. *Directive 99/31/EC* is intended to prevent or reduce negative effects of landfilling on the environment, particularly on surface and ground water, soil, air and human health (Europa EC 2009). This directive is a difficult compromise between nations. Its first proposal was in

1990, when the Commisson started the discussion and its final approval was in 1999 (Dubois *et al.* 2004). Having in mind that most of the EU countries are using landfilling as main waste disposal treatment, putting high standards has raised also the prices of waste management (Europa EC 2009). In order to avoid any risks, typical set up measures are described by both Europa EC (2009) and Dubois *et al.* (2004):

- Waste must be treated before being sent to the landfill
- Hazardous waste must be assigned to a separate hazardous waste landfills
- Non-hazardous waste landfills must be used for MSW and non-hazardous waste only
- Supervision of closure and aftercare processes is a necessary measure, because dumping of soil on an old landfill is not enough any more to put it out of sight
- Regarding PPP, a minimum price for landfilling is determined. In this price must be included costs such as: pretreatment costs, investment and operating costs as well as costs for closure and aftercare
- For the reduction of biodegradable waste sent to landfills, targets are set based on the amount of municipal biodegradable waste in 1995 as following:
    - 2006: 75 % of biodegradable waste sent to landfill
    - 2009: 50 % of biodegradable waste sent to landfill
    - 2016: 35 % of biodegradable waste sent to landfill

The directive puts also some requirements for the permits of landfill sites. Application for an authorization must contain the following information (Europa EC 2009):

- the identity of the applicant and description of the site
- a description of the types and quantity of waste to be disposed
- the capacity of the site
- the proposed measures for pollution prevention

- the projected monitoring and control operations
- the closure and aftercare plan
- the applicant's financial security

Another important issue to be considered from all Member States is that all existing landfills that do not comply with the provisions of the new directive must stop their operation as soon as possible (Europa EC 2009).

4.3 Incineration directive

Described by Dubois *et al.* (2004) *Directive 2000/76/EU* has the aim to reduce pollution of air, soil and water as well as the damage to human health and the environment by incineration. The directive puts technical standards for the incineration facilities where emissions such as CO, HCL, Total Organic Carbon (TOC), SO_2, NO, NO_2, dioxins etc. are limited.

4.4 Waste transport directive

The aim of *Directive EEC/259/93 and EC/1013/2006* is to control the imports and exports of waste both within and into or out of the European Union (Europa 2006). The reason for this directive is based on a conflict of some of the principles mentioned in section 4.1. Usually a producer attempts to recycle his waste at a lower price and sell it at the best price. However, this can create a conflict with the principles of self-sufficiency and proximity, according to which the producer must recycle and export his waste as close as possible (Dubois *et al.* 2004).

The *Directive EEC/259/93* grouped the waste into three different lists regarding different priorities (Dubois *et al.* 2004):

- Green list – free transport with just a notification to the government, for example sorted MSW
- Orange list – limited transport, when the waste is subject to a consent, e.g. unsorted MSW
- Red list – strongly restricted transport, e.g. hazardous waste

Products that are in the green list can be traded freely, but those in the orange and red lists fall under the principles of proximity nad self-sufficiency and their trade is resticted (Dubois *et al.* 2004).

Regulation EC/1013/2006 replaced the one from 1993 and set up some new priorities and changes. One amendment is the reduction of the number of lists for the shipment of authorized waste from three to two, where the red list is removed. Waste prohibited for shipments falls under separate lists (Europa 2006).

Described also by Europa, waste shipments must be a subject of a contract between both the sender and the receiver of the waste. When the waste requires also a notification, the contract should include a financial guarantee as well. Dubois *et al.* (2004) add that exports and imports out and into the EU are prohibited except for specific situations.

4.5 European impact

With the new directives, the European Union set up a start for sound minimum waste management policies for all Member States and put the end of the negligence of burning waste while polluting the environment, dumping randomly in open pits without any protection and exporting waste to third world countries (Dubois *et al*. 2004).

Furthermore, the directives put a clear vision toward the waste hierarchy, giving main concern to waste prevention, reuse, recycle and recovery. It is expected that the targets will become stricter in the future and this will have a strong impact on the waste management in Europe (Dubois *et al.* 2004).

5 Research findings and discussion

As already mentioned in the introduction, Corsica is one of the least polluted islands in the Mediterranean, but it is under the pressure of the continuously growing industry – tourism. Withstanding the environmental pressure under such circumstances is a difficult task. However, there are already many forces working on the encouragement of sustainable development in Corsica. Currently around 30% of the energy production is hydraulic (3 stations) and the wind power energy is quickly developing (2 stations). Furthermore, following an example of Ireland for preserving the environment and reducing the amount of waste generated, the use of plastic bags in the supermarkets has been forbidden (Corsica 2009).

5.1 Legal status in Corsica

The regional government of the island, the Assembly of Corsica or called also the *Collectivite Territoriale de Corse – CTC* (Territorial Community of Corsica) is seated in Ajaccio, the main city of South Corsica. There are CTC commissions responsible for major aspects concerning public life, where many policies are formulated (Corsica 2009). The executive division is made of six main Offices:

- *Agence de developpement economique de la Corse* (ADEC) – the Agency of the economic development of Corsica responsible for enterprise creation and development
- *Office de l'environnement de la Corse* (OEC) – the Office of the environment of Corsica managing all environmental issues
- *Office des transports de la Corse* (OTC) – the Office of transport of Corsica

- *Agence du tourisme de la Corse* (ATC) – the Agency of tourism of Corsica
- *Office de developpement agricole et rural de Corse* (ORARC) – the Office of agricultural and rural development of Corsica, dealing with the development of rural and agricultural planning
- *Office hydraulique de la Corse* (OEHC) – the Hydraulic Office of Corsica responsible for the water resources of the island

Since the creation of the local government CTC, the protection of the island's environment and the promotion of sustainable development became subjects of a main concern. The protection of the environment and the economic growth are challenging issues since the early 80s. The legislation has partially resolved this problem with the law issued on 13 May 1991 with which the general competence regarding this sector was given to the Assembly of Corsica and the Office of the Environment has been created (CTC 2009a).

The task of the management of human impacts on the environment has been given by the CTC to the department of pollution and risks prevention of the Office of the Environment of Corsica (OEC). The department is dealing with problems such as waste, air, water and soil pollution, natural hazards etc. The OEC is taking part in the waste management during the collection and treatment stages by helping technically and financially all the communities with the MSW and industrial waste production from private and public sectors. These activities are in accordance with the policy of the new EU framework directives (CTC 2009b).

Described by OEC (2009) in the Development Plan of Corsica, a priority has been given to the waste management problems. Based on this priority a contract between the state and the region has been prepared and with the help of EU funding a process of waste management program for the period 2000-2006 has been initiated (OEC 2009). The Office of the Environment is involved in providing monitoring data and information over many operations together with the French Agency for Environment and Energy Control – *Agence*

de l'Environnement et de la Maîtrise de l'Energie (ADEME). Some actions that are not financed by the EU funds must be covered by the OEC itself.

Under the waste law from 1992 and the requirements of the Ministry of the Environment, an Interdepartmental Plan for the Elimination of Municipal Waste (*Plan Interdépartemental d'Elimination des Déchets Ménagers et Assimilés - PIEDMA*) has been developed in order to harmonize the waste management policy on the island (OEC 2009). After the presentation of the plan to the Assembly of Corsica, it has been approved and put into force on 17th of December 2002 (PIEDMA 2002). An establishment of Regional Waste Observation Programs was expected under the supervision of the Office of the Environment (OEC 2009).

5.1.1 PIEDMA

The aim of PIEDMA is to coordinate the actions on local level as well as those of different economic actors during the period of 5 to 10 years and ensure the elimination of waste. It sets basic goals, both technically and economically feasible (PIEDMA 2002):

- Achievement of recycling and recovery of waste
- Implementation of equipment needed for collection
- Time for observation and evaluation of the investments

The plan is a dynamic and evolving instrument driven by communities, a significant tool of combining decisions taken by local public laws regarding waste that have been rejected previously from third parties (PIEDMA 2002).

In general, the plan is coming up to a more reasonable waste management system, trying to deal with the waste in all areas, finding out complementary solutions for the opportunities and constraints for waste recovery. This means an implementation of separate

collection, recycling and recovery of every waste that deserves to be recovered and not send to landfills as 'ultimate' waste (PIEDMA 2002).

The new guidelines on the waste management are defined by the Ministry of Spatial Planning and Environment with the circular of 28 April 1998, which have drawn lessons from plans done in the past and are now implementing updated, advanced rules adapted to both local and government priorities (PIEDMA 2002). The plan has several strengths:

- **Control on the costs** – a main concern of the circular is to control the costs of waste disposal and ensure that the recovery costs are economically feasible
- **Community's involvement** – the circular specifies that the design and implementation of the plan is strongly depended on the community's involvement as well as cooperation between local socio-economic associations
- **Production minimization** – the reduction of the production is based on national or European measures: weight reduction of packaging units and records favored by the policy. According to the local authorities (General Council, group of Communities) two types of actions are possible in Corsica:
    - ***Incentives for individual composting***: giving subsidies for an acquisition of a compost bins and spreading information for the production of the compost
    - ***Promotion of savings practices***: using tapped water instead of bottled one, using less packaging and plastic bags in supermarkets, etc.
- **Strict respect of the regulations** – the circular of 28 April 1998 highlights the need of strict application of the regulations concerning the creation or implementation of waste thermal treatment or waste storage
- **Packaging recovery** – the Decree of 18 November 1996 requires that the country should take into account the European objectives for the recovery of waste packaging:
    - Recovery of at least 50% and maximum 65% of all packaging weight

- Recycling of at least 25% and maximum 45% of the weight of all packaging materials

Thermal treatment with energy recovery is considered as a recovery treatment method.

- **Collection of 50% of the waste for recycling and composting** – in the circular of 28 April 1998, the Minister of the Environment states that the national objective is that half of the waste generated, for which the responsibility and control goes under local authorities, must be collected and recovered for reuse, recycle or biological treatment and agricultural use (PIEDMA 2002). The 50% is a national target set by the Ministry of the Environment, which however can be adapted to areas with specific geographical conditions
- **Treatment of ultimate waste** – the circular of 28 April 1998 puts the minimum rate for waste recovery and recycle, but leaves the choice of a method for dealing with the residual waste: sanitary landfills or thermal treatment with energy recovery

5.2 MSWM in Corsica

The waste management system in France is controlled by Municipalities. Three hundred and sixty towns are registered in Corsica with different waste sites, where Seveso sites are sites presenting risk in a case of accidents and Basol sites are polluted or potentially polluted (Laurian 2008). The percentage of the sites' variety is shown in table 6 and the locations in figure 13.

Table 6 Regional distribution of sites (Laurian 2008)

Region	N. of towns	N. of Nuclear sites	Towns with Seveso sites (%)	Towns with Basol sites (%)	Towns with illegal dumps (%)
Corsica	360	0	0.8	1.4	15.3

Figure 13 Sites' location (Laurian 2008)

Waste collection is also organized by municipalities. Usually, household waste is collected once a day from containers situated near habitants' houses. However, during the summer season waste can be collected from 1 to 5 times per day depending on the tourism development in the specific town (Arrighi pers. comm.). For instance, the municipality of Oletta (comprising several small towns and villages) is collecting MSW twice a day during the summer – once in the morning and once in the afternoon (Saliceti pers. comm.). However, the double work does not mean increase in the employment during the summer months. The number of employees during the summer is equal to the one during the winter (Marchetti pers. comm.).

Arrighi (pers. comm.) also explains that for the separate collection of MSW (paper, glass, cardboard) there are special days and hours defined by each municipality, so people are informed when the collection of a specific recyclable material will take place. Another option is to bring personally the separated waste to centers determined for this purpose (Arrighi pers. comm.).

5.2.1 MSWM system under PIEDMA

In order to improve the waste management system in Corsica, PIEDMA promotes recycling, reduction of disposal to landfills, prevention of dumps formation and decrease in transport costs of waste. Nine basins are under the control of PIEDMA (5 in North Corsica and 4 in South Corsica). Each basin is situated near a collection center which may include:

- a transit station for residual waste
- a main storage place or station for separate collection
- several local storage and collection stations
- a landfill that can accept also inert waste

Green wastes can be received for composting and can be collected as recyclable waste in composting stations situated near households or directly in the storage station. The geographic boundaries of the 9 basins are not static, but it is preferable that the basins are situated as close as possible to the collection centres in order to keep the sense of the whole waste management on the island (OEC 2009). The plan also proposes waste-to-energy recovery as a final treatment method.

5.2.2 The Fund of Corsica for Waste Modernization and Management (*Le Fonds Corse pour la Modernisation de la Gestion des Déchets – FCMGD*)

The Office of the Environment is managing the grand given under the Unique Programming Document *(Document Unique de Programmation - DOCUP)* by the European funds for regional development *(Fonds Européen de Developpement Régional – Feder)*. OEC is also a partner of ADEME with which it creates the Corsican fund for waste modernization and management. Both organizations faced difficulties created by local officials, private companies and associations regarding the waste management. Partnership has been established for a better cooperation between the State and the regions. It also contributes for the implementation of PIEDMA helping various stakeholders with financial and technical assistance and it has been put into practice by signing a framework agreement between the ADEME and the OEC (OEC 2009).

5.2.3 Interventions of OEC

Operations financed by the OEC, ADEME and the EU:

- research
- rehabilitation of landfills
- implementation of separate collection

- storage centres
- transfer stations
- sorting centres
- composting program
- individual composting

Operations financed by the OEC and the EU:

- storage centres
- waste-to-energy recovery

Operations financed only by the OEC

- management of polluting activities
- specific sites
- vehicles for municipal waste collection

5.2.4 Towards a regional waste observation

While implementing the waste management policy in Corsica, PIEDMA is also preparing a regional waste observation plan for which realization the responsibility is given to the OEC. The objectives of the plan are as follows (OEC 2009):

- to control waste generation and treatment from producers, collectors and disposers, creating a database system
- to spread all information regarding waste to policy decision makers and the general public

The evolution of waste treatment methods (collection of glass, light packaging and paper, called also multi-material collection) from 2003 to 2007 is shown in figure 14 (OEC 2009).

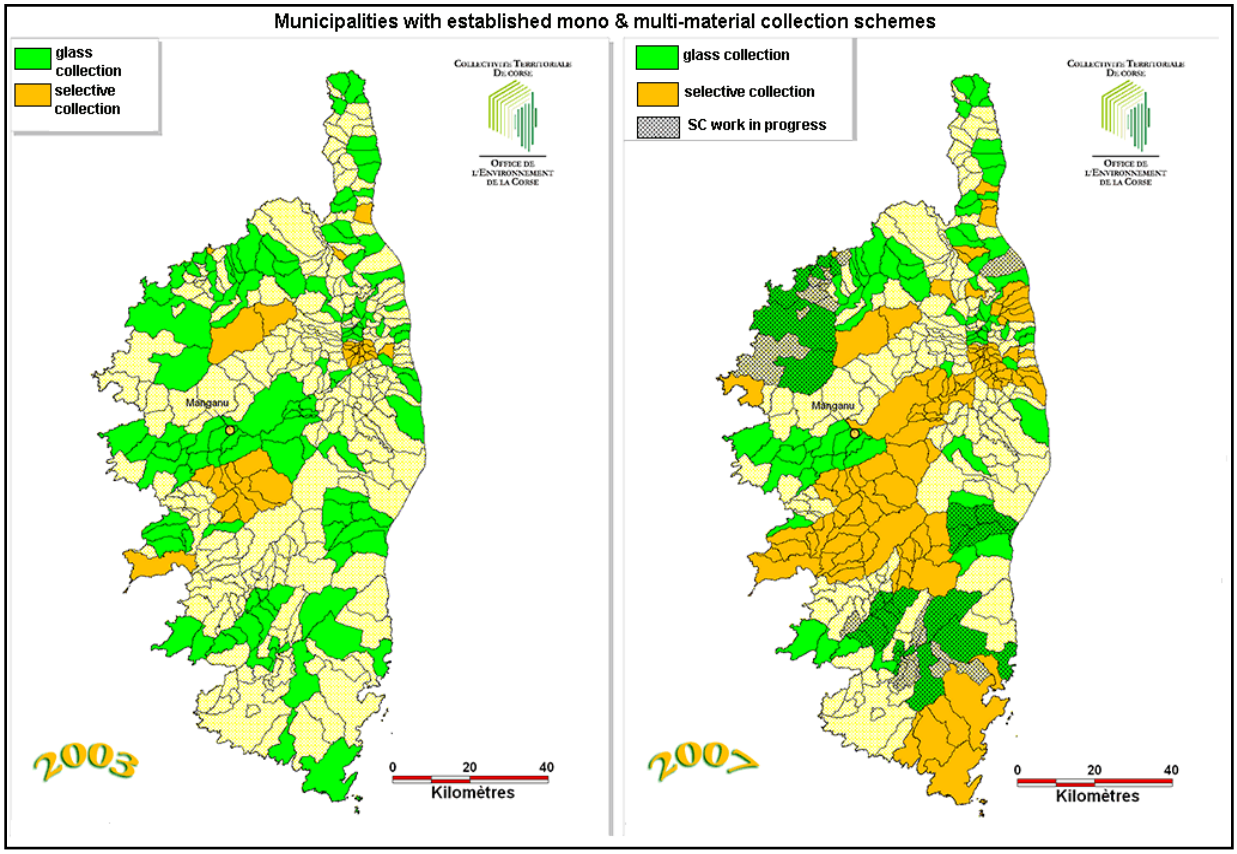

Figure 14 Evolution of Selective Collection within the years (OEC 2009, *with amendments*)

Despite the role of transmitting information (data collection and analysis), the plan of Regional Waste Observation is also responsible for the provision of information, concerning waste treatment methods, collection systems and the role of the communities, to the general public. The information can be also useful for officials responsible for the evolution of waste management system of the island and the development of waste treatment techniques (OEC 2009).

5.2.5 Current situation: SYVADEC

SYVADEC is the first Syndicate in France in charge of the prevention, recycling, recovery and treatment of household waste. It determines the waste management policy of

Corsica based on regional waste treatment plan. Established on 13 July 2007, its policy enters into force on 1st of October 2007 (Arrighi pers. comm.).

Syvadec controls and manages the MSW instead of the regional communities. The territory of Syvadec comprises 58% of the island population and 60% of the municipalities in the region. Until now 250 municipalities went under the policy of Syvadec (Arrighi pers. comm.). In December 2008, 76 more municipalities joined Syvadec and are waiting for its policy implementation (Saliceti pers. comm.).

Parallel to the creation of multi-stream treatment methods, Syvadec is also responsible for (Syvadec 2009h):

- creation of a Plan for Regional Prevention
- generalization of selective collection
- public awareness and information

5.2.5.1 General policy

The structure of Syvadec policy is organized around 4 strategic pillars. Having also in mind the unity of its territory, Syvadec has the opportunity to address the waste not only from technical point of view but also from a political (Syvadec 2009d). The four key issues of the policy are:

- ***focus on the prevention*** – the aim is to change the way of thinking and consider that the waste cannot be avoided. Inspired from the example of plastic bags removal in supermarkets in Corsica, Syvadec believes that the minimization of waste production at source is possible not only in Corsica but everywhere (Syvadec 2009d)
- ***development of local centres for recycling*** – the development of waste recovery and recycling meets several complementary goals: savings from transportation costs of recyclable materials to the continent; reduce the impact on the environment and create

new economic activities and local employment. Recycling creates 10 to 20 times more working places than thermal treatment or waste storage (Syvadec 2009d)

- ***increase the understanding for residual waste*** – having abandoned the option of incineration due to public disagreement in 2007, Syvadec is now trying to find different treatment options including combined pretreatment of residual waste, waste material and energy recovery with a landfilling as an ultimate waste treatment technique (Syvadec 2009d)
- ***development of an efficient and supportive regional management*** – the main objective is to apply the principle of proximity in order to decrease transport costs and create jobs closer to the production sites. Furthermore, every region is responsible for the waste it generates. The other aspect is the political and financial solidarity between territories reinforced by a dynamic financial incentive for selective treatment and sharing of equipments (Syvadec 2009d)

These strategic orientations have been validated by the Territorial Community of Corsica on 11th of July 2008.

The new vision of the Syndicate has two main points: the coherence of the area and the ability of influencing public's behaviour. Therefore, the main goal of Syvadec is to transform the waste management of the island from a technique where the main concern is to collect the consequences of society consumption into a management where the main idea is to change people's behaviour, raise awareness to a more sustainable way of living (eco-citizenship) (Syvadec 2009h).

Beside the efforts to promote waste prevention and different treatment methods, it is also necessary to create specific technical facilities for managing the residual waste:

- ***equipment for transfer and recycle*** – according to the 4 main strategies, the idea is to provide all regions with an appropriate recycling and transfer facilities in order to reduce the transport costs
- ***storage of ultimate waste*** – Corsica is facing a specific problem that forces the creation of large capacity storage stations in order to manage the current situation while working on the development of waste reduction at source. Therefore, the creation of appropriate facilities is necessary for waste harmfulness and quantity minimization. At present, there are two storage sites in South Corsica (Viggianello and Vico) controlled by Syvadec and two in North Corsica (Tallone and Prunelli) (Arrighi pers. comm.)
- ***mechanical-biological treatment*** – the main idea is to give equipment for mechanical-biological treatment to Corsica for separating the biodegradable residual waste from the dry one and in this way reach the objective for residual waste reduction of 35%-40% by composting and recycling of sorted materials (Syvadec 2009d)
- ***energy recovery from combustible solids*** – combustible solids are a waste fraction with high calorific value, including wood, paper, cardboard and plastics that make up about 25% of the incoming waste production. The idea is to use the recovery of energy as alternative energy for industries such as cement, ceramic and steel production. However, there are no plans for energy recovery implementation in Corsica. Due to the lack of appropriate facilities, Syvadec did not manage to develop any project. Contacts with the island of Sardinia have been established and the combustible solid materials are likely to be accepted for the cement industry there (Syvadec 2009d)

The implementation of the Syvadec technical structure has been validated by the CTC on 4th of May 2009 (Syvadec 2009d).

5.2.5.2 Syvadec infrastructure

The infrastructure of the waste management is an essential problem. How to grade the equipment in order to optimize its management and how to consider the environment of the site are some of the questions that need to be taken into account before organizing the infrastructure. Moreover, Corsica is having its specific characteristics such as insularity and seasonality. Syvadec is trying to answer all this questions offering different treatment methods suitable for the territory of the island (Syvadec 2009g). Since its establishment, Syvadec have chosen the following:

- to treat the urgency with the establishment of temporary facilities on certain territories that have no infrastructure
- to create step by step new treatment methods in order to meet specific goals

The new methods will be organized in a way to minimize the negative impacts on the environment, designed on the model 'zero discharge', wastewater treatment, utilization of biogas for electricity production, etc.

There are various existing constraints regarding the waste management in Corsica: geographical location, seasonality and availability of initial equipments. These constraints must be taken into account when promoting and developing new treatment techniques (Syvadec 2009g). The treatment facilities of Syvadec are:

- **landfill sites** – sites designed to receive waste without polluting the environment. They consist of several units in a complex sealing system (passive and active). When operating, these units are presenting a drainage network and collection of biogas. There are 3 landfill sites in Corsica: Tallone, Prunelli and Vigganello (Arrighi pers. comm.)
- **transfer stations** – stations where the waste is collected from different regions in order to be transported after to the sites for recovery and treatment. To facilitate

people's collection of recyclable materials and residual waste, the waste is accepted in the transfer station and further transported to different treatment centres. The transportation of waste must be organized in a way to minimize costs and impact on the environment (Syvadec 2009g)

- **recycling centres** – these are closed places that can accommodate bulky or dangerous waste. The sites accept waste materials that cannot be collected by traditional household waste collection system, due to the size, volume, density or nature of the waste products (Syvadec 2009g)
- **projects 2009**
    - **Pretreatment** – focus on the reduction of waste volume using techniques such as mechanical-biological treatment, etc.
    - **Replacement of provisional treatment facilities** – renovation in order to integrate the treatment facilities into the natural environment and be certified for Environmental High Quality (Syvadec 2009g)

5.2.5.3 Waste prevention and reduction initiatives

Prevention is the major goal of Syvadec. This is an essential concept, which appears in every action of the Syndicate (Arrighi pers. comm.). Prevention is a set of actions organized before the abandonment or the assumption of the waste by the community. It reduces the quantity and harmfulness of waste. Prevention shows people a new look of what they are consuming and what they are throwing away (Syvadec 2009e).

Since February 2008, Syvadec has strengthened his prevention centre whose mission is to develop a local program for prevention consisting of different strategies and initiatives. The implementation of the local prevention program promotes an action based on 3 main issues (Syvadec 2009e):

- ***Environmental benefits*** – reduce waste (removal of plastic bags, using recycled paper, composting etc.) and in this way limit the negative impacts on the environment and control the use of natural resources
- ***Economic benefits*** – managing waste is an important issue for all involved actors. Less waste production can lead to significant economic benefits. Furthermore, the prevention can be seen as a stimulating factor for a given industry, creating new office-branches and enterprises
- ***Social benefits*** – prevention measures often result in increase of environmental consciousness and development of solidarity

Some of the initiatives for waste prevention and reduction apart from recycling and selective collections are:

- **Composting**

There are several major goals for the introduction of composting in Corsica (Arrighi pers. comm.):

  - to reduce the quantity of waste at source close to its production by natural process
  - to reduce the volume of waste that must be collected by the community
  - to produce its own soil, for the period of 8-10 months

In 2008, households from two main areas have been equipped with composters. In 2009 Syvadec started again a campaign promoting composting. The aim is to distribute 5 000 composters throughout households from the whole Syvadec territory and give at least 10% of the island's population the possibility to divert 70kg of household waste into compost per year (Syvadec 2009f).

On 5th of May 2009, the Composting Plan started with a meeting at Vico, where more than 200 people gathered together and 120 composters were freely distributed to volunteers attending the meeting. Fifteen more reunions hold throughout the country managed to educate almost 3 000 people and 2 500 more composters were distributed. Technical advices and tips for making compost of high quality as well as practical guidelines have been given together with the composters (Syvadec 2009c).

- **Stop Advertisements**

As a part of its mission to prevent the increase of waste amount, Syvadec launched in 2007 the first campaign against the unaddressed advertisements in Corsica. These advertisements' letters comprise more than 40kg of paper per household for a year. For example, each year Corsica receives 4 500 tonnes of commercial papers (Syvadec 2009i). ADEME has already started awareness campaign on national level and Syvadec developed it on a regional stage. The Syndicate creates a sticker saying "*Stop Pub*" ('Stop the advertisements') as shown in Figure 15 in order to reduce the amount of unaddressed mails (Syvadec 2009i).

Figure 15 Stop Advertisements (Syvadec 2009i)

It must be noticed that all other addressed advertisements continue to be received normally. The sticker is available in every Syvadec office as well as on a web site from where it can be directly printed and ready for use (Arrighi pers. comm.).

The results of the campaign showed that in 2008, around 8% of the households in Corsica and approximately 4% in France started to use the sticker (Syvadec 2009i).

- **Smart Buy**

The generation of waste has been doubled in the last 40 years. The living style and consumption patterns have evolved and now people are using much more complicated goods consisting of packagings that represent 30% of weight and 50% of the produced garbage (Syvadec 2009a). It is necessary to educate the general public how to overcome this problem by buying in a smart way and thus saving money as well as protecting the environment (Arrighi pers. comm.).

In the second half of 2009, Syvadec started an initiative called "Smart Buy" – educating consumers how to do their everyday shopping in the supermarket. By purchasing in an eco-responsible way the economic and environmental gains are immediate. The motivation of the smart shopping cart is: "It is good for the planet as well as for the wallet" (Syvadec 2009a).

Promoting this campaign, Syvadec is trying to educate consumers how to combine the ecology with the economy. The "Smart Buy" is intending to teach the consumers how to change their everyday life and make savings while preserving the environment (Arrighi pers. comm.). ADEME conducted a comparison study on the content of two shopping carts:

  - One cart called the 'mini-waste cart' contains products with less waste content such as: reusable products without packaging, or with reusable ones, etc. (big bottles and cartoons of juice and milk instead of small ones, bigger packages of

coffee instead of small individual coffee capsules, dairy and meat products directly from the cutting stand instead of portions of individual packaging, etc.)

- and the other cart called 'maxi-waste cart' that contains the opposite – products that generate a lot of waste such as individual cans, bottles, capsules, tissues etc.

The comparison study showed that the mini-waste shopping cart not only brings benefits for the environment but indeed it saves also the consumer's money. On the selection of 150 necessary household products, for the use of one month, the mini-waste cart saves approximately 50€ compared to the maxi-waste cart (Syvadec 2009a). The web site of Syvadec shows also this comparison on a video, trying to inspire as much as possible the potential eco-consumers.

5.3 The relationship between tourism and waste

5.3.1 INSEE estimations

Considering the importance of the tourism industry for the island of Corsica, a research was conducted by the OEC in order to determine the influence of tourism activity on the generation of waste (PREDIS 2004). Estimates done by the French National Institute of Statistics and Economic Studies - INSEE, categorized the tourism activity into two types: tourist-market (hotels, camping sites, residence houses for rent) and tourist non-market (second-home houses). The occupancy rate of those tourist activities is defined based on statistical data provided from the Agency of Tourism in Corsica (number of overnight stays) as shown in table 7 (PREDIS 2004).

Table 7 Residents & Tourist Population in Corsica (PREDIS 2004, *with amendments*)

Population	2003	2009	2014
Residents	265 000	272 000	278 000
Tourists	82 000	92 000	100 000
Total	347 000	364 000	378 000

The tourist population in 2003 is representing approximately 30% of the permanent population of Corsica. Estimations show that in 2014 the tourist's number will increase to 100 000 or 36% of the Corsican residents (PREDIS 2004).

PREDIS also describes that the tourism industry generates a significant amount of waste (34 000 t/year), 15 000t/year (44%) of which from commercial activities (hotels, restaurants, camping etc.). Syvadec gives more data regarding the increase of waste amount during the summer, comparing the months of January and August. The waste generated during January is equal to 6 100 tonnes and in August is approximately 50% more – 11 460 tonnes (Arrighi pers. comm.). Arrighi also states that the waste generation usually is stabilized again in September.

5.3.2 STELLA modeling results

The results from the Stella modeling proved that the increase in tourists' arrivals is influencing drastically the waste generation and its amount as shown in the following graph.

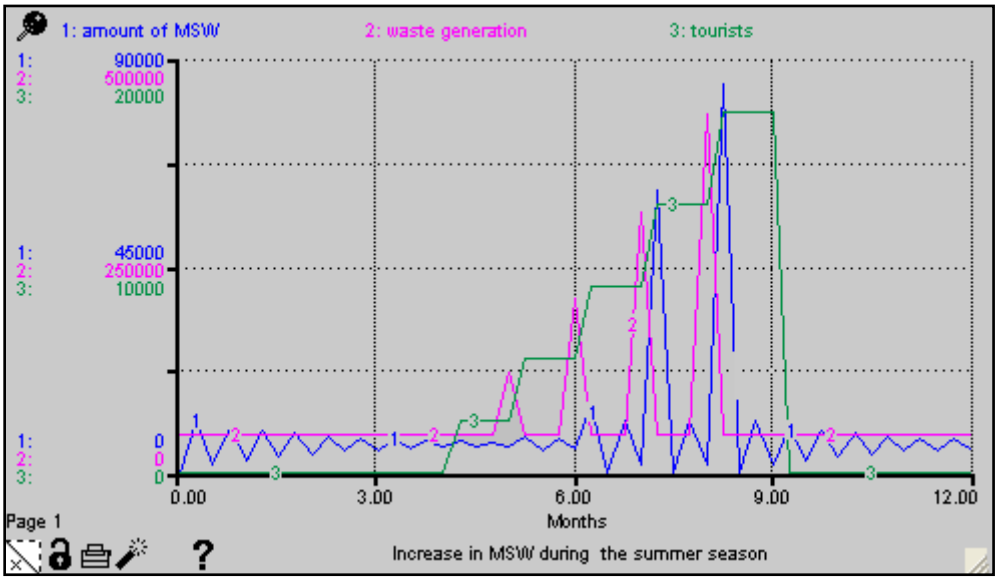

Figure 16 Increase in tourists' flows and amount of MSW during the summer (own-made)

Figure 16 illustrates the tourists' arrivals variation during the year, showing that in the winter the presence of tourist is equal to zero. The arriving period starts from April/May and finishes at the end of September. During the vacation period, tourists are coming and going, but the total number of visitors is increasing exponentially from May to September. The amount of MSW generated during the winter and summer is also shown in figure 16. It can be seen that waste generation and waste amount have a constant rate during the winter months and is highly increasing during the summer. The importance of the model is to show the relationship between the tourism industry and the waste generation in Corsica, and therefore increase the attention and awareness for the need of an appropriate MSW treatment techniques suitable for the island peculiarities.

5.4 Summary

It has been seen that the tourism is influencing significantly the increase in waste generation in the island of Corsica. Despite the progress that has been made in 2009 due to projects conducted by Syvadec, the generation of waste is still too much, its recovery is less

than 7,5% and more than 75% is landfilled as already discussed in section 2.3.1 (Syvadec 2009j). Corsica does not have appropriate facilities for residual waste treatment and is baring a lack of storage capacity in accordance with the regulations (Syvadec 2009b). The situation of South Corsica has been improved, but North Corsica is still suffering a shortage of storage capacity in a short term (Arrighi pers. comm.). The Assembly of Corsica had validated the proposals made by Syvadec for managing the MSW with new technical infrastructure and facilities without modifying the policy of PIEDMA. Thus, Syvadec is now promoting projects on a short and medium term, for the creation of mechanical – biological treatment stations and storage centres in both South and North Corsica (Syvadec 2009b). As Arrighi (pers. comm.) said, since 2007 when Syvadec has been established until now the MSWM system on the island has been significantly improved and more developments are expected in the future.

6 Conclusion and recommendations

6.1 Conclusion

MSW in small island regions has some characteristic features already mentioned in the introduction, which make it unique from MSW found in larger industrialized countries. It is important that these differences are considered when creating a MSWM plan.

In highly populated regions and tourist islands such as Corsica, where the population doubles during the summer, it becomes more difficult to find space for landfills. Disposal sites are full and the NIMBY syndrome as well as the specific island conditions and geography are some of the reasons for the limitations faced while looking for new locations suitable for landfill sites. Collection, disposal as well as recycling of waste are becoming more expensive over the years. Therefore, waste prevention and reduction are the preferable options for waste management. However, to reduce the amount of waste at source means to reduce the comfort of living. Thus, it can be concluded that waste is a quite complicated issue and there is no easy solution.

Before the establishment of the PIEDMA, Corsica suffered from a lack of adequate treatment facilities for MSW in order to meet European standards. This situation posed threats for human health and the environment. The PIEDMA plan was intended to organize the collection, transport and disposal of household waste. The main principles of the plan as already discussed in section 5.1.1 and 5.2.1 are: to promote the separate collection of all materials from organic matter, to limit the disposal to landfills only for ultimate waste if necessary, to organize the collection and transport of waste in such a way as to reduce costs, to promote rail for waste transportation wherever possible and to rehabilitate illegal landfills.

In recent years the MSWM system in the island of Corsica has been improved due to the PIEDMA regulations and the creation of the Syndicate for the Recovery of Household Waste in Corsica (Syvadec). Since its establishment in 2007, the Syndicate managed to implement its policy in almost 60% of the island territory, promoting new waste treatment strategies and planning more initiatives for the future.

In order to continue the research about the correlation between tourism and MSWM in Corsica, besides the research done for this thesis, the study could be extended with further investigations on some problematic issues that have not been examined due to time limitations. There are several recommendations that further researchers must take into account to achieve their aim and objectives and to obtain a significant quantity and quality of information:

- take into account the language barriers and plan accordingly
- conduct a questionnaire survey within the local population in order to get information how well they are informed and aware of the treatment options of their waste
- conduct a questionnaire survey within the commercial sector (hotels, restaurants) in order to see if they are promoting separate collection in the hotels, using mini-waste products, less packaging etc. If the results are negative, then propose an educational campaign especially for the staff of the commercial sector which will further educate their guests

During the research period it has been also noticed that most of the general public is not well-acquainted with selective collection, recycling and composting projects promoted throughout the territory of the island. However, in order to prove this assumption, such questionnaires have to be conducted by future researchers. General recommendations regarding tourism development and MSWM system are discussed in the following section 6.2.

6.2 Recommendations

In order to manage the problem of tourism and waste, improvements must be done considering main aspects of both the tourism industry and the MSWM in the island of Corsica. The tourism development and the MSWM system in every country have its specific characteristics and there is no certain formula that can have success in all destinations. Therefore, actions should be taken in order that every country finds out its own formula based on own requirements and conditions.

Ellul (1996) grouped some general recommendations for managing the tourism activity into four categories and some of them could be applied to the situation in Corsica as illustrated below:

- **Planning**
  - every hotel, residence house or camping site should develop an educational campaigns in order to improve visitor and tourist behaviour through enhanced environmental awareness and avoid degradation of natural resources while promoting leisure activities
  - the local government should take into consideration the carrying capacity of the island when developing the infrastructure and tourism activities and provide an environmental impact assessment for every tourist development
  - every municipality should be responsible for its coastal areas and rehabilitate all damaged regions as well as create preventive and protective measures to control the coast degradation
- **Legislation**
  - tourism organizations should try to enhance public's awareness for preserving the environment

- the island government should introduce measures in the present legislation in order to regulate some recreational activities that may bring harm to the environment as well as restrict such activities in certain periods of the year

- **Economic**
  - taxes, grants and incentives should be introduced in order to stimulate any tourism development that promotes sustainable and environment-friendly use of natural resources
  - fiscal and other control measures should be established to direct the private initiatives towards environmentally conscious investments (polluter pays principle)
- **Research**
  - criteria and indicators should be created to help measuring the impacts of tourism on the environment

Recommendations regarding the MSWM system are also a subject of variation due to different regulations, geographic and seasonal conditions in every country. Some actions proposed by *Le Grenelle Environnement* (2007) are similar to the ones found out during the research period. Grouped in four main categories, these actions can be used as general recommendations for the specific situation of the island of Corsica. All of them are based on one motivation: to reduce the quantity of waste generated and promote prevention and recycling as well as decrease the waste dumped or incinerated:

- **Action 1: to reduce the production of household and similar waste**
  - a fair incentive pricing should be introduce as fast as possible for the funding of public waste services
  - the principle of environmental responsibility should be developed amongst producers in order to stimulate the eco-design products and thus reduce waste

- the service life of some products should be prolonged
- companies should be guided in their waste prevention and reduction initiatives
- development of local plans for waste prevention should be enhanced

- **Action 2: to develop material recycling and organic waste recovery**
  - a boost should be given to the recycling of household packaging waste
  - as promoted by Syvadec, the projects for recovery of organic waste should continue their development and implementation all over the island
- **Action 3: to understand better and control the impacts of different forms of treatment methods**
  - guarantee all assessment forms of the impacts of waste material recovery processing to the environment and human health and be ready to implement a more appropriate regulatory framework
  - treatment options for miscellaneous waste and other specific waste that may cause risks should be developed
- **Action 4: to improve the consultation, information and innovation in the MSWM system**
  - the awareness for waste reduction should be increased among the general public, the commercial sector as well as companies and organizations, and citizens should be provided with information for improving the quality of waste sorting
  - information should be given to the public regarding the treatment of their waste
  - technological research and innovation of prevention, recycling and waste recovery should be strengthen with a focus on the impacts on the environment

and human health as well as the socio-economic aspects of the waste management

People should be aware of the fact that the development of tourism brings more and more waste and the accumulation of this waste within the years if not treated in appropriate way can consequently lead to a decrease in tourist flows. Therefore, a combination of both tourism development and MSWM recommendations as well as further improvements in the field of waste management and implementation of the initiatives promoted by Syvadec, together with an increase in public awareness are key issues in order to keep the tourism industry growing and at the same time preserve the environment and natural resources in the island of Corsica.

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Appendix I

Interview questions

All information and materials related to the tourism and municipal solid waste in Corsica as well as the relation between them will be of great help. Here are also some general questions in order to clarify the objectives of my research.

1. Can you tell me something more for the development of tourism industry over the last few years and what are the positive and negative impacts of tourism on the environment?

2. One of the negative impacts of tourism industry on the environment is waste generation. Do you think that the amount of Municipal Solid Waste (MSW) in Corsica has increased since the development of the tourism industry? Can you provide me some statistical information and materials supporting your answer?

3. How was the situation with the MSWM years ago, when the tourism industry was not developed so much? Is the management system better or worse now? Has the MSWM system improved in recent years?

4. Do you think that different tourists are producing different amounts of municipal solid waste and different types of MSW (meaning different nationalities: Germans, Italians etc.)?

5. What type of tourism has higher percentage in Corsica (camping, private boats, hotels etc.)? And what are the impacts from each different type?

6. Did somebody already do a research or analysis of the relationship between tourism and MSW? If yes, could you provide me some information about that?

7. As I heard, in some regions different communities combined their efforts for managing the MSW problems. Is this the same in the region of Corte? If yes, when did the Communities combined? How and who gave this idea and why? Is the situation better now, after the integration of all Communities from the region? Is this strategy implemented only in North Corsica or also in the South?

8. Can you tell me in more detail how the Community of Corte (and if possible other Communities you are acquainted with) is dealing with the MSW in the region (collecting, reducing, recycling, transferring, transporting, disposing)?

9. Do you have any information stating approximately how much municipal solid waste (domestic and commercial) in kg is produced per capita per year? And what type of taxes is paid from the population for the waste generated?

10. Do you have an idea or can you provide me some statistics regarding the amount of MSW produced during winter and summer seasons in order to make a comparison between both (with and without tourists)?

11. What can be defined as the main problems for the MSWM in the island of Corsica?

12. Regarding legal status, does Corsica obey some specific legislation for the island or does it follow the same regulations as France?

13. What is the current situation with MSW? Where does the waste go now, when most of the sites, as I have heard, are closed? Are there landfills still functioning and where? What are the other ways of treating the waste in Corsica (recycling, composting, incineration or shipping the waste to mainland regions)?

14. When was the incinerator near St. Florent closed and what were the reasons for its closure?

15. When was Teghime closed and what were the reasons for its closure? Where is the waste from the region disposed of now?

16. How many landfills are there in Corsica? What are the other waste management disposal methods in Corsica?

17. Are there any projects for implementing the 'Waste Management Hierarchy' or the '3Rs' as a strategy for dealing with the MSW problems?

18. What are the initiatives taken or planned to be taken in the future in order to improve the MSWM system in Corsica?