Waste Problem and Management in Insular and Isolated Systems. Case Study in the Canary Islands (Spain)

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Abstract

The municipal waste management is becoming increasingly important in regional policies. While, on one hand there are currently high rates of recycling, it is also true that waste production grows exponentially. Waste management is a difficult task, but in the case of island territories is very complex, being isolated and limited territories. Also the need to establish a plan for restoration of degraded areas, as landfills must be considered. Given the continuous increase in the amount of waste managed, waste is one of the biggest problems facing environmental management in the Canaries. In small and limited spaces such as islands, even taking into account the increased capacity of waste recovery is where it has the greatest sense premise that "the best waste is not produced". The Canary Islands lie with the challenge of developing a management model that solves the collection and treatment of new waste streams according to the EU, national and regional legislation. It has to be taken into account its character as an island with an important tourist population, which, although not considered legal population, is generating waste.

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1. Introduction

As time goes by and the runaway economic and population growth experienced by the islands, it has been long forgotten that much of what we call today and we considered waste were earlier reused as domestic and local resource. Changes in consumption patterns, rapid urbanization of the population and an increase in living standards of the citizens have also led to a more significant increase in the size of the problem, which today has a tremendous and unprecedented scale in isolated and limited territories such as islands.

One of the oldest methods for getting rid of waste has been freely throwing them away without any control in many different places, which are not far from the population center where they are generated (ravines, near roads, abandoned quarries etc.). This system of uncontrolled disposal of waste entails several problems: the presence of rodents and insects, fire risk, presence of odors, pollution of water and air, lack of aesthetic and environmental degradation.

Considering the basic European standard waste is Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008, known as the Waste Framework Directive, all island systems must have a plan waste management, which should at least consider the following points:

- Decreasing the generation of waste
- Reusing
- Recycling
- Energy valorization
- Landfill deposit

There is a great problem in waste management in island spaces all around the world, from Hawaii and the islands of the Caribbean to the Azores and the Canary Islands, Malta, Cyprus and Mallorca, among others. The limiting characteristics of the territory greatly impede the activities of collection, transportation, storage, treatment and disposal of waste and entail high management costs, compounded by the need to transfer waste to remote areas. Particularly, the common problems of these places are:

- Reduced number of facilities for treatment or disposal
- Importance of tourism
- High population density
- Limited territory to locate landfills
- Difficult to achieve economies of scale
- Transportation of waste to the mainland

2. Case Study in Canary Islands

The Canary Islands are a Spanish archipelago located just off the northwest coast of mainland Africa, 100 kilometers (62 miles) west of the border between Morocco and the Western Sahara. The Canaries are one of Spain's 17 autonomous communities and are among the outermost region of the European Union proper. The Canary Islands have a population of 2,117,519 inhabitants (2011), making it the eighth most populous of Spain's autonomous communities, with a density of 282.6 inhabitants per km². The total area of the archipelago is 7,493 km² (2,893 sq. mi).

The Canary Islands has its own law on waste, Law 1/1999 of January 29, which purpose is the management of the waste generated in this region. In the Canary Islands, only 9% of the waste is selectively collected, being the national average in Spain 16%. The primary treatment of waste in Canary is landfill, and a large part of the generated biodegradable waste goes to landfill. Another issue to note is that the islands have a very important economic sector related to tourism, which translates into an equivalent population much higher than the census, the number of tourists per year usually exceeding 10 million. The distance to the
mainland to the islands represents another major handicap. Residues in Canary are classified into the following types:

- Municipal waste
- Special waste
- Health care waste
- Industrial-hazardous
- Livestock waste

There are 7 waste management & environmental centers in the Canary Islands. The integrated waste management plan of the Canary Islands is developed in different areas for different types of waste: municipal, special, industry, health, livestock, agriculture, forestry and dangerous. In regard to urban, establishes the following basic objectives:

- Insularity of urban waste management (collection, transportation, treatment and disposal)
- Integration with other waste streams (e.g., processing of plastics from greenhouses in conjunction with those from urban waste)
- Recovery of hazardous waste in the municipal waste
- Recovery and valuation of those waste fractions that are feasible from both a technical, economic and environmental
- Safe disposal of non-recoverable fractions
- Conduct communication campaigns and training

The Canary Islands is the second highest Autonomic Community in generation of municipal waste during the period 2010-2011, with an average of 679 kilograms per capita per year, behind Balearic leading this statistic. In relation to the whole country, where the average yield is about 500 kg per capita per year, in Canary Islands an increased production of municipal waste is given. This can be due to the large number of tourists visiting the islands annually. Reference production of waste is described in Table 1.

Table 1. Evolution of the production of urban waste in the Canary Islands (source INE)

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban Waste (Tm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>1.141.005</td>
</tr>
<tr>
<td>2006</td>
<td>1.397.206</td>
</tr>
<tr>
<td>2007</td>
<td>1.210.410</td>
</tr>
<tr>
<td>2008</td>
<td>1.255.650</td>
</tr>
<tr>
<td>2009</td>
<td>1.151.349</td>
</tr>
<tr>
<td>2010</td>
<td>1.439.982</td>
</tr>
<tr>
<td>2011</td>
<td>1.388.895</td>
</tr>
</tbody>
</table>

The greatest weaknesses of the waste management system of the Canary Islands are based on a lack of infrastructure and space for new landfill cells, few managers for separate collection, recycling containers few and paucity of data in general. In the case of special waste such as tires there is a progressive increase due to the increased number of vehicles, and the reuse and recycling are complex. Hazardous wastes are managed outside the islands, thereby significantly expensive management.

3. Landfill restoration in insular systems

The restoration of degraded areas is born as one of the possible solutions to the impacts made by human activity, whose activities carry the deterioration of the natural environment (Gómez, 2004). Soils, forests,
canyons and in general all kinds of ecosystems and the plants and animals that inhabit them, suffer daily degradation caused by all kinds of works such as roads, power lines, dams, quarries, landfills, etc.

Wasteland restoration means having a scientific and technical knowledge needed for proper monitoring and implementation of the actions of plant restoration or decontamination and environmental integration, aimed at solving the problems of watershed restoration mines, public works, monitoring desertification and biodiversity conservation.

In insular systems, degradation of natural areas is a major environmental problem, mainly due to the fragility of ecosystems, which in some cases, such as the Canary Islands involve breaking the balance of relict plant communities.

In addition to this impact, there is the fact that one of the peculiarities of the Canary Islands for tourism is the environmental values of the islands, especially the non-capital that makes much quality tourism attracted to these values.

Around the Canary Islands the presence of uncontrolled landfills and old abandoned objects seen. Records by illegal dumping of garbage in the Canaries are greater than any other environmental offenses, including illegal constructions. All this leads to the indiscriminate and constant proliferation of illegal dumping, especially in coastal areas and ravines whose degradation begins to be worrisome, especially on islands like Gran Canaria and Lanzarote.

Infringing activity on environmental issues has been significantly reduced in the Canaries due to increased inspection and control. These spaces, like the controlled landfills require a recovery order to increase the environmental quality of the site (Santamarta, 2013).

The key actions of the restoration work include:
- Excavation and removal of waste in order to achieve a final relief as consistent as possible with the environment
- Contribution of topsoil to facilitate landscape integration
- Revegetation with species adequate to the environment
- Perimeter fence to prevent further releases

3.1 Possibilities for energy use of waste

Since the Canary Islands are dependent on foreign energy, landfills offer the possibility of generating power and in some way enhance the waste stored in the cells.

The organic waste disposed in a landfill undergoes biological degradation during which landfill gas is generated, which consists primarily of methane (50-70 %), carbon dioxide (20-50 %), nitrogen (4-20 %), water vapor, hydrogen sulphide and organic halogen compounds and organosulphur. Methane has a lower heating value (LHV) of about 8900 kcal/Nm³.

The environmental impact and the combustible nature of landfill recommend its uptake and subsequent utilization of biogas energy, besides obtaining a financial benefit and reducing foreign energy dependence of the islands, although this supply is a very low percentage compared to the demand external, may be useful for supplying the managed waste facilities.

On the other hand an environmental benefit is realized because if that energy is not used to that gas would be emitted into the atmosphere can cause:
- Fires and explosions
- Toxicity
- Odors
- Damage to vegetation and wildlife
- Greenhouse Gases
3.2 Success case in Tenerife, Canary Islands, El Palmentum

The case discussed below is a complex restoration of a landfill as a botanical park, according to peculiarities of the climate of the Canary Islands. The Palmetum Santa Cruz de Tenerife (Fig. 1) is a botanical garden of 12 hectares with a maximum height of 42 m above sea level, specializing in the palm family and biogeographies divided into sections. It is the theme park with the largest collection of palm trees in Europe.

The Palmetum occupies the space of a former landfill abandoned beside the closed 1983. Its conversion into a botanical garden was started in 1995, while currently closed awaiting funds for its reform and opening sea. The overall objective was to transform and improve one of the most degraded areas of the city of Tenerife. Another important condition was that the city of Tenerife grew to that point. The biggest problems that the technicians responsible for this great project found were initially a lack of fertile soil, which had to be transported from other areas of the island, and the stability of the mountain of solid waste was solved by blocking the mountain with a maritime defense. Finally, against the effect of residual gases due to fermentation was a complex system to construct and burning exhaust gases, to prevent high temperatures kill plants. The case discussed below is a complex restoration of a landfill as a botanical park, according the peculiarities of the climate of the Canary Islands.

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The Palmetum has become a grand experiment of acclimatization, with the presence of some 1,200 plant taxa, the most singular represented by the palm family and species from around the world like Cuba, South America, Indochina, New Guinea, Borneo.

4. Conclusions

Population growth, new cultures of consumption, increased use of rapid aging goods and the widespread use of non returnable packages made with non-biodegradable materials are factors that contribute to increased waste generation in the islands and involve increased the needs and capabilities of their management.

The efficient and sustainable waste management will compromise many variables for environmental future and life quality of the inhabitants of small areas, such as islands, not to mention its outstanding influence on the economy and on the health of companies and different sectors, with a focus on tourism, as many islands have this vector as an economic sector.

Waste generation in the islands has grown significantly at the same time on the continent. Therefore, it is necessary to prevent the generation of excess waste through a series of steps that can be summarized in the following points:

- Avoid food waste
- Reduce paper use by businesses and schools
Reduction of packaging
Reuse of goods and products
Training and awareness campaigns

It must be kept in mind that in the islands, in relation to waste, there is seasonal due to tourism where the increase of waste is high and saturates the facilities, although the Canary Islands tourist flow is constant throughout the year.

Experiences made in other European islands show that it is possible to improve the performance of waste management at a reasonable cost and increase their level of self-sufficiency in waste treatment. Among the ideas for improvement of waste management in the islands include (Puig, 2011):

- Implementation of systems for self-management of the organic fraction
- Establish models door to door collection
- Promote treatment facilities to small scale
- Adjust the rates of waste generation thereof

In the case of forest and agricultural waste, forest biomass and its use may become an economically profitable activity so clearing forests should be not only taken into account as a way to end or reduce the number forest fires but also as a source of jobs, primarily in rural areas of the islands, although the problem with this option is the lack of waste managers and the lack of reliable data in their generation.

Lack of awareness of the risks present and future condition and poor implementation of an advanced culture on waste minimization and recycling responsibly, significantly increase the scope of the problem.

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