

Municipal waste management in remote areas of Spain: islands and rural communities

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Abstract

The Spanish population distribution further complicates municipal waste management. Only 0.8 percent of Spanish municipalities have more than 100,000 inhabitants, whereas 60 percent have less than 1,000 inhabitants. This concentration of population in smaller administrative units gives waste collection a more rural character.

Special attention has to be paid to Spanish islands. Waste generation in the islands has grown significantly while tourism has done. 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 in some cases, as the Canary Islands, tourist flow is constant throughout the year.

Experiences carried out 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 Spanish remote areas, include:

- 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.

Keywords

Islands . Isolated areas . Municipal waste . Remote areas . Rural communities.

Introduction

Municipal waste is waste collected by or on behalf of municipalities. It includes household waste originating from households (i.e. waste generated by the domestic activity of households) and similar waste from small commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that treat or dispose of waste at the same facilities used for municipally collected waste. Municipal waste is only part of total waste generated (about 10%), but its management and treatment often represents more than one-third of public sector financial efforts to abate and control pollution [1]. The amount and composition of municipal waste vary widely among countries, being related to levels and patterns of consumption, the rate of urbanization, lifestyles, and national waste management practices.

Each year, ca.7.5 billion tons of resources are consumed in the EU. The environmental problems associated with the extraction and production of material resources include impacts on land, water and air, the movement of large quantities of materials and high energy consumption, toxic emissions and large-scale waste generation. In this sense, almost 3 billion tons of waste are annually produced in the EU, of which only 40% is reused or recycled, with the rest being landfilled [2]. In the particular case of Spain, material recycling tripled since 2000, but it still covers only 17% of municipal waste. Two-thirds of waste in Spain is still landfilled [3].

Europe in general, and Spain in particular, have been traditionally using more and more materials and, this has been the trend for several decades with the exception of short term decreases due to economic recession. This is the current situation in Spain: in 2008 the total amount of municipal waste (household and equivalent) generated in Spain reached almost 25.3 million tons (556 kg of waste per capita). A total that in 2013 reached 20.9 million (455 kg of waste per capita). The result is a decrease, in 5 years, of 17.3% (18.2% in terms of per capita) [4]. Surely that behind this very positive fact, as it is the reduction of waste generated, it is the increasing awareness by the population that waste can pose a serious environmental problem. Also, we need to value the efforts made by the different administrations with public awareness campaigns. But it is not less true that this reduction of waste generation has also much to do with the economic crisis that began in 2007. That is, a reduction of waste as a result of the shrinkage of economic activity, particularly commercial activity. It is easy then to foresee that after Spanish economy recovery the waste generation will return to an increasing trend.

Furthermore, household waste distribution differs between Spanish regions from 727.4 kg per inhabitant in Balearics islands to 365.9 kg per inhabitant in Madrid (Fig. 1). The highest household waste production rates in 2013 were reported in the Balearics and Canary islands, remote regions that are also important holiday destinations, where tourists produce waste although they are not considered inhabitants.

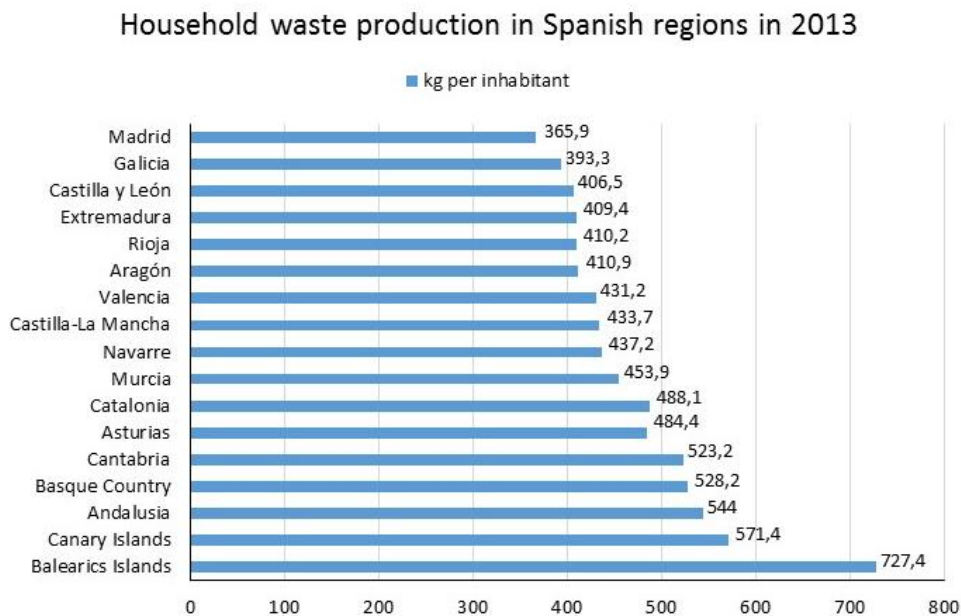


Fig. 1 Household waste production in Spanish regions in 2013. Source: INE, [5]

The Spanish population distribution further complicates municipal waste management. Only 0.8 percent of Spanish municipalities have more than 100,000 inhabitants, whereas 60 percent have less than 1,000 inhabitants. However, cities with more than 100,000 inhabitants represent 50% of the population and produce 70% of the waste, while municipalities with less than 1,000 inhabitants represent 5% of the population and produce 3% of the waste [6]. Furthermore, 90% of the Spanish territory counts on a population density less than 20 inhabitants per km² (Fig. 2). This dispersion of the population and its concentration in small administrative

units give waste collection a more rural character. Furthermore, there are rural and island areas whose characteristics cause them to be isolated zones. In order to perform the upscale at European level a threshold of “45 minutes travel time to reach an urban center with at least 50,000 inhabitants” has been selected to classify a commune as “remote” or “close to an urban center”. According to this definition, 55% of the Spanish territory can be considered as remote (Fig. 3).

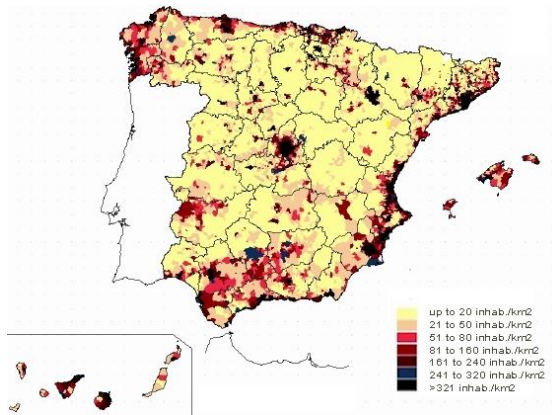


Fig. 2 Density and distribution of the population in Spain

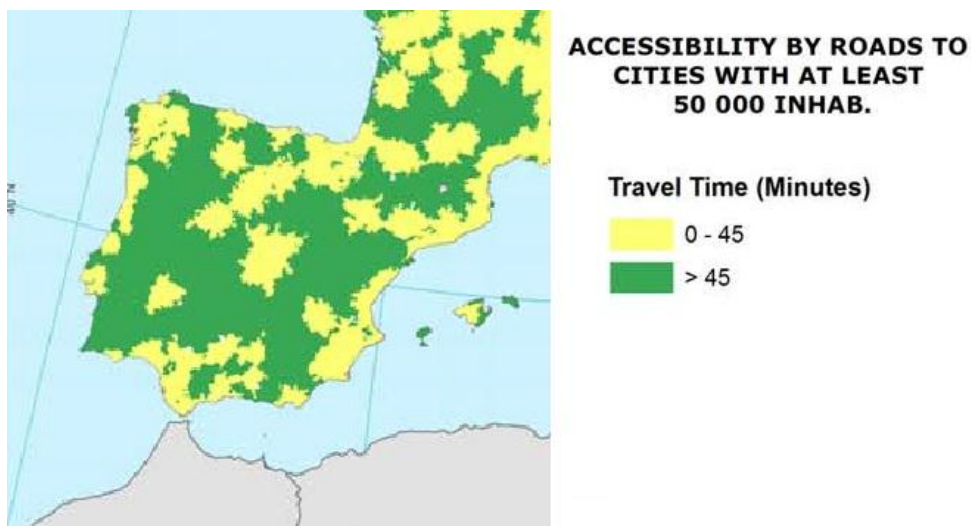


Fig. 3 Remote areas in Spain. Source: adapted from Jonard et al. [7]

Difficult access, above all at certain times of the year, locations far from centralized municipal management services, population dispersal, etc., are factors that make these areas a municipal waste treatment challenge. Lack of awareness of the existing risks and poor implementation of an advanced culture on waste minimization and recycling responsibly in these areas, significantly increase the scope of the problem.

Special attention has to be paid to Spanish islands (Balearic and Canary), since they also fit in the category of remote areas. Waste generation in the islands has grown significantly while tourism has done. The Balearic Islands, for example, is the Spanish autonomous community with the highest rate of waste generation per capita year after year. The limiting characteristics of the territory in these cases 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 [8].

The collection, treatment, transport and removal of solid urban waste are considered as public services of general interest, provision of which is obligatory in all the Spanish municipalities and, in the case of councils of more than 5,000 inhabitants, selective waste collection is also required by law. Although Spain does not have the recycling facilities such as those found in Northern Europe, facilities have improved remarkably in recent years and most municipalities, including some located in remote zones, now recycle glass, paper, cardboard, aluminum, cans, plastic, batteries and other materials, although there are sometimes few collection points. Many municipalities also recycle garden waste, which is then sold as compost.

In 2013 Spain developed a State Waste Prevention Program for the period 2014 to 2020 with the objective of reducing waste by 10 % by 2020, and in 2015 the State Waste Management Plan for the period 2016 to 2022. This new plan aims to be the tool to guide waste policy in Spain, promoting the necessary steps to improve identified deficiencies and promoting actions that provide better environmental results and to ensure the achievement of the legal objectives. In recent years the Spanish Autonomous Communities (regions) have also developed strategic waste plans based on their own policies and competences. Certain municipalities have also established programs and objectives for the improvement of waste management, mostly concerning household waste.

In the case of Spain the municipalities, large or small, have a high-priority paper in the waste sector. The councils are responsible for the majority of waste process phases: collection, treatment and disposal, and each decides how to provide and to finance the services with total independence.

The aim of this paper is to identify different alternatives for the management of municipal waste generated in remote areas of Spain and to analyze the efficiency and extent to which the targets proposed by current law are met in each case.

Municipal waste management models in Spain

In Spain the waste collection, treatment, transport and disposal of urban waste are considered public services of general interest, the provision of which is obligatory in all municipalities and, in the case of settlements of more than 5,000 inhabitants, selective waste refuse collection is also required by law. Waste legislation in Spain is administered by the relevant authorities at different administrative levels. At the national level, the Ministry of Agriculture, Food and Environment is responsible for the national plans. At the regional level, the autonomous communities are responsible for issuing strategic waste management plans for each specific region. Finally, at the local level, the municipal authorities are responsible for the management of the urban waste (domestic, industry and commerce, offices and services), including separate collection and transportation [9].

In Spain 76% of the waste collection market is provided by private companies and 24% is under municipal management. A similar situation occurs in the waste treatment and disposal market where 79% is covered by private companies and 21% is under municipal management [10]. The Spanish situation contrasts with the rest of Europe, where in almost 65% of the cases household waste is directly managed by the municipalities [11].

The provision of urban waste services in Spain can be organized under direct or indirect management modalities. The direct management can be offered by the home municipality (as a public service) or by own public entities (subcontracted or license service). Indirect management can be carried out by private agents under a public contract (public bidding) system with the municipality being responsible only for the regulatory aspects. Fig. 4 shows the various legal modalities established in the Spanish legislation. [10].

Each municipality decides the form of management modality of its waste services. The Spanish councils have decision capacity when deciding rules and procedures. Municipalities may even be sometimes grouped in order to optimize the management of the waste services. Spain is now one of the European countries with more private contracting in public waste services.

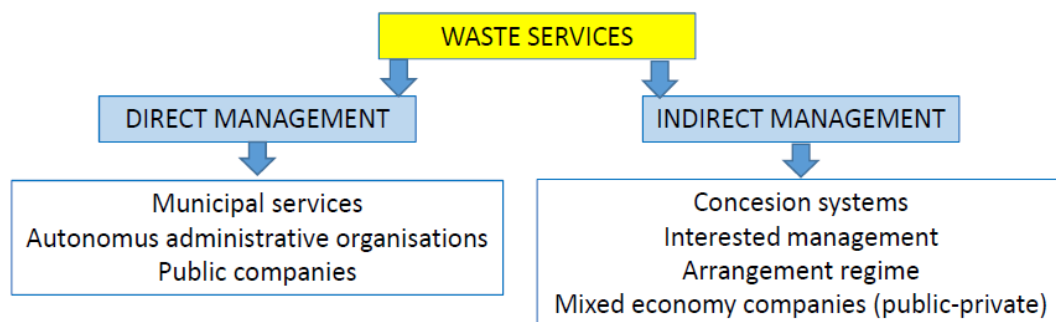


Fig. 4 Forms of waste management organizations in Spain. Adapted from [10].

There are six identifiable household waste collection models in Spain (Table 1), but not all of them with the same degree of application. The most common models are the Model 5, Model 1 and Model 4 with a 78% of client population. The wet-dry model (Model 2), which primarily performs the separation of organic and inorganic fraction (including packaging waste) only applies in some cities (14% of client population). Model 6 is a residual model in Spain, which does not integrate the separation of light packaging waste (2% of client population). Finally, Model 3 (Multiproduct) exists only in some areas and gathers together the residue of paper-

cardboard and light packaging waste (6% of client population). Collection without preselection still exist in some remote areas, but it is an almost extinguished practice.

Table 1. Municipal waste collection models implanted in Spain. Source: MAGRAMA [12]

Model 1: 5 fractions	Model 2: Wet-dry	Model 3: Multiproduct	Model 4: 4 fractions + pruning	Model 5: 4 fractions	Model 6: 3 fractions
Glass Paper/Cardboard	Glass Paper/-Cardboard	Glass Paper/Cardboard + light packaging	Glass Paper/-Cardboard	Glass Paper/Cardboard	Glass Paper/Cardboard
Light packaging Remaining fraction	Light packaging + Remaining fraction	Remaining fraction	Light packaging Remaining fraction (including OF)	Light packaging Remaining fraction (including OF)	Remaining fraction (including OF + light packaging)
Organic fraction	Organic fraction	Organic fraction	Pruning		

OF: Organic fraction; Remaining fraction: undifferentiated fraction no considered as separate collection

The remaining fraction collected in Spain is very high. 82% of municipal waste is, in reality, a mix of products: 13.3% of these mixed waste would be light packaging, 13.9% paper/cardboard, 4.8% glass packaging and 47% organic matter. So that in order to progress in meeting these goals is necessary to grasp these materials, reinforcing separate collection models. Since there are different models of separate collection (in sidewalk, door-to-door, etc.) it should be necessary to analyze what is the most efficient model under different circumstances to capture these materials.

Whatever the chosen models is, the streets of Spanish municipalities have large-capacity containers to receive paper, cardboard and glass. Most municipalities charge an annual fee for rubbish collection, which varies depending on whether you live in a town or a rural area. The amount of the waste tax is very different between municipalities and within the same municipality depending on the street. The national average could be estimated at 60 euros per year per household. Costs are usually reduced for the elderly or low incomes.

In Spain collection frequencies are very high. Almost 90% of the municipal services are available six days a week; in the capital province and large municipalities collection is daily for 363 days of the year. Furthermore, most of the waste collection services are nocturnal: 42% of municipalities perform the service in night shifts and 58% run next-day and night shifts. The common forms of collection are: night collection in the city center for reasons of traffic and morning shifts in suburban and remote areas.

Waste management in Spanish islands

The physical separation of islands from other land masses can constrain the flow of materials, organisms or information, but it also limits the ability of islands to outsource some of their problems, notably the management of modern waste streams [13].

Spain has 162 islands, of which about 3.2 million people (6.9% of the Spanish population) live [14]. Most of these islands are uninhabited, and 99.8% of this population is concentrated in the Balearics and the Canaries, which in turn are those that are furthest from the mainland. Furthermore, the Canary Islands are one of the ultra peripheral regions of the European Union for their greater distance from the mainland. This aspect also influences the management of waste generated on its territory.

Waste are one of the biggest problems facing environmental management in the Spanish islands. They are small and limited spaces 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. To this it is necessary to add, in general, the importance of tourism-related activities, such as the hospitality sector, catering and leisure. This results in an equivalent population much higher than included in the census. The waste management of tourism activities has certain characteristics that must be taken into account to carry out efficient management of waste; especially when there is significant seasonality. This requires, in some cases, to overestimate the services of municipal waste collection. Indeed, in both Spanish island communities (Canary and Balearics), tourism has certain differences that result from weather conditions in both regions: while the Balearics tourism is concentrated especially in summer, in the Canaries there is a continuous movement of tourists throughout all the year.

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 [8]: 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 and transportation of waste to the mainland.

The levels of selective collection are especially low in the Canary Islands, where only 11% of waste were collected selectively in 2013, while this percentage reaches 25% in the Balearics, exceeding the Spanish average (17.9%) (Table 2). Separate collection of organic waste is only implemented in some municipalities of Mallorca and Menorca, and it is not expected its establishment in the other islands in the short term.

Table 2. Municipal waste collection in Spanish islands in 2013 (thousands of tons). Source: INE [14]

	Mix waste	Glass	Paper/cardboard	Mixed packaging	Total waste
Spain (total)	17,852.8	720.9	988.2	559.3	21,785.7
Balearic islands	607.2	29.3	38.2	14.0	809.4
Canary islands	1,072.2	29.4	30.6	15.9	1,204.8

One of the specific difficulties of the Balearics in terms of waste management is the collection of the oceanic *Posidonia* (algae) in beaches, that municipalities are driven to perform because of the tourist pressure. This problem is especially acute in Ibiza and Formentera. The removal of such waste supposes a challenge for municipal services and, at the same time, it has a negative impact on coastal ecosystems (the beach is more exposed to erosion).

The most common collection model in the islands are the areas of contribution (where the waste are placed by type into grouped containers in streets and squares). In the Balearic and Canary Islands, paper/cardboard, glass and packaging are collected selectively. There are also some experiences on door-to-door collection in Mallorca and collection in underground containers. Experience shows that the door-to-door model generally achieved better results in terms of selective collection. There are some specific practices of home composting in the Balearic Islands, but very isolated.

Table 3. Features of the collection of municipal waste in the Spanish islands. Source: Adapted from Jofra [15]

	Canary Islands (Gran Canaria, Fuerteventura, Lanzarote, La Gomera, El Hierro, La Palma, Tenerife)	Balearic Islands (Mallorca, Menorca, Ibiza, Formentera)
Collection of paper/cardboard, glass and packaging	Areas of contribution	Areas of contribution in general Door-to-door in Mallorca
Collection of the organic fraction and home composting	Home composting in Tenerife	Door-to-door, in Mallorca Home composting in Menorca and Formentera
Collection of mixed waste	Surface containers in general	Surface containers in general Underground containers and door-to-door collection in main downtowns
Specific collection of commercial waste	Collection of commercial cardboard in all the islands but in El Hierro	Collection of commercial cardboard
Collection of special waste	Collection centers (<i>punto limpio</i>) in all the islands	Collection centers (<i>punto limpio</i>) in all the islands
Algae collection	Not done	Collection and disposal in general. Agricultural valorization in Menorca
Waste transfer	Transfer plants in Gran Canaria, Fuerteventura, La Palma and Tenerife	Transfer plants in all the islands but in Menorca

The main waste treatment, both in the Canary and Balearic islands, is the landfill. Some islands have plants for selection of the remaining fraction, which allow to separate and stabilize the organic fraction of mixed waste, but in most of the islands this process is not carried out, so an important part of the generated biodegradable waste goes to landfill. Mallorca is the only island with an incineration plant whose capacity was recently expanded.

Because of their isolation, the main problem of the islands in the field of waste management is the difficulty to achieve economies of scale for the treatment of these residual streams, forcing the authorities to transfer them to another island or the mainland, which implies expensive transport. However, there are a variety

of proposals that the islands can take to optimize the management of their waste and reduce the cost and environmental impact that this activity represents.

Experiences carried out 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; especially if the insularity of the collection and treatment of waste is achieved, and if a differential treatment is given to those waste derived from tourism activities. Among the ideas for improvement of waste management in the islands include [15]: implementation of systems for self-management of the organic fraction, establish models door-to-door collection, promote treatment facilities to small scale, or, adjust the rates of waste generation thereof.

The islands local governments in Spain has considered necessary to promote good practices in relation to urban waste management that can be summarized in the Table 4.

Table 4. Proposals on waste management in Spanish islands. Source: Adapted from Jofra [15]

Type of proposal	Specific measures
Proposals on waste prevention	<ul style="list-style-type: none"> - Avoiding food waste - Reducing paper use by businesses and schools - Reduction of packaging - Reusing of goods and products - Minimizing advertising and free newspapers - Actions to promote the repair of goods and products - To boost consumption intangible - To promote the use of reusable nappies
Proposals on waste collection	<ul style="list-style-type: none"> - To assess the implementation of door-to-door collection - Incorporating improvements in the collection in containers model - Specific containers for commercial waste, specifically for large generators
Proposals on waste transfer and transport	<ul style="list-style-type: none"> - In situ pre-treatment of bulky waste - Optimize transport requirements by temporary storage of waste in an intermediate facility between collection and final disposal
Proposals on waste treatment	<ul style="list-style-type: none"> - Promoting home and community composting - To promote treatment facilities at small-scale - Increasing levels of selection of the remaining fraction
Proposals on institutional and administrative organization	<ul style="list-style-type: none"> - To promote pooling / insularity of waste collection services - To improve agreements with recycling organizations (Ecoembes, Ecodidrio,...)
Proposals on legal regulation	<ul style="list-style-type: none"> - To promote the adoption of municipal bylaws regulating the waste collection service - To provide normatively differentiated treatment for commercial waste - To include the mandatory implementation of selective collection of the organic fraction in the regional rules
Proposals on economic instruments	<ul style="list-style-type: none"> - Taxes on products - Taxes on final disposal - Municipal garbage tax - Payment systems for generation - Bonus-penalty systems
Proposals on environmental communication	<ul style="list-style-type: none"> - Training and awareness campaigns

Waste management in isolated Spanish rural communities

23% of the Spanish population lives in rural areas. Some of these areas also have characteristics that make them isolated areas, such as the distance to transfer / processing / selection plants or difficulty of access at certain times of year. These characteristics represent a challenge for the management of municipal waste.

In Spain, most of the waste plans in rural regions does not recognize the particularities of the waste management activity in isolated rural areas or provides specific solutions to them.

The analysis of existing waste generation data shows that, in general, waste production per capita in rural areas does not significantly differ from urban areas, although in some communities, is lower in small

municipalities. In such rural areas, the major fraction of municipal waste is organic, and represents more than 40% of the municipal waste.

In reference to the levels of selective collection, inferior results are reached in rural communities, probably due to incomplete deployment of selective collection; in particular, the organic fraction. This results in lower rates of material valorization.

Waste collection is usually performed using surface containers for the remaining fraction and using areas of contribution for separately collected fractions. However, there are also experiences of selective collection door-to-door and underground containers. Furthermore, difficulties in implementing the selective collection of paper/cardboard and light containers fractions have been detected.

The remoteness of the facilities hampers the selection of the remaining fraction. This factor, together with the low levels of selective collection and a shortage of recycling facilities in these areas makes most of the waste are dumped without prequalification. The situation is aggravated by the fact that there are no taxes on the disposal of municipal waste in most of the rural areas.

The waste collection service in rural areas is usually provided through supra local entities such as associations, consortia, regional councils or county councils. To compensate for the higher costs of waste collection in isolated rural areas, these local authorities usually set unique collection and treatment rates for the entire field of competence. Sometimes the glass collection is assigned to integrated management entities, which allow to provide the service at no cost to the municipalities.

The generation of waste can be reduced through various measures, such as food waste prevention, prevention of packaging waste or the reuse and repair of goods and products. In isolated rural settings, many of these actions make sense on a county or provincial scale.

To improve waste management models in isolated rural areas, the main action proposed by Jofra et al. [16] is to carry out self-management by organic waste self-composting (household and community composting), and decentralized composting. Existing experiences in Spain show that it is possible to treat most of the organic fraction produced in rural settings using these options, and this results in lower management costs, since much of the waste generated is diverted from the usual collection system.

In the collection, the implementation of a door-to-door system can greatly improve performance. For recoverable fractions collected in containers, it is also recommended to increase the rates of containerization and ensure that all rural communities have access to selective collection (in this case, the higher cost of implementing this model can be partly compensated by optimizing the frequency of collection), and improve the collection of hazardous waste through mobile clean points.

On the other hand, the efficiency of collection service in remote areas can be substantially improved with loading centers, transfer stations and nurse-satellite systems. It is also desirable to optimize the selection process of the remaining fraction through the provision of sorting plants and creating incentives for maximizing the recovery of materials.

Finally, at regional scale, it is recommendable to promote supra municipal provision of waste collection services to increase the quality and efficiency in isolated rural areas. It is also recommended to better capture the special characteristics of isolated rural areas in the agreements signed with the integrated management entities, to approve regulatory ordinances for the waste collection service, giving differential treatment to commercial waste when needed, and including mandatory separation of the organic fraction in the regional regulations.

Economic instruments are, also, a powerful tool to encourage waste reduction and selective collection. In this area, a number of such instruments, such as taxes on products or on final treatment, garbage taxes adjusted to waste generation levels, bonus-penalty systems or tradable permits for dumping or incineration are proposed.

All these measures, gathered in Table 5, should be accompanied by actions of environmental communication in order to be successful.

Table 5. Proposals on waste management in Spanish isolated rural communities. Source: Adapted from Jofra [16]

Type of proposal	Specific measures
Proposals on waste prevention	<ul style="list-style-type: none"> - Avoiding food waste - Reduction of packaging - Reusing of goods and products - Actions to promote the repair of goods and products
Proposals on waste collection	<ul style="list-style-type: none"> - To assess the implementation of door-to-door collection - Increasing containerization rates, especially for recoverable fractions - To improve the collection of special waste
Proposals on waste transfer and transport	<ul style="list-style-type: none"> - Implementation of nurse-satellite systems (large capacity compactor trucks (nurse vehicles) receiving waste from collecting trucks (satellite))

	- Implementation of loading centers or transfer stations
Proposals on waste treatment	- Promoting home and decentralized composting - Increasing levels of selection of the remaining fraction
Proposals on institutional and administrative organization	- To promote the provision of services at supra municipal level - To include the specifics of isolated rural areas in the agreements signed with the integrated management entities
Proposals on legal regulation	- To promote the adoption of municipal bylaws regulating the waste collection service - To provide normatively differentiated treatment for commercial waste - To include the mandatory implementation of selective collection of the organic fraction in the regional regulations
Proposals on economic instruments	- Taxes on products - Taxes on final disposal - Municipal garbage tax - Payment systems for generation - Bonus-penalty systems - Tradeable landfill and incineration permits
Proposals on environmental communication	- Campaign on selective collection of organic matter - Campaign on implementation of door-to-door selective collection - Campaign on implementation of self-composting

Despite efforts in selective collection and recycling, landfilling remains the main destination of the waste in the whole of Spanish rural areas. However, there is much disparity in the amount of waste dumped by the different regions.

Good practices in waste management in remote areas in Spain

A small locality of Mallorca, Puigpunyent, was the pioneer city to implement the selective collection door-to-door in the Balearic Islands, in 2004. The introduction had the support of a group of citizens organized in the "Support Group to door-to-door collection." Since previously the organic fraction was not separately collected, the action was used to implement this new collection model. The current frequency of collection of each fraction is 3 days a week for the organic fraction, 2 days for packaging and 1 day for the remaining fraction.

The paper/cardboard and glass are still gathered in containers by "areas of non-permanent contribution", which are enabled one day a week by placing a container of about 100 liters in a specific place. These areas are located in the most populated streets (about 50 points for a population of 1,500 inhabitants).

It also has "areas of restricted contribution", small constructions (approx. 3 meters long and 1 wide), house type and locked, designed for organic and remaining fractions produced by population of rural areas and citizens who have difficulty to adapt to the times of the door-to-door model.

The use of compostable bags for the organic fraction is mandatory, and the City Council distribute them free of charge through retail partners. The stores keep track of the bags delivered, periodically informing the City Council.

The introduction of the door-to-door system has allowed in this location:

- Collecting the organic fraction with a very low percentage of unfit material (3.5% on average).
- Reduce the remaining fraction collected by more than 70%.
- To increase the collection of light packaging by more than 300%.
- To increase the collection of paper / cardboard by 166%.
- To increase the collection of glass over 115%.
- To reduce the garbage tax by 20%.

In 2006, after the experience of Puigpunyent, eight municipalities from Mallorca jointly implemented the door-to-door collection model, and in 2007, 12 municipalities more, also jointly, following the initiative. In 2010, a total of 28 municipalities in Mallorca had adopted the door-to-door collection model. In total, the collection door-to-door in Mallorca currently serves more than 115,000 inhabitants.

In most municipalities, the packaging fractions, paper/cardboard and glass are collected in reusable canvas bags (sometimes numbered), with a different color depending on the fraction. Moreover, in most of the cases, buckets or bags should be mandatorily hung on a hook (usually facilitated by the council) on the facade of the building. The reasons for this requirement are several:

- Prevent animals from accessing the trash.
- Facilitate viewing cube or bag by the collection operator.
- Avoid the displacement or loss of material in case of bad weather.

In some cases (pedestrian or inaccessible streets, vertical buildings, etc.), there are concentrated points of contribution to facilitate the collection, consisting of small infrastructure (post type) enabled with hooks for use by several neighbors.

Another successful story is the case of Riudecanyes. Riudecanyes is a little town (750 inhabitants all year and 1.500 in summer) in a south Catalan shire (El Baix Camp). It has 303 households and it spreads over an area of 17.10 km².

The inhabitants of Riudecanyes set a great example of how individuals can help to improve municipal waste management. In this case, the door-to-door collection systems started with an intense citizens' participation process. The system, launched in 2000, differs from others because here the locals collect their waste individually in small containers. Therefore collecting the containers is easy and fast – therefore cost-efficient. The greatest achievement of the initiative is that it makes people feel more responsible for the environment. Furthermore, people get immediate feedback if their waste was not collected properly.

Waste is divided at homes into 3 groups: compostable organic wastes; packing papers; glass and non-compostable wastes. The compostable wastes are usually collected three to four times a week while the non-compostable are collected once or twice a week.

Due to the recycling the rate of the selected wastes reached 70-80% in the target area, which is a remarkable result, especially if compared to the typical 10-20% rate before the implementation of the initiative [17].

Another interesting case is Argentona, a municipality in the comarca of the Maresme in Catalonia, with 11,963 (2014 datum) inhabitants. When the door-to-door collection system was introduced in 2004, Argentona more than doubled its recycling rates. Later, a pay-as-you-throw model for refuse and packaging, both for households and commercial activities was implemented in 2009. It was based on the principle of "who recycles and reduces, pays less". The model was called "fair charge", and it was conceived as a pay-per-bag scheme. Thus the variable part of the waste tax depends on waste generation of refuse and packaging. Standardized bags of known volume are used as a counter. The use of these bags is mandatory.

The introduction of this system does not supposed significant variations for the population in the system of door-to-door collection but the fair tax meant a slight improvement (2%) in collection results of the whole county. Furthermore, an overall waste reduction of 10% was achieved, largely attributable to lifestyle changes.

The application of the new model of waste charging introduces fairer distribution of costs for all citizens and commercial activities, which saw their efforts rewarded for reducing and recycling.

Although Argentona cannot be considered a real "remote area", the interest of this experience derives from its potential for replication in remote municipalities [18].

Conclusions

Innovative municipal waste management is a key driver for resource efficiency, as well as offering economic opportunities and job creation potential. However, for many regions in Europe, especially for those "remote" or "isolated" the optimization of urban waste management is problematic. The main challenge here is to move these remote areas up the waste hierarchy towards waste minimization, recycling and reuse.

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