Waste Management 33 (2013) 2589–2593

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

The impact of tourism on municipal solid waste generation: The case of Menorca Island (Spain)

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ARTICLE INFO

Article history:
Received 8 March 2013
Accepted 10 August 2013
Available online 31 August 2013

Keywords:
Municipal solid waste
Separately collected recyclables
Tourist population
Quantification

ABSTRACT

Tourism can sustain high levels of employment and income, but the sector is a source of environmental and health impacts. One of the most important is the generation of municipal solid waste (MSW). However, there is a lack of studies which quantify how much the tourist population engages in total MSW and separately collected recyclables. The aim of this paper is to estimate the impact of the tourist population on MSW, both total and separately collected, for the period 1998–2010, for the Mediterranean island of Menorca (Spain). We use dynamic regressions models, including data for monthly stocks of tourists. The results show that, on average, a 1% increase in the tourist population in Menorca causes an overall MSW increase of 0.282% and one more tourist in Menorca generates 1.31 kg day^{-1} (while one more resident generates 1.48 kg day^{-1}). This result could be useful to better estimate the seasonal population of different regions, since intrannual fluctuation of MSW is used as a proxy measure of actual population (the sum of residents and tourists). Moreover, an increase of 1% in the tourist population causes an increase of 0.232% in separately collected recyclables and an additional tourist generates 0.160 kg day^{-1}. One resident selectively collects on average 47.3% more than one tourist. These results can help in the planning of waste infrastructure and waste collection services in tourist areas.

1. Introduction

Tourism has become one of the most important industries in recent decades. In 2011, 980 million tourists traveled outside their borders, generating revenues of 710,000 € million and underlining the importance of tourism in the economy, which accounts for around 12% of global GDP (World Tourism Organization, 2012).

Tourism can sustain high levels of employment and income in the economies of many regions. However, the sector is a source of environmental impacts and resource consumption with consequent public health problems (Evci and Gulis, 2006). One of the most important impacts of tourism is the generation of municipal solid waste (MSW) (Holden, 2008). Many studies have reported this phenomenon where MSW increases as the seasonal population of the tourist areas or regions rises (Shamshiry et al., 2011; Espinosa-Lloréns et al., 2008; The and Cabanban, 2007). Therefore, in these areas, it is especially important to collect, transport, process and finally dispose of the MSW in an environmentally sound and cost-efficient way (Chen et al., 2005).

In fact, the quantity of MSW is used as a proxy for calculating the seasonal population of different towns and regions with high amount of tourist (Perea-Milla et al., 2007; Sajani et al., 2005; Mateu, 2003). These studies are based on the fluctuations of MSW series along the year. Thus, given the ratio between MSW and residents during the non-touristic months, the studies can approximate the seasonal population along the year. Therefore, in these studies it is assumed, on the one hand, that tourists generate the same amount of waste as residents and, on the other hand, the ratio between MSW and population (residents + tourists) is constant along the year. However, there is no scientific evidence on whether the proportion of waste generated by the tourist population is the same as that of the resident population, and whether the effect of the tourist population on MSW extends over the following months or not.

Of concern is the lack of studies which quantify how much the tourist population engages in separately collected recyclables of municipal solid waste (MSWS) compared with the resident population. Separately collected recyclables (the separation of materials intended for recycling) is particularly necessary in small islands,

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http://dx.doi.org/10.1016/j.wasman.2013.08.007

because they are environmentally more vulnerable to growth in the amount of solid waste and any negative effects on health may spread more quickly (World Health Organization, 1996).

The aim of this paper is to estimate the impact of the tourist population on MSW, both total and separately collected, for the period 1998–2010, which has implications for the environment and health. For this purpose, we chose to conduct our study in the Mediterranean island of Menorca (Spain), due to its small size (702 km^2) and high seasonal tourism rates. In summer, the tourist population is greater than the resident population. Menorca is an area with availability of monthly population stock data over a long period, which is required to quantify the impacts.

2. Material and methods

2.1. Data collection and pattern

The data needed to carry out the objectives of the study are, on the one hand, the municipal solid waste generated on the island of Menorca – distinguishing between quantity of MSW and MSWS – and, on the other hand, the demographic burden of resident population and tourist population that the island supports.

MSW and MSWS data are compiled monthly by the Menorca local government (Consorci per a la Gestió de Residus, 2010). MSW comprises waste from all sectors (households, small businesses, services, commerce and industry). MSWS is a specific part of MSW and consists of all separately collected waste (paper and cardboard, packaging and glass).

The monthly population stock in Menorca has been calculated through the monthly average of the '*Daily Indicator of Human Pressure*' (*DIHP*). The *DIHP*, proposed by Mateu and Riera (2006), estimates the demographic burden that Menorca – and the whole of the Balearic Islands – supports on a given day. The methodology for estimating the *DIHP* takes as a reference point the resident population on the first day of each year. For each of the following days, the daily balance between arrivals and departures of people from inter-territorial movements (passenger transit at ports and airports) is added to the natural resident population growth (balance between births and deaths). The methodology also addresses the bias that exists due to the fact that the airport arrivals are estimated by the authorities (while departures from the airport are recorded). Subsequently, the breakdown of the monthly population stock for Menorca Island into resident population (*RP*) and tourist population (*TUR*) can be computed (Bakhat and Rosselló, 2011).

Data used are summarized in Table 1. It shows the monthly average of MSW and MSWS, in tons day^{-1}, and *RP* and *TUR*, in number of people. Both the MSW and *TUR* series show strong seasonality: during August, the seasonal peak, almost double the amount of MSW is generated compared with the winter months. In August, on average there are more than 106,000 tourists a day in Menorca, while in January there are fewer than 1200. MSWS also has a seasonal pattern, but much less pronounced than MSW.

Table 1
Daily average MSW, MSWS, *TUR* and *RP*, 1998–2010. Source: Consorci Residus Urbans de Menorca and own calculations.

	MSW[1]	MSWS[1]	*TUR*[2]	*RP*[2]
January	111.6	19.3	1155	80,079
February	112.5	17.5	1654	80,255
March	119.6	18.4	6123	80,324
April	138.3	21.0	19,257	81,150
May	182.6	26.0	47,254	82,575
June	214.2	30.4	60,787	82,388
July	243.2	34.2	81,521	82,768
August	270.3	36.9	106,024	81,757
September	220.9	31.8	65,744	82,763
October	172.2	26.1	41,000	82,737
November	122.6	20.4	3487	81,151
December	110.8	18.6	1203	80,009

MSW: municipal solid waste; MSWS: selective collection of municipal solid waste; *TUR*: tourist population; *RP*: resident population
[1] tons day^{-1}.
[2] Number of persons.

2.2. Method and statistical analysis

Dynamic regression models were performed to estimate the effect of tourism on the generation of MSW on average for the whole of the island. Due to lack of information available, we cannot estimate the regressions for smaller areas of Menorca.

In this study, dynamic models allow taking into account two aspects. On the one hand, they allow capturing the fact that the current value of a certain variable depends on its own past values. Thus, the behavior of MSW in a certain region reveals itself through a dependence of the current value on its own past (Navarro-Esbrí et al., 2002). On the other hand, dynamic models allow specifying independent variables. In this sense, MSW depends dynamically on the quantity of population (resident and tourist) in this region.

Thus, MSW can be generated either by the resident population (with elasticity α) or by the tourist population (with elasticity β). We fixed a restriction to improve the efficiency of the estimate. Thus, we assumed that the overall elasticity is 1 ($\alpha + \beta = 1$). That is, if the amount of actual population (residents and tourists, treated together) in a given month is changed by a positive proportional factor, MSW increases by exactly the same factor. Thus, we can simplify the analysis and consider the logarithm of the ratios MSW/*RP* and *TUR*/*RP* [$\ln(MSW_t/RP_t)$ and $\ln(TUR_t/RP_t)$].

The coefficient associated with $\ln(TUR_t/RP_t)$, β, is, in the long term, interpreted as the percentage effect that the tourist population has on the generation of MSW and $1 - \beta(=\alpha)$ is the percentage effect attributable to the resident population.

These ratios would be the variables used in the regression. We constructed two autoregressive distributed lag models (of order 1 in autoregression and order 1 in distributed lags: ADL(1, 1)) (Baltagi, 2011). Regression A explains the MSW pattern through $\ln(MSW_t/RP_t)$ as a dependent variable. As explanatory variables, regression A includes one contemporary and one lagged variable of $\ln(TUR_t/RP_t)$, and one lagged dependent variable.

The model is justified, firstly, because the behavior of individuals in relation to the generation of waste in a given month depends in part on the immediately preceding months. Secondly, there is an offset between the moment when waste is generated and when it is recorded at the waste management plant. Thus, some part of MSW or MSWS generated on the lasts days of the given month is recorded at the management plant next month.

Moreover, we specify dummy variables for the spring (*SPR*) and summer (*SMR*) seasons in the regression model to capture the possible differences in the propensity to waste generation. If the coefficients estimated associated to this variables are significantly different to 0, it would indicate that there are different propensities towards waste generation along the year. Regression B explains MSWS and, analogously, is specified through the ADL (1, 1) regression with $\ln(MSWS_t/RP_t)$ as a dependent variable.

Previously, we used the TRAMO-SEATS program in order to identify and correct outliers automatically (Gómez and Maravall, 1996). Statistical analysis was performed using the econometric software EViews 5.0 (IHS Inc., 2008).

The assumptions of linear regression have been tested for each regression model. First of all, linearity of the relationship between dependent and independent variables have been examined on the basis of a scatterplot between the standardized predicted values and the standardized residuals. The independence of the residuals