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Data Article

Data on urban waste collection: The case of the Apulia region in Italy

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A B S T R A C T

The collection of urban waste is an important step of the waste management cycle, because the collection of sorted waste that soon separates different kind of materials makes their reusing, recovering, and recycling easier and more efficient, reducing the amount of landfilled waste. In Italy, municipalities have to meet specific targets relative to the yearly percentage of sorted waste collection. Collecting and analyzing data about waste collection and the proportion of sorted waste and the specific type of waste materials is a critical activity to measure the performance and monitor the effort of the municipalities to meet targets. Raw data relative to the yearly amounts of total and sorted waste collected from 2007 to 2017, and data relative to socio-economics in 258 municipalities of the Apulia region were retrieved from public databases and were used to calculate waste statistical indicators. Data about total and sorted waste collection in Italy at the regional and country level were retrieved and analysed to compare the Apulia region and specific groups of regions. The evolution of the per capita total and sorted waste amounts was also analysed over time for Apulia and the rest of Italy. The effects of the municipality surface area, the number of inhabitants and population density on the sorted waste collection rate were investigated by performing regression analysis. These data may help policy makers and stakeholders to evaluate total and sorted waste production over time, set and assess targets, and identify best policy practices.

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Specifications table

Subject	Environmental science
Specific subject area	Waste Management and Disposal
Type of data	Table and graph
How data were acquired	Data were acquired from the national statistical databases, and from the national agency for the environmental protection databases
Data format	Raw, calculated
Experimental factors	The raw data collected were organized in spreadsheets. The information relative to the Apulia region was organized by alphabetic order, using the name of the municipality as sorting criterion. The information relative to the remaining Italian territories were grouped either using the geographical location or the per capita income as criteria. Aggregated data relative to Apulia were compared to data relative to other territories.
Experimental features	Raw data relative to total and sorted waste collected yearly from 2007 to 2017, and data relative to socio-economics were used to calculate waste statistical indicators. The dynamics of both total and sorted waste indicators were analysed over time for Apulia and the rest of Italy. The effects of the municipality surface area, the number of inhabitants and population density on the sorted waste collection rate were investigated by implementing regression analysis.
Data source location	Italy
Data accessibility	Data are provided in the article

Value of the data
- These data may help to evaluate total and sorted waste production over time, set and assess targets, and identify best policy practices
- These data allowed to evaluate the impact of the EU cohesion policy actions and funds implemented in Apulia during the 2007–2013 programming period in the environmental area, and fine-tune the strategy for the 2014–2020 period
- Policy makers and other stakeholders can benefit from these data
- The data can be processed by implementing a variety of statistical techniques (i.e., descriptive statistics, multivariate regression, cluster analysis).
- These data can be used for benchmarking studies by comparing waste statistical indicators of the Apulia region to those of the other Italian territories
- These data can be used to calculate new indicators based on the measurement of the sorted waste collection.

1. Data

Article 3(1) of Directive 2008/98 of the European Commission defines waste as "any substance or object which the holder discards or intends or is required to discard". Thus, decreasing the amount of waste and achieving higher recycling levels contribute to reduce the loss of materials and energy resources, and, at the same time, the environmental impact.

Public policies relative to waste management, either supported by national or UE funds, are aimed at improving resource efficiency and sustainability, and reducing environmental impact. Collecting data about waste generation helps policy makers to design and implement more effective waste management policies. These data give an overview about waste generation in Apulia, one of the Southern Italian regions. Data were collected in accordance with Regulation no. 2150/2002 on waste statistics of the European Parliament.

Fig. 1 shows the evolution of total waste production, Gross-domestic product (GDP) and household consumption expenditure in the Apulia from 2007 to 2017. Indicators were normalized utilizing 2007 values as references, giving to each of them the value of 100.

Fig. 2 presents the graphs of the percentage change of the ratio "total production of urban waste" (UW) to GDP and of the ratio "total production of urban waste" to "household consumption expenditure" (CEX) from 2011 to 2017, assuming the year 2010 as reference year. Both ratios were calculated using the following formula:
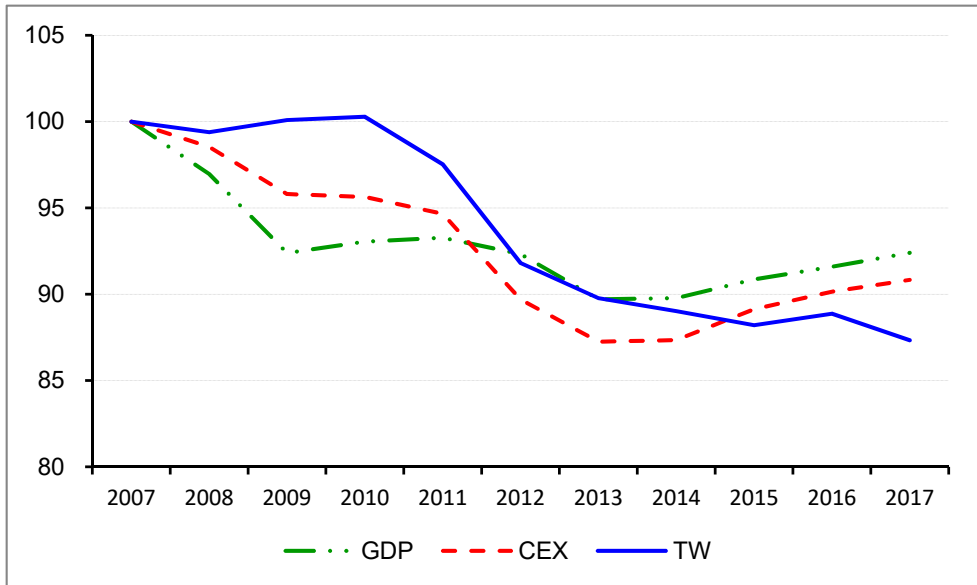
Fig. 1. Waste production and macroeconomics indicators dynamics between 2007 and 2017 in Apulia.

$$change \ (TW/X)_{2010-year\,t} = \frac{TW_{year\,t}/X_{year\,t} - TW_{2010}/X_{2010}}{TW_{2010}/X_{2010}} \times 100$$

where $X_{year\,t}$ and X_{2010} respectively indicate the measurement of the macroeconomic variable (either GDP or CEX) for year t (in 2011, …, 2017) and in year 2010.

Fig. 3 shows data relative to the total and sorted amount of waste collected in Apulia between 2007 and 2017. Data are measured in tonnes. The trend lines for both variables are emphasized.

Fig. 4 shows data relative to the percentage of sorted waste collected between 2007 and 2013 in Apulia.

In Table 1 municipalities have been grouped using the sorted waste collection rate as a grouping criterion, and a 4-level classification: rate <15%; rate between 15% and 35%; rate between 35% and 50%; rate >50%. The classification levels are reported in the first column of table, while columns 2−7 contains the number of municipalities that classify at each level.

Fig. 5 shows the yearly evolution of the indicators "per capita total production of urban waste" and "per capita sorted waste collection" of the municipalities in Apulia from 2007 to 2017. The yearly per capita total (sorted) urban waste production was calculated as the ratio of the total (sorted) urban waste produced every year to the number of resident inhabitants. Therefore, both indicators do not take into account the population fluctuation due to tourism, education and job driven people flows. In some cases, this fluctuation can become considerable, especially during some months, heavily affecting the value of total waste production and, consequently, the per capita waste production because only the number of resident inhabitants is used to build the indicator [1]. Data relative to the number of resident inhabitants (population) living in the Apulia municipalities that were used to compute the ratios were retrieved from the ISTAT database.[1] Particularly, the population relative to year "n" was obtained as the arithmetic average between the population relative to year "n-1" and the population
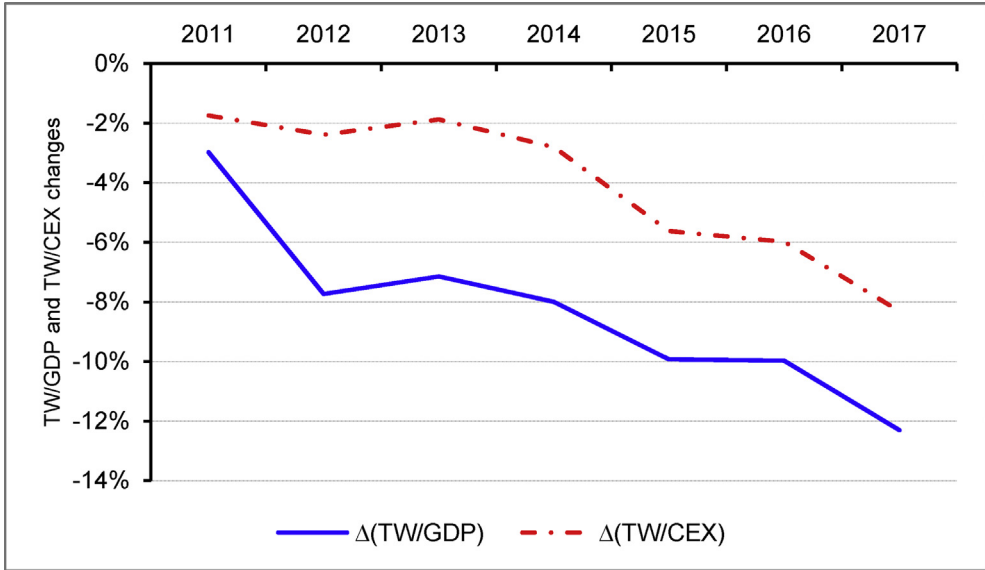

Fig. 2. Percentage change of the ratios TW/GDP and TW/CEX between 2007 and 2017 in Apulia.
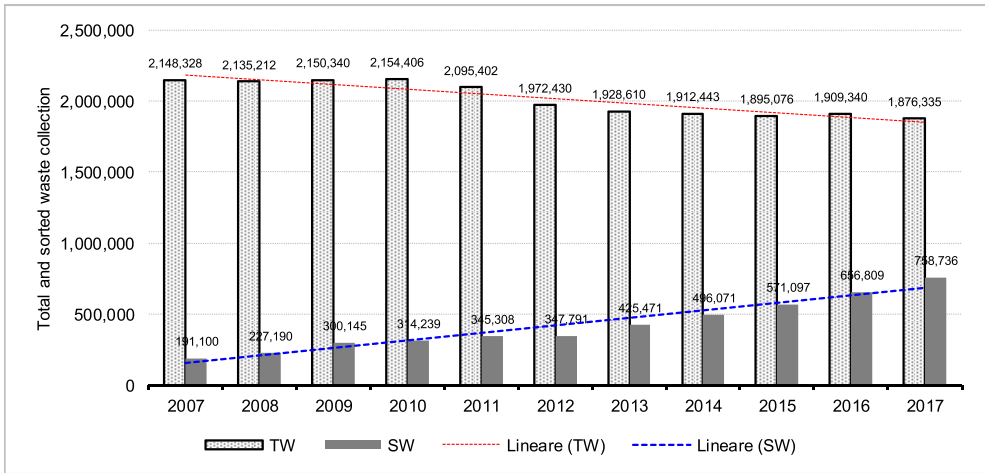

Fig. 3. Total (TW) and sorted (SW) urban waste collection from 2007 to 2017 in Apulia.

relative to the year "n", in order to obtain a more reliable measurement consistent with the nature of yearly waste collection which should be considered as a "flow variable" rather than a "stock variable".

Fig. 6 illustrates the evolution of the indicator "per capita waste production" from 2007 to 2017 for Apulia, and for 4 groups: the regions of the convergence area, the Northern regions, the Southern and Islands regions, the Central regions, and the whole national territory. With the exception for Apulia, the mean value of the indicator was calculated using data relative to all Italian regions belonging to the group. In Italy, four regions were eligible under the convergence and competitiveness objectives of the
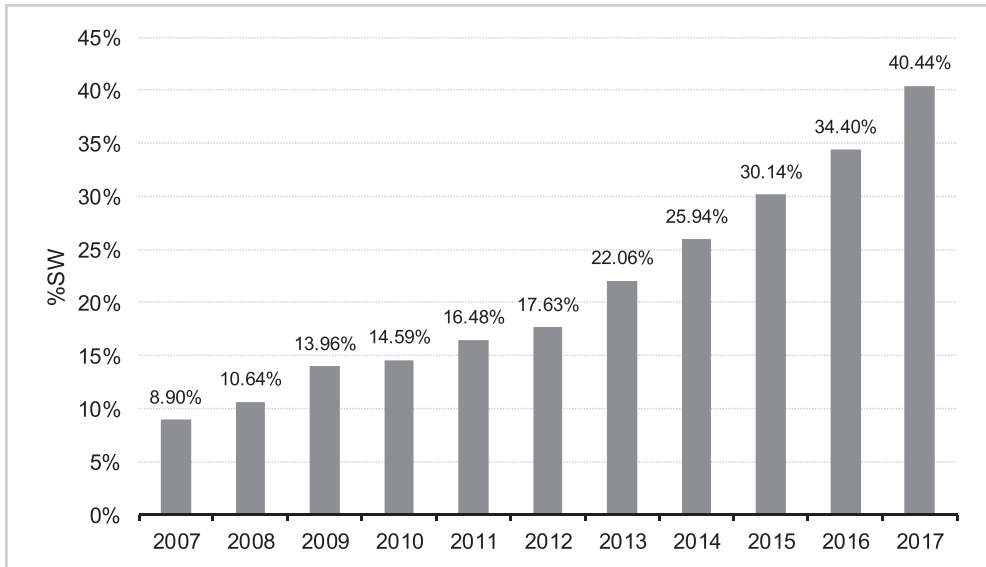
Fig. 4. Weight of the urban sorted waste on total waste collection from 2007 to 2017 in Apulia.

EU cohesion policy between 2007 and 2013 (Apulia, Calabria, Campania, and Sicily).[2] Northern regions include: Aosta Valley, Piedmont, Liguria, Lombardy, Emilia-Romagna, Veneto, Friuli-Venezia Giulia and Trentino-Alto Adige/Südtirol. Central regions include: Lazio, Marche, Tuscany, and Umbria. Southern and Islands regions include: Abruzzo, Apulia, Basilicata, Calabria, Campania, Molise, Sardinia, and Sicily.

Fig. 7 presents the trend of the sorted waste collection rate between 2007 and 2017. Apulia, the 4 regions of the convergence area, the Northern regions, the Central regions, the Southern and Islands regions, and the whole national territory have been considered. The average value of the indicator was calculated for grouped regions.

Fig. 8 illustrates the evolution of the indicator "per capita sorted waste collection" from 2007 to 2017 for Apulia, the 4 regions of the convergence area, the Northern regions, the Southern and Islands regions, the Central regions, and the whole national territory. The indicator was built as the ratio of the yearly amount of sorted waste collected to the number of resident inhabitants. The average value was considered for grouped regions.

Figs. 9–11 respectively show the relationship between the percentage of sorted waste collected in each municipality, and the municipality population, municipality surface area, and municipality population density. This latter variable was calculated as the ratio of the municipality total population to surface area. For every municipality, except for the surface area, the average between the variables measurements in 2016 and 2017 was used to have a more robust measurement, obtaining the following new variables: %aSW, apopulation and adensity. The logarithm of the municipality population, surface area and density measurements was calculated.

2. Experimental design, materials, and methods

Over time, the improvement of the economic and social well-being, and the living conditions that led to increased family consumption threw the traditional waste management system into crisis because waste production rose in line with family consumption [2]. In Europe, since the early 1990s the

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Table 1
Classification of Apulia municipalities according to the rate of sorted waste collection.

% SW	2010	2011	2012	2013	2014	2015
<15%	129	121	109	91	63	46
15%−35%	115	118	124	122	132	132
35%−50%	11	11	16	23	21	24
>50%	3	8	9	22	42	56
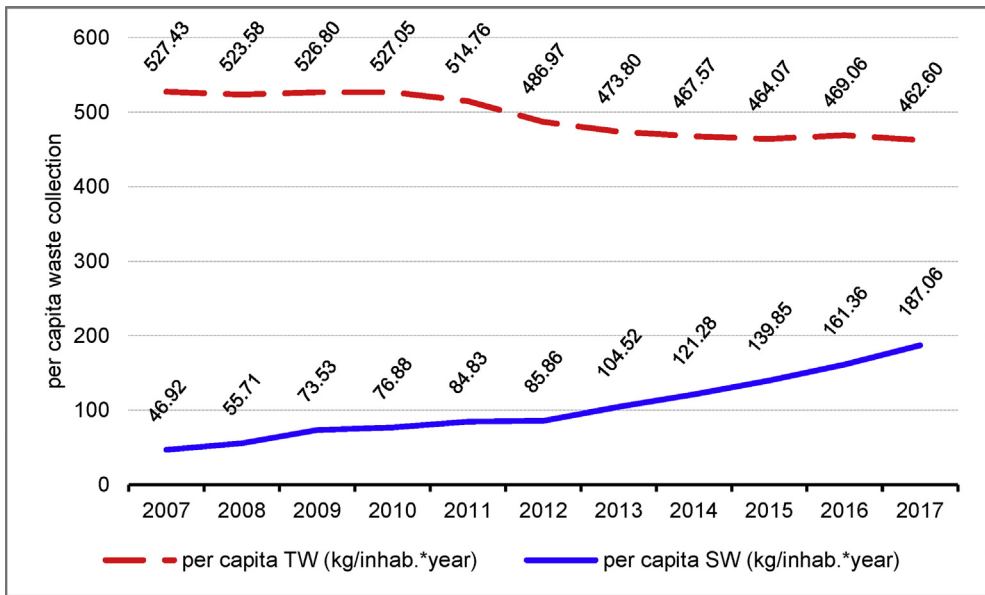
Fig. 5. Evolution of yearly per capita total urban total waste (TW) and sorted waste collection (SW) from 2007 to 2017 in Apulia.

European Commission has issued specific guidelines and directives to encourage the adoption of practices to recover and recycle materials and reduce waste production [3].

The collection and transportation of urban waste is an important step of the waste management cycle, as the collection of sorted waste that soon separates different kind of materials makes their reusing, recovering, and recycling easier and more efficient, at the same time reducing the amount of landfilled waste [4]. In Italy, the Legislative Decree no. 152/2006 and Law no. 296 of 27.12.2006 have set the following targets to achieve:

- at least 35% by 31 December 2006;
- at least 40% by 31 December 2007;
- at least 45% by 31 December 2008;
- at least 50% by 31 December 2009;
- at least 60% by 31 December 2011;
- at least 65% by 31 December 2012.

Additionally, the National Waste Prevention Program of the Italian Ministry of Environment issued in 2013 set the 5% decrease of the ratio "total production of urban waste to GDP" with reference to 2010 as a goal to achieve by 2020. The Regional Plan for Urban Waste Management approved by the Apulia Regional Government in 2013 established the following targets to achieve: 10% decrease of total waste
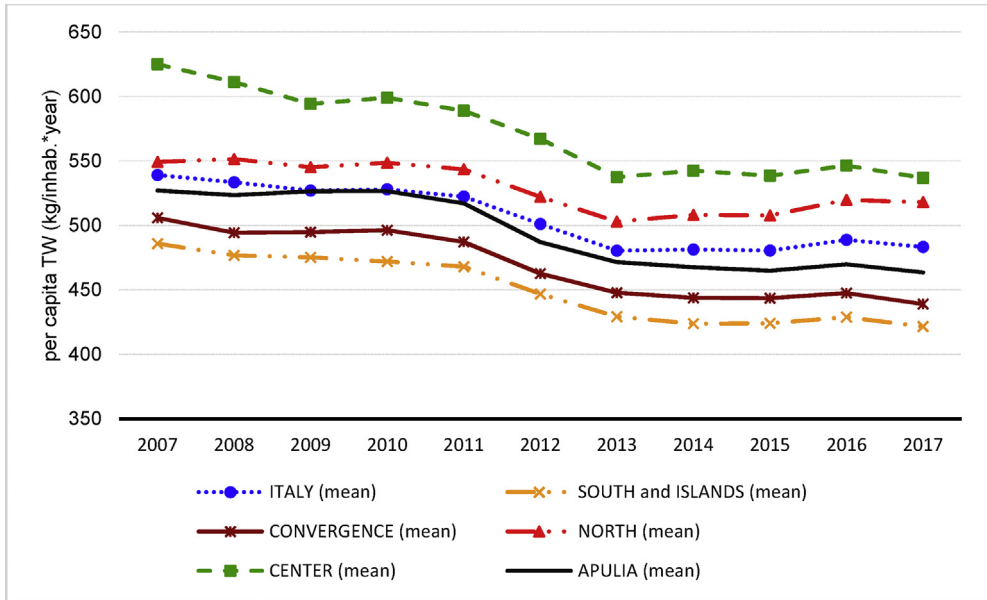
Fig. 6. Per capita waste collection from 2007 to 2017. Data relative for Apulia, Italy and specific territorial areas.

production, and 65% of sorted waste collection as prescribed by Decree no. 152/2006. Both the Apulia ERDF[3] Operating Program and the National Strategic Framework relative to the 2007—2013 programming period set further goals to be achieved by the end of 2013: to increase the percentage of urban sorted waste collection from 8.2% (year 2005) to 40%; to reduce landfilled waste from 453 kg per capita (year 2005) to 230 kg per capita.

Thus, collecting and analyzing data about waste production and, particularly, about the proportion of sorted waste and the specific type of waste materials has become a critical activity to assess the performance and monitor the effort of the municipalities to meet targets [5]. Moreover, the Common Provisions Regulation (CPR) for the 2014—2020 European Structural and Investment Funds emphasizes the evaluation of the effectiveness and impacts of the actions performed by regions to implement the cohesion policy supported by EU funds (ESIFs), particularly to have useful indications and benefit from lesson learned from the previous programming cycle. In order to strengthen the results-focus of the cohesion policy, the Article 56(3) of the CPR requires the Managing Authorities of the Regional Operational Programs to carry out specific evaluations to assess the effects of the actions supported by ESIFs.

The Legislative Decree no. 397 of 9 September 1988 has established the Italian Registry of Waste (RoW) (Catasto Rifiuti), while the Legislative Decree no. 152 of 3 April 2006 has defined the tasks of this latter. Every year, municipalities have to transmit data relative to the total and sorted amount of urban waste collected in the previous year, amount of special waste, specific types of waste materials, cost of waste management service, and treatment plant capacity to the Chambers of Trade, Agricolture and Industry. Data are finally transferred to the National Institute for the Environmental Protection and Research (Istituto Superiore per la Protezione e la Ricerca Ambientale - ISPRA) to populate the RoW database. Raw data collected by the RoW are made freely available to the public under an open source license, organized in three different databases: waste production and sorted waste collection (available at the national, regional and municipal level); waste material treatment (available at the national,
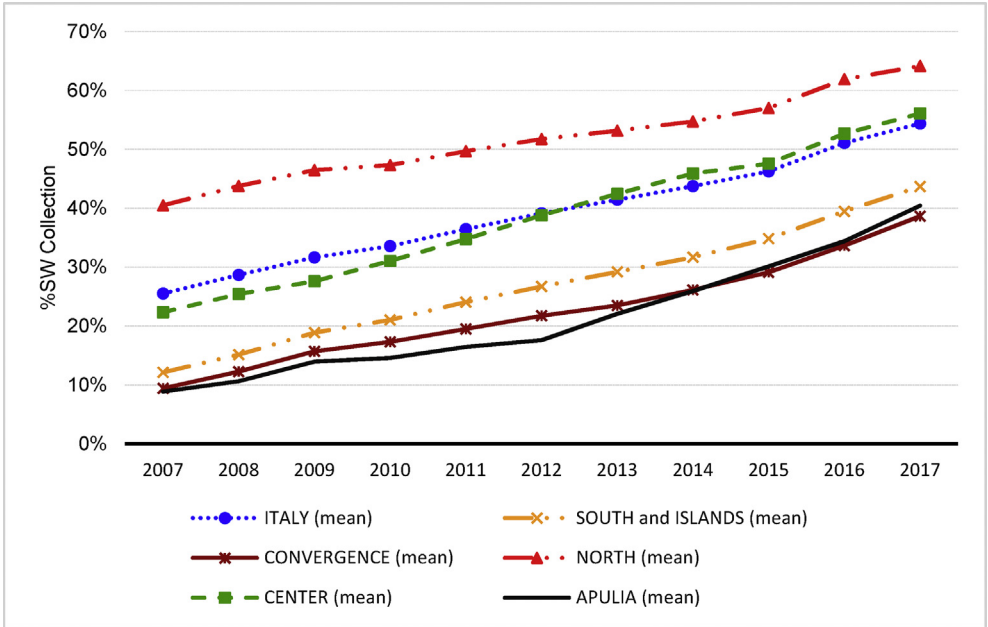
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[3] European Regional Development Fund.

Fig. 7. Sorted waste collection rate from 2007 to 2017 in Italy, specific territories and Apulia.
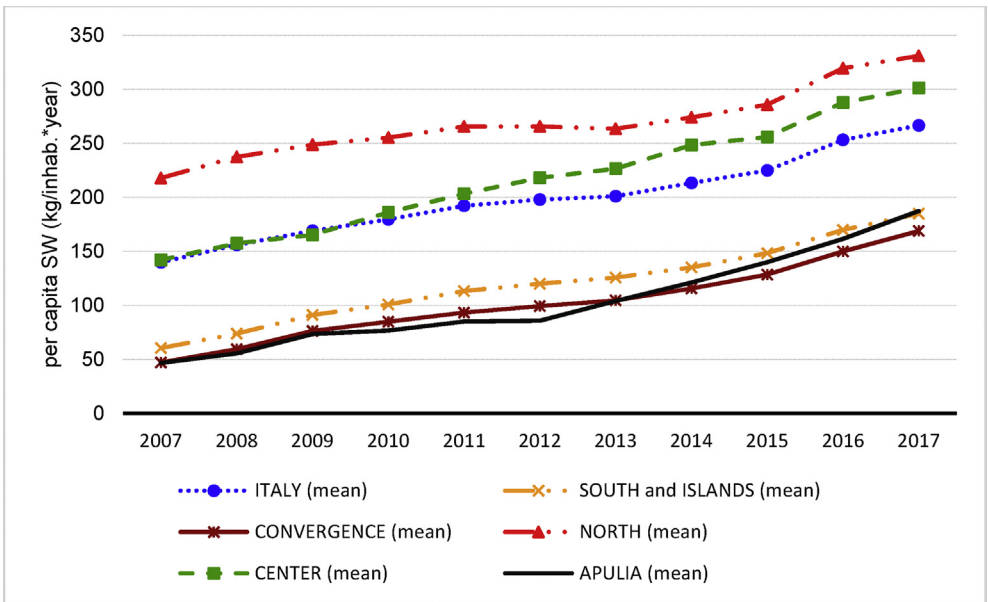

Fig. 8. Per capita sorted waste collection from 2007 to 2017. Data relative for Apulia, Italy and specific territorial areas.
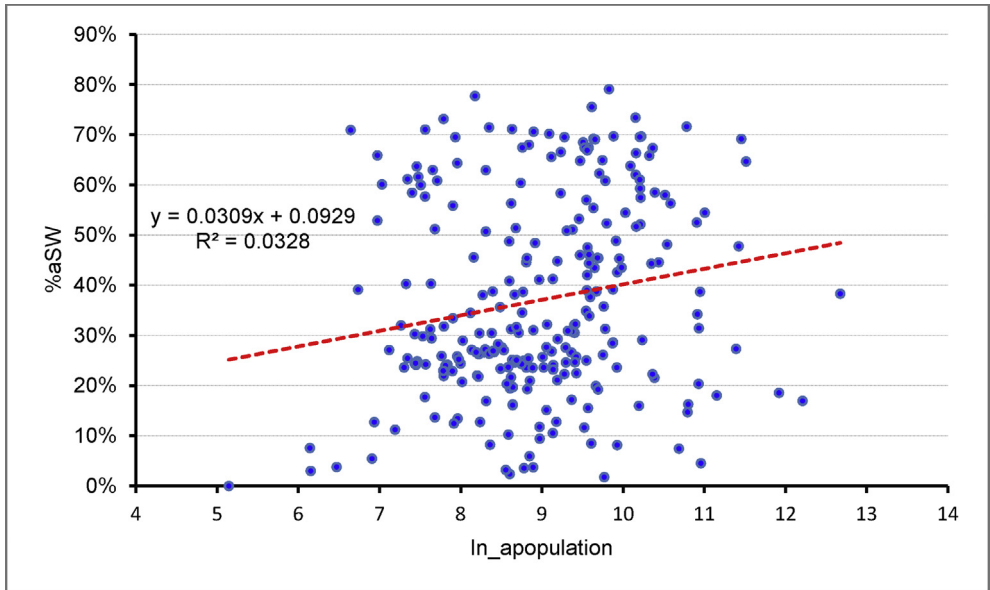
Fig. 9. Plot of the average sorted waste collection rate (%aSW) vs the average number of resident inhabitants (ln_apopulation).
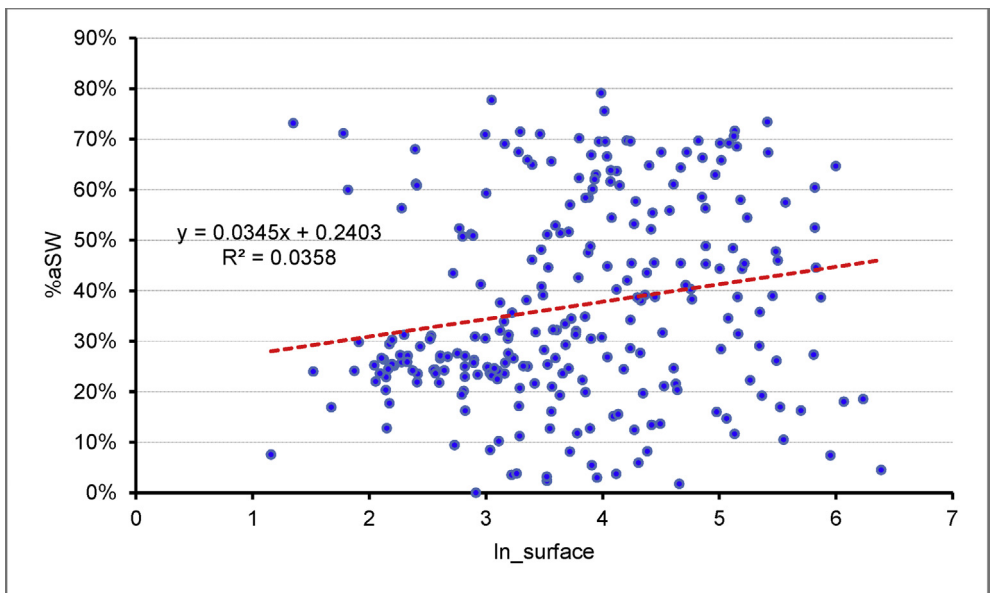

Fig. 10. Plot of the average sorted waste collection rate (%aSW) vs the surface area (ln_surface area).
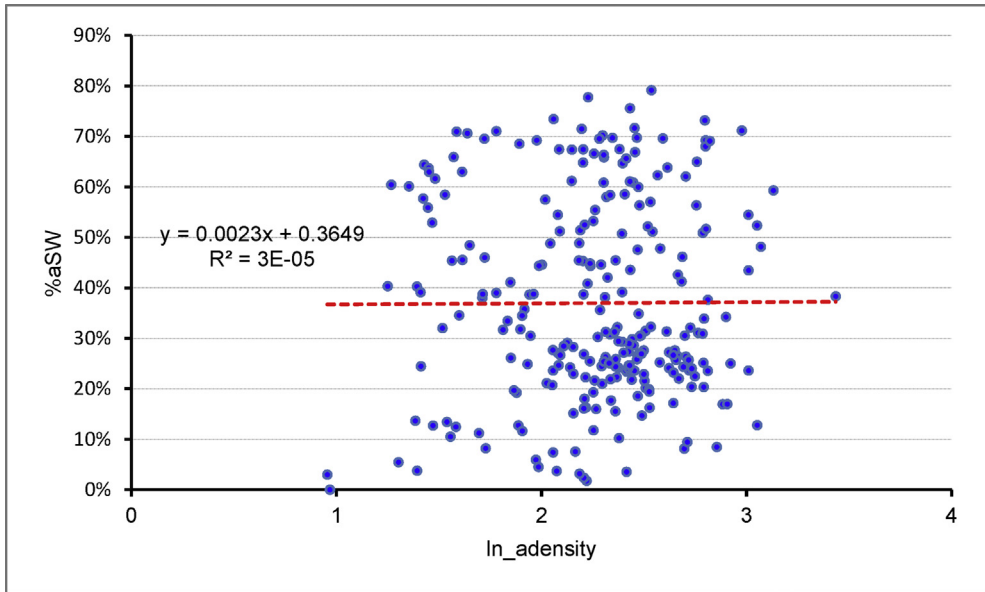
Fig. 11. Plot of the average sorted waste collection rate (%aSW) vs the average population density (ln_apopulation density).

regional, and plant level); costs of the urban waste management service (available at the national, regional, and municipal level).[4]

Data analysis is focused on Apulia, which is the most southeastern region of Italy, having about 800 km of coastline. With a population of about 4 million people and an area of 19,366 square kilometres (7,469 sq. mi), it has a demographic density higher than the national average. There are 258 municipalities spread in the regional territory. In 2017 the per capita GDP was € 16,895, lower than the national average, but growing more than in the other Southern regions, with a 3% rate between 2015 and 2017 [6—8]. Agriculture is still the primary source of wealth, but in the last years the tourism industry is growing because of the high number of artistic-historical localities and bathing places, and a nice climate. The region faces a number of challenges, including the low development of the high added value manufacturing and service industries, the dominance of family owned SMEs, and poor interconnection of the railway networks [9].

Raw data retrieved from the RoW databases have been used to evaluate the performance of the waste management system in Apulia, Italy and the groups of Italian regions between 2007 and 2017, while raw data relative to the Apulia municipalities and socio-economics have been retrieved from the ISTAT database. Particularly, data relative to the total waste and sorted waste collection from 2007 to 2017 were retrieved for each municipality, and finally the generated 258 records were used to assemble the database for the Apulia region. Raw data including information relative to the size (population and surface area) of the 258 municipalities were added to the database. The information relative to the Apulia region was organized by alphabetic order, using the name of the municipality as sorting criterion. Data relative to the total and sorted waste collection amounts for all Italian regions between 2007 and 2017 retrieved from the RoW databases and data providing information relative to macro-economic variables (GDP and household consumption expenditure) were organized in spreadsheets. Raw data for waste and socio-economics were used to develop performance indicators (the ratios "total waste to GDP", "total waste to household consumption expenditure", "total waste collection to number

of inhabitants", "sorted waste collection to number of inhabitants", and the percentage of sorted waste collected). The information relative to the remaining Italian territories were grouped either using the geographical location or the per capita income as criteria. Aggregated data relative to Apulia were compared to those relative to grouped regions and Italy. Both raw data and calculated indicators have been analyzed by measuring descriptive statistics.

The dynamics of both total and sorted waste indicators were analysed over time for Apulia and the rest of Italy. The effects of the municipality surface area, the number of inhabitants and population density on the sorted waste collection rate were investigated by performing regression analysis. A log-transformation was preliminarily used to make variable (surface area, number of inhabitants and population density) measurements comparable because of their skewed distributions.

Acknowledgments

Conflict of Interest

The author declare that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.104380.

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