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# Per capita municipal solid waste generation and its relationship with socioeconomic and demographic factors in Goiás State, Brazil

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## ABSTRACT

In Brazil, per capita municipal solid waste (MSW) generation has been increasing in the last years. This situation, combined with inadequate MSW management, provides a disturbing scenario in the Brazilian States. For example, in Goiás State, just 16 of the 246 municipalities send their MSW to licensed landfills. To change this, Goiás should prevent waste generation, as advocated by the waste hierarchy, among other measures. To do this, it is necessary to identify elements that may be associated with increased MSW production. Thus, the goal of this study is to perform a statistical analysis to identify socioeconomic and demographic factors that may be associated with the per capita MSW generation in Goiás. For this analysis, descriptive analysis and linear regression with robust estimation were used. The results showed that the daily per capita MSW generation in Goiás can be better justified by socioeconomic and demographic variables rather than just by socioeconomic variables. The Municipal Human Development Index for Education has shown to be a statistically significant variable to exert influence on waste production, in order to contribute to the 39% growth of daily per capita MSW generation, in the State.

**KEYWORDS:** Production of MSW. Waste management. Statistical analysis. Municipal Human Development Index for Education Developing country.

## INTRODUCTION

Population growth, coupled with urban lifestyle, has been responsible for the increase in municipal solid waste (MSW) production in the world (HANNAN *et al.*, 2015; SANTOS *et al.*, 2014). It can be proven by the WORLD BANK (2012) study, that pointed out that, in 2012, were generated around 1.3 billion tons of MSW, which is equivalent to a per capita MSW generation of 1.2 $kg.inhabitants^{-1}.day^{-1}$. And, if this scenario of growing MSW production is maintained, in 2025, there will be 2.2 billion tons of this waste, which is equivalent to 1.4 $kg.inhabitants^{-1}.day^{-1}$. As a result, this per capita MSW generation increase can bring serious environmental problems, like soil and water resources contamination, as well as endangering human health (BARROS *et al.*, 2015; LAVEE; NARDIYA, 2013; MALAKAHMAD *et al.*, 2017).

Currently, developed countries (for example, some Member States of the European Union – EU, United States of America – USA, Japan) are responsible for the largest per capita MSW generation and almost half of the total amount of solid waste on the planet. However, in these countries, the per capita MSW generation is decreasing (WORLD BANK, 2012). Meanwhile, developing countries walk in the opposite direction. An example is Brazil, where it has been identified an increase in the per capita MSW generation (ABRAMOVAY *et al.*, 2013).

In addition, in Brazil and in other developing countries, it is observed a restricted knowledge about good practices for solid waste management, lack of equipment for the collection of segregated materials and the deficiency of decision makers who are effectively engaged in environmental issues (GUERRERO *et al.*, 2013).

According to the National Sanitation Information System (SNIS, 2016), in 2014, 48% of Brazilian municipalities had dumps, 25.9% had unlicensed landfills and only 26.1% had licenced landfills. In Goiás State, MSW management is even more deficient, as only 16 of 246 municipalities send their waste to landfills licensed by the Department of Environment, Water Resources, Infrastructure, Cities and Metropolitan Affairs (SECIMA/GO,2015). The remaining 230 municipalities deposit their MSW in dumps or non-licensed landfills. This situation occurs even after the imposition of the Brazilian Solid Waste Policy (through law no. 12 305/2010), which determined that, until August of 2014, all Brazilian municipalities should terminate their dumps (BRASIL, 2010).

To modify this alarming scenario of MSW management of Goiás, before dwelling on the proper disposal of this waste, public managers must implement actions aimed at stopping MSW generation (GODECKE *et al.*, 2012). This statement is the first principle of the waste management hierarchy, that prioritises waste generation prevention and reduction (BRASIL, 2010; European Commission – EC, 2008). To achieve this, the first step is to know the per capita MSW generation (COLVERO *et al.*, 2017) and identify the factors that influence the waste generation.

According to the studies of MAZZANTI (2008) and SJÖSTRÖM and ÖSTBLOM (2010), one of the factors directly related with waste production is the Gross Domestic Product (GDP). GDP measures the total amount of goods and services produced, somewhere, in a specific period. In other words, GDP represents the

sum of values from different economic sectors, plus taxes on products not included in the production value, excluding the subsidies. Therefore, GDP is the sum of final consumption of goods and services valued at market price (MATOS, 2004). This relationship was observed between 1980 and 2005, in which the amount of per capita MSW generated grew 54% in EU countries, 35% in the Member States integrating the Organization for Economic Cooperation and Development (OECD) and 29% in North America (SJÖSTRÖM; ÖSTBLOM, 2010). Beyond GDP, other socioeconomic and demographic variables can also have direct relation on MSW production, such as the level of education and cultural aspects of urbanization (MEDEIROS *et al.*, 2015).

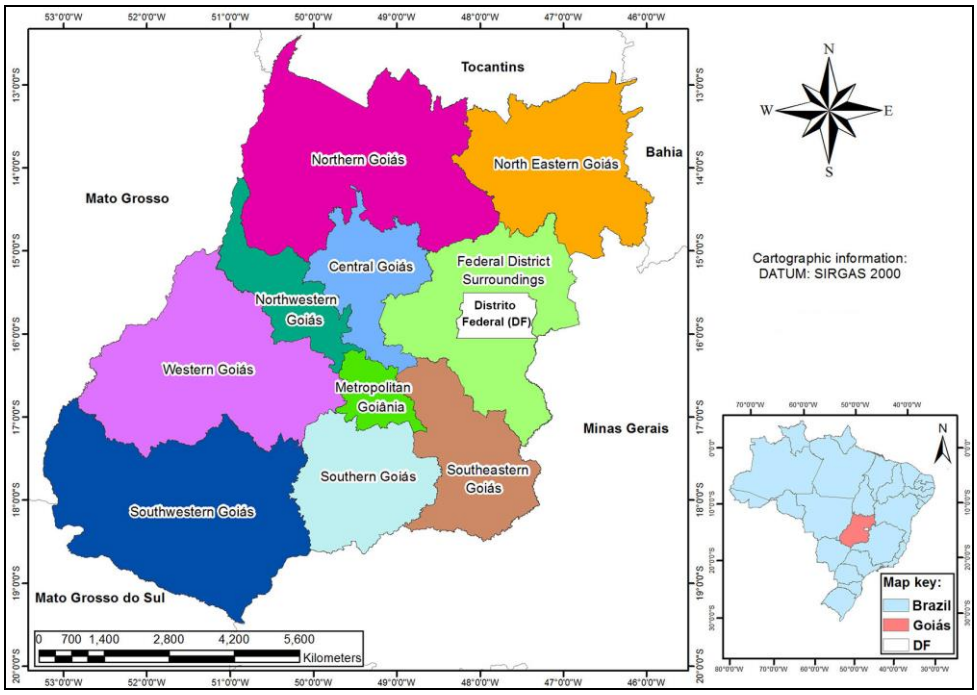
Therefore, the goal of this study was to perform a statistical analysis to identify socioeconomic and demographic factors that may be associated with the per capita MSW generation in the municipalities of Goiás State, Brazil.

## METHODOLOGY

### Study area

Goiás State is situated in Brazil's Midwest region and is adjacent to six other Brazilian States: Tocantins (North), Mato Grosso (Northwest and West), Mato Grosso do Sul (Southwest and South), Minas Gerais (South and Southeast), Bahia (Northeast) and the Federal District (ROMERO *et al.*, 2014). According to the latest official demographic census of Brazil, in 2010, the population of Goiás was 6,003,788 inhabitants, distributed in an area of 340,000 $km^2$, which represents a Demographic density of about 17.7 inhabitants.$km^{-2}$ (IBGE, 2010). To ensure that the State Government's investments meet the socioeconomic needs of all 246 municipalities, Goiás is divided into ten planning regions, as presented in Figure 1 (IMB, 2014).

Figure 1 – Goiás State planning regions.




## Amount of municipal solid waste produced in Goiás State

To perform an assessment of a possible relationship between the per capita MSW generation and socioeconomic and demographic factors (PINTO *et al.*, 2012), first it was necessary to identify the amount of waste produced by each citizen of Goiás. For this, the estimated projection from COLVERO *et al.* (2017) study was used. It establishes a relationship between the median of the per capita MSW generation (of the years 2012 and 2013) and the number of inhabitants of each municipality (Table 1) – COLVERO *et al.* (2017). As this is the only study in Goiás that makes a reference to the MSW amount produced in all municipalities, it was considered that the waste generation per person in 2010 would be the same as in 2012/2013, remaining constant.

Table 1 – Estimation of the per capita MSW generation in Goiás State, by population range.

| Population range of the Goiás municipalities (inhabitants) | Per capita MSW generation median ($kg.inhabitants^{-1}.day^{-1}$) |
|---|---|
| Up to 5,000 | 0.46 |
| 5,001 to 10,000 | 0.50 |
| 10,001 to 20,000 | 0.54 |
| 20,001 to 50,000 | 0.60 |
| 50,001 to 100,000 | 0.69 |
| More than 100,000 | 0.77 |

Source: Adapted from COLVERO *et al.* (2017).

Thus, the median value of per capita MSW generation, in each of the 246 municipalities of Goiás, was obtained. The median was chosen (instead of the mean), because it excludes the outlier values, thereby ensuring greater data accuracy (COLVERO *et al.*, 2017). For a better understanding of how the MSW production is distributed in Goiás, a map with the per capita MSW generation in

every Goiás municipality has been drawn up with a Geographic Information System (GIS) tool (ArcGIS, version 10.3.1).

## Socio-economic and demographic data

For each Goiás municipality, data was gathered from the four socioeconomic and demographic variables ("GDP per capita", Municipal Human Development Index ("MHDI Education"), " Population density" and "Urban domiciles") that were used in this study to perform the statistical analysis. This information was collected from the Mauro Borges Institute databases (IMB, 2017), based on the information available on Brazil's last official census, conducted in 2010 by the Brazilian Institute of Geography and Statistics (IBGE).

To clarify each of the independent variables used in the statistical analysis, a definition is presented, as IMB (2017):

- "GDP per capita": GDP represents the total wealth generated in a specific time period (usually one year) in a particular geographical area (municipality, region, country). To obtain "GDP per capita", the total GDP is simply divided by the number of inhabitants of the evaluated territory. According to INOUE and RIBEIRO (2016), MAZZANTI (2008) and SJÖSTRÖM and ÖSTBLOM (2010), there is a direct relationship between "GDP per capita" and MSW generation. Hence, this economic variable was used to analyse whether it has an influence on the per capita MSW generation of the municipalities of Goiás. This methodology has already been used for studies conducted in the Brazilian municipalities of João Pessoa/PB and São Paulo/SP (FRANCA *et al.*, 2013; MEDEIROS *et al.*, 2015; MELO, *et al.*, 2009).

- "MHDI Education": this indicator is obtained from the composition of two sub-indicators that are valued with different weights: weight 1 for the education level of the adult population (people aged over 18); and weight 2 for the school path of the young population (covering children between five and six years old, teenagers between 15 and 17 years old and young adults aged between 18 and 20). This way, the education level of the adult population is calculated from the percentage of people in this age group who possess complete elementary school. Conversely, the education path of young people and children is measured by the arithmetic mean of the percentage of children attending school, with the percentage of young people that completed elementary school and the percentage of young adults that completed high school, as well. MHDI ranges between 0 and 1, and is classified as follows: Very low (from 0 to 0.500); Low (from 0.500 to 0.599), Medium (from 0.600 to 0.699), High (from 0.700 to 0.799), Very high (above 0.800). According to Medeiros *et al.* (2015), the sociocultural education variable may affect waste production. Consequently, the analysis of a possible relationship between MSW generation and "MHDI Education" in Goiás, was also performed.

In addition, an analysis of the relationship between other sociodemographic variables and the amount of MSW produced can be done (RIBEIRO, 2012; SILVA *et al.*, 2012). So, two other variables were used to analyse a possible relationship with the per capita MSW generation: total number of "Urban domiciles" and "Population density".

• "Population density": this indicator, defined by the ratio between the population and the area of a specific location, points out how a population is distributed in a given territory. It tells how crowded is an area.

• "Urban domiciles": are the dwellings situated in the urban area, in which the occupants are associated by kinship, through domestic dependence or precepts of cohabitation.

### Statistical analysis

To analyse a possible relationship between the per capita MSW generation and the socioeconomic and demographic variables selected for this study (Table 2), statistical techniques were used, like descriptive analysis and linear regression (LIMA, 2012). Linear regression was performed using the Ordinary Least Squares method (OLS). The multiple linear regression model was adopted, in which the endogenous variable depends on two or more explanatory variables or regressors (GUJARATI; PORTER, 2011). Subsequently, Variance Inflation Factor (Vif) and Breusch-Pagan-Godfrey (Prob. $>\chi^2$) tests were applied, to identify the existence of multicollinearity problems among variables and to evaluate the hypothesis of homoscedasticity or heteroscedasticity, respectively.

Multicollinearity happens when the independent variables are correlated with each other, usually when a small sample is used. The homoscedasticity refers to a constant or equal variance of each error term ($u_i$) of the regression, while in heteroscedasticity the variance or error distribution is not constant (GUJARATI; PORTER, 2011). When observing heteroscedasticity in the model, the robust estimation method was employed, as it is not sensitive to small disregards to the assumptions, which produces accurate results (BARBIERI, 2012).

As well as in the Franca *et al.* (2013) study, the statistical analysis was performed using the Statistics Data Analysis (STATA) software.

Table 2 – Relationship of the variables used in linear regressions.

| Regressions | Dependent variable | Independent variables |
|---|---|---|
| Regression 1 | Per capita MSW generation | Socioeconomic:<br>MHDI Education<br>GDP per capita |
| Regression 2 | Per capita MSW generation | Sociodemographic:<br>Demographic density<br>Urban domiciles |
| Regression 3 | Per capita MSW generation | Socioeconomic and demographic:<br>Demographic density<br>Urban domiciles<br>MHDI Education<br>GDP per capita |

## RESULTS AND DISCUSSIONS

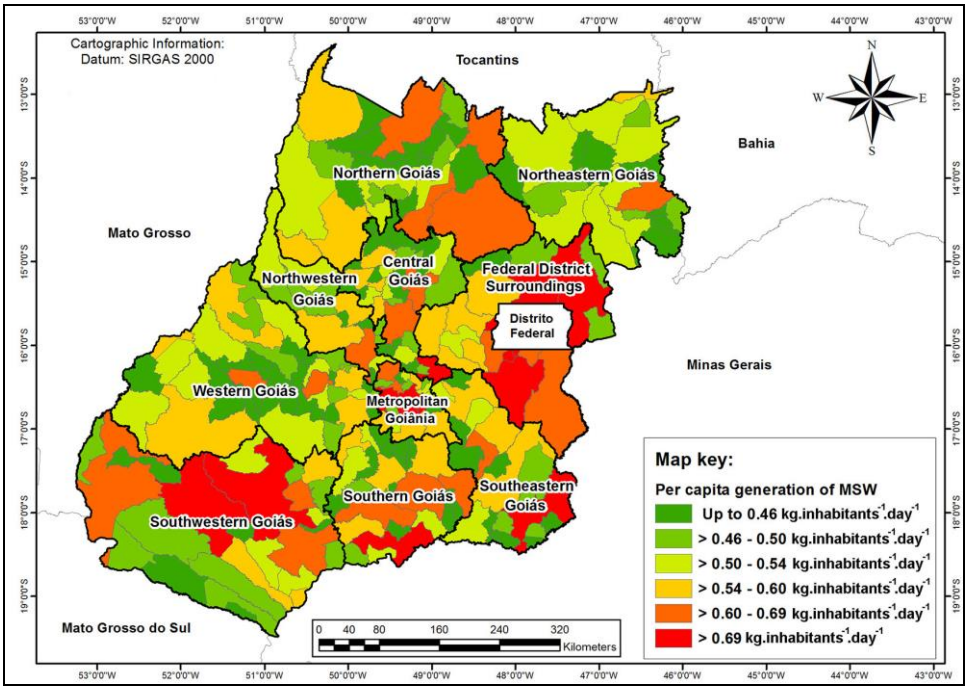


### Per capita MSW generation of Goiás State's municipalities

With each municipality's population, from the demographic census of IBGE (2010) and the amount of per capita MSW generation for each population size (COLVERO *et al.*, 2017), it was possible to elaborate the per capita MSW generation map of the 246 municipalities of Goiás (Figure 2).

The results show that 8 of the 10 municipalities with the highest per capita MSW generation are in two planning regions: Goiânia Metropolitan Region (3 municipalities) and Federal District Surroundings (5 municipalities). This means that the municipalities with higher population quotas are concentrated in these two regions, according to the per capita projections presented in Table 1.

**Figure 2** – Per capita MSW generation for each municipality in Goiás State.




Regarding total quantity, in 2010 was produced about 4,436 t.day$^{-1}$ of MSW (Table 3), in Goiás. And in Goiânia Metropolitan Goiânia, where about 36% of the entire population of Goiás reside, 45% of the State's total MSW was generated. In this region, the Demographic density is about 17 times greater than the mean population density of the State. This is the result of very dense municipalities distributed in the smallest state planning region (with only 2.2% of the total area of Goiás).

Table 3 – Demographic outline of the ten planning regions of Goiás State.

| Region | Number of municipalities | Goiás Population (inhabitants) | Area (km$^2$) | Demographic density (inh.km$^{-2}$) | Estimated MSW production in 2010 (t.day$^{-1}$) |
|---|---|---|---|---|---|
| North Goiás | 26 | 308,127 | 60,946 | 5.1 | 175.7 |
| Northeast Goiás | 20 | 169,995 | 40,181 | 4.2 | 90.1 |
| Northwest Goiás | 13 | 140,900 | 14,872 | 9.5 | 78.6 |
| Goiás Center | 31 | 622,541 | 18,536 | 33.6 | 443.3 |
| FD Surroundings | 19 | 1,047,266 | 30,982 | 33.8 | 734.9 |
| West Goiás | 43 | 338,333 | 55,535 | 6.1 | 180.9 |
| Metropolitan Goiânia | 20 | 2,173,141 | 7,315 | 297.1 | 1,975.7 |
| Southeast Goiás | 22 | 248,372 | 25,425 | 9.8 | 147.6 |
| Southwest Goiás | 26 | 553,900 | 61,499 | 9.0 | 363.1 |
| South Goiás | 26 | 401,213 | 24,820 | 16.2 | 245.8 |
| **Goiás State Total** | **246** | **6,003,788** | **340,111** | **17.7** | **4,435.7** |

Source: Adapted from IMB (2014), IBGE (2010).

## Statistical analysis of the per capita MSW generation

According to the data used in this research, the list of analysed variables and their respective information related to the mean, standard deviation, minimum and maximum allowed values for this study is presented (Table 4).

Table 4 – Descriptive statistics of the sample.

| Variable | Observations | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| MSW generation | 246 | 0.51 | 0.09 | 0.38 | 1.01 |
| GDP per capita | 246 | 15,909 | 16,540 | 4,812 | 164,730 |
| MHDI Education | 246 | 0.596 | 0.054 | 0.415 | 0.739 |
| Urban domiciles | 246 | 6,401 | 28,317 | 132 | 421,242 |
| Demographic density | 246 | 46.4 | 215.1 | 1.3 | 2,197.1 |

Considering the 246 municipalities, it is observed: a mean “GDP per capita” of R$ 15,909; a mean “MHDI Education of approximately 0.6; a mean of 6,401 domiciles located in urban areas; and a mean “Population density” of 46.4. Regarding standard deviation, which describes the variability observed in the sample compared to the mean of the variables for this study, there is a greater variability and, consequently, greater standard deviation in the variables “Urban domiciles” and “GDP per capita”. This information demonstrates the heterogeneity the analysed municipalities, regarding the number of households and income. So, the largest number of residences in the urban region is concentrated in the capital of the State, in Goiânia municipality; while the largest “GDP per capita” of the sample belongs to Alto Horizonte municipality, located in North Goiás region.

The results presented in Table 5 refer to robust estimates of three linear regressions, in order to evaluate the influence of socioeconomic and demographic factors on the daily per capita MSW generation, in Goiás. According to BIASOLI *et al*. (2007), *robust estimates* is a method that provides more precise estimates for reference measures, it is an important aspectto produce accurate results (BARBIERE, 2012).

Table 5 – Results of the linear regressions (*robust* estimate).

| Variable | Regression 1 | | | Regression 2 | | | Regression 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | P-value | t | Coef. | P-value | t | Coef. | P-value | t |
| GDP Per capita | 1.09e-08 | 0.975 | 0.04 | - | - | - | 6.82e-08 | 0.749 | 0.32 |
| MHDI Education | 0.397824 | 0.000* | 3.11 | - | - | - | 0.144771 | 0.068*** | 1.83 |
| Urban domiciles | - | - | - | 1.30e-06 | 0.038** | 2.09 | 1.25e-06 | 0.044** | 2.03 |
| Demographic density | - | - | - | 0.000121 | 0.008* | 2.66 | 0.000118 | 0.013** | 2.51 |
| Obs. | 246 | 246 | 246 | | | | | | |
| $R^2$ | 0.0573 | 0.3915 | 0.3990 | | | | | | |
| Prob. > F | 0.0086 | 0.0000 | 0.0000 | | | | | | |
| Vif | 1.01 | 1.58 | 1.33 | | | | | | |

Notes: *Coef.* is the partial regression coefficient or the angular partial coefficient, which measures the variation in the mean value of the dependent variable, per unit of variation of the independent variable; *t* is the hypothesis test over the individual partial coefficients of the regression, that one variable exerts influence over another; *P-value* indicates the exact significance level, representing the percentage interval of acceptance/rejection of the hypothesis; in this study, */**/*** represent the significance level at 1%, 5% and 10%, respectively; $R^2$ is the multiple determination coefficient, indicating the quality of adjustment of the regression equation, i.e., it presents the percentage of the total variation of the dependent variable according to the set of explanatory variables; *Prob. > F* presents the general significance level of the multiple linear regression; Vif *(Variation Inflation Factor)* indicates the test for multicollinearity between the variables (GUJARATI; PORTER, 2011).

In Regression 1, the contribution of the socioeconomic variables “GDP per capita” and “MHDI Education” for the daily per capita MSW generation in Goiás was estimated. In the second regression, the independent variables were “Urban domiciles” and “Population density”. Finally, in Regression 3, all previous variables were related, resulting in the influence analysis of the socioeconomic and demographic factors (“GDP per capita”, “MHDI Education”, “Urban domiciles” and “Population density”) in the daily per capita MSW generation, for the parsed sample.

According to Table 5, the model with such variables for the three estimated regressions rejects the null hypothesis, that none of the independent variables exerts influence on the dependent variable. The assigned P-values of 0.000, justifies the relationship between variables, in a range of 1% of significance.

Observing the diagnostic results of Variance Inflation Factor (Vif) test, in the three regressions, it is admitted that no multicollinearity problems exist, namely, there is no correlation of the explanatory variables with each other. Based on the $R^2$ indicator to the estimated models, 0.0573 in Regression 1, 0.3915 in Regression 2 and 0.3990 in Regression 3, it is acknowledged that the daily per capita MSW generation in Goiás, demonstrates to be more explained by the group of socioeconomic and demographic variables rather than by the socioeconomic variables used in this study (stated in Table 2), when the influence of the variables is analysed together in the specified models.

Checking the significance level and the coefficients of each variable in the Regression 1, it is noted that:

- "GDP per capita" has no statistical significance to the sample under analysis, showing a P-value of 0.975, allowing to assert that it has not been possible to establish a relationship between the level of income per capita and the per capita MSW generation to the reviewed municipalities. Similarly, in a similar study performed in Belo Horizonte, Minas Gerais, PINTO *et al*. (2012) have

not obtained a meaningful result to the income variable in explanation of MSW generation.

- The "MHDI Education" variable presented statistically significant (P = 0.000) to influence the dependent variable, at a 1% confidence level. The coefficient (0.397824) demonstrates that there is a positive relationship between the educational level of the municipality and the daily per capita MSW generation. This variable contributes to a 39.8% increase in the daily per capita solid waste generation in Goiás, with everything else remaining constant, in this study.

In respect to the influence of educational levels, SILVA *et al*. (2012) stated that a higher education, among other factors that compose what they entitled of "urban-contemporary demographic profile", is associated with the largest per capita MSW generation. DIAS *et al.* (2012) highlighted education as one of the elements of greatest impact on solid waste generation. Also, for VIANA *et al.* (2015), the educational level of individuals can influence MSW generation. To the aforementioned authors, the higher level of schooling exerts influence on the gravimetric composition and amount of waste generated. Their studies have demonstrated consumption habits with a higher generation of potential recyclable materials, such as plastic and glass, among families with higher education, since their consumption strongly includes the acquisition of industrialized foods (COSTA *et al.*, 2012; SILVA *et al.*, 2012).

It should be noted that the educational level of individuals is bound to the formal education system, in which accounts for the years of study, but that does not allow to express the knowledge related to environmental issues, including excessive MSW generation. In this sense, MORAR and BUCUR (2017) claim that the tool to implement behavioural changes against the environmental problems in the world is environmental education. These authors believe that only through environmental education it is possible to create a society aware of the environmental problems and the need to prevent them, especially raising awareness of the younger generations.

In the Second Regression, the variables "Urban domiciles" and "Population density" demonstrate to influence positively the per capita MSW generation in the municipalities of Goiás, in the range of 5% and 1% confidence, respectively. Corroborating with these results, the literature points out that the higher the population in the urban area, the higher will be the per capita MSW generation (IBAM, 2001). This is because the population density in urban areas ends up influencing solid waste production, due to increasing consumption, given the greater access to the market, industries and services (VIANA *et al.*, 2015).

However, observing the coefficients presented by the two variables, this case study proves that there is an insignificant increment to the case of the "Urban domiciles" variable. It featured a 0.00000130 coefficient, i.e., has zero influence on solid waste generation, for the analysed sample. While the "Population density" variable is relatively validated with greater influence among the two variables used in Regression 2, contributing in 0.01% to increase the per capita waste generation in the present study, with everything else remaining constant. Hockett *et al.* (1995) conducted a similar study in the USA, using the demographic variable "Urbanization", and also found a diminutive explanatory

relationship to the variable, which showed a 0.7% increase in solid waste generation.

In the estimated third Regression, in which the socioeconomic and demographic variables were related, the variable "GDP per capita" remained not significant for the sample used in this study, showing a P-value of 0.749. The variable "MHDI Education" presented statistically significant (P=0.068) to the model, at a 10% level of confidence. It had a positive relationship between the education and per capita MSW generation, demonstrated by the sign related to its coefficient (0.144771). Moreover, it is possible to affirm that a higher degree of "MHDI Education" increases the per capita MSW generation by 14.47%.

In the case of "Urban domiciles" and "Population density" variables, in Regression 3, both remain statistically significant for the model and influence positively the MSW generation at a level of 5% confidence interval, however, they feature a hardly expressive positive variation in the per capita solid waste generation (less than 1%).

## FINAL CONSIDERATIONS

From the determined results, regarding the influence of socioeconomic and demographic factors on the per capita MSW generation in Goiás State, it is noted that, when the influence of the variables is analysed together in the three specified models, the daily per capita MSW generation showed more influence by the socioeconomic and demographic variables than just by the socioeconomic variables used in this study.

Nevertheless, analysing the socioeconomic variables separately, “MHDI Education” has presented statistically significant (P = 0.000) to exert influence on waste production, contributing to the increase in 39.8% of the daily per capita MSW generation, in Goiás. Though the variable “GDP per capita” has not demonstrated statistical significance for the sample in study in any of the estimated regressions.

After the addition of the socioeconomic and demographic variables, in the last estimated regression, it was found that the variable “MHDI Education” became significant only in the 10% confidence interval, remaining positive the relationship with the per capita MSW generation, contributing to increase the dependent variable in 14.5%. The variables “Urban domiciles” and “Demographic density” have resulted significant, although both have presented a reduced increment in the dependent variable, with coefficients less than 1%.

It should be emphasized that, because this article is a case study of a region in Goiás, it does not intend to exhaust the discussion about the issue of solid waste generation and its influence variables. Nonetheless, the results show that the problem of solid waste production is not exclusive to large urban centres, that hold of the largest income ranges and population clusters. In this way, it is desirable to highlight the need for formulating public policies, especially the implementation of environmental education programs that focus on encouraging waste generation reduction in Goiás, with emphasis on the construction of new habits and environmentally responsible production and consumption practices.

Finally, the main limitation during this study was the compilation of data that actually represented the per capita MSW generation of Goiás municipalities. To overcome this difficulty, studies with trustworthy methodologies were used, to find these figures.



**COLVERO**, D. A.. et al. Per capita municipal solid waste generation and its relationship with socioeconomic and demographic factors in a developing country. **R. Tecnol. Soc.,** Curitiba, v. 15, n. 36, p. 254-271, abr./jun. 2019R. Tecnol. Soc., Curitiba, v. 15, n. 36, p. 1-26, abr./jun. 2019.

# Produção per capita de resíduos sólidos urbanos e sua relação com fatores socioeconômicos e demográficos no estado de Goiás, Brasil


## ABSTRACT

No Brasil, a geração de resíduos sólidos urbanos (RSU) per capita vem aumentando nos últimos anos. Essa situação, combinada com a gestão inadequada de RSU, fornece um cenário preocupante nos estados brasileiros. Por exemplo, em Goiás, apenas 16 dos 246 municípios enviam seus RSU para aterros licenciados. Para mudar isso, Goiás deve evitar a geração de resíduos, conforme preconizado pela hierarquia de resíduos, entre outras medidas. Para isso, é necessário identificar elementos que possam estar associados ao aumento da produção de RSU. Assim, o objetivo deste estudo é realizar uma análise estatística para identificar fatores socioeconômicos e demográficos que possam estar associados à geração de RSU per capita em Goiás. Para esta análise, utilizou-se análise descritiva e regressão linear com estimação robusta. Os resultados mostraram que a geração de RSU per capita diária em Goiás pode ser melhor justificada por variáveis socioeconômicas e demográficas do que apenas por variáveis socioeconômicas. O Índice de Desenvolvimento Humano Municipal para a Educação mostrou-se uma variável estatisticamente significativa para exercer influência na produção de resíduos, de forma a contribuir para o crescimento de 39% da geração de RSU per capita diária, no Estado.


**KEYWORDS:** Produção de RSU. Gestão de resíduos. Análise estatística. Índice de Desenvolvimento Humano Municipal para o País em Desenvolvimento.



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