

# SOCIOECONOMIC VARIABLES AND PUBLIC ENVIRONMENTAL EXPENDITURES OF BRAZILIAN MUNICIPALITIES: AN ANALYSIS IN THE PERIOD 2005-2015

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## ABSTRACT

The objective of this article was to analyze the relation between some socioeconomic variables and the public environmental expenditures of Brazilian municipalities with more than 100 thousand inhabitants, between 2005 and 2015. To this end, multiple linear regression was used with public environmental expenditures and socioeconomic data of the 303 municipalities with population greater than 100 thousand inhabitants. In addition to the Environmental Expenditure, the following variables were also analyzed: Total Expenditures, Income per capita, Gross Domestic Product (GDP), Expenditure per capita, Green Expenditure Performance, Environmental Performance of GDP, Environmental Expenditure per Territorial Area and Environmental Expenditure per Inhabitant. The analysis indicated that socioeconomic issues seem to determine, to a greater extent, municipal environmental expenditures since regression confirmed that 8 variables were significant (Environmental Performance of GDP was not significant). The results suggest that these socioeconomic variables present a strong influence of about 85% on the environmental expenditure performed by Brazilian municipalities in the investigated period. This research is an additional contribution related to the theme, presenting a quantitative analysis of environmental spending in the municipal context, and may become an important tool to public managers that contributes to debate, planning and execution of environmental public policy.

**Keywords:** Environmental Management. Environmental Public Policy. Municipal Public Management

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# 1 INTRODUCTION

Faced with the world economic growth, sustained by a process of globalization, much has been debated about the finiteness of natural resources. The State, through its political agenda, subject to the perspective of economic growth, expanded its public policies, focusing on the consumption of goods and services and the generation of employment and income.

Because of this, public administration has been investing in methods for environmental preservation and recovery. In this sense, the environmental issue became the core of discussions, becoming an important point in the development of public policies oriented towards sustainability.

According to Pacheco *et al.* (2015), an ecologically balanced environment is a right to be guaranteed by the State, where environmental management actions must be planned and publicly exposed, in a transparent way, in the public budget, enabling the control by the society.

These actions, according to Barbieri (2011), are called Environmental Public Policies, which are "... a set of objectives, guidelines and instruments of action that the public authorities possess to avoid new environmental problems, as well as to eliminate or minimize the existing ones" (BARBIERI, 2011, p.71). According to Guandalini, Borinelli and Godoy (2013), with environmental policies, governments have created environmental agencies, laws and programs, allocating financial resources for this purpose.

The creation of Federal Law 6.938 of 1981 has initiated the institutionalization of environmental management in Brazil, establishing the so-called National Environment Policy (PNMA, in Portuguese) and the constitution of the National Environmental System (SISNAMA, in Portuguese), ensuring the decentralization of environmental management, being this system composed of all federative entities and functions instituted by the public power, in order to articulate the different spheres of power, seeking to facilitate the execution of the respective competencies (SCARDUA, 2003).

The studies involving environmental expenditures started to be carried from the 1990s (Guimarães, Carneiro, DOWELL, 1992; YOUNG, RONCISVALLE, 2002), providing reasonable explanations about public environmental policies, since studies in this sense improve the comprehension of the political context, sustainability and the budget process. The standardization and transparency of public information, which occurred at the beginning of the 2000, has led to the expansion of the possibilities for analysis and evaluation of public environmental policies (BORINELLI *et al.*, 2011; TRIDAPALLI *et al.*, 2011; YOUNG, GELUDA, LEMOS, 2006; GUANDALINI, BORINELLI, GODOY, 2013; DANTAS *et al.*, 2014).

## 1.1 Objectives and Justification

Recently, studies have been conducted in this field using multivariate techniques to analyze the relation between environmental expenditure and regional characteristics (BUENO, 2013; GUANDALINI, 2016). According to Bueno (2013), multivariate analysis techniques can provide a more detailed investigation of the factors that interfere in environmental expenditures. Thus, it is asked: are there factors that influence public environmental expenditures of Brazilian municipalities?

In this context, this research seeks to cooperate in the knowledge about the perspectives and relevance of studies in relation to environmental public spending, adding that more comprehensive studies on public environmental expenditures at the national level are scarce.

Thus, the study aims to analyze the Brazilian municipalities with a population greater than 100 thousand inhabitants. Considering that the standardized registration of public environmental expenditures started to occur only from 2000 (Ordinance No. 42 of 1999 of the Ministry of Budget and

Management), and that the process of creating municipalities in Brazil is a natural process, it is necessary to perform a study, especially in the largest Brazilian municipalities (population above 100 thousand), since they are municipalities created previously to the Ordinance, that is, they possess data from a large time interval, and constitute areas in which more than half (56.1%) of the population lives (IBGE, 2016).

According to IBGE (2016), the distribution of the Brazilian population in its 5,570 municipalities shows a high concentration in large urban centers; the 41 municipalities with more than 500 thousand inhabitants concentrate 29.9% of the population of the country (61.2 million inhabitants) and more than half of the population (56.1% or 114.6 million inhabitants) lives in only 5.5% of the municipalities (304 municipalities), which are those with more than 100 thousand inhabitants.

In view of the above, this study aims to analyze the relation between selected socio-economic variables and public environmental expenditures of Brazilian municipalities. Specifically, this relationship was investigated in municipalities with a population equal to or greater than 100 thousand inhabitants, from 2005 to 2015.

## 2 LITERATURE REVIEW

The study of public expenditures is strongly related to the analysis of state intervention in the economy, specially, by obtaining resources from society and their reallocation in the form of goods and services offered to the public, to suppress market failures (SILVA *et al.*, 2007).

Public expenditures are outlays incurred legally in the form of funding, investments, transfers and financial investments to fulfill government functions (GIAMBIAGI; ALÉM, 2000).

Matias-Pereira (2010) states that, in developing countries, where the goal is to achieve optimal levels of social equity, the government's economic attributions are expanded through public revenue and expenditures, with public spending being the main intervention. Through its use, the government defines its priorities in relation to the provision of basic public services and the investments to be made.

According to Carneiro; Moura e Neto (2013), public budget allocations have several classifications and one of them is expenditure by Function. By function of expense, according to Ordinance no. 42/99, one must understand the higher level of aggregation of the various areas of expenditure that compete with the public sector. Also, according to this norm, the subfunction represents a function partition. The subfunctions of Function 18 - Environmental Management are: i) preservation and environmental conservation (541); ii) environmental control (542); iii) recovery of degraded areas (543); (iv) water resources (544); and, v) meteorology (545). It is important to clarify that public environmental expenditures reflect the infrastructure for environmental management, the political demands and the economic production of a given region, which makes its analysis essentially complex, since it involves economic relations between the market and the public entity, which are not always easy to measure (CARNEIRO, 2008).

Thus, public environmental expenditures are related to environmental preservation and recovery, and such public sector expenditures are carried out by agencies in charge of environmental control, reforestation programs, monitoring of degraded areas, environmental prevention programs, waste removal in areas of protection and maintenance of environmental reserves (TRIDAPALLI *et al.*, 2011).

One of the first studies to analyze the factors associated with environmental expenditures was made by Sacco and Leduc (1969), whose objective was verifying socioeconomic factors and the environmental political structure. These authors identified an indication that economic development (socioeconomic characteristics) was more correlated with the variation of (environmental) politics than with the political structure. They also identified that population density, heating, and mass transportation, as well as garbage collection, influenced environmental expenditures.

Another pioneer study that analyzed public environmental expenditures was done by Stanton and Whitehead (1994), who evaluated the influence of interest groups on air and water quality expenditures in the United States in the decades of 1970 and 1980. One of the conclusions of the study was that public environmental spending has an inverse relation to influence of organized groups (lobbies) on environmental issues.

Lemos, Young and Geluda (2006) conducted a study on Brazilian environmental expenditures between 2000 and 2005 for the Federal, State and Municipality Governments, in which they considered the total expenditure and environmental expenditure corrected for the last year of the study.

Dutra, Oliveira and Prado (2006), also using the total expenditures and the primary revenues of the Federal Government, analyzed the expenditures of the Ministry of the Environment from 2000 to 2005. In both studies it was concluded that environmental expenditures were not a priority in the public budget. The authors emphasized that a significant part of the authorized resources was allocated to the contingency reserve (in some situations for the payment of debt services) and, at the same time, part of the authorized expenses was not properly applied due to budgetary execution difficulties.

Carneiro (2008) conducted studies on Brazilian public environmental expenditures, specifically for the Ministry of Environment, and found that the Ministry's budget is very small when compared to other ministries (approximately 0.15% of total expenditures) and that there are no large swings in their spending. The author pointed out that the environmental management function played an average of 0.31% of total expenditure.

Tridapalli *et al.* (2011) performed a bibliographical and documentary research in internationally and nationally studies. In Brazil, research on environmental expenditures began in the 1990s, with emphasis on federal government analysis and total expenditures, by function and sub-functions of environmental management, and the use of absolute and relative value indicators by function, the ratio between budgeted and settled expenditure. On the other hand, in international studies, the correlation between economic indicators and environmental expenditures is emphasized.

Magnani (1999), comparing data of four different countries, studied how income growth and income distribution affect public expenditure on research and development in the environmental field in high-income countries using data from 1980 to 1991. It was observed a positive correlation with investments in the environmental area and higher income per capita.

Bacot and Dawes (1997); Daley and Garand (2005) classified the determinant factors of environmental expenditures in: Socioeconomic, including demographic characteristics; structural / administrative, including public institutions that are linked to environmental issues; and policy, which includes the existence of interest groups for the environmental business, forming a classification based on various indices and / or environmental measures.

The table 1 presents the main variables that are classified as socioeconomic, according with different authors. It is observed that in the above-mentioned studies, the public expenditures on the environment were considered as a dependent variable, as well as several explanatory variables to understand the determinant factors in governmental actions when facing the environmental problems. The authors used a variety of inferential techniques, among them, multiple regression (STANTON, WHITEHEAD, 1994; BACOT, DAVES, 1997; NEWMARK, WITKO, 2007; KONISKY, WOODS, 2012).

In the study conducted by Stanton and Whitehead (1994), for water quality expenditures, only the environmental pressure groups and the per capita income were significant. According to this work, the increase in per capita income probably leads to an increase in the attempt to conserve the environment, that is, the higher the per capita income of society, the greater the concern with environmental issues.

**Table 1** – Main socioeconomic variables used in environmental expenditure studies.

<b>Variables</b>	<b>Authors</b>
<b>General Expenses</b>	Lombard (1993); Sacco, Leduc (1969); Bueno (2013); Guandalini (2016)
<b>Per Capita Income</b>	Sacco, Leduc (1969), Stanton, Whitehead (1994), Lombard, 1993; Newmark, Witko, (2007); Konisky, Woods (2012); Hays, Esler, Hays (1996); Daley, Garand, (2005); Bueno (2013)
<b>Gross Domestic Product (GDP)</b>	Sacco, Leduc (1969); Stanton, Whitehead (1994); Lombard (1993); Magnani (2000); Newmark, Witko (2007); Konisky, Woods (2012); Hays, Esler, Hays (1996); Daley, Garand (2005); Bueno (2013); Guandalini (2016)
<b>Expenditure per capita</b>	Almeida (2010); Melo, Sousa (2016); Bueno (2013)
<b>Green Performance of Expenses</b>	Almeida (2010); Melo, Sousa (2016); Tridapalli <i>et al.</i> (2011)
<b>Environmental Performance of GDP</b>	Almeida (2010); Melo, Sousa (2016); Tridapalli <i>et al.</i> (2011)
<b>Environmental Expenditure per Area</b>	Potoski e Woods (2012), Newmark, Witko (2007); Almeida (2010); Melo, Sousa (2016);
<b>Environmental Expenditure per Inhabitant</b>	Almeida (2010); Melo, Sousa (2016); Tridapalli <i>et al.</i> (2011)
<b>Demographic Density</b>	Stanton, Whitehead, (1994); Lombard (1993); Daley, Garand (2005); Melo, Sousa (2016); Bueno (2013); Guandalini (2016)

Source: Research (2017)

The study by Magnani (2000) concluded that in these countries with higher per capita income, GDP per capita presented a robust statistical significance with the investigated environmental expenditures, that is, the higher the per capita GDP, the higher the expenditure and its counterpart, the lower the inequality in distribution of the income (GINI Index) the greater are the public expenditures with research and development for the environmental area.

However, the study by Daley and Garand (2005) did not obtain conclusive results besides evidencing the existence of collinearity problems. Despite this, the authors report that in the determination of the state's hazardous waste policy (dependent variable) among the factors that are related, the socioeconomic variables (industrial GDP per capita, education and demographic density) are present.

Bueno (2013) analyzed the factors associated with the behavior of environmental expenditures in the municipalities of Paraná State (Brazil) from 2002 to 2011. The results indicated that there was an increase in the volume of environmental expenditures in the municipalities, besides the growth in the local environmental structure. Another conclusion was that socioeconomic characteristics exert a great influence on environmental expenditures in the municipalities of Paraná. However, the environmental structure in these municipalities also presented statistical significance.

Guandalini (2016) analyzed some determinants of environmental expenditures in the Brazilian states, studied in what different measures the variables may explain the amount of public budget spent in the environmental management of the states between 2002 and 2012. By the regression technique, it was observed that socio-economic, political / social, and environmental issues determine environmental expenditures.

According to Konisky and Woods (2012), the researcher must be careful in the choice of both the techniques and the variables to be used in the study, in such a way that they are consistent with each other. Regarding public spending, the study confirmed that states with high environmental expenditures per capita are usually small, relatively rural and with low GDP, otherwise, states with higher total environmental expenditures are usually larger and with higher budget levels, that is, the use of per capita or total expenditures can make a difference in a particular study and this should also be analyzed by the researcher.

Most of the studies in this field used the technique of multiple linear regression between the dependent and independent variables to stipulate a set of factors that were associated in the determination of this dependence. Some variables had differences, since in one study they are significant and in other studies it is not, even though they were considered in the same studies.

In relation to this, Bueno (2013) states that these divergences are not only due to the differences in the variable used to represent a certain theory, but also in the use of absolute values, relative and per capita; each author must specify the unit that is more appropriate to your study.

### 3 METHODOLOGY

According to the proposed objectives, this study can be classified as descriptive, with a quantitative and longitudinal approach. It is descriptive because it aims to describe the factors associated with public environmental expenditure in a municipal level. (COLLIS; HUSSEY, 2005; GIL, 1999; VERGARA, 2005).

Regarding the approach of the current study, the research is quantitative, that is, the research involves the processes of collection, analysis and interpretation of numerical data and application of statistical tests that will be related to phenomena of practical action, providing elements regarding the characteristics of a particular problem or issue. It is a longitudinal study because of the use of one or more variables, to analyze the dynamics of a situation over a long period of time (CRESWELL, 2010).

The collection of data was performed through budget execution reports with information on the Expenses Payable by Function of the individual data of the 303 Brazilian municipalities with population greater than 100 thousand inhabitants (IBGE, 2016), in the period of 2005 to 2015, available on the website of the National Treasury Secretariat (SNT), in which they were corrected by the General Price Index - Internal Availability (IGP-DI), which is contractually employed for the correction of certain administered prices. According to the BCB (2016), in the long term, the values of the National Extended Consumer Price Index - IPCA (official index used by the federal government for monetary and fiscal policy) and the IGP - DI converge to similar values (BCB, 2016). Other data were collected on the website of the Brazilian Institute of Geography and Statistics (IBGE).

The budgetary function corresponding to environmental expenditures was classified with code 18 (FINBRA - Secretary of the National Treasury), and this classification allows a more detailed analysis of the environmental expenditure, since it divides its classification in the following subfunctions: Preservation and Conservation Environmental; Environmental control; Recovery of Degraded Areas; Water resources and Meteorology.

The annual municipal environmental public expenditure, which accounts each municipality in the Environmental Management function (18) executed from the municipal budget will be considered as the dependent variable, because it is the main variable, and the other variables will be marked as independent variables as shown in Table 2 below.

**Table 2** – Variables considered in the current study.

Variable	Period	Authors
<b>Dependent Variables</b>		
<b>Environmental Expenses</b>	2005-2015	Sacco, Leduc (1969); Stanton, Whitehead (1994); Lombard, (1993); Potoski, Woods, (2012); Newmark, Witko (2007); Konisky, Woods (2012); Bacot, Dawes (1997); Bueno (2013); Guandalini (2016)
<b>Independent Variables</b>		
<b>General Expenses</b>	2005-2015	Lombard (1993); Sacco, Leduc (1969); Bueno (2013); Guandalini (2016)

<b>Per Capita Income</b>	2005-2014	Sacco e Leduc (1969), Stanton, Whitehead (1994), Lombard (1993); Newmark, Witko, (2007); Konisky, Woods (2012); Hays, Esler, Hays (1996); Daley, Garand, (2005); Bueno (2013)
<b>Gross Domestic Product (GDP)</b>	2005-2014	Sacco, Leduc (1969); Stanton, Whitehead (1994); Lombard (1993); Magnani (2000); Newmark, Witko (2007); Konisky, Woods (2012); Hays, Esler, Hays (1996); Daley, Garand (2005); Bueno (2013); Guandalini (2016)
<b>Expenditure per capita</b>	2005-2015	Almeida (2010); Melo, Sousa (2016); Bueno (2013)
<b>Green Performance of Expenses</b>	2005-2015	Almeida (2010); Melo, Sousa (2016); Tridapalli <i>et al.</i> (2010)
<b>Desempenho Ambiental do PIB</b>	2005-2014	Almeida (2010); Melo, Sousa (2016); Tridapalli <i>et al.</i> (2010)
<b>Environmental Expenditure by Area</b>	2005-2015	Potoski e Woods (2012), Newmark, Witko (2007); Almeida (2010); Melo, Sousa (2016);
<b>Environmental Expenditure per Inhabitant</b>	2005-2015	Almeida (2010); Melo, Sousa (2016); Tridapalli <i>et al.</i> (2010)
<b>Demographic Density</b>	2005-2015	Stanton, Whitehead, (1994); Lombard (1993); Daley, Garand (2005); Melo, Sousa (2016); Bueno (2013); Guandalini (2016)

Source: Research (2017)

The “General Expenditure” variable represents the sum of all the annual expenditures of the municipalities, i.e. the sum of all the functions (committed budget expenditures). According to the authors (see Table 2), general expenditure usually has positive relation as environmental expenditure; the per capita income represents the division of the municipal wealth index by the number of inhabitants of each state; the Gross Domestic Product (GDP), which was collected at current prices (in thousand Brazilian reais). Thus, per capita Income and GDP expects a positive relation with the dependent variable, that is, the greater the purchasing power of a population, the greater the economic wealth and the greater the spending on the environment.

Regarding the per capita expenditure, green expenditure performance, environmental performance of GDP, environmental expenditure per area and environmental expenditure per inhabitant, created by Almeida (2010), they constitute indicators of environmental performance for the public sector. They relate the environmental expenditures established under the budget to the total budget expenditure components, aiming to analyze how much is invested and spent in environmental management because of the fixed expenses. Other components used for correlation with environmental expenditures were: the total area of the municipality, the GDP and the number of inhabitants. In this way, the indicators identify the green performance of each entity of a public nature.

The per capita expenditure is the sum of all budget expenditures of municipalities divided by the number of inhabitants.

The green performance of expenditures summarizes the results obtained from the relation between quotient of the values referring to total expenditures and expenditures on environmental management in the studied municipalities (code 18); environmental performance of GDP, is the ratio of the GDP of the investigated cities with their expenditures on environmental management. In these variables, it is expected that most of the wealth produced will have greater investments in the conservation and restoration of the environment.

The environmental expenditure per territorial area and environmental expenditure per inhabitant represent, respectively, the total expenditure on environmental management, in relation to the extent of the municipalities and how much has been invested in the environment by each inhabitant of the city. The demographic density is the ratio between the population and the area of that territory, allowing to verify the intensity of occupation of the municipality. Thus, the expected relationship is that the larger these values, the greater the municipal environmental expenditures.

Hence, in this study, the analysis of multiple linear regression has been used, with available data of the public expenditures in environment, as well as of the socioeconomic data of the investigated municipalities. According to Gujarati and Porter (2011, p. 39), regression analysis is the study “[...] of the dependence of a variable, the dependent variable, in relation to one or more variables, explanatory variables, to estimate and / or predict the mean (population) value of the former in terms of the known or fixed values (in repeated sampling) of the later.”

The multiple linear regression model can be obtained by (1):

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \mu \quad (1)$$

where:

$Y$  = represents the phenomenon under study (dependent variable);

$\alpha$  = linear coefficient, constant or intercept, shows the point on the regression line in which  $X = 0$  (intercept);

$\beta_k$  = coefficient of each variable (angular coefficients of increment or decrement) and indicates the slope of the line, that is, how much  $Y$  varies for each additional unit of each  $X$  included in the model;

$X_k$  = independent variables (explanatory variables - metrics or dummies);

$\mu$  = error term, evidences the effect of variables not included in the model.

Through multiple regression, the variance of  $Y$  (dependent variable) is explained by the variation behavior of variable  $X$  (independent variables). This is called the explanatory power of the regression and it is measured by the coefficient of adjustment or explanation  $R^2$ . Fávero (2015) and Gujarati and Porter (2011) define  $R^2$  as the fraction of the variance of the  $Y$  sample explained (or predicted) by the explanatory variables, that is, the proportion of the sample variation of the dependent variable explained by the set of explanatory variables, in which it works as a scale of the degree of adjustment of the proposed model.

For the evaluation of the general significance of the model and of each parameter, we took advantage of the application of the  $F$  test and the  $t$ -test ( $p$ -value). According to Fávero (2015, p.20), the  $F$  test makes it possible “to check if the model that is actually estimated exists, since, if all  $\beta_j$  values are equal to zero, the change behavior of each of the explanatory variables will not influence the behavior of variation of the dependent variable”.

In this way, it is necessary to “evaluate if each of the parameters of the regression model is statistically different of zero so that its respective variable  $X$  is in fact included in the proposed final model.” In this sense, the  $t$  statistic is important, because it provides the researcher with “[...] the statistical significance of each parameter to be considered in the model of regression [...]” (FÁVERO, 2015, p.22).

The usual guideline is that for a 95% confidence level the values of significance of  $F$  and  $t$  ( $p$ -value) should be less than 0.05 (FÁVERO et al., 2009).

Finally, with the information extracted from the secondary databases, an analysis involving descriptive statistics was performed in an electronic spreadsheet editor and, for the multivariate analysis, statistical software (Stata 13) was employed

The use of multiple linear regression as the analysis technique provides both confirmation of the robustness of the model tested and the elaboration of inferences or, more specifically, the prediction of possible values for municipal environmental expenditure.

It was initially estimated the regression model using Ordinary Least Squares (*OLS*). However, because problems were found due to the presence of heteroskedasticity, the regressions were performed through Generalized Least Squares (*GLS*) to minimize the variance of the estimators, making them more consistent and reliable (Gujarati and Porter, 2011).

To ensure a greater inference about the results generated by multiple regression, Gujarati and Porter (2011) argue that a general model, estimated by the ordinary least squares (*OLS*) method, has some basic premises. Among them, it is common to find, in studies where companies with different characteristics are the objects of studies, problems in the estimation of the model due to the absence of homoscedasticity. In this case, the estimation of *OLS* must be treated in a special way once it actually finds the presence of heteroscedasticity or heterogeneity of the residues.

According to Wooldridge (2017), an alternative method to White's correction is corrected heteroscedasticity, which calculates a weighted series of residues (when there is many explanatory variables in the model, since the inclusion of all terms and combinations formulated for the test can quickly consume degrees of freedom). Thus, the estimation of the parameters can be performed by least squares, once it is provided a correction of the covariance matrix of the errors to consider the heteroskedasticity. In such situations, estimation, according to Gujarati and Porter (2011), is said to be robust, and the estimation method is called generalized least square (*GLS*).

## 4 PRESENTATION AND ANALYSIS OF THE RESULTS

Multiple linear regression was estimated by the generalized least squares method for the 9 explanatory variables, namely: General Expenditure (EG), Per Capita Income (PCI), Gross Domestic Product (GDP), Expenditure Per Capita (EPC), Green Performance of Expenditures (GPE), Environmental Performance of GDP (EPGPD), Environmental Expenditure per Area (EEA), Environmental Expenditure per Inhabitant (EEI) and Demographic Density (DD).

Multiple regression analysis is usually initiated by inspection in the correlation matrix. Therefore, the correlation test between the explanatory variables was first made, to observe if there was any high correlation between them (Table 3).

**Table 3** – Matrix of linear correlation of the variables considered in the study.

	EG	PCI	GDP	EPC	GPE	EPGPD	EEA	EEI	DD
EG	1								
PCI	0.0807	1							
GDP	-0.0532	0.1294	1						
EPC	0.1769	0.4362	0.1705	1					
GPE	0.0018	0.4936	0.0225	0.1037	1				
EPGPD	-0.0059	-0.0096	-0.0094	0.0053	0.1083	1			
EEA	0.2361	0.2286	0.241	0.3277	0.2325	0.0742	1		
EEI	0.0418	0.4592	0.0575	0.4386	0.613	0.151	0.5226	1	
DD	0.2457	0.0283	0.2749	0.0006	-0.0345	-0.0168	0.3243	-0.0304	1

Source: Research (2017).

Table 3 shows that the selected variables do not have high levels of correlation between the explanatory variables, suggesting that they form a reliable group of variables selected for the model. According to Hair *et al* (2005), if the values presented in the correlation matrix (in module) are smaller than 0.7, they will be display moderate correlation, values below 0.4 are evaluated as small, and less than 0.2, as slight.

It is observed initially that the correlation of the socioeconomic components of the work, corroborates the empirical review performed with several studies on environmental expenditures (LOMBARD, 1993, STANTON, WHITEHEAD, 1994, BACOT and DAWES 1997; DALEY; GARAND, 2005; NEWMARK; WITKO, 2007; SOUZA *et al.*, 2012; GOOD, 2013; GUANDALINI, 2016), in which, General Expenditure, Income per capita, Gross Domestic Product, Expenditure per capita and Demographic Density are usually variables analyzed as factors with explanatory power over environmental expenditures.

The equation resulting from the model adjustment is (2):

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 \quad (2)$$

where:

Y= value of public environmental expenditure of Brazilian municipalities;

$\alpha$  = linear coefficient 0 (intercept);

$\beta_1 X_1$  = variable General Expense (\$);

$\beta_2 X_2$  = variable Income per capita (\$);

$\beta_3 X_3$  = variable Gross Domestic Product – GDP (\$);

$\beta_4 X_4$  = variable Per capita expenditure (\$);

$\beta_5 X_5$  = variable Green Performance of Expenditure (%);

$\beta_6 X_6$  = variable Environmental Performance of GDP (%);

$\beta_7 X_7$  = variable Environmental Expenditure per Area (\$/Km<sup>2</sup>);

$\beta_8 X_8$  = variable Environmental Expenditure per Inhabitant (\$);

$\beta_9 X_9$  = variable Demographic Density (pop/Km<sup>2</sup>).

According to the data needed for a proper adjustment of the model, shown in Table 4, based on the interpretation of the municipal public environmental expenditures of the sample, with 95% confidence interval, it is observed that, by the F distribution test, the models are well adjusted.

**Table 4** – Variation specifications of the variable “Environmental Expenditure” explained by the linear regression model (with 95% confidence interval).

	Number of obser- vations	Degrees of freedon	F	Prob> F	R <sup>2</sup>	Root mean squared error
Y	2.722	9	113,37	0,0000	0,8582	1,0 × 10 <sup>7</sup>

Source: Reserarch (2017)

As also shown in Table 3, the null hypothesis was rejected, since the level of significance F, for 95% confidence, was below 0.05, which led to the acceptance of the alternative hypothesis, in which at least one of the variables is significant. The coefficient of determination (R<sup>2</sup>) of the model suggests that 85.82% of the variation of the public environmental expenditure of Brazilian municipalities is explained by the selected variables. The remaining variation, 14.18%, is attributed to factors not included in the current study.

Therefore, also with a 95% confidence interval, Table 5 presents the results for interpretation of the estimated values of the parameters

**Table 5** – Results of the estimated values for the parameters of the linear regression model of the variable “Environmental Expenditure”

Dependent Variable	Independent Variables	Coefficients	Standard error Robust	P-value> t	Mean	Standard Deviation
Y	General Expense	0.0125788	0,0018783	0.000	9295350.00	2.79x107
	Income per capita	70.96502	32.07003	0.027	34331.5	46123.5
	GDP	-0.0003254	0,0001262	0.010	12.9x109	43.9x109
	Per capita expenditure	-1372.513	462.0552	0.003	2379.76	1396.98
	Green Performance of Expenditure	$3.99 \times 10^8$	$9.03 \times 10^7$	0.000	1.005	2.446
	Environmental Performance of GDP	$-3.20 \times 10^7$	$2.32 \times 10^7$	0.168	0.0996	0.59
	Environmental Expenditure per Area	45.0079	8.591787	0.000	31080.75	101215.1
	Environmental Expenditure per Inhabitant	37596.54	14410.98	0.009	28.09	61.09
	Demographic Density	-288.6446	117,095	0,014	1263,68	2526,12
	Constant	-3001595	796644,7	0,000	-	-

Source: Research (2017)

According to Hair *et al.* (2005), the P-value represents the lowest level of significance to reject a null hypothesis, and the level of significance is the probability of rejecting  $H_0$  (null hypothesis) when  $H_0$  is true.  $H_0$  there is no significant relation to the differences between the variables - and -  $H_a$  (alternative hypothesis) there is a significant relation.

The initial analysis, by observing P-value, demonstrated that the variables General Expenditure, Per capita Income, Gross Domestic Product, Per capita Expenditure, Green Expenditure Performance, Environmental Expenditure per Area, Environmental Expenditure per Inhabitant, Demographic Density and Constant had significant influence on the dependent variable Environmental Public Expenditure. The Environmental Performance of GDP, which is the participation of environmental expenditures in municipal wealth, was the only variable in the model (Table 5) that did not show significance for municipal environmental public spending between 2005 and 2015.

For the variable General Expenditure, the increase of one monetary unit in municipal budget expenditures, has a greater financial impact on the increase in environmental expenses.

Bueno (2013) and Guandaline (2016) conclude in their study that the variable Expense or General Expenditure is strongly related to environmental expenditure. According to the authors, the regions with the highest GDP and total expenditure are those most involved with environmental management activity

Regarding the income per capita of these municipalities, the results showed a positive relation; the higher the value of this variable in the municipalities, the higher the public environmental expenditures.

In the work of Stanton and Whitehead (1994), per capita income was the only factor associated with two dependent variables: environmental expenditures for air and water quality. For both environmental expenditures, the per capita income variable indicates the strong explanatory power of economic variables.

Despite having used only high-income countries per capita, the study of Magnani (2000) concluded that per capita income presented a robust statistical significance with the environmental expenditures studied, i.e. the higher the income per capita the greater the expense.

Another variable that displayed a positive relation to environmental spending was the Green Performance of Expenditures, which consists in the participation of the expenditure in environmental management in the budgetary expenditures of the municipalities. The results show a direct correlation of this variable with the amount of municipal environmental expenditure, that is, the municipalities are increasing the participation of environmental management in the municipalities.

Melo and Sousa (2016) contrasted this result for the same variable (Green Performance of Expenditure). In their study, this variable had a negative relation with the environmental expenditures in the investigated municipalities (in the Brazilian state of Paraíba), indicating that managers are not adopting a government policy prioritizing actions focused on the environment.

Another positive relation is the one between environmental expenditure per area and per inhabitant. When there is an increase in monetary units of environmental expenditure, both per area and per inhabitant, part of this expenditure is associated with an increase in the environmental expenditure of the municipality.

For Bacot and Dawes (1997) the population is a factor associated with environmental spending, because the larger the population, the greater the demand for environmental policies, including the legislation and funds needed to implement the programs

Bueno (2013), in his research, corroborates this assertion, because in the study in the municipalities of Paraná State, the population and the municipal area is significant in relation to environmental expenditure, and has a positive relation.

Data in Table 5 also identifies variables that had negative behavior in relation to the dependent variable (GDP, Demographic Density, Per Capita Expenditure and Demographic Density).

Regarding the GDP of the investigated municipalities, the results were negative, that is the higher the value of this variable, the lower are the expenses with environment.

In the study performed by Sacco and Leduc (1969), it was also confirmed the above-mentioned result, showing the same negative relation with the environmental expenditure variable. This factor may be related to the fact that as the municipal GDP grows, the greater the amount spent with the environment in the municipalities, but the higher budget spent in the environment in these localities may not be exactly the amount proportional to the growth rate of the economic wealth. On the other hand, Newmark and Witko (2007) and Konisky and Woods (2012) reported a significant relation between the GDP and environmental public expenditure variable, positively influencing environmental expenditures

Regarding the observed different results depending on the place, some authors claim that the influence of the economic wealth (GDP) on the environment depends strongly on the financial availability in spending more with the environment and the profile of the people with higher income, that, usually, are more susceptible to support environmental policies. In other words, regional differences and the socioeconomic context will be able to influence environmental spending (SACCO, LEDUC, 1969, STANTON, WHITEHEAD, 1994, NEWMARK, WITKO, 2007, KONISKY, WOODS, 2012, DALEY and GARAND, 2005).

The variable expense per capita displayed an inverse relation to the environmental expenses, presenting a negative result. The result reinforces the conclusions found by Melo and Sousa (2016), who found the same type of behavior for per capita expenditure. The authors point out that municipalities still do not demonstrate a planning of actions and programs focused on the regional environment, since the public expenditures in the studied municipalities represent relatively low values when compared to the expenses / number of inhabitants.

In the current study, Demographic Density variable displayed a negative relation, where, by increasing the number of people per square kilometer, there is a decrease in environmen-

tal expenditure. In an opposite manner, Sacco and Leduc (1969) found that population density positively influences environmental expenditure. The first results of these authors revealed that the degree of urbanization (population density) influenced environmental expenditures, that is, more urbanized states have spent more on controlling air pollution and water quality.

Paiva and Wajnman (2005) also evaluated that, although the population growth of the urban area can contribute to economic growth, it does not guarantee the improvement of income distribution. On the other hand, population expansion may lead to greater social inequality, lower levels of human development and higher poverty rates. In this sense, for higher demographic density, and consequently, major urban problems, higher expenditures in the environment may be the key factor for improving quality of life.

On the other hand, the variables Gross Domestic Product, Expenditure per capita and Demographic Density obtained negative relation to the environmental expenses, contradicting in part the theory. Nevertheless, the results of the above-mentioned studies seem to confirm that environmental factors, such as those tested in the research, may interfere in the performance of environmental policies.

Finally, other characteristics of the influence of economic wealth on the environment can be considered in an environmentalist point of view. The emphasis is mainly focused on the economy itself, in which two main factors are linked: production and consumption, which directly affect the environment (SCHNAIBERG, 1997; FOLADORI, 1999).

## 5 FINAL CONSIDERATIONS

Sustainable development, environmental management and the decentralization of public policies are issues present in the current debate on public policies focused on the environment. The socioeconomic development of mankind, associated with concerns about the impacts of economic production on the environment, interfering in the quality of life of future generations, as well as the process of decentralization of public actions in Brazil, have made fundamental the practice of environmental public policies. Thus, this becomes of great interest to society, companies and, especially, to governments.

In this way, an increasing amount of studies has been reporting the entire process of public spending on the environment, and how these resources interfere in public policies focused on the environment. In this context, there is a growing evolution of research aiming to identify factors that influence and / or determine these public expenditures.

The present study aimed to investigate socioeconomic and environmental variables associated with the behavior of public expenditures with the environmental management function in the budget of Brazilian municipalities with a population equal to or greater than 100 thousand inhabitants, from 2005 to 2015.

It was observed, from the researched literature, that socioeconomic and environmental issues influence municipal environmental expenditures. To confirm this relation, a regression analysis was performed, using variables that include socioeconomic and environmental dimensions, to explain the behavior of expenditures related to the environmental function of municipalities.

Based on the selected variables, the results indicated the significance of 8 explanatory variables: General Expenditure, Per Capita Income, Gross Domestic Product, Per Capita Expenditure, Green Expenditure Performance, Environmental Expenditure per Area, Environmental Expenditure by Inhabitant and Demographic Density. These selected variables showed an explanatory power of 85.82% on the environmental expenditures carried out by the Brazilian municipalities in the investigated period.

By monitoring the environmental expenditures in academic research and in the social control of environmental policies can be an important emphasis to better characterize the commitment and demonstrate the factors involved in the implementation of environmental policies, contributing and expanding the area of knowledge that deals with environmental management in the public sector.

The current study presented some limitations regarding the selection of the variables. In the literature, other variables are used to evaluate the factors associated with public environmental expenditure. Another limitation concerns restrictions on the values reported by the municipalities, since, in some cases, municipalities do not inform environmental expense or report it as equal to zero.

As a proposal for a new study, it is suggested to broaden the data collection to other bases, such as the Federal Audit Court and States, to raise information on the environmental expenditure of municipalities that did not provide the data and to apply questionnaires to managers connected to the environmental issue. It is also recommended to include other variables such as: Environmental Structure, political, ideological and partisan social issues, interest groups, among others.

Several studies have already proved the importance of Environmental Public Expenditure as an instrument of environmental policy, especially in relation to the determinants, associated factors and components that influence environmental expenditures. One could note that the results presented in this report are not enough to explain the whole dynamics on the subject, however, they cannot be discarded, since they are important data, specially at the national level, and together with others, can be used for the comparative analysis of the policy public environmental policy.

Studying public environmental expenditures is relevant, since the information provided by the surveys allows monitoring public performance in relation to the environment. One approach to this understanding is to follow the allocation of these resources, through the identification of determinants.

Therefore, this study is another contribution related to the theme, presenting the importance of environmental expenditures in the municipal context, and may be a tool for municipal public managers to assist the implementation of public policy focused on the environment.

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