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Papers

# Ecological-ICMS as a public policy instrument for biodiversity preservation: a study conducted in small municipalities in Paraná State, Brazil

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**Abstract**
The Ecological Tax on the Circulation of Goods and Services for Biodiversity (ICMS-E) was created in 1991 as an initiative of the government of Paraná State. It is an important public policy instrument for the preservation of biodiversity in small municipalities that house Conservation Units. The aim of this article was to analyze whether resources from the ICMS-E, added to municipal tax revenues, improve sustainable development over time. As part of the methodological procedures, a descriptive-comparative analysis was conducted between municipalities that receive and do not receive ICMS-E. For this purpose, a sampling of the 399 municipalities that comprise Paraná State was conducted, involving 193 municipalities with a population of up to 50,000 inhabitants. The comparative analysis was based on the definition of two study groups, each constituted by 76 municipalities: one called the ICMS-E Recipient Group, municipalities that receive the ecological tax; and the Control Group, composed of those that do not receive it. The main results indicate that 19.80% of the municipalities are concentrated in the North Central mesoregion, while the Metropolitan Region of Curitiba is home to 33.45% of the population of Paraná. In relation to population loss, this factor represents 44.73% in the ICMS-E Recipient Group, while in the Control Group this number is 34.21%. In relation to the Environmental Management Function, 60.53% of the municipalities in the Recipient Group applied up to 75% of this tax to this function. It was concluded that the ICMS-E is an important incentive for the preservation of biodiversity and represents a significant increase in resources for the local governments of small municipalities.



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## INTRODUCTION

With the promulgation of the Citizens' Constitution (Brasil, 1988), municipalities were elevated to the same level of a federative entity, equal to the state and federal level, with the right to constitutional powers and their own income to provide services and benefits for the local population.

A number of functions that fell to the States and Federal Government were transferred to the municipalities when they were raised to the same level as federal entities. However, this transfer was not matched by the resources necessary to execute these functions. The Federal Government and States can create taxes to improve their revenues that are not redistributed to municipalities because they can take advantage of "loopholes" in tax legislation. In this respect, municipalities have few legal options to expand their tax revenues, as occurs in other countries (Servillo *et al.*, 2017; Servillo; Russo, 2017).

Many cities house Biodiversity Conservation Units throughout Brazil and it was in this context that Paraná State created the Ecological Tax on the Circulation of Goods and Services (ICMS-E) - Paraná, 1991. The intention of this public policy is to transfer financial resources to municipalities in the state territory that have Conservation Units or water sources to supply neighboring municipalities. Constitutionally, this transfer of part of the ICMS to municipalities is mandatory. However, the Paraná State innovated by directing a percentage to municipalities with Conservation Units or water sources, according to previously established criteria for obtaining these funds (Henrique; Toniolo, 2021).

The public policy proved to be effective in achieving its goals and has been adopted by several other state governments, and could be characterized as a state rather than a government policy. It is a result of negotiations between the state government at the time and the mayors of municipalities that had Conservation Units and water sources and required more funding due to restrictions on land use owing to the presence of these Conservation Units and water sources (Loureiro, 2002).

The ICMS-E has resulted in higher transfers of funds to municipal governments, which can now offer an improvement in or more benefits and services for their local population (Ruggiero *et al.*, 2022; Selva *et al.*, 2020; Brito; Marques, 2017), in addition to municipal initiatives (Gonçalves, 2018).

In his study, Loureiro (2002) concluded that the ICMS-E is a positive incentive for conserving biodiversity. Nevertheless, the results require further investigation for municipalities with different population sizes. (Droste *et al.*, 2017). Moreover, this issue is aligned with the concept of sustainable development (SD) proposed in the 1987 Brundtland Report, which was published in Brazil under the title of Our Common Future (Nosso Futuro Comum, 1991), but depends on a better understanding of the results achieved with these funds (Cao *et al.*, 2021).

However, there are few studies involving small municipalities, and many can be considered case studies or limited to a small group. Nevertheless, data from the population estimate for 2021 (IBGE, 2021) show that three hundred and sixty-three (363), in other words, 90.97% of the three hundred and ninety-nine (399) municipalities in Paraná, have a population of under 50,000 people, and thus fit the typology of small municipalities.

Therefore, the aim of this article was to analyze whether the resources that stem from the ICMS-E, added to municipal tax revenues, spur sustainable development in small municipalities from a territorial and environmental viewpoint.

As a delimitation, Paraná State was chosen for the purposes of this study, focusing on municipalities with a population of up to 50,000 people, resulting in a total of 193 municipalities, which corresponds to 48.87% of all the municipalities in Paraná, and which house Conservation Units and/or water sources, maintaining restrictions on land use and limiting agricultural, commercial and industrial activities. The period selected for the research spans the years 2017 to 2021.

## MATERIALS AND METHODS

### *Population and the formation of groups*

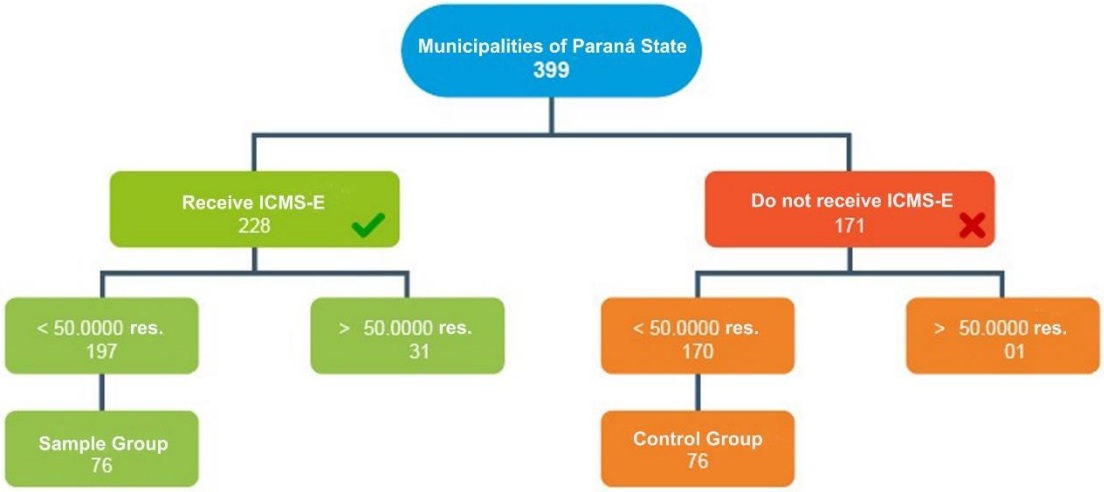
Paraná State is located in the South of Brazil, with a territorial area of 199,298.981 km². In political and administrative terms, the state is divided into 399 municipalities, with a population of 10,444,526 people in 2010 (IBGE, 2010), and an estimated population of 11,597,484 in 2021. The Human Development Index (HDI) is 0.749 and the per capita monthly income is R$1,541.00 (IBGE, 2021).

According to the 2010 Census and estimated figures in 2021, municipalities with up to 50,000 inhabitants totaled 367 units and 363, respectively (Sample), which represents 91.97%

and 90.97% of the total number of municipalities in Paraná State (Universe).

For the purpose of analyzing the main data from the municipalities, two groups were created. The first was called the ICMS-E Recipient Group, with 76 administrative political units within the group of those who receive the ICMS-E. The second group consisted of those who do not receive the ICMS -E, called the Control Group, which has the same number of units (76) (Figure 1).

Figure 1 – Number of municipalities that receive and do not receive funds from the ICMS-E




Source: The authors based on data from the IBGE (2010).

Regarding the municipalities that receive the ICMS-E, there are different population sizes, and for this reason Table 1 was created, showing that 67.10% of the municipalities are concentrated in the range of up to 20,000 residents.

**Table 1**- Population levels of the municipalities that receive funds from the ICMS-E

| Population | Municipalities | % |
|---|---|---|
| Up to 2,000 residents | 1 | 0.44% |
| 2,001 to 5,000 residents | 32 | 14.04% |
| 5,001 to 10,000 residents | 46 | 20.18% |
| 10,001 to 20,000 residents | 74 | 32.46% |
| 20,001 to 50,000 residents | 44 | 19.30% |
| 50,001 to 100,000 residents | 13 | 5.70% |
| 100,001 to 500,000 residents | 16 | 7.02% |
| Over 500,000 residents | 2 | 0.88% |
| **Total municipalities that receive the ICMS-E** | **228** | **100.00%** |

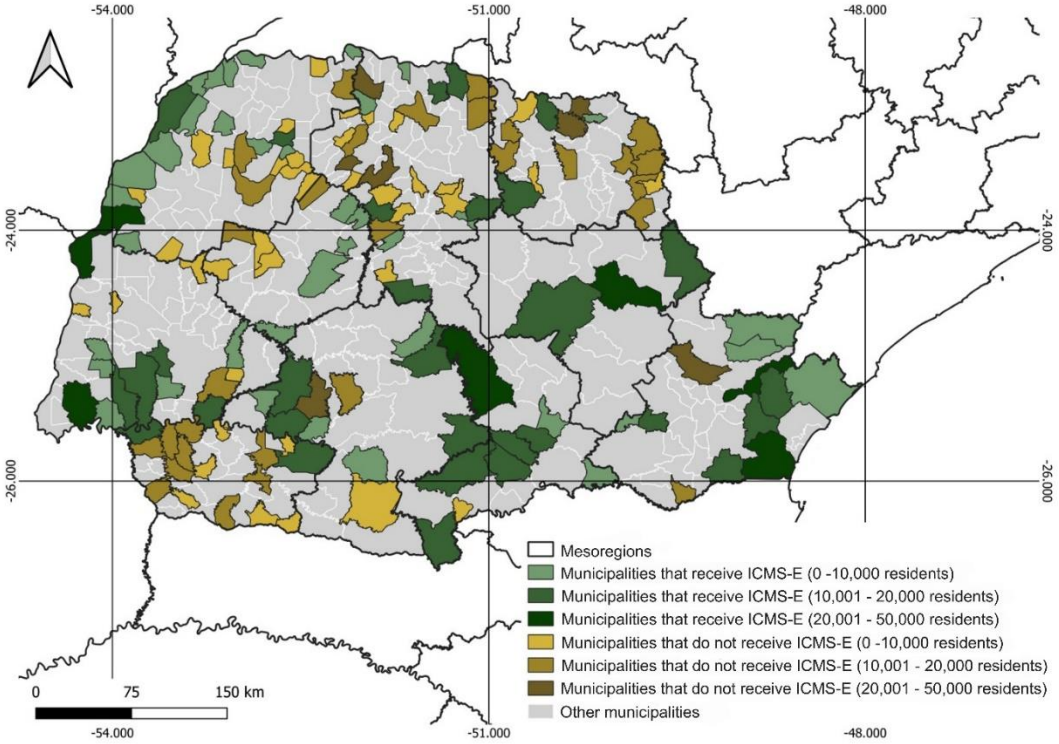
Source: Prepared by the authors based on IPARDES (2023a).

The capital, Curitiba, and Londrina, with populations over five hundred thousand (500,000) residents, also receive funds from this ecological tax, which demonstrates the local government's concern for the environment. These cities have significant tax collection capacity, due to their various productive activities. However, they maintain green areas that provide resources from the ICMS-E and a better quality of life for their population.

### *ICMS-E Recipient and Control Groups in Paraná State*

To define the scope of the study, seventy-six (76) units that receive the ICMS-E and with a population of up to 50,000 inhabitants were selected, forming the group called the ICMS-E Recipients Group. Likewise, another group composed of seventy-six (76) municipalities with the same population size and which do not receive resources from ICMS-E was created, called the Control Group for the purpose of comparison of the variables applied to the Recipients Group (Figure 2).

Figure 2 – Distribution of the municipalities in the ICMS-E Recipient and Control Groups

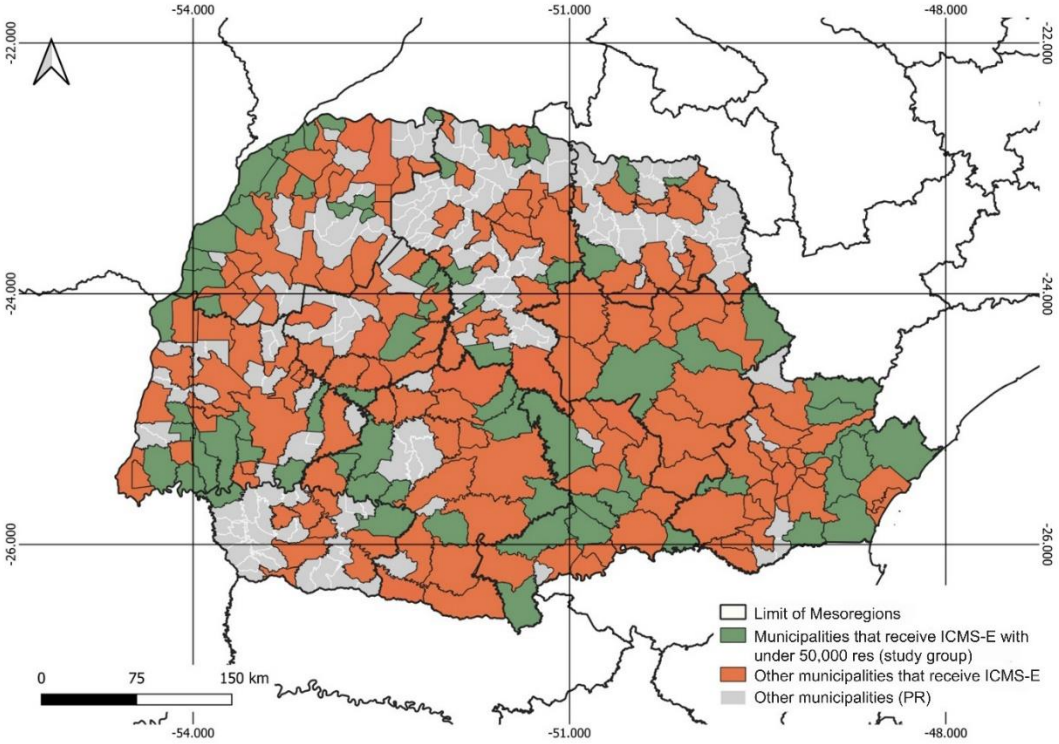



Source: The authors (2023).

The Control Group was made up of municipalities whose population was close to that found in the ICMS-E Recipient Group. In terms of total values, the results were 830,779 and 810,147 inhabitants for the ICMS-E Recipient Group and the Control Group, respectively.

The geographical distribution of the municipalities belonging to the ICMS-E Recipient Group and their respective mesoregions can be seen in Figure 3.

Figure 3 – Distribution of the municipalities in the ICMS-E Recipient Group




Source: The authors (2023).

### *Data collection and treatment*

The data were collected from the website of Instituto Brasileiro de Geografia e Estatísticas (IBGE), which is reponsible for brazilian statistics, Instituto Paranaense de Desenvolvimento Econômico e Social (IPARDES), which is responsible for Paraná statistics, Ministério da Saúde (DATASUS), which is responsible for health statistics, Instituto de Água e Terra (IAT), which is responsible for environmental data in Paraná and the Tribunal de Contas do Paraná (TCE/PR), which is responsible to evaluated public account of Paraná, as shown in Chart 1.

**Chart 1** – Sources of data used in the study

| Data | Source |
|---|---|
| Population 2010 | IBGE (2010) |
| Population – 2021 Estimate | IBGE (2021) |
| Municipalities of Paraná | IPARDES (2023a) |
| Geographical Regions | IPARDES (2023a) |
| Areas of growth and population reduction, Paraná | IPARDES (2023a) |
| Hierarchy of Urban Centers, Paraná | IPARDES (2023b) |
| MHDI, Paraná | IPARDES (2023b) |
| Population Density | IPARDES (2023a) |
| Population Projection | IPARDES (2023b) |
| Regional Profiles | IPARDES (2023b) |
| Municipal GDP | IPARDES (2023b) |
| Conservation Units, Paraná | IAT (2023) |
| State Conservation Units | IAT (2023) |
| Private Natural Heritage Reserve (PNHR) | IAT (2023) |
| State Registry of CU and PA | IAT (2023) |
| Ecological ICMS | IAT (2023) |
| Gini Index of per capita household income, Paraná | DATASUS (2023) |
| Environmental Management Expenditure | TCE PR (2023b) |

Source: The authors (2023).

The data extracted from the various available data sources and institutional websites were transferred to Calc spreadsheet software from The Document Foundation, as it is free software and compatible with Windows, version 10, through various functionalities and filters, composing a database organized by thematic axis and archived by the authors.

## RESULTS AND DISCUSSION

The analysis of the results of this study was structured based on the use of dimensions that help to understand different perceptions regarding how the ICMS-E affects the selected municipalities (Novaes; Pires, 2020; Mattar *et al.*, 2023).

The analysis can involve several dimensions, which the research process covered in full: Legislation, Territory, Demography, Public Finances, Social and Economic Aspects, and the Environment. However, this article specifically

addresses the dimensions of Territory and the Environment because these dimensions have as yet been studied little and are more pertinent to the purpose of this work.

### *Territorial dimension*

The territory of Paraná State is subdivided into ten (10) mesoregions by IPARDES and the IBGE in order to facilitate academic, scientific, statistical and other studies. These mesoregions have different populations and economic and social dynamics and, therefore, knowing the distribution of the municipalities that form the two study groups offers new elements for analysis.

To provide analysis parameters, Table 2 was prepared, in which the mesoregions, number of municipalities that belong to these units, territorial area of the regions, population in 2010, according to the 2010 Census, and number of municipalities per group are identified.

**Table 2** – Mesoregions, municipalities, territorial area and population (2010)

| MReg. PR | Mun. | % | TA (km²) | % | Pop. (2010) | Dens. (res./km²) | RG | CG |
|---|---|---|---|---|---|---|---|---|
| Northwest | 61 | 15.29 | 24,726.04 | 12.37 | 678,319 | 27.43 | 16 | 13 |
| Midwest | 25 | 6.27 | 11,941.74 | 5.97 | 334,125 | 27.98 | 5 | 5 |
| North Central | 79 | 19.80 | 24,552.76 | 12.28 | 2,037,183 | 82.97 | 10 | 19 |
| Pioneer Northern | 46 | 11.53 | 15,733.05 | 7.87 | 546,224 | 34.72 | 3 | 13 |
| Mideast | 14 | 3.51 | 21,892.30 | 10.95 | 689.279 | 31.49 | 3 | 0 |
| West | 50 | 12.53 | 22,859.76 | 11.44 | 1,219,558 | 53.35 | 11 | 5 |
| Southwest | 42 | 10.53 | 17,060.78 | 8.54 | 587,496 | 34.44 | 2 | 17 |
| Central Southeast | 24 | 6.02 | 21,072.95 | 10.54 | 453,821 | 21.54 | 9 | 2 |
| Southwest | 21 | 5.26 | 16,945.36 | 8.48 | 404,779 | 23.89 | 8 | 0 |
| Metropolitan Region of Curitiba | 37 | 9.27 | 23,105.65 | 11.56 | 3,493,742 | 151.21 | 9 | 2 |
| **Estado do PR** | **399** | **100.00** | **199,890.38** | **100.00** | **10,444,526** | **52.25** | **76** | **76** |

MReg: Paraná: Mesoregions of Paraná; Mun: Number of municipalities; TA: Territorial Area; Pop: RG: ICMS-E Recipient Group; CG: Control Group.
Source: Prepared by the authors based on IPARDES (2023a).

It should be noted that the highest number of municipalities (19.80%) is concentrated in North Central mesoregion of Paraná, followed by the Northwest (15.29%), the West (12.53%) and the Southwest (10.53%). Furthermore, in terms of population, the Metropolitan Region of Curitiba is home to 33.45% of the population of Paraná, followed by the North Central mesoregion (19.50%) and the West mesoregion (11.68%). In terms of territorial area, the Northwest mesoregion represents 12.37% of the territorial area of the State of Paraná, the North Central region 12.28%, the Metropolitan Region of Curitiba 11.56% and the West 11.44%.

Sixteen (16) municipalities from the ICMS-E Recipients Group are concentrated in the Northwest mesoregion, eleven (11) in the West mesoregion and ten (10) in the North Central mesoregion, while nineteen (19) municipalities from the Control Group are concentrated in the North Central mesoregion, seventeen (17) in the Southwest mesoregion and thirteen (13) in the Northwest region and thirteen (13) in the Pioneer Northern mesoregion. Two mesoregions, the Northeast and North Central, share the same percentage of the ICMS-E Recipient and Control groups.

Another interesting element, in addition to the issue of mesoregions that influenced the growth or decline of the municipal population, is the analysis of population growth in municipalities, as it offers important insights. An important variable regarding demographic studies refers to Geometric Population Growth. This indicator demonstrates the growth rate of local society in the territory during the period in question, corresponding to demographic censuses.

Alongside other indicators, it enables researchers to chart a dynamic of the location, such as the occupation of space, income-generating activities and activities that attract labor, public health and other areas, as outlined by Sgarbi *et al.* (2018).

Population growth estimates are made using the geometric method. This variable has

demonstrated that, since the 1940s, population growth has decreased, mainly in rural areas, but growth is not even in all municipalities, as there are situations in which some territorial units are growing rapidly, while others remain stable and some are in decline. These situations can fluctuate depending on several factors. Thus, a territory may present a positive growth value in a given period and a negative or stable value in another.

We identified population decline in the municipalities of the Recipient Group and Control group from 2001 to 2021, using the Estimated Population (IBGE) of residents on 01/07 as a parameter, as shown in Table 3.

**Table 3** – Population reduction of the ICMS-E Recipient and Control Groups (2001-2021)

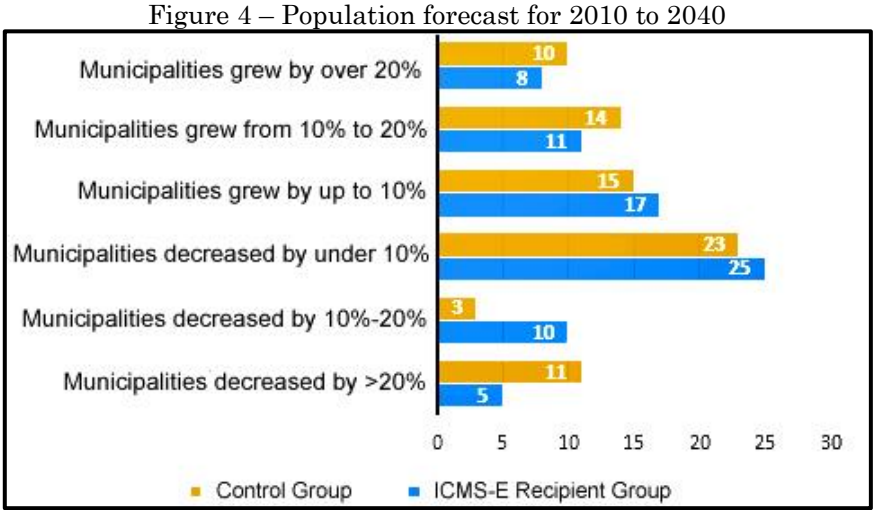
| Population Decline 2001-2021 | Number of Municipalities | | | | % |
|---|---|---|---|---|---|
| | RG | CG | Others | No. | |
| Decline > 20% | 10 | 7 | 29 | 46 | 28.39 |
| Decline of 10-20% | 13 | 7 | 31 | 51 | 31.48 |
| Decline < 10% | 11 | 12 | 42 | 65 | 40.12 |
| Total | 34 | 26 | 102 | 162 | 40.60 |
| **Total in Paraná** | | | | **399** | **100.00** |

RG: ICMS-E Recipient Group; CG: Control Group.
Source: The authors (2023).

The municipalities whose population declined during the period make up 40.60% of the total number of territorial units (399) of Paraná State, with most of these (40,12%) being in the range of decline lower than 10%. Note the percentage of 28.39% in the range of municipalities that had a reduction of more than 20%, indicating a very significant value. The reasons are related to economic dynamism and the services provided by the public sector (Silva; Carvalho, 2018; Sykora; Mulicek, 2017; Servillo; Russo, 2017).

In terms of the groups, the loss for the ICMS-E Recipient Group represents 44.73% of the total group (76 cities), while for the Control Group the percentage is 34.21%. Based on population loss, a projection was made for the period from 2010 to 2040 for the ICMS-E Recipient and Control Group to gauge whether there is a trend in this phenomenon. It can be seen from the results that the Control Group, in relation to the estimated increase in population, presents a value of 51.32% for the three ranges grouped together, while for the ICMS-E Recipients Group this value is 47.37%, a difference of 3.95% between the two groups (Figure 4).

Figure 4 – Population forecast for 2010 to 2040




Source: Prepared by the authors based on IPARDES (2023a).

Regarding the three ranges of population reduction, the ICMS-E Recipients Group showed a value of 52.63%, while this value was 48.68% for the Control Group. The result of the difference between the two values was 3.95%.

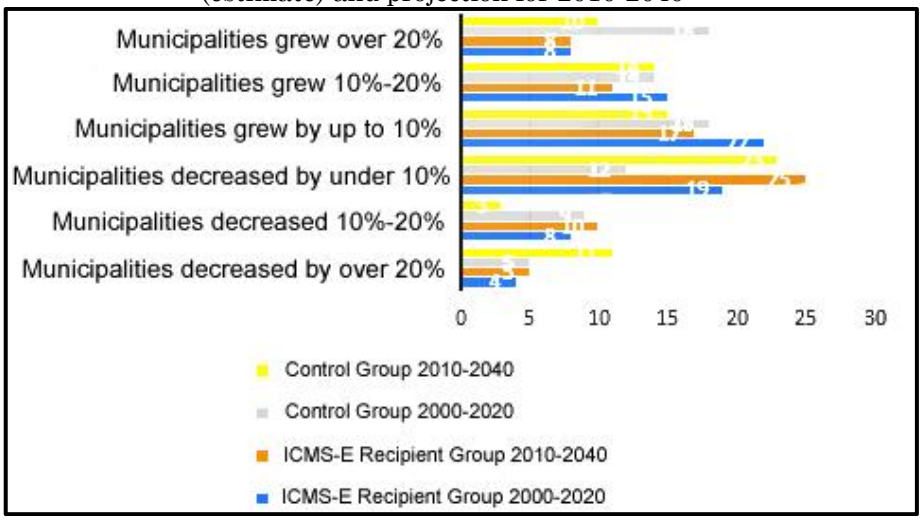
The values indicate a trend that small municipalities will continue to have few residents and that any change in this trend is associated with other factors, such as a change in impact on economic production, such as the

establishment of industry or services that attract a significant labor or immigration flow.

In municipalities where the area designated for environmental preservation or water sources occupies a significant surface area, an assumption made for the purposes of this study is that this change should not occur intensely. Based on this consideration, receiving ICMS-E resources and other forms of capital or value input is essential for the development of a municipality.

Regarding the tendency to maintain few inhabitants, this phenomenon can be identified in Figure 5, with the estimated population projection calculated for 2010 to 2040.

Figure 5 – Population variations – ICMS-E Recipient and Control Groups. 2000/2020 census (estimate) and projection for 2010-2040




Source: Prepared by the authors based on IPARDES (2023a).

In Figure 5, the 20% increase in the municipal population was greater in the Control Group than in the Recipient Group. The value for the period from 2000 to 2020 was double that for the Control group, including in the increase range between 10% and 20%, in which the advantage of this group prevailed. In the increase range of up to 10%, the ICMS-E Recipient Group prevailed for both periods.

In the reduction range of up to 10%, the ICMS-E Recipient Group presented higher values than the Control Group in the census and projection periods, while in the 10% to 20% range the ICMS-E Recipient Group had a much higher result for the projection period and similar to the Control Group for the 2000 to 2020 census period.

The Control Group presented a higher number in the reduction range of over 20%. The ICMS-E Recipient Group presented a trend for the census period and a projection higher than the Control Group in the range of increase up to 10%, as well as a reduction of less than 10%, demonstrating that the population growth of small municipalities will tend to be low until the projection for the year 2040, which implies that the typology of small municipalities will remain a phenomenon that lasts over time and allows for new academic studies.

Based on the previous analyses, concerns arose over whether small municipalities can achieve human development similar to other territories in Paraná. As the data relating to the MHDI refer to the year 2010, it was assumed that there would be a substantial change when the results of the 2022 Census are published. However, the available data indicate that Paraná State is at a High Development level, while 71.05% of the municipalities belonging to the Control Group are also in this range, and the same occurs for 42.10% of the political-administrative units in the ICMS-E Recipient Group.

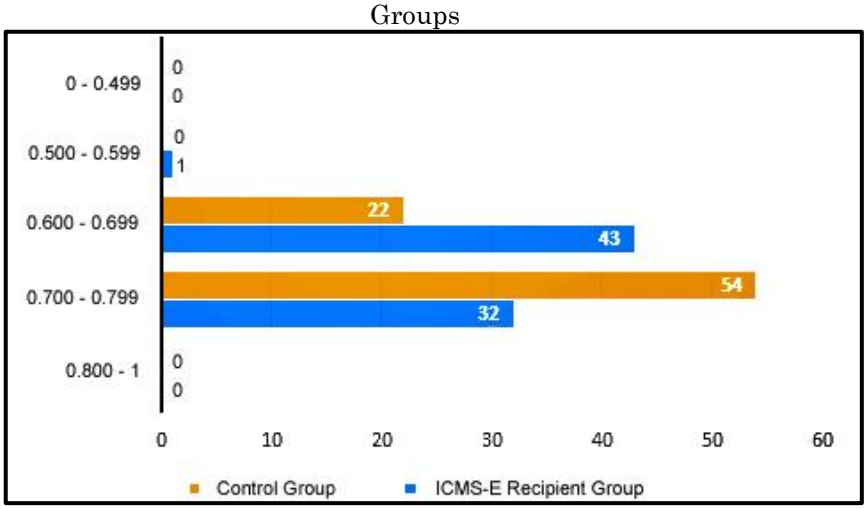
With twenty-two (22) municipalities (28.94%) from the Control Group in the Medium Development range, forty-three (43) municipalities from the ICMS-E Recipient Group, 56.57%, are also included in this range. The municipality of Guaraqueçaba is the only one that is in the Low Development range, and it is possible to infer that it will move to the Medium Development position with the publication of the new census.

It was calculated that the mean and median value for the ICMS-E Recipient Group is 0.684, which is considered medium development (IPARDES, 2023b). This value is close to the next scale (0.70), which is considered high development. As the index values are from 2010,

due to the delay in the population census by the IBGE, it can be assumed that some municipalities will be placed at the higher level, according to the values presented in the 2000 and 2010 census, due to a tendency for the indices presented by the municipalities of Paraná to improve.

The results for the Control Group showed a median value of 0.713 and a mean of 0.707, indicating that these municipalities are in the high development range (Figure 6).

Figure 6 – Municipal Human Development Index (MHDI 2010) – ICMS-E Recipient and Control Groups

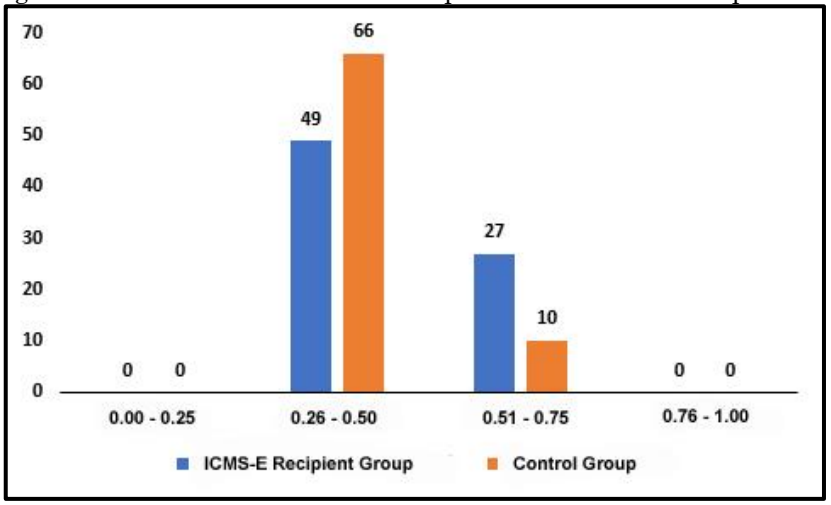



Source: Prepared by the authors based on IPARDES (2023b).

According to the results obtained, it is possible to conclude that there is a small difference between the municipalities that receive the ICMS-E and those that do not, with the Control Group presenting results superior to the Recipient Group albeit lower than the index of 0.749 presented by Paraná State. The index of 0.749 places Paraná in the high human development range, which is the case of the Control Group, while the ICMS-E Recipient Group is in the medium development range, with the exception of the municipality of Guaraqueçaba, which lies in the low development range.

As municipalities with preserved areas have restrictions imposed on productive activities, it was necessary to study the nature of social inequality in municipalities that receive the ICMS-E. The results indicated that the ICMS-E Recipient Group presented a mean and median of 0.48 for this index in 2010, with values being slightly higher than those of Paraná State, at 0.475. On the other hand, the Control Group had lower rates of 0.45 (mean) and 0.44 (median), lower than the level for Paraná State, and with a difference of 6.66% for the mean and 9.09% for the median, proving that social inequality is greater in municipalities that receive the ICMS-E (Figure 7).

Figure 7 – Gini Index – ICMS-E Recipient and Control Groups - 2010




Source: Prepared by the authors based on IPARDES (2023b).

The main source of income for the residents of a territory is related to paid work in the formal market. However, with changes in Brazilian labor laws and economic crises, this market has undergone several transformations, such as work allotted to outsourced companies that provide services to others, short-term contracts and the replacement of employees with self-employed workers. The current economic crisis and the COVID-19 pandemic have led to the expansion of the informal market or alternatives to supplement income.

### *Environmental Dimension*

Currently, there is great concern about the Environment and the negative side effects of human intervention, such as deforestation, and the various types of pollution, such as noise and visual pollution and the pollution of the land and water, to name a few.

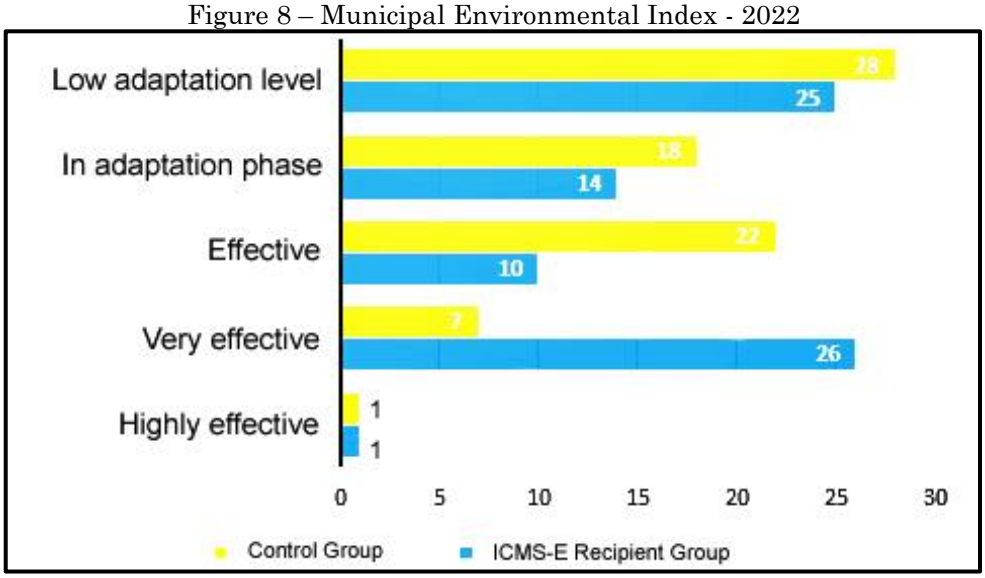
At the municipal level, the public sector must address these issues by collecting and disposing of solid waste, preserving parks and natural sources of drinking water, planting and pruning trees in public areas, environmental education and an administrative structure that includes setting standards, inspection and environmental monitoring. Furthermore, the population and sectors interested in this issue must participate by creating an effective Environmental Council.

A problem that arises is related to how to measure the effectiveness of the municipal public sector with regard to the environment and, to this end, the TCEPR has compiled the Municipal Management Effectiveness Index (IEGM) since 2017. This index consists of seven (7) sector indices, namely: Education, Health, Planning, Fiscal Management, the Environment, Protected Cities and Information Technology Governance. The IEGM is calculated for every municipality in the state.

In the specific case of the Municipal Environmental Index (i-Amb), it has qualitative scales for analyzing the effectiveness of municipal government actions, and these scales are described below: (A) Highly effective, (B+) Very effective, (C+) in the adaptation phase, (C) Low adaptation level of adaptation.

To guide the analysis using this index of the effectiveness of municipal management of small municipalities in the ICMS-E and Recipient and Control Group, it was decided to gauge whether small municipalities that receive funds from the ICMS-E perform better in terms of the environment than the municipalities in the Control Group (Figure 8).

Figure 8 – Municipal Environmental Index - 2022




Source: Prepared by the authors based on TCEPR (2023a).

On the Highly Effective scale, both groups had the same result, with only one municipality in this range. On the second scale, Very Effective, the ICMS-E Recipient Group presented a percentage of 34.21% and the Control Group of 9.21%. This result indicates greater attention from municipal managers in the field and may be related to the expertise of the staff and the structure established in the executive government to manage areas with Environmental Protection Units and water sources.

On the other hand, on the third Effective scale, the positions of the two groups were reversed, and the Control Group presented a percentage of 120%, positively, over the ICMS-E Recipients Group. On the fourth scale, the difference in favor of the Control Group was

28.57% and, finally, on the last scale, the difference dropped to 12%. However, the number of municipalities in relation to the total groups showed values of 32.89% and 36.84%, respectively.

If we consider the two ranges of "Low Level" and "In the Adaptation Phase", the number for the ICMS-E Recipient Group was 51.31%, and for the Control Group, it was 60.52%. Therefore, it can be concluded that the two groups presented preponderant results in the adequacy range and that they require greater efforts to be considered effective.

In isolation, the value of 51.31% of the ICMS-E Recipient Group indicates the weakness of municipal public administration regarding environmental issues, which demonstrates an inconsistency with the requirements for receiving the ICMS-E funds, which includes the quality of the preserved area, environmental education, and other issues.

If the preservation of the environment means benefits to society, it can be assumed that these would include economic benefits, such as the per capita share in Local Gross Domestic Product. Therefore, to measure values that add income to residents of territories, we sought to calculate the per capita value of the ICMS-E in 2022. In other words, the value each individual would receive if the ICMS-E funds were redistributed to the local population (Table 4).

**Table 4** – Per capita distribution of ICMS-E resources in 2022

| Classes | Municipalities | % |
|---|---|---|
| 0.00 to R$ 553.00 | 63 | 82.89% |
| R$ 554.00 to R$ 1,107.00 | 8 | 10.53% |
| R$ 1,108.00 to R$ 1,661.00 | 2 | 2.63% |
| Acima de R$ 1,662.00 | 3 | 3.95% |
| **Total** | **76** | **100.00%** |

Source: Prepared by the authors based on research and IPARDES (2023a).

The population of 82.89% of the municipalities in the ICMS-E Recipient Group would receive amounts of approximately R$553.00, equivalent at the upper limit to 42.47% of the current Minimum Wage in 2023. The inhabitants of thirteen (13) municipalities in the group would receive higher values.

Considering that the municipalities that receive ICMS-E funds should, strictly speaking, apply these resources in their entirety to environmental management, even though municipal public administrators can allocate them to other functions at their discretion, it would not make sense to go against the ideals for proposing the legal instrument. Therefore, it is important to ask what percentage of the ecological tax is allocated to the environmental management function.

The results for the ICMS-E Recipient Group indicated that five (5) municipalities in 2022 did not invest resources in this function, namely: Guaraqueçaba, Balsa Nova, Morretes, Florestópolis and Corumbataí do Sul. Conversely, twenty-eight (28) municipalities applied a percentage higher than 100%. The vast majority, that is, 60.53% of municipalities, representing 46 political-administrative units, allocated between 0% and 75% of these resources to environmental management (Table 5).

**Table 5** – Application of resources in the environmental management function in 2022

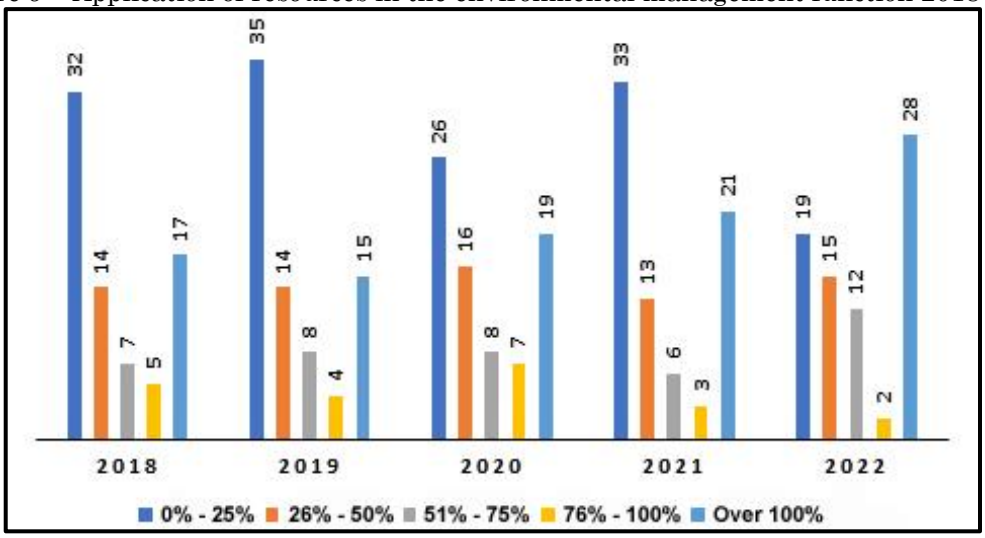
| Range of application in the Environmental Management Function (2022) | Municipalities | % |
|---|---|---|
| 0-25% | 19 | 25.00% |
| 26-50% | 15 | 19.74% |
| 51-75% | 12 | 15.79% |
| 76-100% | 2 | 2.63% |
| Over 100% | 28 | 36.84% |
| **Total** | **76** | 100.00% |

Source: Prepared by the authors based on research, IAT (2023); TCEPR (2023b).

The numbers indicated that the aforementioned twenty-eight (28) municipalities, in addition to the amounts from the green tax, redirected sums from other sources to environmental management, indicating municipal managers' willingness to develop various actions and programs for the environment. In the 2018 and 2019 biennium, eleven (11) municipalities did not invest resources in the environmental management function, with this number decreasing to eight (8) in 2020 and 2021 and to five (5) in 2022.

From 2018 to 2022, there was a decline in the number of municipalities that invested resources in the Environmental Function in the range of 0% to 25% and stability with small fluctuations in the other ranges up to the upper limit of 100%. However, in the range above this limit, there was a significant variation, rising from seventeen (17) to twenty-eight (28) municipalities that apply resources in addition to the amount they receive from the ecological tax (Figure 9).

Figure 9 – Application of resources in the environmental management function 2018-2022




Source: Prepared by the authors based on research, IAT (2023); TCEPR (2023b).

In response to the question that was raised, municipalities apply varying percentages to environmental management, with the majority (between 60.53% and 75% of the ICMS-E Recipient Group) applying up to the limit of 75% of the resources in this function, while redirecting the difference to other functions. However, a significant and growing number of these municipalities apply 100% of this ecological resource and add more.

It is worth noting that although Private Natural Heritage Reserves contribute to the receipt of the ICMS-E from some municipalities, few local public administrations transfer resources to these reserves, as shown by Mattar et al. (2023).

## FINAL CONSIDERATIONS

The ICMS-E has proved to be an important instrument for preserving biodiversity in Paraná, according to the comparative results for the groups under study (ICMS-E Recipient Group and Control Group). This importance was highlighted by the perspectives of the recipient municipalities and the relevance of this resource for municipal administration, which considered this public policy to be successful and served as a model implemented in other Brazilian states.

It was noted that a significant number of municipal public administrations invested up to 75% of resources in the environmental management function and redirected the difference to other functions to meet the needs of local society. This fact highlights the local government's discretion over tax resources and the commitment to environmental preservation. In this way, funds from the ICMS-E increase sustainable development over time, as can be seen from the indicators presented.

However, despite the contribution of resources available to local governments, they are not sufficient to prevent population reduction in these locations. The population projection for 2040 indicates that small municipalities tend to have low levels of dynamism (IBGE, 2021), which highlights that the ICMS allows for improvements in environmental conditions and public service functions, but does not create the economic

dynamism capable of retaining the population in these municipalities.

Another relevant factor is related to the Municipal Environmental Index (i-Amb) produced by the TCEPR, which revealed weaknesses in the ICMS-E Recipient Group in terms of the environment. This indicates that external control is necessary to guide the actions of municipal public administration, as well as greater use in private natural heritage reserves. A suggestion for future studies is to explore these research questions further to gain a better understanding of the effectiveness of the ICMS-E in Paraná State.

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## AUTHOR CONTRIBUTION

Christian Luiz da Silva conceived the study, analyzed the data, wrote the text. Nelson Granados Moratta analyzed the data written in the text. Alain Hernández Santoyo analyzed the data and wrote the text.