INCOME, ENVIRONMENTAL POLLUTION AND HEALTH INEQUALITIES IN ITALY: A REGIONAL PERSPECTIVE IN THE ERA OF TRANSITIONS

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Abstract. Poverty and inequality are increasingly intertwined with territorial and environmental dimensions, especially in a context of profound demographic, environmental and technological change.
In particular, health inequalities reflect disparities in access to and quality of care among different population groups, which are shaped by socio-economic and environmental determinants. Among these, income and living conditions emerge as key factors influencing individual and collective vulnerability to health risks.
This study examines the interaction between income levels, environmental pollution and population health from a regional perspective. By integrating statistical indicators and multidimensional data - economic, social and environmental - the analysis aims to identify territorial patterns of disadvantage and their impact on health outcomes and access to care.
The proposed multidisciplinary approach contributes to a broader reflection on how structural inequalities intersect with environmental degradation and how these dynamics evolve in a period of environmental and social transition.
The study provides insights to support the design of more inclusive, sustainable and resilient public policies, capable of addressing multiple forms of vulnerability simultaneously and promoting equity across territories and populations.

1. Introduction

In recent years, the analysis of territorial and multidimensional inequalities has become central to the scientific and political debate, especially in light of the Sustainable Development Goals (SDGs) promoted by the United Nations. The growing complexity of social and environmental vulnerabilities has made it necessary to have an integrated approach that takes into account the multiple dimensions of well-being and quality of life (Sen, 1999; Stiglitz *et al*., 2009).

From this perspective, this work aims to systematically analyze the interaction between poverty, environmental conditions, health inequalities, and employment dynamics, through a coherent set of recognized and comparable statistical indicators at the territorial level. As highlighted by Segre, Rondinella, and Mascherini (Segre *et al.,* 2011), measuring well-being requires a multidimensional vision that also

values the contribution of civil society, focusing on qualitative aspects of life and involving local communities in defining priorities. Their work emphasizes how the significance of regional differences in Italy must be addressed not only with economic data, but also with tools capable of capturing perceived well-being and local social dynamics.

Similarly, recent studies such as that of Yebetchou Tchounkeu (Yebetchou Tchounkeu, 2024) show how the efficiency of the public healthcare system significantly impacts the overall well-being of the population, revealing strong heterogeneity across Italian provinces. This evidence reinforces the need to analyze the territorial performance of public services—particularly healthcare—as fundamental determinants of living conditions and individual opportunities.

The data used, coming from Istat databases and referring to the year 2022, were analyzed at different territorial levels, from national to regional and autonomous provinces, in order to highlight the critical issues and disparities present between the different areas of the country.

The theoretical-methodological approach is inspired by Amartya Sen's (Sen, 1999) capabilities perspective, according to which well-being cannot be reduced to a single economic dimension, as well as by the most recent proposals for measuring well-being and quality of life that go beyond income alone as a measure of progress (OECD, 2020).

This is supported by the work of the Stiglitz-Sen-Fitoussi Commission, which has promoted the use of alternative indicators to GDP to measure social progress. "The Commission also recommends measuring well-being through a multidimensional approach that also takes into account aspects of citizens' subjective evaluation and considering indicators of sustainability, not only environmental, but also economic and social" (Stiglitz *et al.*, 2009).

At the national level, institutions such as Istat and CNEL have promoted multidimensional approaches to measuring well-being, as in the case of the BES – Equitable and Sustainable Well-being (Istat-Cnel, 2013) project, which proposes a set of indicators divided into twelve areas, including health, environment, work, and economic inequality.

This work refers to the scientific literature that studies the phenomena of poverty and inequality in an integrated way. In particular, reference is made to the studies of Brandolini and Saraceno (Brandolini *et al*., 2007), who underline the importance of adopting a combined perspective to understand the conditions of material deprivation, and to those of Wilkinson and Pickett (Wilkinson *et al.*, 2009), who highlight the link between economic inequalities and worsening of public health indicators.

In summary, the aim of the study is to provide a territorial and comparative reading of social and economic fragilities in Italy, through an integrated analysis of

the most up-to-date data available. The choice of indicators reflects a targeted and theoretically founded selection, capable of providing a complex but readable picture of the structural inequalities that characterize our country.

This paper is structured as follows: Section 2 presents the data and methods. Section 3 introduces the statistical analysis results. Finally, section 4 contains the conclusions.

2. Data and methods

To carry out this study, I used a series of multidimensional data that allowed me to analyze in an integrated way the intersection between poverty, health inequalities, environmental conditions and territorial dynamics. The processing was carried out with Excel and XLSTAT, a statistical software that works as an add-in for Microsoft Excel.

The data, referring to the year 2022, were extracted from the Istat databases and analyzed by NUTS 2 level territorial units, including the 20 Italian regions and the 2 autonomous provinces of Trento and Bolzano, in line with the European statistical classification.

The main thematic areas examined are:

- Poverty
- Employment system
- Environment
- Health system

Table 1 - *List of statistical indicators divided by thematic area*.

Thematic area	Statistical indicators	Unit
Poverty	1. Relative family poverty incidence	percentage
	2. Homogeneity in the distribution of family net income	Gini index
	3. Average annual household income	Euro
Employment system	1. Labour force (15-64 years)	percentage
	2. Youth employment rate (15-29 years)	percentage
	3. Unemployment rate	percentage
Environment	1. Air quality - PM2.5	percentage
	2. Families reporting air pollution	percentage
	3. Families reporting unpleasant odours	percentage
	4. Service for the separate collection of municipal waste	percentage
Health system	1. Medical specialists active in the health system	For 10,000 inhab
	2. Hospital emigration index	percentage
	3. Current public health expenditure per inhabitant	Euro
	4. Avoidable mortality (0-74 years)	Years
	5. Healthy life expectancy at birth	Years
	6. Standardized mortality rate	For 10,000 inhab
	7. Infant mortality	For 1,000 inhab

3. Statistical analysis

3.1 Descriptive analysis

To perform the data analysis, I started using descriptive analysis techniques to obtain a preliminary understanding of the main characteristics of the dataset; these techniques represent the first step in the exploratory approach to the data and are essential to summarize the information in a simple, clear and effective way.

I calculated the descriptive measures of location, the measure of central tendency, the measure of dispersion and graphical representations (bar charts, cartograms) to better visualize the distributions and facilitate the interpretation of the data.

Table 2 - *Descriptive Statistics.*

Variable	Min	Max	Mean	Std. Dev.
Average annual household income	29807,00	51632,00	40673,73	6390,31
Homogeneity in the distribution of family net income	0,25	0,34	0,28	0,02
Relative family poverty incidence	5,10	30,00	11,37	6,79
Labour force (15-64 years)	51,12	75,82	66,18	7,93
Youth employment rate (15-29 years)	20,53	51,74	34,41	8,67
Unemployment rate	2,27	17,11	8,09	4,06
Medical specialists	24,40	40,50	32,35	4,46
Hospital emigration index	4,75	30,37	11,79	7,33
Avoidable mortality (0-74 years)	14,20	22,40	17,49	2,08
Current public health expenditure per inhabitant	2025,66	2914,22	2281,39	191,72
Healthy life expectancy at birth	53,10	69,30	60,28	2,95
Standardized mortality rate	75,93	104,91	89,77	6,70
infant mortality	1,40	6,40	2,60	0,99
Air quality - PM2.5	12,50	100,00	74,85	22,37
Families reporting air pollution	17,00	47,70	29,79	9,83
Families reporting unpleasant odours	8,60	28,60	16,67	4,81
Service for the separate collection of municipal waste.	32,10	95,50	63,86	19,37

Source: Elaborations on data from Istat databases

The indicator "Incidence of relative family poverty" presented two observations with missing data (P.A. Bolzano and Valle D'Aosta) that were estimated with the mean value. The analysis showed that the variables Average annual household income (in euro) Current public health expenditure per inhabitant are those that present the greatest variability between observations.

3.2 Thematic area Poverty

For the topic of poverty, since data for the indicator Average annual family income for the Trentino Alto Adige region were not available, I used data from the autonomous provinces of Trento and Bolzano. The national analysis of the main Italian economic and social indicators highlights significant aspects related to income distribution and the living conditions of the population. The average value of the total income received by families stands at €41,004, this figure being an arithmetic mean can be influenced by very high incomes in a narrow segment of the population, therefore it is useful to compare it with the inequality index.

The Gini index measures inequality in income distribution, on a scale from 0 (perfect equality) to 1 (maximum inequality). Italy has a value of 0.296 thus indicating moderate inequality. The relative poverty rate indicates the percentage of individuals who live in families with a disposable income lower than the threshold of 60% of the national median income.

A national value of 10.10% indicates that over a tenth of the Italian population lives with resources lower than the level considered necessary for a dignified life. This data highlights a persistent socioeconomic fragility.

Figure 1 – *Spatial distribution of the average annual household income, the Gini index and the incidence of relative family poverty. Year 2022 Values in Euro and percentages.*

Source: Elaborations on data from IstatData

Figure 1 illustrates the regional geographical analysis, which confirms the dualistic opposition between North and South in our country, specifically we see that the regions of the North with the most favorable socio-economic conditions are Emilia-Romagna, Trento, Toscana, Veneto, Lombardia, Friuli-Venezia Giulia, have Medium-high income between €43,000 and €48,000, low inequality (Gini < 0.270) and low relative poverty (5–6%)

While the most disadvantaged regions, with low income, high inequality and poverty are Calabria, Campania, Sicilia, Basilicata, Puglia have low income between €28,000 and 35,000, high inequality (Gini > 0.30) and high relative poverty (over 17%, up to 30%)

3.3 Thematic area Employment system

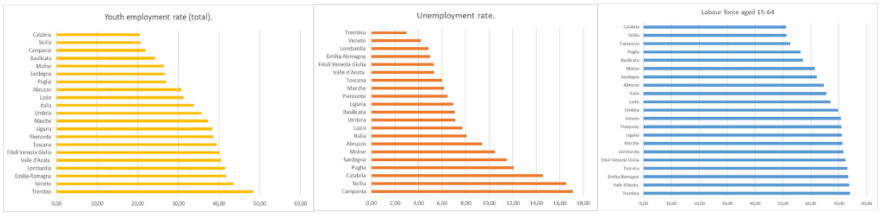
To analyze the issue of the employment system, I have selected three fundamental indicators that allow us to grasp in a complex way the dynamics of the labor market, with particular attention to active participation, the employment status of young people and the level of unemployment.

At the national level, the unemployment rate stands at around 8.07%, while participation in the labor market (active population between 15 and 64 years) reaches approximately 66%. As for young people (15-29 years), the employment rate is approximately 34%, highlighting a still limited participation of this age group in the world of work.

The regional analysis, shown in Figure 2, always highlights the gap between the North and the South of the country.

The Southern regions show low participation in the labor market, indicating a possible disincentive or lack of opportunities. Young people from the North find work more easily than their peers in the South. The North-South gap is also marked in the unemployment rate: the lowest values are recorded in the North, with Bolzano in the lead, while in the South the percentages often exceed 12%

Figure 2 – *Regional Labour Market Indicators: Youth Employment, Unemployment and the Labour Force rates. Year 2022 Values in percentages.*



Source: Elaborations on data from Territorial indicators for development policies, Istat

3.4 Thematic area Environment

The statistical analysis conducted focuses on a series of relevant environmental indicators, with the aim of evaluating the quality of the urban environment and the subjective perception of citizens with respect to phenomena of air pollution and olfactory discomfort. For this topic too, the analysis was started from the data available at national level. In Italy, 81.8% of the population lives in areas characterized by high levels of fine particulate matter (PM2.5), while 37% of families report the presence of polluted air and 19.3% perceive unpleasant odors in the environment in which they live. Only 60.2% of the population lives in

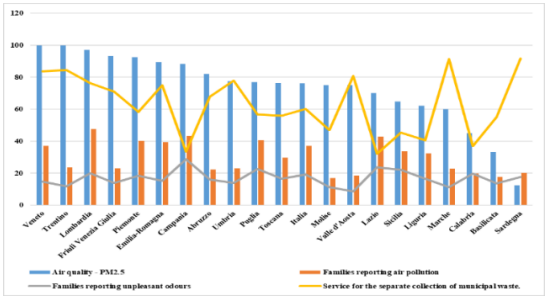
municipalities that exceed the threshold of 65% of separate waste collection, a value considered indicative of virtuous waste management. From a territorial point of view, as shown in Figure 3, significant differences emerge, the regions of Northern Italy (in particular Lombardia, Veneto and Piemonte) show generally positive performances in separate waste collection, but at the same time record high concentrations of PM2.5 and widespread perceptions of air pollution by citizens.

It is interesting to note how the subjective perception of pollution does not always coincide with objective data. Some regions, in fact, show measured levels of good environmental quality, but negative perceptions by the population, and vice versa. Trentino-Alto Adige, for example, has very high PM2.5 values (100%), but a low subjective perception of both air pollution and the presence of unpleasant odors.

Marche and Sardegna stand out positively both for the low negative perception by families and for the good objective quality of environmental services.

On the other hand, Campania represents one of the most critical cases: poor air quality, low levels of separate waste collection and strongly negative subjective perceptions are detected, signaling a particularly problematic environmental context.

Figure 3- *Perceived and measured environmental quality in the Italian regions: PM2.5, perception of pollution, odors and separate waste collection. Year 2022. Values in percentages.*



Source: *Elaborations on data from Bes of the territories 2024 and We Italy 2024, Istat*

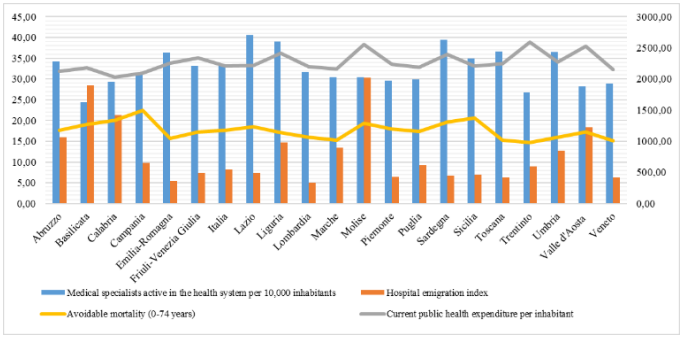
3.5 Thematic area Health system

The proposed statistical analysis focuses on a set of key healthcare system indicators, with the aim of assessing regional differences in service provision, system efficiency, and health outcomes. To this end, we use synthetic and standardized indicators, which are essential for accurately and comparably describing the population's health status and capturing crucial aspects such as quality of life and the effectiveness of regional healthcare systems.

Nationally, Italy has an average of 33.2 specialist doctors per 10,000 inhabitants, with per capita public healthcare spending of approximately €2,212.16. The hospital out-migration rate stands at 8.3%, indicating a significant proportion of patients traveling outside the region to receive treatment. Regarding health outcomes, the avoidable mortality rate in the 0-74 age group averages 17.6 deaths per 10,000 inhabitants, while the standardized mortality rate is 90.41 per 10,000 inhabitants. Healthy life expectancy at birth stands at 60.1 years, and the infant mortality rate is 2.5 deaths in the first year of life for every 1,000 resident live births.

The regional overview, Figure 4, shows that regions in the Centre-North (such as Lazio and Tuscany) tend to have a higher density of specialist doctors than many regions in the South (e.g., Basilicata, Calabria). However, some exceptions, such as Sardinia, indicate that this indicator does not follow a clear North-South division. Southern regions and some regions with low population density (e.g. Molise, Basilicata) show the highest levels of health emigration, indicating a likely deficiency in the quality or availability of local health services.

Figure 4 – *Indicators of the Italian Regional Health System: Medical Staffing, Hospital Mobility, Health Spending and Avoidable Mortality. Year 2022. Values in years, euro and percentages.*



Source: Elaborations on data from Bes of the territories 2024 and We Italy 2024, Istat

Per capita spending is quite variable and not always higher in regions with better health outcomes or a low rate of hospital emigration. For example, Molise has high spending, but also a high rate of emigration and avoidable mortality.

Healthcare emigration, in this context, refers to patient mobility, i.e., the movement of Molise residents to other Italian regions to receive medical care that is unavailable, inaccessible, or perceived to be of higher quality than that provided locally. While this phenomenon can contribute to improving certain health outcomes, it also has significant economic and organizational consequences. Specifically, it translates into significant financial outflows from Molise to host

regions, as the national healthcare system provides interregional financial compensation based on patient mobility. This can further weaken the local healthcare system, diverting resources that could be invested in improving domestic provision and contributing to a vicious cycle of service impoverishment.

This suggests that the efficiency and quality of resource allocation are critical factors, in addition to the amount of spending. Avoidable mortality is significantly higher in southern regions, suggesting significant differences in the effectiveness of prevention, access to early care and overall quality of the health system.

3.6 Study of relationships between variables

In recent decades, the growing attention to environmental and social issues has highlighted the importance of understanding the interconnections between economic, environmental and health factors. In particular, individual or family income, the quality of the environment in which one lives and the state of health of people represent three fundamental dimensions of human well-being. The aim of this analysis is to investigate the correlations existing between these elements, to verify to what extent the level of income influences the quality of the surrounding environment and, consequently, the state of health of individuals.

Bivariate analyses were conducted to explore the relationships between the different pairs of elementary indicators. The following table 3 shows the correlation coefficients, with the statistically significant ones highlighted in bold.

It should be remembered that correlation analysis, by its nature, does not allow for the establishment of causal relationships between variables: it simply measures the intensity and direction of the link.

Table 3 – *Correlations.*

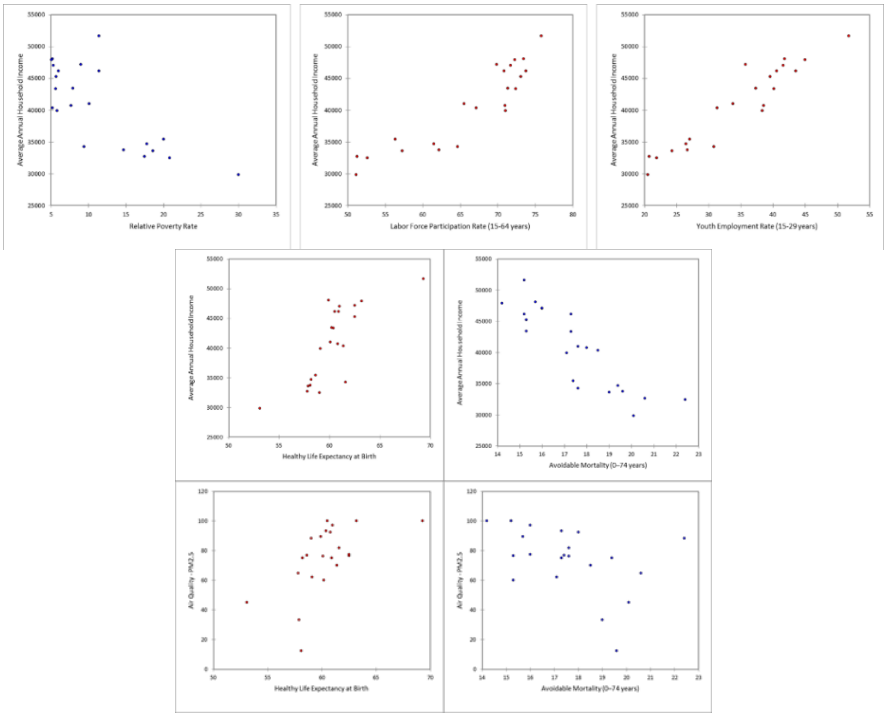
Varible	Average annual household income	Gini index	Relative family poverty incidence	Labour force aged 15-64	Youth employment rate	Unemployment rate	Medical specialists	Hospital emigration index	Current public health expenditure per inhabitant	Healthy life expectancy at birth	Avoidable mortality (0-74 years)	Standardized mortality rate	infant mortality	Air quality - PM2.5	Families reporting air pollution	Families reporting unpleasant odours	Service for the separate collection of municipal waste.
Average annual household income	**1**																
Gini index	**-0,544**	**1**															
Relative family poverty incidence	**-0,762**	**0,519**	**1**														
Labour force aged 15-64	**0,905**	**-0,623**	**-0,871**	**1**													
Youth employment rate	**0,946**	**-0,553**	**0,779**	**0,943**	**1**												
Unemployment rate	**0,870**	**0,628**	**0,772**	**0,923**	**0,913**	**1**											
Medical specialists	-0,061	0,234	-0,299	0,076	-0,112	0,168	**1**										
Hospital emigration index	**0,439**	-0,114	**0,481**	-0,346	-0,421	0,179	-0,400	**1**									
Current public health expenditure per inhabitant	**0,427**	-0,347	-0,161	**0,448**	**0,483**	-0,412	-0,045	0,009	**1**								
Healthy life expectancy at birth	**0,770**	**0,442**	**0,614**	**0,714**	**0,780**	**0,674**	-0,047	-0,419	**0,597**	**1**							
Avoidable mortality (0-74 years)	**-0,866**	**0,621**	**0,724**	**-0,836**	**-0,871**	**0,871**	0,115	0,288	-0,241	**-0,637**	**1**						
Standardized mortality rate	**-0,829**	**0,623**	**0,697**	**-0,824**	**-0,839**	**0,880**	0,125	0,235	-0,265	**-0,606**	**0,942**	**1**					
infant mortality	-0,181	0,231	0,317	-0,179	-0,185	0,217	-0,191	0,230	0,043	-0,221	0,319	0,310	**1**				
Air quality - PM2.5	**0,618**	-0,347	**-0,486**	**0,491**	**0,628**	**-0,430**	-0,237	-0,391	0,139	**0,585**	**-0,474**	-0,406	-0,153	**1**			
Families reporting air pollution	0,119	0,260	-0,246	0,005	0,075	0,076	0,259	**-0,656**	-0,322	0,056	0,027	0,119	-0,160	**0,428**	**1**		
Families reporting unpleasant odours	**-0,514**	**0,705**	0,311	**0,603**	**0,559**	**0,679**	0,334	-0,353	**0,555**	-0,369	**0,592**	**0,595**	-0,022	-0,064	**0,700**	**1**	
Service for the separate collection of municipal waste.	**0,593**	**-0,657**	**-0,461**	**0,581**	**0,592**	**-0,590**	-0,220	-0,216	0,211	0,410	**-0,669**	**-0,728**	-0,072	0,142	-0,293	**-0,617**	**1**

Source: *Elaborations on data from Istat databases.*

Table 4 shows the significant correlations; the average income indicator shows a rather strong negative correlation with the relative poverty rate (-0.76), suggesting that regions with a higher average income tend to record lower levels of poverty.

This confirms the role of income, especially if equally distributed, as a determining factor in reducing economic inequalities.

Table 4 – S*ignificant correlations.*



Furthermore, average income is positively associated with both the labour force participation rate and the level of youth employment, highlighting a link with a greater vitality of the labour market. Average income also has a positive correlation with healthy life expectancy and a negative correlation with avoidable mortality.

This suggests that regions with higher income levels tend to associate greater healthy longevity and a lower incidence of avoidable deaths, probably due to better access to health services, more favourable living conditions and a greater capacity for prevention. The indicator for air pollution shows a positive correlation with both average per capita income and healthy life expectancy, and a negative correlation with avoidable mortality. This apparent paradox can be explained by the fact that

regions with higher levels of pollution often coincide with urbanized and economically developed areas, where average income is higher.

In such contexts, greater availability of health services, modern infrastructure and favorable socio-economic conditions contribute to improving health outcomes, partly mitigating the negative effects of exposure to air pollutants.

4. Conclusions

The analysis conducted highlights profound territorial inequalities among the Italian regions, with the South presenting the greatest structural criticalities. The regions of the South, in particular Calabria and Sicily, are characterized by low levels of per capita income, high economic inequality and widespread relative poverty. Added to these conditions is a fragile employment situation, especially among young people: in regions such as Campania and Calabria, youth employment rates are less than 30%, among the lowest in the country.

Signs of vulnerability also emerge in terms of health. Campania has the highest avoidable mortality rate, while Molise, Basilicata and Calabria show high health emigration, a symptom of deficiencies in local health services.

From an environmental point of view, air pollution is generally less critical in the South, with the exception of Campania. However, separate waste collection remains insufficient in many areas of the South, indicating a delay in sustainable waste management practices.

On the contrary, the Northern regions, such as Trentino-Alto Adige, Lombardia and Veneto, stand out for their overall positive performance.

These territories have an average income higher than the national average, low levels of poverty and, in particular Veneto and Trentino, low unemployment rates. In terms of healthcare, Lombardia, Emilia-Romagna and Veneto show a high level of hospital self-sufficiency, retaining the majority of patients within their own healthcare facilities. The Alpine and North-Eastern regions (in particular Trentino, Veneto, Friuli Venezia Giulia and Lombardia) offer very favorable economic and healthcare conditions, despite presenting environmental criticalities linked to air pollution, especially in urbanized and industrialized areas. On the other hand, the North confirms its virtuousness in separate waste collection, with results significantly higher than the national average.

Overall, the data analyzed highlight the need for differentiated and territorially targeted public policies, aimed at reducing regional inequalities and strengthening socio-economic, healthcare and environmental conditions in the most disadvantaged areas, promoting greater territorial cohesion and justice.

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