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Sustainability Assessment in the Metropolitan Region of Paraíba Valley and North Coast - RMVPLN

Monica Franchi Carniello
Universidade de Taubaté – Taubaté – SP – Brazil
ORCID: https://orcid.org/0000-0002-3107-901X

Moacir José dos Santos
Universidade de Taubaté – Taubaté – SP – Brazil
ORCID: https://orcid.org/0000-0001-6865-0630

Nelson Marcos Calderaro da Silva
Universidade de Taubaté – Taubaté – SP – Brazil
ORCID: https://orcid.org/0000-0002-5875-4732

Abstract
The Metropolitan Region of the Paraíba Valley and North Coast (RMVPLN), formed by 39 municipalities, was created in 2012. The research has the objective of evaluating the sustainability of the RMVPLN, through the application of the Sustainability Barometer (BS) tool in two distinct phases, before and after its creation by law. As for the method, the research is characterized as documentary, with descriptive modeling and a quantitative approach in the analyses. It was possible to demonstrate that the municipalities of the RMVPLN are heterogeneous in terms of their characteristics and, as a region, they do not fully meet the training requirements of the metropolitan regions. As for the sustainability of the region, although it has advanced a little, it is still on the scale of almost unsustainable. It is concluded that, in the first decade of metropolitanization, there were no significant advances in the consolidation of ecosystem well-being indexes and in human well-being from a regional perspective. When analyzed individually, the municipalities present different results regarding sustainability.
Keywords: Sustainability Barometer. Metropolitan Region. Paraíba Valley. North Coast. Regional Development.

Avaliação da Sustentabilidade na Região Metropolitana do Vale do Paraíba e Litoral Norte – RMVPLN

Resumo
A Região Metropolitana do Vale do Paraíba (RMVPLN), formada por 39 municípios, foi criada em 2012. A pesquisa tem como objetivo avaliar a sustentabilidade da RMVPLN, por meio da aplicação da ferramenta Barômetro da Sustentabilidade (BS) em duas fases distintas, antes e depois da criação da região metropolitana por lei. Quanto ao método, a pesquisa caracteriza-se como documental, com modelagem descritiva e uma abordagem quantitativa nas análises. Foi possível demonstrar que os municípios da RMVPLN são heterogêneos quanto às suas características e, como região, não atendem plenamente aos requisitos de formação das regiões metropolitanas. Quanto à sustentabilidade da região, embora tenha avançado um pouco, ainda se encontra na escala de quase insustentabilidade. Conclui-se que, na primeira década de metropolização, não houve avanços significativos no consolidado dos

índices do bem-estar do ecossistema e no bem-estar humano na perspectiva regional. Quando analisados individualmente, os municípios apresentam resultados distintos quanto à sustentabilidade.
Palavras-chave: Barômetro da Sustentabilidade. Região Metropolitana. Vale do Paraíba. Litoral Norte. Desenvolvimento Regional.

Evaluación de la Sostenibilidad en la Región Metropolitana de Vale do Paraíba y Litoral Norte – RMVPLN

Resumen
La Región Metropolitana de Vale do Paraíba y Litoral Norte (RMVPLN), formada por 39 municipios, fue creada en 2012. La investigación tiene como objetivo evaluar la sostenibilidad de la RMVPLN, a través de la aplicación de la herramienta Barómetro de Sostenibilidad (BS) en dos fases bien diferenciadas, antes y después de su creación por ley. En cuanto al método, la investigación se caracteriza por ser documental, con modelado descriptivo y enfoque cuantitativo en los análisis. Se pudo evidenciar que los municipios de la RMVPLN son heterogéneos en cuanto a sus características y, como región, no satisfacen en su totalidad los requerimientos de formación de las regiones metropolitanas. En cuanto a la sostenibilidad de la región, aunque ha avanzado un poco, todavía está en la escala de casi insostenible. Se concluye que, en la primera década de la metropolitanización, no hubo avances significativos en la consolidación de los índices de bienestar ecosistémico y en el bienestar humano desde una perspectiva regional. Cuando se analizan individualmente, los municipios presentan resultados diferentes en cuanto a la sostenibilidad.
Palabras clave: Barómetro de la Sostenibilidad. Región Metropolitana. Valle de Paraíba. Litoral norte. Desarrollo regional.

1 Introduction

Conducting territorial management processes from the perspective of regionalization and in accordance with the premises of sustainable development is one of the challenges of contemporary times. Among different territories, those with high rates of urbanization present particular challenges.

In Brazil, the urbanization process gained prominence in the second half of the 20th century. From the 1970s onwards, as a reflection of this phenomenon, metropolization was identified as one of the forms of urban organization, instigated by logistical connections, industrialization and population concentration, among other factors. Metropolitan regions became a form of regionalization, seeking to strengthen and integrate municipalities.

The Metropolis Statute was embodied in Federal Law No. 13,089 (January 12, 2015) and establishes general guidelines for metropolitan regions and urban agglomerations (Brasil, 2015). This Statute can "be understood as an innovative normative diploma to promote metropolitan development and, above all, to stimulate and make it viable, through instruments that present integrated actions between the Union, states and municipalities" (Santos, 2018, p. 02).

This Law highlights the need for integration and mutual assistance between municipalities in Metropolitan Regions and Urban Agglomerations, which results in coordinated actions that go beyond the territorial divisions of them. Furthermore, the aim is to materialize inter-federative instruments for planning, managing and

executing urban development relating to public functions, as well as criteria for aid from the Union to institutionalized entities.

The state of São Paulo delineated the São Paulo Macrometropolis, mainly because of the intensity of growth of the city of São Paulo. In this context, regional deconcentration arises beyond the borders of the São Paulo Metropolis, expanding to different regions of the state (Gomes; Reschilian; Uehara, 2018). This process guides the decentralization and political integration of the so-called peripheral regions through extensive road networks starting from the Capital, in all directions of the State territory.

Since the 1970s, according to Mello, Teixeira and Iwama (2016, p. 02), the "state of São Paulo has been systematically reconfiguring its territorial and administrative organization, introducing territorial administrative units such as administrative regions, government regions and metropolitan regions". These restructurings seek to bring compliance with the search for efficiency and autonomy in the various hierarchical structures in the several government bodies and entities. In that same decade, the city of São José dos Campos stood out as an emerging metropolis involving neighboring cities in its services sector (Costa *et al.*, 2015).

It is in these circumstances that the Metropolitan Region of Vale do Paraíba and North Coast (RMValley) finds itself, created in 2012, which declares as its objective to promote integration, cooperation, rational and sustainable use of resources in favor of common well-being and the most egalitarian society in the region (Law No. 1,166, 2012). As can be seen, this region was established before the promulgation of the Metropolis Statute, in addition, it was in line with the positions and technical studies of São Paulo Metropolitan Planning Company (Emplasa) that warned about the absence of the necessary requirements for the composition of a metropolitan region.

Even so, it was created and is made up of 39 municipalities and five sub-regions: Caçapava, Igaratá, Jacareí, Jambeiro, Monteiro Lobato, Paraibuna, Santa Branca and São José dos Campos; Campos do Jordão, Lagoinha, Natividade da Serra, Pindamonhangaba, Redenção da Serra, Santo Antônio do Pinhal, São Bento do Sapucaí, São Luiz do Paraitinga, Taubaté and Tremembé; Aparecida, Cachoeira Paulista, Canas, Cunha, Guaratinguetá, Lorena, Piquete, Potim and Roseira; Arapeí, Areias, Bananal, Cruzeiro, Lavrinhas, Queluz, São José do Barreiro and Silveiras; Caraguatatuba, Ilhabela, São Sebastião and Ubatuba.

A decade after the establishment of RMValley, questions arise about the impact on regional sustainable development, understood as that which meets the needs of the present without compromising the possibility of future generations meeting their needs, as defined in the Brundtland Report (CGEE, 2012; Barbiere, 2020). The general objective of this research was to evaluate the RMVPLN in a two-dimensional way in terms of sustainability, through the application of the Sustainability Barometer (BS) tool in two distinct phases, before and after its creation by law.

To assess the sustainability of the delimited region, the Sustainability Barometer (BS) was chosen, a tool designed by Prescott Allen (1997) to be applied without spatial limitations and with the possibility of using varied indicators in its composition, often even contradictory and without temporal restrictions. In this context, the BS tool provides a methodology for measuring and producing

information that provides responsive decisions for a sustainable future. Due to the specific complexity of the method, it was decided, in this paper, to prepare an empirical literature review, focusing on detailing the application phases of the Sustainability Barometer.

Among the applications of the results of this research, it is important to serve as a support for the maintenance and correction of the goals to be pursued by the public administration.

2 Methods and tools for assessing sustainable development: the Sustainability Barometer

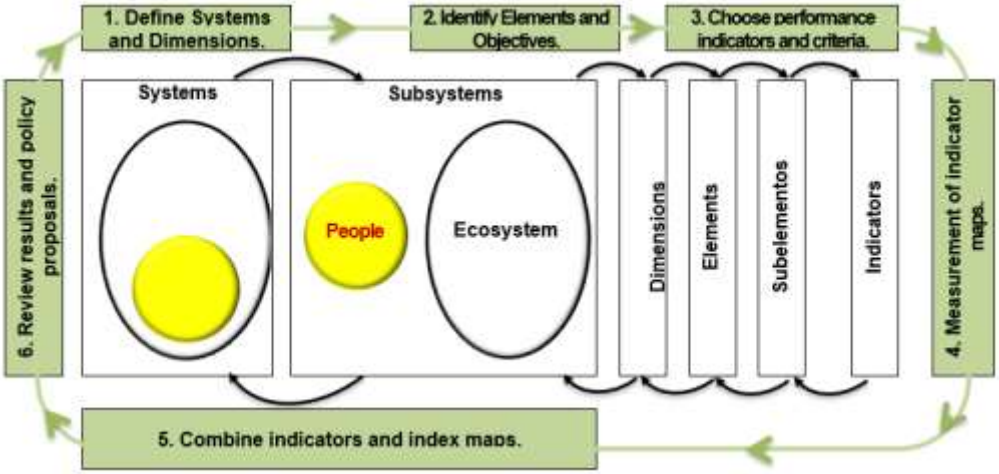
There is a consensus among scholars of issues related to the ecosystem, the need for sustainability assessment tools that can foster changes through effective public practices. According to Stiglitz, Sen and Fitoussi (2010), for actions to be correct, they must be supported by accurate assessments, as decision-making will be a reflection of what is measured. According to Jannuzzi (2006), these assessments should mainly affect the direction of public policies, which must be analyzed periodically and regardless of the restrictions imposed by specific territorial divisions.

Therefore, in accordance with Bellen's (2008) approach, effective public policies that address sustainability must rely on the technical support of assessment tools. Consequently, the adoption of tools for this measurement must aim to support the planning and execution of government actions with activities and projects capable of being evaluated and allowing for corrections. Among the sustainability measurement tools, the BS was chosen for this research.

The BS originated from the need to report on the sustainability of the Canadian province called British Columbia. This task was assigned to a group of experts, including the author and one of the main researchers Prescott-Allen (1997). According to its creator, the "Sustainability Barometer is a tool for measuring and communicating the well-being of a society and progress towards sustainability" (Prescott-Allen, 1997, p. 08).

The author also reports that the tool presents a systematic methodology that allows gathering and combining indicators to plan actions linked to people's interactions with the ecosystem. To achieve this, in accordance with the instructions of Prescott-Allen (2001), it is necessary to enhance the application of the Sustainability Barometer tool by observing the hierarchical and sequential methodology of the six-stage cycle. This step-by-step guiding process of its design was outlined according to Figure 1.

Figure 1 – Six Stages of applying the Sustainability Barometer



Source: Adapted from Prescott-Allen (2001).

In the first stage of the cycle, the system and goals that will guide the assessment of human and ecosystem well-being must be defined (Bellen , 2008). The system is composed of the people and ecosystem of the geographic area of the assessment and its population according to Prescott-Allen (2001). This area can be delimited into smaller areas, which adapted to the territorial division of our country would be: Nation, State Regions, States, Metropolitan Regions, Municipalities and Neighborhoods. Along the same lines, the author argues that, in addition to political and administrative divisions, evaluation units are useful for vegetation areas, river basins and coastal zones. In this aspect, the goals provide the decision-making structure for what will be evaluated and measured, through the vision of sustainable development (Bellen, 2008). These goals must be condensed into the system and subsystems and must be signed as indissoluble pacts suitable for both human beings and the ecosystem well-being.

Human well-being is defined by the population's degree of access to freedom and options to satisfy their needs. The ecosystem well-being, according to Oliveira, Oliveira and Carniello (2015), is characterized by the conditions in which the ecosystem satisfies human needs and regenerates itself over time. In a similar way, Dalchiavon (2017) establishes the concepts of human well-being and ecosystem well-being:

> "Human well-being" is the condition in which all members of society can determine and satisfy their needs, within a range of choices, and "ecosystem well-being" is a condition in which the ecosystem maintains its diversity and quality, its ability to support all life and its potential to adapt to changes provided by future options (Dalchiavon, 2017, p. 58).

The second stage is used to identify the elements and objectives that will be evaluated and that will make up the evaluation dimensions. These dimensions constitute categories of elements defined for the ecosystem: Soil, Air, Water, Species and the use of Resources; while for society: Health and population, Wealth, Education and Culture, Community and Equity (Prescott-Allen, 1997). However, in this study the equity dimension will be replaced by the institutional dimension, used by the United Nations Commission on Sustainable Development (CSD) according to Prescott-Allen (1997) and due to the difficulty of collecting indicators representative of that

category. Furthermore, institutional indicators are part of the list of dimensions necessary to assess sustainable development IBGE (2020).

Table 1 – Dimensions used in the Sustainability Barometer

SOCIETY - Human Dimensions				
Health and Population	Wealth	Education and Culture	Community	Institutional

ECOSYSTEM - Ecosystem Dimensions				
Soil	Water	Air	Species	Resources

Source: Adapted from Prescott-Allen (2001)

The elements are the subjects or issues that are associated with problems common to the entire society, taking care to protect the methodology without privileging interest groups. The objectives can be seen as the link between the steps to arrive at the indicator that evaluates the specific situation and will serve as a parameter for defining the performance scale. At this point, the sources that will be used to collect the data to be processed must be identified and mapped.

The third stage involves choosing performance indicators and criteria. The indicators, in accordance with pre-established development parameters, are measurable and representative points of an element. After defining the indicators, the next step must be to establish the performance criteria that will serve as a basis for transposing the real value of the indicator into the BS equivalent according to the numerical range represented by the colors of the scale shown in Table 2.

Table 2 – BS Performance Scale

Numerical scale	**0 – 20.00**	**20.01 – 40.00**	**40.01 – 60.00**	**60.01 – 80.00**	**80.01 – 100**
BS color scale					
Well-being	**Unsustainable**	**Almost Unsustainable**	**Intermediary**	**Almost Sustainable**	**Sustainable**
Dimensions	**Bad**	**Poor**	**Average**	**OK**	**Good**

Source: Adapted from Prescott-Allen (1997).

The scale established to assess the combined the ecosystem and human well-being is divided into five sectors of 20 points each, as: unsustainable (0-20.00), almost unsustainable (20.01-40.00), intermediate (40.01-60.00), near sustainable (60.01-80.00) and sustainable (80.01-100) (Prescott-Allen, 1997). Likewise, this scale will be used to classify the individual dimensions as: bad (0 - 20.00), poor (20.01-40.00), average (40.01-60.00), ok and (60.01-80.00) and good (80.01-100) (Prescott-Allen, 1997). This understanding is based on the fact that the index generated by an isolated dimension is insufficient to assign a classification on the sustainability scale. Therefore, to assign a rating on the sustainability scale it is necessary to combine the results of the ecosystem and/or human dimensions, using all five dimensions of these two subsystems, if possible.

Once the performance criteria for each indicator have been defined, they must be adapted according to the scale of the Sustainability Barometer, which after adjustments will be consolidated into indexes, with the purpose of representing the dimensions and subsystems they represent in unique values. According to Prescott-Allen, the stage of defining performance criteria is essential, as described below.

> Choosing performance criteria is the most delicate stage of the Well-being Assessment. It is a matter of showing judgment. Much better. The discussion and analysis of what will achieve levels of well-being for humans and the ecosystem are essential to reach the consensus necessary to guide sustainable development (Prescott-Allen, 2001, p. 284).

Through this methodology it is possible to receive and combine different indicators, which according to Kronemberger *et al.* (2008, 2015) is one of its striking characteristics. In fact, in addition to being extremely flexible in its composition, it allows territorial and temporal comparisons and the visualization of the situation of each dimension of the subsystem, which facilitates and makes the researchers' work viable.

These indicators will result in indexes of the dimensions that will represent the well-being of the ecosystem and human well-being through their agglutination by simple arithmetic average. They will then be allocated to the two-dimensional diagram that will demonstrate the scale of sustainability of the evaluated region or location.

The fourth stage deals with data collection and mapping of indicators. At this stage of the study, data must be collected regarding the indicators selected in the previous stage for their organization and use (Prescott-Allen, 2001). Here it is necessary to formulate a data structure so that its evaluations are possible. The indicator values are generated by collecting and tabulating data in accordance with pre-established performance criteria, giving rise to the consolidated index for each dimension.

According to Prescott-Allen (2001), data will not always be accessible in a cohesive manner, therefore, the availability or unavailability of information for some indicators to the detriment of others can cause distortions in the results. After scoring, the data must be allocated to maps elaborated in step 1, so that the indicators can be represented geographically.

The fifth stage involves combining indicators and index maps. In line with Prescott-Allen (2001), the consolidation of the values obtained with the indicators in the previous stage will result in two indexes, the ecosystem well-being index (IBE) and the human well-being index (IBH). Depending on the availability of information, there may be a single indicator, or even the combination of two or more indicators that will form a representativeness index for the dimensions. When consolidating these indicators, the author suggests using the simple average or the weighted average, the latter can be used to assign different weights to the dimensions with greater significance in the context of the systems.

After adjusting the real values of the indicators, the equivalent value on the BS performance scale is obtained for all dimensions that will result in the IBE and IBH through the consolidation of the average values of their indicators. With these two indexes, in accordance with Prescott-Allen (2001), the BS graph is used to represent the situation of human well-being on the X axis and the ecosystem's well-being on the Y axis, whose intersection represents the sector of sustainability of the analyzed geographic region.

It is also possible, through the average value of these two indexes, to obtain the well-being index (IB), in which a low value of one index can be counterbalanced by a high value of the other, resulting in a median value. There is also the possibility of generating two other indexes: the ecosystem stress index (ISE) and the well-being stress index (ISB). According to (Bellen , 2008) the ISE demonstrates the degradation of the ecosystem caused by the subsistence of the human system in the area under study and on a scale of 100 points, the lower the result, the better. The stress suffered by the ecosystem is obtained by the formula:

$$ISE = 100 - IBE$$

It is also possible to obtain the ISB, which is an index derived from the concept of environmental stress and is calculated using the expression below (Bellen , 2008):

$$ISB = (IBH / ISE)$$

According to the author, the higher the ISB score, the lower the stress caused to the Environmental system by maintaining the human system in the evaluated location. The desired ISB for a community to achieve a good stress condition that it places on the environment is above 4 points, which would mean a stress level four times lower than that calculated for human well-being (Prescott-Allen, 2001). The author also considers a reasonably good ISB above 2.0 (a human well-being of twice the ecosystem stress).

In the sixth stage, results are reviewed and implications are assessed. Prescott-Allen (2001) considers that the study should be the link between theory and practice, provoking reflections and analyzes on the structures that resulted in indicators and indexes. Furthermore, it is possible to define the areas in which resources are most scarce, suggest mechanisms to achieve goals and priority actions, as well as study and review strategies, programs and defined goals, always seeking sustainable development.

3 Method

In terms of objective, this work is characterized as an exploratory-descriptive research, with the technical procedure used and classified as documentary research, carried out through the collection of secondary data. Regarding the approach, it is considered quantitative, as it uses quantifiable procedures through the systematic collection of data to obtain answers for the proposed investigations.

The corpus chosen for the application of this study is called Metropolitan Region of Paraíba Valley and North Coast (RMVPLN) (São Paulo, 2012). It has a population estimated by IBGE of 2,552,610 inhabitants (2019), it has a degree of urbanization of 94.77% (SEADE, 2021). According to Gomes, Reschilian and Uehara, (2018) it is among the main industrial production areas in the country, due to its privileged location between the two main economic hubs of the country, the capitals São Paulo and Rio de Janeiro.

The use of the Sustainability Barometer is justified by the evidence of two indexes, human well-being and the ecosystem well-being, which, if balanced, can preserve them. These two indexes condense the result of a methodology that consolidates several indicators of the human subsystem (Health and Population, Wealth, Education and Culture, Community and Institutional dimensions) and the ecosystem (Soil, Water, Air, Species and Resources dimensions). It is also aligned with the approach of Prediger *et al.* (2021) which highlights the limitation of using only revenue and population as evaluation parameters, especially for small municipalities.

At this point, some of the limitations found in the collection of indicators that would provide a systematic analysis of fixed periods, limited to 2010 and years ≅ and 2019 and years ≅, therefore, prior to the outbreak of the Covid-19 pandemic, are noted. Furthermore, the Covid-19 pandemic in 2020 made it impossible to carry out the Census, whose data collection only began in 2022.

It is necessary to clarify that the expression years ≅ is due to the absence of all specific indicators set for 2019 and/or 2010, as is the case of IDEB, which is only carried out in odd-numbered years, making its collection for 2010 unfeasible, being used the 2011 values. Despite these setbacks, in accordance with Kronemberger and Junior (2008, 2015); Oliveira *et al.* (2019); Oliveira, Oliveira, and Carniello, (2015); Araújo and Carniello, (2018) the methodology for constructing the Sustainability Barometer indexes, allows the researcher to have a certain flexibility in choosing the territorial sections, indicators and periods that will make up the evaluations.

In the human approach there are five dimensions: Health and Population, Wealth, Education and Culture, Community and Institutional, which will be structured with five indicators each. The justifications and sources of research were also defined according to the following data:

Table 3 - Map of Human Dimensions and Indicators

	Indicator	Justification/Source
Health and Population	% Family Health Coverage.	In consonance with O SDG 3.8 from the UN (2015). https://egestorab.saude.gov.br/index.xhtml
	% Basic Care Coverage.	In consonance with O SDG 3.8 from the UN (2015). https://egestorab.saude.gov.br/index.xhtml
	Rate in Mortality Infant (Per thousand live births).	In consonance with O SDG 3.2 from the UN (2015). https://perfil.seade.gov.br/
	Infant mortality rate (per thousand live births).	In consonance with O SDG 3.2 from the UN (2015). https://perfil.seade.gov.br/
	Beds of SUS (Coefficient per thousand inhabitants).	In consonance with O SDG 3.8 from the UN (2015). https://perfil.seade.gov.br/
Wealth	GDP per capita.	In consonance with O SDG 8.1 from the UN (2015). https://perfil.seade.gov.br/ and https://cidades.ibge.gov.br/
	Average Income from Formal Service Jobs (BRL).	In consonance with O SDG 10.4 from the UN (2015). https://perfil.seade.gov.br/
	Average Income from Formal Commerce Jobs (BRL).	In consonance with O SDG 10.4 from the UN (2015). https://perfil.seade.gov.br/
	Average Income from Formal Construction Jobs (BRL).	In consonance with O SDG 10.4 from the UN (2015). Source: https://perfil.seade.gov.br/
	Average Income from Formal Industry Jobs (BRL).	In consonance with O SDG 10.4 from the UN (2015). https://perfil.seade.gov.br/
Education and Culture	IDEB initial years.	In consonance with O SDG 4.1 from the UN (2015). http://ideb.inep.gov.br/
	IDEB final years.	In consonance with O SDG 4.1 from the UN (2015). http://ideb.inep.gov.br/
	Ratio between daycare enrollment and the number of children aged 0 to 3 years.	In consonance with O SDG 4 from the UN (2015). https://dataparcerias.sp.gov.br/resultados.php
	Ratio between preschool enrollment and the number of children aged 4 to 5 years.	In consonance with O SDG 4 from the UN (2015). https://dataparcerias.sp.gov.br/resultados.php
	Spent Yearly in Culture per inhabitant.	In consonance with O SDG 11.4 from the UN (2015). Source: https://siconfi.tesouro.gov.br/siconfi/index.jsf
Community	Rate in homicides.	In consonance with O SDG 16.1 from the UN (2015). Source: https: //www. i pea.gov.br/
	Traffic accident rate with victim (per 100 thousand inhabitants).	In consonance with O SDG 3.6 from the UN (2015). https: //www. i pea.gov.br/
	Rate in suicide (per 100 thousand inhabitants).	In consonance with O SDG 16.1 from the UN (2015). https: //www. i pea.gov.br/
	Urban water service index (%).	In consonance with O SDG 6.1 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
	Sewage Collection Index (%).	In consonance with O SDG 6.2 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
Institutional	Investment educational per early childhood education student.	In consonance with O SDG 4.2 from the UN (2015). https: //www.fnd e .gov.br/siope/relatoriosMunicipais.jsp
	Investment educational per elementary school student.	In consonance with O SDG 4.1 from the UN (2015). https: //www.fnd e .gov.br/siope/relatoriosMunicipais.jsp
	Spent Yearly in Social Assistance per inhabitant.	In consonance with O SDG 10.4 from the UN (2015). https://siconfi.tesouro.gov.br/siconfi/index.jsf
	Spent Yearly in Health per inhabitant.	In consonance with O SDG 3.8 from the UN (2015). https://siconfi.tesouro.gov.br/siconfi/index.jsf
	Spent Yearly in Urbanism per inhabitant.	In consonance with O SDG 9.1 from the UN (2015). https://siconfi.tesouro.gov.br/siconfi/index.jsf

Source: Elaborated by the authors, 2022.

In the ecosystem theme, five dimensions were formed: soil, water, air, species and resources, each with 3 indicators.

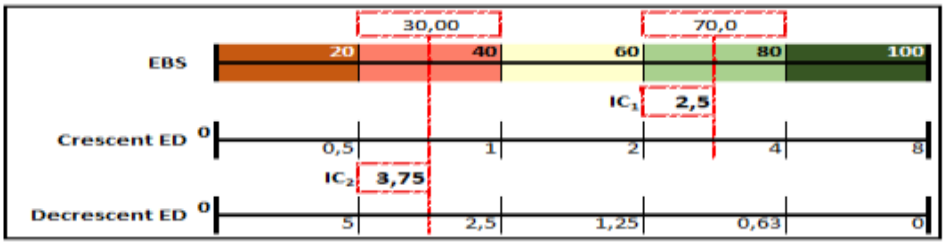
Table 4 - Map of Ecosystem Dimensions and Indicators

	Indicator	Justification/Source
Soil	Number of tractors in relation to the State (un) .	In consonance with O SDG 15.3 from the UN (2015). https://cidades.ibge.gov.br/
	Index in Collect from the Sewage (%).	In consonance with O SDG 6.2 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
	Urban household waste coverage rate.	In consonance with O SDG 11.6 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
Water	Loss rate in water distribution (%).	In consonance with O SDG 6.4 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
	Incidence of non-standard total coliform analyses.	In consonance with O SDG 6.3 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
	Investment in exhaustion Restroom for the provider of services per capita.	In consonance with O SDG 6.3 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
Air	Vehicles Per Capita in relation to the Municipalities of the state(%).	In consonance with O SDG 11.6 from the UN (2015). https://cidades.ibge.gov.br/
	Emission totals in CO2e (t) per capita.	In consonance with O SDG 11.6 from the UN (2015). https://plataforma.seeg.eco.br/total_emission
	Net CO2 emissions (t) from the use of Soil and Forests.	In consonance with O SDG 11.6 from the UN (2015). https://plataforma.seeg.eco.br/total_emission
Species	Incidence of turbidity analyzes from the water outside of standard.	In consonance with O SDG 15.5 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
	Forest remnants of the Atlantic Forest (%).	In consonance with O SDG 15.5 from the UN (2015). https://www.aq u itemmata.org.br/#/
	Index in Treatment in Sewage (%).	In consonance with O SDG 6.2 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
Resources	Consumption per capita in energy.	In consonance with O SDG 7.a from the UN (2015). https://dadosenergeticos.energia.sp.gov.br//portalcev2/index.html
	Consumption average in water by economics.	In consonance with O SDG 6.4 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#
	Consumption average per capita of water.	In consonance with O SDG 6.4 from the UN (2015). http://app4.mdr.gov.br/serieHistorica/#

Source: Elaborated by the authors, 2022.

It is noteworthy that there are no limitations or quantitative impositions in the formulation of indicators for the studies, collecting data with the same number of indicators for the dimensions was the author's option during the preparation this work. Once these definitions were made, and the data relating to the indicators were collected, they were subjected to a correlation of scales as shown below:

Figure 2 – Scale correlation: RMVPLN and BS



Source: Adapted from Kronemberger *et al.*, 2008.

To collect data and theoretical references, available material collected on publicly accessible institutional websites was used. Once the increasing or decreasing Performance Scales were defined, the equation for transposing the Regional Indicator (DNx) to the Sustainability Barometer (EBS) scale was used, with adaptations from Kronemberger and Junior (2015) of the scale permutation formula and the relationship between DNx and BSx. It is noteworthy that these ED's can present increasing or decreasing characteristics according to the pre-defined parameters and frameworks on the Sustainability Barometer scale. After processing the data, the evaluation and comparison of municipalities regarding their sustainability must be studied and interpreted within the graphical representation proposed by the barometer.

Figure 3 – BS equation

$$BS_X = \left\{\left[\frac{(DN_A - DN_X)x(BS_A - BS_P)}{(DN_A - DN_P)}\right]x(-1)\right\} + BS_A$$

Where: A = previous limit of the interval containing X.
P = posterior limit of the interval containing X.

Source: Adapted from Kronemberger *et al.*, 2008.

The result will be more consistent, the larger and more representative the themes and indicators used are (Kronemberger and Junior, 2015). At this stage, the consolidated indicators generate the index for that dimension. The indexes of these dimensions aggregated by subsystem (Ecosystem and Society) result in two values, one for Ecosystem Well-being and another for Human Well-being, which allocated in the BS graph demonstrate the scale of sustainability at which the studied system (RMVPLN) is located. Furthermore, the simple arithmetic mean of these two indexes represents the general well-being of the location under study.

4 Results and Discussions

The results of the investigation are presented below, considering the description of the BS presented previously. It is noteworthy that the research produced a considerable volume of data and information about the RMVPLN, which required care to organize and synthesize the results within the limits of the paper in question. We chose to represent the results on maps, focusing on the time frame with the most current data. In the summary figure presented at the end, the comparative approach is presented in the delimited time period, with the aim of

verifying the situation regarding sustainability at the time of the creation of the metropolitan region and after a decade of existence. Observation of these conditions is necessary, as the approaches and respective dimensions outline a heterogeneous and complex regional reality. Figures 4 and 5 provide a condensed perception of the results obtained.

Figure 4 – Ecosystem Dimension

Soil dimension in 2019 and years ≅.

Water dimension in 2019 and years ≅.

Air dimension in 2019 and years ≅.

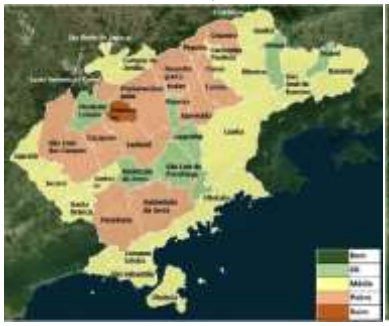
Species dimension in 2019 and years ≅.

Resources dimension in 2019 and years ≅.

Source: Elaborated by the authors, 2022.

Figure 5 – Society

Health and population dimension in 2019 and years ≅.

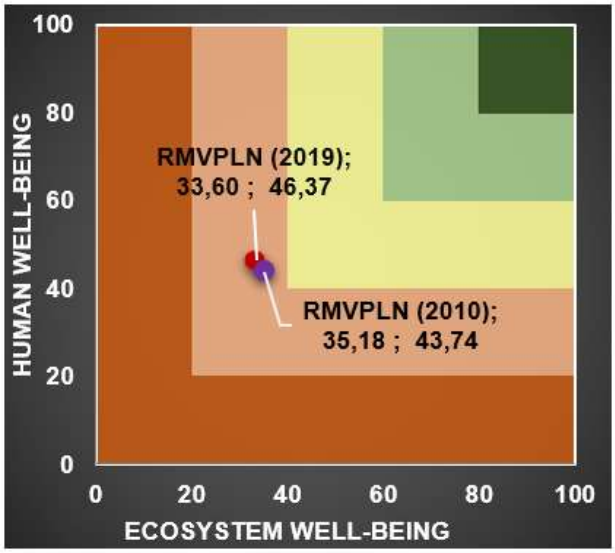


Wealth dimension in 2019 and years ≅.

Education and culture dimension in 2019 and years ≅.

Source: Elaborated by the authors, 2022.

Figure 6 – BS at RMVPLN
(2010 and ≅ and 2019 and ≅).



Source: Elaborated by the author, 2022.

It appears that the RMVPLN remains in 2019 and ≅ on the Almost Unsustainable scale with a slight increase of 1.34% on the same scale in relation to 2010 and ≅ (IB from 39.46 to 39 .99). In the IBE there was an evolution influenced by the Resources and Water dimensions, while the Species, Soil and Air dimensions showed an evolution without reversing the decrease in the result of this index. In IBH there was an evolution influenced by all the dimensions analyzed: Wealth, Education and Culture, Community and Institutional, Health and Population. Furthermore, RMVPLN has an ISE of 66.40 with an ISB of 0.70. Keeping the proportions in mind and with different indicators, studies by Prescott-Allen (2001) place the municipality in similarity to countries such as Romania (97th), Kyrgyzstan (98th) and Malaysia (99th).

Therefore, it is inferred that this is negligible growth, in a region that brings together human and natural resources in its territory with the capacity to obtain better results in sustainability. Arapeí, Campos do Jordão, Bananal, Redenção da Serra Jacareí, Ilhabela, São Bento do Sapucaí and Taubaté contributed positively to this small advance in sustainability in RMVPLN. On the other hand, there were municipalities that had a negative impact on the period, such as Canas, Silveiras, Jambeiro and Aparecida. As for the other locations, they contributed less significantly to the evolution of sustainable development in the region.

It is observed that the social, economic and management indicators presented better results than the environmental indicators, however, the Almost Unsustainable classification of RMVPLN in the BS denotes deficiencies in both indexes that need to be addressed to guarantee improvements. in well-being. Therefore, the metropolization of the region was not enough to guarantee significant advances that would allow us to reach higher levels of sustainability, even after almost a decade of validity of the legal norm, which did not fill the gap in the transformation of legislation into a concrete act of sustainable development for the region.

It is necessary to clarify that there are no strict formulas, much less closed processes that guarantee positive and impactful results on the sustainability of the analyzed system. In this sense, Freitas and Freitas (2016, p. 16) state that "the notion of sustainability is diffuse and fluid. It is in the process of construction and technical legitimization, in its identification and contextualization to the socioeconomic processes of regions and countries". In this context of development, to achieve sustainability in a broad way and that go beyond territorial demarcations, the participation of varied actors is essential, which, according to Barbieri (2020), among others are, governments, the private sector, the third sector and the scientific community.

As a result, working on sustainability in the RMVPLN requires coordinated actions of good governance, as this territorial structuring, according to Scaquetti, Moreira and Maciel (2021, p. 8) "in fact offers greater possibilities for resolving challenges than governance in municipal borders". In the same way, Dallabrida (2017) asserts that the understanding of the socioeconomic-environmental realities of localities must be situated in a broader spatial totality, given the context in which they are inserted. With this perspective, the importance of integrated actions to solve local problems that go beyond territorial and administrative limits and political interests that are often contrary to the real needs of society and the ecosystem is reinforced.

Consequently, dealing with sustainability is directly related to regional development and according to Vieira (2009), this is a subject that has been thought about since the 1970s, with the creation of the Consortium of Municipalities of Vale do Paraíba (CODIVAP) , an intermunicipal entity for the integration and development of the region. For this Consortium, the following weaknesses were detected by Vieira (2009), which were the absence of an institutional structure that represented the region, the capture of its own resources and external interference. More recently, Mota in an interview provided to Scaquetti, Moreira and Maciel (2019) describes the Consortium as a figurative entity with little effectiveness for the region.

> [...] a criticism that almost historically all mayors, when they become mayors, over time begin to make in relation to the consortium, which is CODIVAP: 'Ah, CODIVAP isn't, it's just that it's a club of friends', because they cannot be resolute, they cannot tackle the problems together, they cannot form a consortium between some municipalities to see. What CODIVAP generated until today that I have seen, was very specific here in our region, in the case of Jacareí, it was the Três Rios consortium which was supposed to take care of the maintenance of rural roads in partnership with two or three municipalities. (Scaquetti, Moreira and Maciel, 2019).

It should be noted that on March 18, 2022, in Taubaté, the Council of Mayors of CODIVAP met to formalize the extinction of the entity. It was also decided to allocate the Consortium's assets to the Association of Municipalities of Paraíba Valley and the North Coast (AMVALE), which, constituted in another way, will have the mission of regionally articulating the municipalities. However, the change in the legal nature of the Entity is not synonymous with guarantees that this new name will produce more effective results for the region.

There were initiatives to promote regionalization, including the promulgation of Law 13,089 (2015), which established the Statute of the Metropolis, which

> Although it does not contemplate the diversity and complexity of the different spatial configurations that characterize Brazilian metropolitan areas, the Metropolis Statute reinforces regional development and governance strategies for planning, management and execution of public functions of common interest (Moreira Junior, 2017, p. 42).

In this regionalization process, the Emplasa also acted, a public company established in 1975, to collect information and prepare studies. In this process, Emplasa argued against the creation of the RMVPLN, justifying it by the fragmentation and heterogeneity of the municipalities of the region, which according to the Entity, presents characteristics of urban clusters formed by three micro-regions (Mantiqueira, North Coast and Historic Valley) (Scaquetti , Moreira and Maciel, 2019). In addition to its institutional activities, this company contributed a vast collection to carry out research, however, it was dissolved in 2018 due to changes in the administrative structure of the Metropolitan Planning Secretariat of the state of São Paulo, which took over its functions.

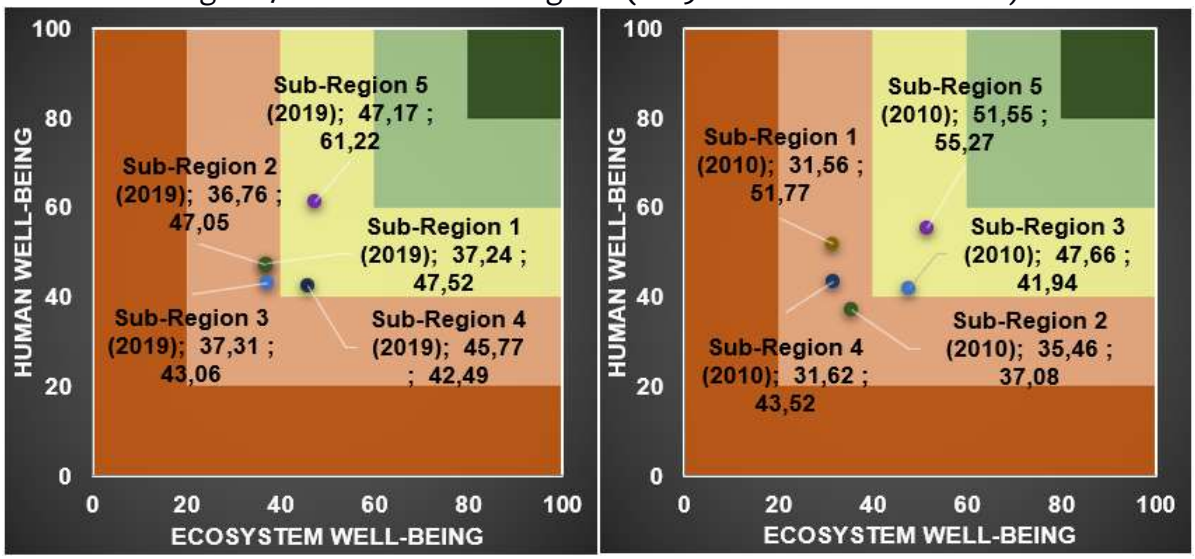
In 2015, the Metropolitan Agency of Paraíba Valley and North Coast (AGEMVALE) was created, a state agency with administrative structure attributes and the ability to speed up procedures for the development of RMVPLN (Theodoro, 2015). However, according to Scaquetti, Moreira and Maciel (2021), structural deficiencies can be seen in the coordination of actions that should be planned, given the involvement of diverse actors, public and private, and without the mediation of an authority that brings together efforts and resources. Therefore, at this juncture, even if established to represent the development interests of the region, it may not achieve, or even if it achieves, the objectives for which it was created, it may do so slowly.

That said, Scaquetti, Moreira and Maciel corroborate the inertia of the entities that proposed to deal with the development of the region with the meager result of the evolution of sustainability found for the RMVPLN. These authors describe the few actions that aim to bring together efforts for the integration and effective execution of projects and activities carried out and implemented by the previously mentioned entities, in favor of the region in the search for advances in sustainable regional development.

> It is possible to state that, after almost 10 years of approval of the institutionalization of the RMVPLN, the activities carried out on this scale of governance were limited to the creation of FUNDOVALE, provided for in the law, with sufficient values for the creation of the same and some protocol decrees relating to the actions of mobility, arising from the legislative requirements to be fulfilled. Furthermore, meetings were held between the components of the RMVPLN Development Council, within the scope of discussions were held for the preparation of the Integrated Urban Development Plan – PDUI, provided for in the rules of the Statute of the Metropolis, a process that is currently, as informed in an interview, within a financial and political-administrative impasse (Scaquetti, Moreira and Maciel, 2021, p. 15).

The data collected, processed and allocated in the BS revealed the scale of sustainability in which the RMVVPLN sub-regions were found.

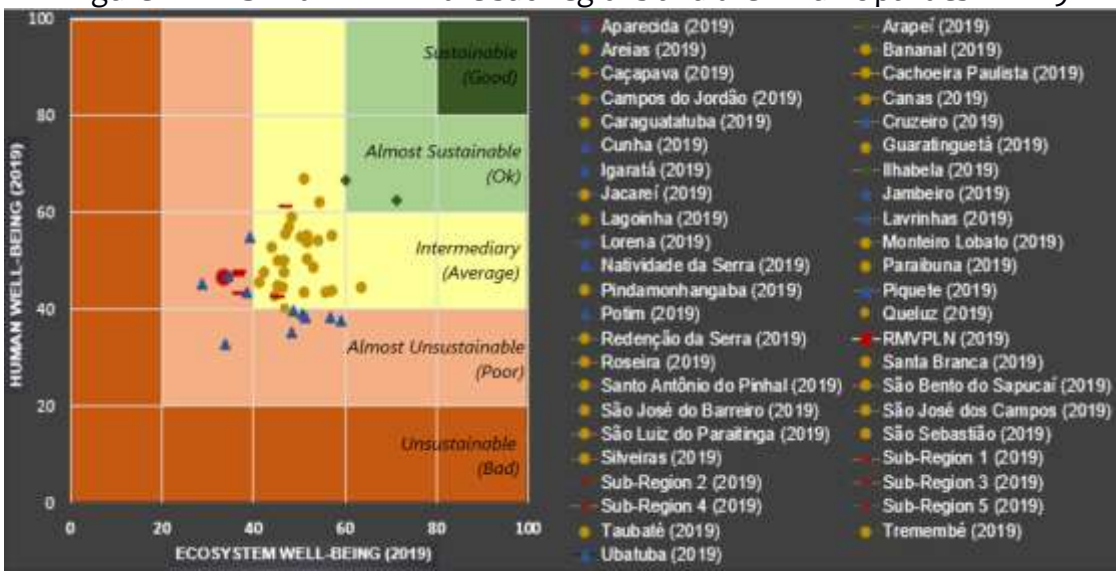
Figure 71 – BS in the Sub-Regions (2019 and ≅ and 2010 and ≅)



Source: Elaborated by the author, 2022.

It is possible to observe in Figure 7 two sub-regions on the Intermediate Sustainability scale and three on the Almost Unsustainable scale. Of the five sub-regions, three evolved on the same scale and sub-region 4 evolved from the Almost Unsustainable to the Intermediate scale, while sub-region 3 went back from the Intermediate to the Almost Unsustainable scale.

Figure 82 – BS with RMVLN the sub-regions and their municipalities in 2019



Source: Elaborated by the author, 2022

With these indicators, which formed the dimension indexes and were consolidated in the IBE and IBH, two Almost Sustainable municipalities were identified using the BS tool, 24 municipalities on the Intermediate scale of sustainability and 13 on the Almost Unsustainable scale. It is emphasized that the

indexes of the 39 municipalities of the RMVPLN, in this research, showed 19 in which IBH surpassed the IBE and in the other 20 the IBE was superior to the IBH. In general, the studies by Prescott-Allen (2001) also showed, among the 180 countries evaluated, 92 in which the ecosystem well-being index presented better results than the human well-being index, with a slight advantage about the countries where this situation is reversed.

In possession of the results, Prescott-Allen (1997, 2001) asserts that managerial decision-making processes and reorientations on the actions to be adopted for sustainability must use measurements to equalize the system, which is highly complex and dynamic. Therefore, Freitas and Freitas (2016) add the need to make the operational notion of sustainability concrete with specific measures that materialize structured and consistent public policies. Along the same lines, Arruda (2013) adds that a region will have real development in short, medium and long-term periods, with a break in paradigms, when based on the construction of alternative and impactful actions.

These actions refer to the need for planned and integrated activities and projects for the sustainable development of the various entities involved, which, if not carried out, will be understood as a passing trend and a fad that could be lost over time. In such a way, Gomes, Reschilian and Uehara, (2018) and Dallabrida (2020), recognize that the unrestricted participation of society and inter-federative cooperation are the challenges posed to the good governance of metropolitan regions. So, the aim is to have brought together a set of basic indicators that make up the evaluative dimensions of sustainability in the RMVPLN, which, if properly adjusted, will improve the population's quality of life, respecting the limitations of exploration of the ecosystem.

5 Final considerations

The analysis of the RMVPLN data in relation to the creation law demonstrated that the RMVPLN has municipalities with diverse characteristics and that do not present population and economic homogeneity, in addition to the absence of conurbation between several municipalities, conditions stipulated for the creation of metropolitan regions. However, once it was established, it has rights and obligations that enable the adoption of integrated solutions designed to seek the well-being of society without neglecting the ecosystem for sustainable regional development, whose effectiveness depends on the engagement of the population and political goodwill.

The political delimitation of regions must consider and articulate regional dynamics, which requires planning as a condition for the development of regional spaces.

It was evident that advances had occurred, albeit simple, in most of the dimensions studied and which represent the well-being of the ecosystem and human well-being, in the consolidated municipal indicators for the RMVPLN. In the Ecosystem Well-being subsystem, the Species, Air, Soil dimensions showed slight increases in relation to 2010 and ≅, while the Resources and Water dimensions had a drop in relation to the result of the initial period. While in the five dimensions analyzed in Human Well-being there are small increases in Wealth, Institutional,

Community, Education and Culture and Health and Population. It is reiterated that there were no significant increases in the indexes of the dimensions that, when consolidated, would have an impact on the well-being indexes and cause changes in scale, therefore, it is clear that there is a stagnation in the development of the dimensions that detract from relevant advances in the region under analysis.

With these results, the majority of municipalities under study, both in 2019 and in years ≅ , and in 2010 and in years ≅ , are on the Intermediate scale of sustainability. During this period , there were ten municipalities with advances on the BS scale, with Arapeí and Ilhabela moving towards the Almost Sustainability range. Bananal, Campos do Jordão, Jacareí, Lagoinha, Monteiro Lobato, Queluz, Redenção da Serra and Tremembé Advanced to the Intermediate scale. On the other hand, four of them, Aparecida, Cruzeiro, Jambeiro and Ubatuba, fell from the Intermediate scale to Almost unsustainable. Furthermore, four municipalities, Cunha, Igaratá, Natividade da Serra and Potim remained in the Almost unsustainable category and the remaining 21 remained in the Intermediate scale.

In relation to the sub-regions, there are two on the Intermediate scale and three on the Almost Unsustainable scale in 2019 and ≅, a result derived from the average of the indicators of the municipalities that make up them. While sub-region 3 went back from the Intermediate scale to almost unsustainability, sub-region 4 advanced from that to the Intermediate scale. Sub-regions 1 and 2 remained on the Almost unsustainable scale and sub-region 5 on the Intermediate scale.

Therefore, it is concluded that in this sustainability analysis, RMVPLN in the selected periods, although it has made little progress, remains in the Almost Unsustainable sector. As for the results achieved in the "human well-being" index, they presented, on average, higher values than the "ecosystem well-being" in the two periods analyzed, with simple advances in both in relation to 2010 and ≅. It can also be inferred that after approximately one decade of its creation by state Law, there were no advances with significant results resulting from integrated regional actions in favor of the ecosystem and human well-being.

Having achieved the proposed objective, to identify whether there were advances in the RMVPLN in relation to the initial years of its creation, this study contributes to the literature on the use of the Sustainability Barometer tool at the level of the metropolitan region and its municipalities in a comparative analysis of two periods. It is noteworthy that Kronemberger *et al.* (2008 and 2015) made a comparison of this nature in Brazil, however, the collection, data analysis and publication occurred in different periods. Thus, this research collaborates with society by demonstrating the need for continuous monitoring of the degree of sustainability as a support for the search for well-being at sustainable levels.

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