Original Research Article

Megaprojects - Socioeconomic and Environmental Dynamics in D. Pedro I-Tamoios Road Axis, São Paulo, Brazil

ABSTRACT

Aims: Megaprojects development has generated changes in the socioeconomic and environmental structure of several regions. This paper aims to analyse socioenvironmental changes in 10 municipalities located along the D. Pedro I - Tamoios road axis, São Paulo state, Brazil, chosen for their regional relevance, and transformations caused by the roads duplication.
Study design: Analysis on how megaprojects influence the urban structure, the environment and different social groups, focusing in Gross Domestic Product (GDP), in different productive sectors (agricultural, services and industrial), in population growth and rural and urban scenarios.
Place and Duration of Study:São Paulo State, Brazil, from July2015to July 2018.
Methodology: Sociodemographic data, the expansion of industry, services, tourism development and agricultural production of these municipalities were analysed with a focus in social and environmental changes that took place in this study area.
Results: The results indicate that an intense process of industrialisation, tourism development, urban growth and population dynamics has accompanied the recent decade's expansion of major roads in the state of São Paulo, Brazil, and that these processes contribute to changes that affect natural systems and may accelerate climate changes.
Conclusion: It verified that this megaproject development had not considered the sustainability of regional natural resources, in a manner that promotes environmental and living quality to the population

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Keywords: Urbanization; Environmental Sustainability; Land Use; Socioenvironmental dynamics; Tourism development

1. INTRODUCTION

The 21st century has been a significant challenge for scholars that study the urban environment: how can cities accommodate the environment or how urban and socioenvironmental more cohesive environments can be planned, constructed and managed? [1-2].

The regions - São Paulo State North Coast and Bragantina Region - interconnected by an Exporter Road Axis composed by Tamoios, Carvalho Pinto and D. Pedro I Highways, have been the object of research carried out by the authors [3-4]. The primary interest of these research activities is focused on the different processes of changes promoted by these highways, representing numerous socioeconomic, political, cultural and ecological factors,

which are consolidated by a development model that reconfigures the identities and vocations of municipalities along this axis.

At the same time, this transformation is affected by other dynamics related to global urban environmental changes, which involve vulnerability, technological risks, climatic variations and extreme events. These changes are already observed in the region and have a substantial impact on the resident's lives, from an objective and subjective point of view. The main differences are in the land use, degradation of natural resources [5], in the pattern of mental health, an increase in data of crime and violence rates [6-8].

This article's goal is to observe how social and environmental changes that are taking place in the municipalities along the D. Pedro I - Tamoios road axis, especially Caraguatatuba, Paraibuna, Jambeiro, Jacareí, Igaratá, Bom Jesus dos Perdões, Nazaré Paulista, Jarinú, Atibaia and Itatiba, chosen for their regional relevance, impact their population quality of life. For this, we analyse the process of urbanisation and socioeconomic, demographic and urban density changes, expansion of industry, services and agricultural production for the 1998-2013 period, considering the highways construction and expansion periods.

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2. METHODOLOGY

From the methodological point of view, demographic and socioeconomic data were collected and systematised from 10 selected municipalities, based on data from Brazilian Institute of Geography and Statistics (IBGE) of the federal government and the São Paulo State System of Data Analysis Foundation (SEADE) [9-13]. Thus, the population density of the municipalities is calculated, and data on the expansion of industry, services and agricultural production were collected for the same towns, considering the period 1998-2013. Fieldwork was also used as a methodological procedure in order to analyse social and environmental changes in the study area.

3. RESULTS AND DISCUSSION

3.1 Urbanisation and socioenvironmental changes.

The built and transformed environment can affect ecosystems and their services, as well as human health and people's well-being [14]. Urban areas, while offering attractions and benefits to residents, such as facilities and access to services, can negatively affect life quality, especially in relation to an overload on natural resources and infrastructure in the region and are also responsible for degrading the environment [15-18].

According to authors [19], among the many phenomena characterizing contemporary urbanisation essential aspects are the expanding scale and complexity of urban areas and the necessity to analyse urbanisation processes, to address the highly dynamic character of urban changes.

The lack of an adequate urban and environmental planning can adversely change sensitive ecosystems that can be modified by the construction of roads, residential condominiums or industrial parks, often polluting reservoirs and groundwater, discharging chemical and pathogens into the sewage, causing frequent adverse effects to human health [14].

In the study region of this research work, a strong tourism vocation is observed, as well as the expansion of petroleum industry ventures along the coast and intense development of diverse industrial projects along the road axis, evidencing its character as a significant export corridor. These aspects allow affirming that there are strong population pressure and severe

impacts on the regional natural resources. The most representative tourism impacts in Brazilian coastal areas and regions of conservation units are the construction of condominiums and other structures that have negatively altered the landscape of these places [3].

Authors [20], analysing the impacts of the Megacity Project in Lagos, points that megaprojects of infrastructure are always privileged as popular strategies to attract private capital in a competitive environment. The author is categorical in affirming that there is a preference of elites for megaprojects and that this practice is reinforcing the socio-spatial impact of exclusion and confirms social inequalities, making them increasingly persistent and directly linked to neoliberal projects [20].

In this sense, the connection between transport and development is one of the most solidly anchored myths in economic development models at any scale, as well as the magnitude of investments in infrastructure on highways, either in their constructions or through the extension of modal interconnections.

Authors [21], highlight this perspective when they analyse whether all this expenditure actually contributes to the development of the regions they serve. The authors also point out that social progress requires clarification on which development model should be used and what kind of growth is the goal of public policies. Identifying potential effects and negative impacts will only make sense if we can present the type of development preferred and the mechanisms through which these dynamics are to be generated [21].

To understand this definition of development model, and how it could contribute to improving the population quality of life authors [22] indicate a policy perspective, from the European Commission, that has promoted actions and policies aimed at reducing adverse environmental effects caused by city logistics.

This approach, in the study region of this article, should be a priority insofar as part of the region is an Environmental Protected Area (EPA) and part is a State Park, and in this sense, the search for the definition of an appropriate development model should be centred on author's vision [23] that he called Sustainable Urbanism. Or as an author [24] points out, Sustainable Urbanism [23] demands the unlikely, that the bottom of the pyramid - millions of us, "understand" and act together, and that national leadership is essential, as the biggest challenge is to change values, perceptions and dreams that help us to persevere in the construction of a better way.

Thus, for some authors [25], without significantly reducing per capita environmental footprints in cities, continued trends for urbanisation are likely to put severe pressure on the environment, which is already under stress from current forces.

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3.2 The Study Region: brief aspects

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The northern coast of São Paulo State, which comprises four municipalities, is bordered by mountains (Serra do Mar/Atlantic Forest) and an extensive set of beaches with traditional population settlements, consisting of communities of artisanal fishermen and new residents, migrants, workers and vacationers in condos built since the 1980s for holiday or second home residents. From this period onwards, there has been a rapid process of modernisation, industrialisation, and population growth driven by speculative and unplanned tourism that has negatively affected residents' quality of life [26]. Despite the change of actors and enterprises, it is observed that the Bragantina Region, composed of 11 municipalities, has

presented the same situation to its residents, with the presence of small farmers and an intense urbanisation process.

Extensive urban sprawl, particularly with the construction of condos attracting a significant migrant labour force, generates a demand for new housing, often built in an unplanned way, both in the northern coastal municipalities and in other settlements along the road axis that stretches from São Paulo north coast to Bragantina Region, and this increases the socioenvironmental vulnerability of local and migrant population. Besides, São Sebastião Port, with its particular terminal - Terminal Almirante Barroso (TEBAR) for PETROBRAS products has provided new development opportunities related to gas exploitation and transport and accentuated migratory processes and urban expansion.

Both regions – São Paulo North Sea Coast and Bragantina are recognised for their extreme importance in the state of São Paulo from landscape, demographic, socio-environmental and economic point of view [3,6]. The geographic and guiding design of the study that provides the base for this article sought to approach the two regions, from the road axis that interconnects them, highlighting the different Conservation Units present in this geographic and landscape space (Figure 1 and 2).

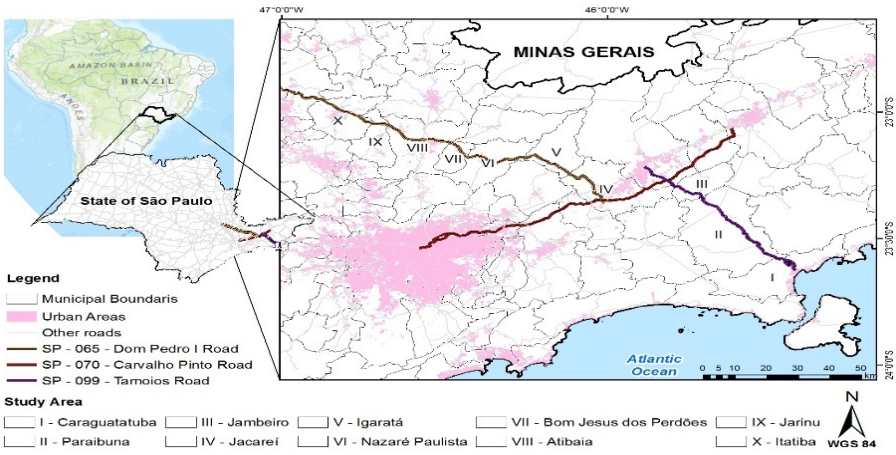

Fig. 1.Location of study municipalities in the context of São Paulo State and Brazil
Source: the authors (2018)

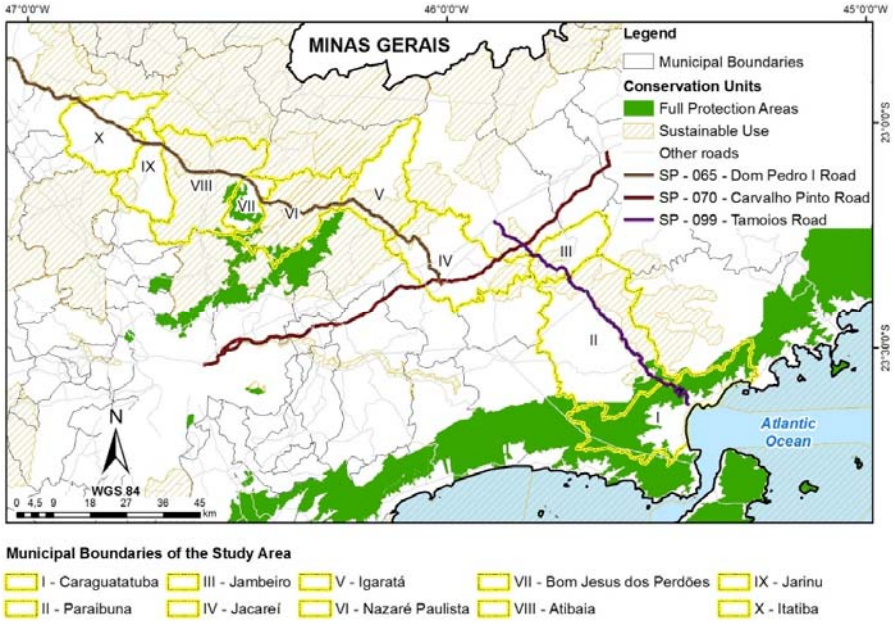

Fig. 2. Road Axis, municipalities and protected areas in the study area
Source: the authors (2018)

3.2.1 Road Axis: Tamoios, Carvalho Pinto and D. Pedro I Highways - the export corridor Viracopos Airport - São Sebastião Port.

Campinas-São Sebastião Export Corridor Project was presented in 2005 by São Paulo state government, and it included the privatisation of Dom Pedro I, Carvalho Pinto, Ayrton Senna Highways and duplication of Tamoios Highway (Figure 3). Its primary function is to transport, through highways, import and export products from Campinas region and the São Paulo State countryside and crosses areas of several municipalities, as shown in figures 01, 02 and 03.

These highways allow connecting the capital – São Paulo – to other municipalities of the state, Viracopos International Airport, in Campinas, and São Sebastião Port, in São Sebastião municipality. The project will create intermodal logistics terminals between Carvalho Pinto and Tamoios highways, facilitating the importation, exportation and distribution of cargoes to customs areas or recipients of any city or country [27].

However, this significant increase in road transport has caused substantial changes in this axis, which includes, among other issues, changes in air quality, the possibility of accidents in areas of intense environmental vulnerability and an increase in urbanisation and industrialisation processes. Another significant aspect of the region is the fact that the Export Corridor crosses or is close to environmental preservation areas or fragile ecosystems included in several Conservation Areas as the Cantareira System Environmental Protected Area and the Serra do Mar State Park, and may generate significant ecological changes.

On the margins of D. Pedro I Highway, there is already an intense occupation by Industrial Districts and large warehouses of industrialised products, which favours the logistics sector, for storage, transportation and distribution of merchandise. The establishment of this economic nucleus is considered as a possibility and expectation of several municipalities along D. Pedro I Highway, which has determined several changes and new dynamics in Atibaia, Paraíba do Sul and Piracicaba River Basins, and for the State of São Paulo North Coast Region [3].

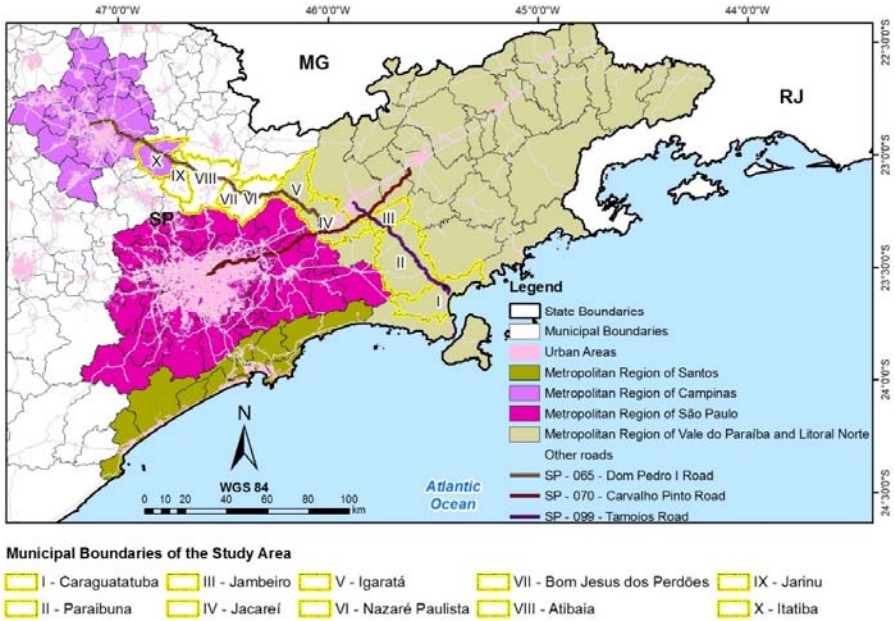

Fig. 3.Road axis and municipalities.

Source: the authors (2019)

3.2.2 Aspects of the urbanisation process on the studied municipalities.

All ten municipalities involved in this study - belonging to São Paulo North Coast and Bragantina Region - are located along the Tamoios-D. Pedro I Highway road axis (Figures 1, 2 and 3). To understand the demographic dynamics that these municipalities present, the primary population data and their evolution for the period from 1980 to 2010 were systematised in Tables 1 and 2, as well as the population density evolution for all municipalities from 1980 to 2010. Table 1 shows the growth presented by these municipalities. The average population growth in São Paulo state regarding the analysed period was 1.5 times, Jacareí, Igaratá, Nazaré Paulista and Atibaia municipalities doubled their population in the same period, Caraguatatuba, Bom Jesus dos Perdões and Itatiba municipalities triplicated, with Paraibuna and Jambeiro growing below this average.

Table 1.Evolution of population growth in studied municipalities, from 1980 to 2010

Municipalities/state	1980	1990	2000	2010
Caraguatatuba	33.563	50.569	78.628	100.634
Paraibuna	14.113	14.814	16.988	17.385
Jambeiro	2.867	3.242	3.985	5.336
Jacareí	115.100	158.12	191.011	211.040
Igaratá	4.346	6.066	8.271	8.826
Bom J. dos Perdões	7.054	9.508	13.275	19.644
Nazaré Paulista	8.371	11.267	14.381	16.396
Jarinu	6.155	10.277	16.970	23.780
Atibaia	57.446	82.727	111.033	126.467
Itatiba	41.377	59.160	80.987	101.283
State of São Paulo	24.953.238	30.783.108	36.974.378	41.223.683

Source: SEADE, 2013 [13].

Table 2 shows this growth significance by demographic density for the period analysed. In 2010 decade, population density of São Paulo State was 166.08 inhabitants/km2 and, in the same period, five of the municipalities had demographic density above the state average, in descending order: Jacareí (454.56 inhabitants/km2); Itatiba (314.32 inhabitants/km2); Atibaia (264.29 inhabitants/km2); Caraguatatuba (207,45 inhabitants/km2) and Bom Jesus dos Perdões (181,27 inhabitants/km2). The municipality of Jarinú in numerical terms was the one that grew the most, but its population density is below the average of the state of São Paulo (114.53%) [11].

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These data reflect an intense process of population growth and urbanisation that has as one of its causes the economic dynamics in progress in the studied road axis.

Authors [28], analyzing socioenvironmental impacts of development projects in the North Coast of São Paulo State, identifies population growth, especially those determined by processes of population attraction, such as migratory flows and increased tourist flow, as an essential agent of changes in the pattern of land use and in the maintenance of regional conservation units.

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Table 2. The Population density of municipalities (inhabitants/Km2), 1980 – 2010

Municipalities/state	1980	1990	2000	2010
Caraguatatuba	69,35	104,49	162,47	207,45
Paraibuna	17,43	18,29	20,98	21,47
Jambeiro	15,6	17,64	21,69	28,94
Jacareí	250,18	343,69	415,18	454,56
Igaratá	14,82	20,68	28,2	30,13
Bom J. dos Perdões	65,01	87,62	122,34	181,27
Nazaré Paulista	25,64	34,5	44,04	50,25
Jarinu	29,64	49,49	81,72	114,53
Atibaia	120,15	173,03	232,24	264,29

Itatiba	128,29	183,43	251,11	314,32
São Paulo State	100,53	124,02	148,96	166,08

Source: SEADE, 2013 [13].

It is interesting to observe these data in Figures 4 and 5, in which the geometric average annual population growth rates of the ten municipalities are represented respectively, and the frequency of urbanisation from 1950 to 2014, considering the construction periods and expansion of the highways that make up the Exporter Axis.

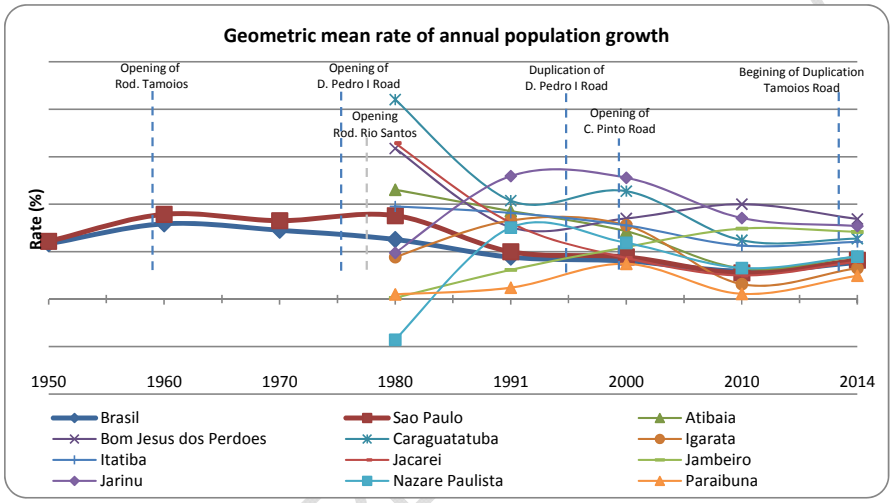

Fig. 4.Geometric mean rate of annual growth of municipalities and São Paulo State population and its relation to the construction and or expansion of the Exporter Road Axis - period 1950-2014.

Source: the authors (2019)

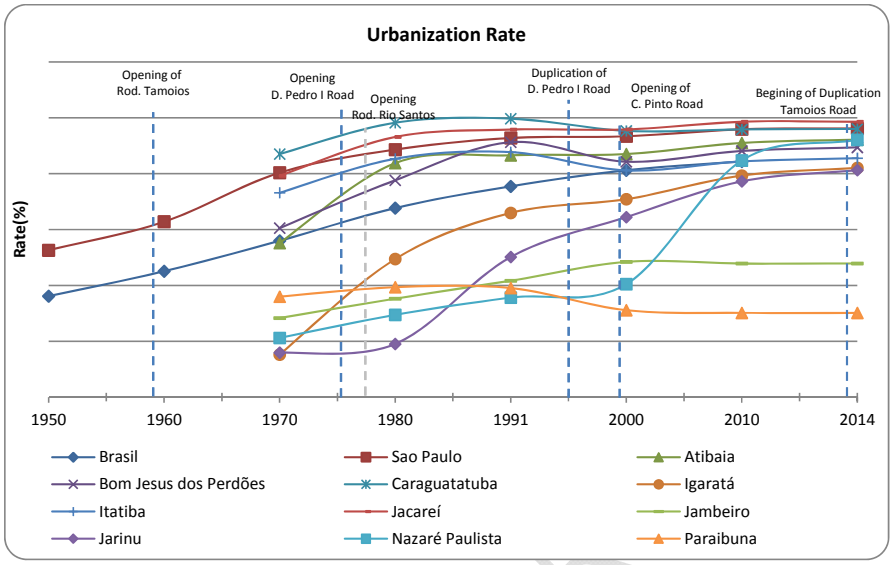

Fig. 5.Municipalities' urbanisation rate and their relation to the construction and or expansion of the Exporter Road Axis - period 1950-2014.

Source: the authors (2019)

As mentioned by some authors [14], the lack of adequate urban planning can affect sensitive ecosystems, pollute reservoirs and groundwater, which in reality are specific aspects of the study region, and that are impacted by the road axis under analysis.

An author [29] analysing how Megaprojects development and implementation are related to socioenvironmental transformation in the Northern Coast of São Paulo state indicates that they generate ecological and social damage to the region. Moreover, he suggests a possible change in the regional vocation, currently of conservation and tourism to an economy with increasing participation of relevant industrial activities, mainly linked to the oil and gas industry complex.

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3.2.3 Socioeconomic dynamics of the studied municipalities

The region has interesting aspects regarding its economic development. According to Gross Domestic Product (GDP) growth variations for the ten municipalities, between 1999 and 2011, it can be stated that its evolutionary dynamics are atypical, in their vast majority, comparing to Brazil's growth variation. Absolute values show Jacareí supremacy, but without much expressiveness in variation, except for the last analysed years, which values indicate a decrease. Regarding absolute values, Itatiba, Atibaia and Caraguatatuba come next, being the growth sustained only for the previous two.

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In 2011, Brazil presented a 2.7% growth, while Jarinú grew 21%; Jambeiro and Bom Jesus dos Perdões grew 18% each; Paraibuna, Itatiba and Jacareí declined 17%, 6% and 5%, respectively; and only Atibaia followed the national average, growing 3% during that period [26] (Table 3).

In 2010, when national economy grew by a positive result of 7.5%, supported by anti-cyclical government policies applied during the 2008 crisis, the studied region kept its movement of significant expansion except for Jambeiro, which dropped 10%. The growth reaches the peak of 34% in Paraibuna, 27% in Igaratá, 22% in Nazaré Paulista, 10% in Atibaia and 11% in Caraguatatuba (Table 3).

Table 3. GDP growth of studied municipalities, 2009, 2010 and 2011

Municipalities	2009	2010	2011
Atibaia	15%	10%	3%
Bom Jesus dos Perdões	17%	16%	18%
Caraguatatuba	20%	11%	8%
Igaratá	14%	27%	5%
Itatiba	10%	10%	-6%
Jacareí	8%	11%	-5%
Jambeiro	14%	-10%	18%
Jarinu	14%	1%	21%
Nazaré Paulista	7%	22%	9%
Paraibuna	13%	34%	-17%

Source: the authors (2019)

The region's growth result analysed for 1999 - 2011 (Table 4) is significant compared to the cumulative 58.3% growth of the country. Jarinú leads the growth with 214.8% of the variation, followed by Bom Jesus dos Perdões with 180.8%, Nazaré Paulista with 163% and Atibaia with 147.7%. Among those who grew less, comparatively, Itatiba with 88.5% and Caraguatatuba with 87.8%. Jacareí and Paraibuna were below the country growth, with 22.3% and 16.1%, respectively.

When analysing 1999-2003 interval, the highest growth occurs in Jarinú, with 56.1%, followed by Nazaré Paulista with 43%. It does not happen in the following period of 2003-2008, in which Jambeiro presents 84% growth, followed by Atibaia with 45.7%. In the last analysed period, 2008-2011, Bom Jesus dos Perdões presents 59.8% growth, above Igaratá with 53.4%. The lowest increase of all ten municipalities in the three periods occurs in the municipality of Paraibuna, with a decrease of 1.4%, a reduction of 6.6% and a growth of 26.1%, respectively in the analysed periods (Table 04).

Table 4. GDP growth of the studied municipalities in selected periods

Municipalities	1999-2003	2003-2008	2008-2011	1999-2011
Atibaia	30,20%	45,70%	30,60%	147,70%
Bom Jesus dos Perdões	22,60%	43,40%	59,80%	180,80%
Caraguatatuba	6,70%	22,40%	43,80%	87,80%
Igaratá	27,80%	20,40%	53,40%	135,90%
Itatiba	37,40%	19,80%	14,50%	88,50%
Jacareí	2,00%	6,10%	13,10%	22,30%
Jambeiro	-9,00%	84,00%	21,60%	103,60%
Jarinu	56,10%	45,50%	38,60%	214,80%

Nazaré Paulista	43,00%	29,40%	42,20%	163,00%
Paraibuna	-1,40%	-6,60%	26,10%	16,10%

Source: the authors (2019)

Composing this region GDP, the Added Values of Services, Industrial and Agricultural sectors, in this order of importance, also show non-cyclical oscillations with GDP aggregate results.

Among the three sectors compared, it was observed that industry has been more vigorous concerning growth, supported by urban expansion and mainly by logistic facility created by the Exporter Road Axis, from the installation of Industrial Districts and Distribution Centers.

Jarinú headed this growth in 1999-2011 with 427.3%, followed by Nazaré Paulista with 336.4%, Atibaia with 308.6% and Itatiba with 155.3%. Caraguatatuba, Jacareí, and Jambeiro showed results for industry equivalent to the effect for the same period of GDP (Table 5).

The periods 1999-2003 and 2003-2008 were the ones with highest average growth for most municipalities (Table 5), with a slight decrease in industrial growth in the last period, beginning the downward trend for this sector, following the national movement. The lowest result is for Paraibuna, which, in the whole period, declined 42.9%, driven by effects decreasing 67% from 1999-2003.

Table 5.Industry Added Value of the studied municipalities in selected periods

Municipalities	1999-2003	2003-2008	2008-2011	1999-2011
Atibaia	60,30%	86,00%	37,10%	308,60%
Bom Jesus dos Perdões	28,50%	71,50%	51,30%	233,20%
Caraguatatuba	-9,30%	20,00%	68,00%	82,80%
Igaratá	25,40%	23,90%	36,00%	111,30%
Itatiba	83,40%	27,80%	8,90%	155,30%
Jacareí	14,90%	-3,90%	10,10%	21,60%
Jambeiro	1,10%	81,80%	11,20%	104,30%
Jarinu	58,40%	104,40%	62,90%	427,30%
Nazaré Paulista	157,90%	29,40%	30,80%	336,40%
Paraibuna	-67,00%	47,50%	17,30%	-42,90%

Source: the authors (2019)

Agriculture and livestock farming added value (Table 6) in 1999-2011 dropped in the municipalities of Caraguatatuba (-17.6%) and Jarinú (-5.3%). In the first municipality real estate speculation has forced the transformation of productive lands in summer resorts, and in the second, industrial growth and the consequent population increase in the proximity of the urban centre, and because they present greater economic value, converted agricultural areas into residential areas. Although growth is significant in some municipalities like Igaratá, Nazaré Paulista and Jacareí, this expansion does not bring the same proportion of income to the municipality due to the low value added by the sector.

The period 2003-2008 has the worst results for the sector, showing the decrease in most of the municipalities, except for growth in Nazaré Paulista and Jambeiro. On the other hand,

the most significant positive changes are in the last period, 2008-2011, mainly for Igaratá and Jambeiro; Caraguatatuba, on the other hand, has a decrease of 26.2%, helping its reduction in the whole period.

Table 6.Agricultural Added Value of the studied municipalities in selected periods

Municipalities	1999-2003	2003-2008	2008-2011	1999-2011
Atibaia	101,20%	-38,80%	15,60%	42,20%
Bom Jesus dos Perdões	66,10%	-28,60%	34,10%	59,00%
Caraguatatuba	19,10%	-6,30%	-26,20%	-17,60%
Igaratá	130,50%	-30,20%	309,90%	559,10%
Itatiba	71,20%	-29,70%	39,00%	67,30%
Jacareí	180,40%	-43,70%	86,20%	194,00%
Jambeiro	-73,80%	27,60%	226,80%	9,40%
Jarinu	1,00%	-33,10%	40,10%	-5,30%
Nazaré Paulista	60,70%	114,40%	54,60%	432,90%
Paraibuna	412,40%	-45,30%	79,30%	402,30%

Source: the authors (2019)

The services sector (Table 7) is the main responsible for GDP growth, with the highest weight regarding the added value and also an area that generates jobs, it shows an increase in all ten municipalities, above national growth. Significant growth occurred in the three analysed periods, particularly 53% growth (1999-2003) in Jarinú, 45% in Paraibuna; 92% (2003-2008) in Jambeiro; 41% in Jarinú; 63% (2008-2011) in Bom Jesus dos Perdões and 44% in Nazaré Paulista.

Table 7.Services Added Value of the studied municipalities in selected periods

Municipalities	1999-2003	2003-2008	2008-2011	1999-2011
Atibaia	13,30%	36,20%	24,90%	92,90%
Bom Jesus dos Perdões	15,90%	32,00%	63,20%	149,60%
Caraguatatuba	7,50%	20,10%	42,00%	83,30%
Igaratá	20,90%	20,20%	43,40%	108,50%
Itatiba	14,10%	11,70%	15,70%	47,40%
Jacareí	0,30%	18,70%	16,40%	38,60%
Jambeiro	-15,20%	92,10%	33,00%	116,70%
Jarinu	52,60%	41,10%	31,00%	182,10%
Nazaré Paulista	13,60%	28,70%	44,10%	110,70%
Paraibuna	45,30%	-11,30%	12,60%	45,00%

Source: the authors (2019)

Concerning 1999-2011, this sector growth was relevant in Jarinú, Bom Jesus dos Perdões, Jambeiro, Nazaré Paulista and Igaratá, which exceeded 100% of the added value by services. In this context, it is important to emphasise that other municipalities, because they

already have an installed capacity, have a lower order of growth, but not less important, such as Atibaia and Caraguatatuba, with 92.9% and 83, 3%, respectively.

Analysing the data presented for Added Values of Services, Industrial and Agricultural sectors, the analyses of an author [20], which emphasises that globally megaprojects of infrastructure are always privileged as popular strategies to attract private capital to a competitive environment become relevant. Thus, according to an author [20], this connection between development and investments in infrastructure on highways are related to myths in economic development models. Moreover, for some authors [21], is relevant to verify whether all this expenditure contributes to the development of the regions they serve.

When analysing the socioenvironmental characteristics of the road axis under analysis and the resulting impacts, which also negatively affect the Cantareira System Water Supply, the primary water supply source to São Paulo Metropolitan Region and Serra do Mar State Park, an Atlantic Forest important Conservation Area, it is verified that the economic model adopted did not consider these issues. In some authors analysis [21], social progress requires clarification on which development model should be used and identifying potential effects, and negative impacts should be related with the type of development preferred [21].

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Finally, some correlations are presented on the economic development of the studied municipalities, concerning the reality of São Paulo State, to evaluate the per capita income of the municipalities by economy different sectors, in the period 2000 and 2010. In this way, the percentage increase in per capita income in each municipality was calculated and presented in table 8, in descending order, according to the rise. It is interesting to note that the two municipalities that stood out, with the highest percentage increase in per capita income (Jambeiro and Igaratá) were more prominent in this period in the agricultural sector, and the third municipality (Nazaré Paulista) performed considerably well both in industrial and agriculture sectors. Interestingly, the two municipalities with the lowest percentage increase in per capita income (Jarinú and Atibaia) seem to have experienced an opposite scenario, with more emphasis in the industrial sector than in the agricultural realm.

It is true that municipalities with the highest per capita income growth had the lowest numbers in 2000, which would justify this effect as a possible "recovery", but more than that, it seems that with this profile (more "agricultural"), Jambeiro would have exceeded in this period, in terms of income per capita, municipalities like Jarinú and Caraguatatuba.

Table 8.Evolution of income per capita of studied municipalities and São Paulo State, period 2000-2010

Municipalities/State	PER CAPITA INCOME - 2000	PER CAPITA INCOME - 2010	PERCENTAGE INCREASE
Jambeiro	265,76	675,02	**154,00%**
Igaratá	244,62	588,07	**140,40%**
Nazaré Paulista	212,91	489,58	**129,95%**
Paraibuna	246,13	558,87	**127,06%**
Bom Jesus dos Perdões	292,94	603,86	**106,14%**
Itatiba	428,84	884,00	**106,14%**
Jacareí	353,34	712,14	**101,55%**
Caraguatatuba	326,16	641,55	**96,70%**

Atibaia	443,94	871,55	**96,32%**
State of São Paulo	440,92	853,75	**93,63%**
Jarinu	315,59	610,76	**93,53%**

Source: IBGE, 2015a; IBGE, 2015b [11-12]

The different sector performances in the analysed period, correlated with the variations in the demographic density of the municipalities (Table 9), indicated that the two with the highest frequency increase (Bom Jesus dos Perdões and Jarinú) presented a stronger profile in the industrial sector for the period. However, Igaratá and Paraibuna, precisely the two municipalities with the lowest population density growth, showed a more focused profile for the "agricultural and livestock sector" for the same period.

Table 9.~~Evolution~~ Evalution of population density of studied municipalities and São Paulo State, in 2000-2010

Municipalities/State	density 2000	density 2010	percentage increase
Bom J dos Perdões	122,34	181,27	**48,17%**
Jarinú	81,72	114,53	**40,15%**
Jambeiro	21,69	28,94	**33,43%**
Caraguatatuba	162,47	207,45	**27,69%**
Itatiba	251,11	314,32	**25,17%**
Nazaré Paulista	44,04	50,25	**14,10%**
Atibaia	232,24	264,29	**13,80%**
State of São Paulo	148,96	166,08	**11,49%**
Jacareí	415,18	454,56	**9,49%**
Igaratá	28,2	30,13	**6,84%**
Paraibuna	20,98	21,47	**2,34%**

Source: SEADE, 2013

4. CONCLUSION

The studied region scenario indicates a significant change in the profile of the surveyed municipalities, in their population aspects, in the growing urbanisation process that has intensified in recent years, and in the land uses that had concentrated in industrial and services sectors.

Comment [NB10]: it would be useful to give information about the changes in the land use rates

At the same time, it observed that the region has high environmental and economic importance, related to the diversity of existing natural resources. On the one hand, north coast presents offshore reserves of natural gas and oil, as well as transport infrastructure, with São Sebastião Port. Authors reported [30] that Serra do Mar State Park is the largest continuous fragment of the Atlantic Forest, known as a "biodiversity corridor", which is of great importance for maintaining this biome, and is considered one of the biodiversity "hotspots". Although preservation efforts can be identified, there are also large government investments for the economic development of the region so that environmental issues

conflicts both with Highways and Port network construction and expansion and with hydrocarbon exploration activities.

The construction of the highway linked the Northern Coast to Paraíba Valley in the 1950s (Tamoios Highway, SP-099), added in the 1960s to the economic development of the municipalities which belongs this study, mainly accentuated by second-home tourism, beginning a broad process of real estate speculation in the region. This process resulted in excessive population growth, urbanisation and disordered occupation where new tourist developments and construction of summerhouses attracted a significant number of migrants, worth noting that in the year 1980, the city experienced the population increase of 125%, intensified by the construction of the Rio/Santos Highway (BR - 101) in the 1970s.

As a reflection of the high demand generated by tourism, the local agricultural economy shifted to the centralisation of the services sector, which, in 2010, had a 48.5% share of formal employment in the municipalities (SEADE, 2013). According to some authors [31], current population growth in São Paulo state North Coast is directly linked to recent investments in infrastructure and industry in the region. The principal investments are the expansion of São Sebastião Port, implementation of the Mexilhão Gas Distribution Complex, construction of Provisional Detention Center and development of structures of road transport such as the Caraguatatuba-São Sebastião ring road and the duplication of Tamoios highway [29].

Another issue to consider in the region is the current production of oil and natural gas, and, according to data from National Petroleum Agency (ANP) and British Petroleum [32], more than 90% of proven oil reserves and about of 80% of natural gas come from offshore exploration along the coast of São Paulo state. The production and exploitation of oil and natural gas can cause environmental changes and emissions of polluting gases affecting the place where it is inserted, promoting degradation in the related ecosystem [5,26,29].

Concerning Bragantina Region, it is relevant to highlight that it is too close to São Paulo and Campinas Metropolitan Regions, with more than twenty million inhabitants and intense industrial use, which dynamise its transformations [26]. This region has undergone an intense process of changes due to easy access, which occurred due to D. Pedro I and Fernão Dias highways duplication, which stimulates its current urbanisation, the expansion of construction sector, industrialisation and tourist use. Currently, this area faces different environmental problems and the increase of activities is not appropriate for a region that inserted in an Environmental Protected Area (EPA) and State Parks, which ~~prioritise~~priorities protecting biodiversity and environmental sustainability. Population increase has occurred in all municipalities in the region, especially Atibaia, Itatiba, Jarinú and Bom Jesus dos Perdões.

It is worth here to return the question posed by some authors [21], if the magnitude of investments in infrastructures, in this case, the D. Pedro I-Tamoios Road Axis, and the socio-environmental impacts they created in fact, contributed to the social development of the regions they serve.

Comment [NB11]: please give these part in the discussion section

Considering this analysis and the resulting changes, it concluded that the Export Corridor reflects several socioenvironmental contradictions that are indicative of regional and local policies and speculative interests. This approach is not adequate for the sustainability of regional natural resources, especially water resources, and does not allow the management and use of resources in a sustainable way that promotes the environmental and life quality of the population.

Comment [NB12]: Describe how you reached this conclusion by contacting your study results

COMPETING INTERESTS

No competing interests exist.

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