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Achieving the Sustainable Development Goal 06 in Brazil: the universal access to sanitation as a possible mission

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ABSTRACT

Sanitation (which includes national public policies for drinking water, sewage services and waste management) is precarious in Brazil and therefore poses a challenge to a range of actors. Poor sanitation impacts public health, education, the environment, and daily life. Globally, it emits increasing greenhouse gases. Universalization of any major public service appears difficult, if not impossible; however, Brazil's program to universalize access to electricity proves the opposite, as will be shown in this paper. By describing the successful implementation of electricity for everyone, we show that planned public efforts, coordinated with private initiatives and local communities, have worked, and the same can be achieved for the sanitation sector. An overview of all sectors that touch on sanitation and emissions is also provided, highlighting the challenges and possibilities for infrastructure projects.

Key words: Solid Waste (SW), water, sewage, sanitation, greenhouse gases, Sustainable Development Goals (SDGs).

INTRODUCTION

In Brazil, sanitation - water, sewage and waste - and electricity are provided by public bodies directly or indirectly through public concessions. Regarding sanitation, the North and Northeast regions and all rural areas significantly lack access to this basic service in the 21st century; Brazil is still far from experiencing universal access, mainly for sewage (Albuquerque 2011, Heller and Castro 2013). In contrast, electricity has had some successful public programs for access and for universalization and presented positive results measured by the 2010 Demographic Census conducted by the Brazilian Institute of Geography and Statistics (IBGE). In 1999, the government launched the National Rural Electrification Program with access targets, called "Electricity for the Countryside", which was

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replaced, in 2003, by "Electricity for Everyone", with universalization goals, both aimed at poor rural populations.

According to official Brazilian figures, presented by the 2000 Census (IBGE 2000, MME-LpT 2011, 2015), more than 9 million Brazilians in the rural area, or more than 2 million families, and more than 1 million Brazilians in the urban area were living then without electricity; that is, more than 10 million people had no access to electricity (Table I).

According to the 2010 Census (IBGE 2010a), these numbers had significantly improved and dropped to just over 2 million people in the rural area and less than 400,000 in the urban area (Table I). Moreover, by 2015, the rural electrification program had reached more than 15 million families. On the other hand, the 2010 census pointed out that more than 27 million households were not connected to a drainage or sewer system, meaning that more than 100 million Brazilians and more than 7 million households do not have adequate waste collection (IBGE 2010). While the efforts towards electricity universalization were effective, there were no significant results for sanitation (Table I). According to data presented in this paper, there is a true black-out for this latter case.

The 2030 Agenda for Sustainable Development, launched in 2015 by the United Nations Organization (UN), aims to transform the world through measurable, and therefore monitorable, goals, targets and indicators for the pursuit of sustainable development. The 17 Sustainable Development Goals (SDG), subdivided into 169 goals, "seek to build on the Millennium Development Goals (MDG) and complete what they did not achieve. They seek to realize the human rights of all and to achieve gender equality and the empowerment of all women and girls. They are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental" (United Nations 2015). In fact, differently from the MDGs, the SDGs are a "network of targets", meaning that each goal is extended through targets that are related to numerous goals and sectors (Blanc 2015). Planning for development tends to be more integrated and coherent.

Access to drinking water and sanitation, as well as appropriate waste management, addresses primarily SDG 06 (clean water and sanitation), but it is extended to SDG 01 (no poverty), SDG 02 (zero hunger), SDG 03 (good health and well-being), SDG 04 (inclusive and equitable quality

TABLE I
Access to electricity.

Data	Permanent households			Residents		
	Total	Urban	Rural	Total	Urban	Rural
			Census 2000			
Total	44,776,740	37,369,953	7,406,788	168,450,492	136,978,588	31,471,905
With access	42,331,817	37,038,305	5,293,512	157,461,483	135,741,144	21,720,339
No access	2,444,923	331,648	2,113,276	10,989,009	1,237,444	9,751,566
			Census 2010			
Total	57,324,167	49,226,751	8,097,416	189,790,211	160,246,510	29,543,701
With access	56,595,495	49,093,514	7,501,981	187,040,968	159,850,216	27,190,752
No access	728,672	133,237	595,435	2,749,243	396,294	2,352,949

Source: Authors, based on data from Census of 2000 and 2010 (IBGE 2000, 2010a).

education), SDG 10 (reduced inequalities), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), and SDG 15 (life on land). Finally, of course, SDG 17 (partnership for the goals) is addressed, as it includes the means to implement all goals (Blanc 2015). To achieve these objectives, Brazil will have to make significant efforts for some decades to come. In summary, achieving the targets of the SDG 06 will have immediate spillover effects on other goals. These influences could be a theme of other paper as it will not be dealt in the present article. Indeed, the focus on this work is solely on the possible achievement of the SDG 06.

AN OVERVIEW OF SANITATION IN BRAZIL

Brazil is divided into five regions: North, Northeast, Southeast, South and Midwest. As shown in Table II, there was a significant increase in the urbanization of the South and Midwest from the 1970s to 2010. The Southeast already presented high levels of urbanization in the late 1950s and early 1970s, which was a period of growth of large metropolises, including São Paulo. The North showed the highest population growth for the period from 1970 to 2010, followed by the Midwest, and both regions showed almost the same population in 2010. The Northeast is the third most populated region in Brazil: its cities are located mainly on the coast, with large population densities and crowded urban centres. While Brazil increased its urban population by 204% overall from 1970 to 2010, the North grew by 517% and the Midwest by 461%. Rapid urban growth in the North and Northeast outstripped public capacity to provide basic services, as will be seen in the indices presented below.

Analyzing the evolution of the urban and rural population in the country is an important factor in the analysis of the provision of basic services (Table II). In fact, according to Costa and Ribeiro (2013), even if unsteady, the sanitation service was considered an urban service until the middle of

TABLE II
Resident population in Brazil (in thousands).

Total Population									
Region	1950	1960	1970	1980	1991	2000	2010	2015	Evolution 1970 - 2010
North	2,049	2,930	4,188	6,767	10,257	12,901	15,864	17,524	279%
Northeast	17,973	22,429	28,675	35,419	42,470	47,742	53,082	56,641	85%
Southeast	22,548	31,063	40,332	52,581	62,661	72,412	80,364	85,916	99%
South	7,841	11,892	16,684	19,380	22,117	25,108	27,387	29,290	64%
Midwest	1,533	2,678	4,630	7,004	9,412	11,637	14,058	15,489	204%
Brazil	51,944	70,992	94,509	121,151	146,917	169,799	190,756	204,860	102%
Urban Population									
Region	1950	1960	1970	1980	1991	2000	2010	2015	Evolution 1970 - 2010
North	923	1,566	3,054	5,298	7,614	9,014	11,665	13,145	517%
Northeast	5,921	9,718	14,809	21,430	28,926	32,975	38,819	41,414	224%
Southeast	14,770	22,989	38,216	51,889	63,636	65,549	74,699	80,020	155%
South	3,508	6,190	8,580	13,803	18,597	20,322	23,260	25,076	215%
Midwest	653	1,584	3,364	6,381	9,442	10,093	12,484	13,911	461%
Brazil	25,671	42,217	67,747	99,302	128,194	137,954	173	173,566	204%

Source: Authors, based on Statistical Series and Synthesis of IBGE (PNAD and Census).

the 20th century. In consonance with the authors, there was an evolution regarding the provision of the service when the federal government began to interfere directly in the provision of these services in 1942, with the Special Public Health Service (SESP); later, in 1960, the SESP Foundation, within the Ministry of Health, also started implementing sanitation actions. In the 1940s, the execution of sanitation works passed to the scope of the Ministry of Works and Transport, with the National Department of Sanitation Works. Subsequently, after the creation of the Superintendence of the Development of the Northeast (SUDENE) in 1959, the creation of state bodies for the provision of these services was strengthened, especially after the formation of the National Fund for Sanitation Works (FNOS) in 1962.

The authors emphasize that in the history of public policies for basic sanitation, there was always "a movement to modify subsidy policies to financing policies" and there were changes in partnerships. Initially, these were via federal government with municipalities until the 1940s; then they became federal government partnerships with state companies during the military government.

It was precisely during the military government, with the National Sanitation Plan (PLANASA), operationalized through the National Housing Bank (BNH), that there was the largest federal effort and the most extensive coverage of water supply and sewage services. This, however, favored the richer regions of the South and Southeast, where there was the greatest possibility of amortization of investments through tariffs (Costa and Ribeiro 2013). With the abolition of the BNH in 1986, and with the Federal Constitution of 1988, stemming from the re-democratization of the country, there was an institutional vacuum that followed until Law 11,445/2007 (Brasil 2007), the National Basic Sanitation Law of 2007. The LNSB modified the concept of basic sanitation as follows:

"The public services of basic sanitation involve not only the public services of drinking water supply and sanitary sewage, but also the public services of public cleaning, management of solid waste and also those of urban storm water management… being a duty of the Union…instituting a Federal Basic Sanitation Policy" (Costa and Ribeiro 2013).

In addition, the municipality became the central point of sanitation policy, and it has been the focus of resistance from previously created state-owned enterprises. This fact resulted in major challenges, as listed by Costa and Ribeiro (2013): the difficulty of making the municipality really do the planning, and of ensuring that the local regulation is independent and that social control is indeed a transparent and integrated policy. The creation of the Ministry of Cities in 2003 was fundamental to integrating existing policies and to providing the centrality of the Federal Basic Sanitation Policy within its National Secretariat of Environmental Sanitation (SNSA) (Costa and Ribeiro 2013).

The results of these decades-old centralized policies in the richest and most urban areas of the country can be glimpsed by analyzing the 2013 Municipal Human Development Index (MHDI) published by the United Nations Development Program (UNDP) for 5,565 cities (Table III), of which 109 cities are counted in the first 100 rankings. The first place with a MHDI of 0.882 is the city of São Caetano do Sul, in São Paulo, and 10 cities are tied in the first 100 places with a MHDI of 0.784 (five in São Paulo, two in Rio Grande do Sul, two in Santa Catarina and one in in Mato Grosso do Sul). The only city in the Northeast in these first 100 places is Fernando de Noronha, in 76th place, a touristic town with a high level of access control.

According to the same data for 2010, 105 cities were classified in the last 104 places, with an MHDI of 0.519 for the six cities tied for 5,461st place, and with the MHDI of 0.418 for last place, rank number 5,565, Melgaço, Pará, according to

TABLE III
MDHI 2013 - first 100 rankings.

100 first rankings		%
	Southeast	
59	São Paulo	54.13%
2	Rio de Janeiro	1.83%
2	Espírito Santo	1.83%
4	Minas Gerais	3.67%
	67 Total	61.47%
	South	
23	Santa Catarina	21.10%
10	Rio Grande do Sul	9.17%
3	Paraná	2.75%
	36 Total	33.03%
	Midwest	
1	Mato Grosso	0.92%
1	Mato Grosso do Sul	0.92%
1	Tocantins	0.92%
1	Goiás	0.92%
1	Distrito Federal	0.92%
	5 Total	4.59%
	Northeast	
1	Pernambuco	0.92%
	1 Total	0.92%

Source: Authors, based on PNUD, IPEA, FJP, 2013.

Table IV. The Northeast has more cities in the lower positions, with 63.81% of the municipalities in the sample; followed by the North, with 35.24% represented in these placements. The worst MHDIs are from Maranhão (22 cities), Pará (20 cities) and Piauí (19 cities). The Northeast has a total of nine states, and six are represented in the last positions of the MHDI. The North has seven states and five are represented. It can be noted that there is a lack of essential services, and abundant poverty and vulnerability, evidenced in this worst index. It should be noted that the lowest MHDI figures do not include states in the Southeast, the South or the Midwest, while among the top places only one state in the Northeast is represented.

This is the Brazilian situation in the 21st century, a country with severe regional imbalances and socioeconomic inequalities, a national MHDI of 0.755 (PNUD, Ipea and FJP 2013), a population of approximately 205 million inhabitants, and a GDP of approximately US $ 1,845 trillion (Banco Central 2017). It is predominantly an urban country (Table II and V).

This paper aims to describe the evolution of the sanitation indices in Brazil over a ten-year period and to provide suggestions for its universal access, that is to say, recommendations to implementing the SDG 06. The main hypothesis is that universal access to sanitation is only possible via the power of the state, by means of investing, catalysing or obliging investments in this sector, as will be shown by using the successful example of rural electrification. First, the overview and the profile of sanitation, as well as its emissions, will be detailed. Next, the program "Electricity for Everyone" will be described, to show how it achieved the universalization of rural electrification. In conclusion, despite being a challenging task, there is, in fact, the possibility of universal access to sanitation.

MATERIALS AND METHODS

The paper consists of qualitative and quantitative analyses of indicators of access to energy and sanitation, in order to provide an overview of the provision of these services, and a qualitative investigation of manuals, laws, reports and governmental releases.

The main sources of data were the National Institute of Geography and Statistics (IBGE); the Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe); the Ministry of Cities (MCID); and the Ministry of Science, Technology, Innovation and Communications (MCTIC). Data were collected focusing mainly on a 10-year evolution of statistics, when possible.

TABLE IV
MHDI 2013 - last 104 placements.

104 last		%
	Northeast	
22	Maranhão	20.95%
19	Piauí	18.10%
12	Alagoas	11.43%
8	Bahia	7.62%
4	Pernambuco	3.81%
2	Paraíba	1.90%
	67 Total	63.81%
	North	
20	Pará	19.05%
12	Amazonas	11.43%
3	Acre	2.86%
2	Roraima	2.86%
1	Tocantins	0.95%
	38 Total	36.19%

Source: Authors, based on PNUD, IPEA, FJP, 2013.

Some indicators did not present any historical series and were collected in a manner that came as close as possible to a 10-year historical series, as will be detailed. The Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe) has an annual assessment of solid waste (SW) statistics, so, the authors chose to analyze the ten-year evolution of data (2005 - 2015), but also considered the most up-to-date numbers of Abrelpe (2016).

Sanitation and population data were extracted from IBGE, which holds its main indicators in the database Bank of Statistical Tables (SIDRA). The Population Censuses of 2000 and 2010, and the National Sample Survey of Households (PNAD) were collected from SIDRA. A profile of the Brazilian population (urban and rural) and Access to Energy were retrieved from both Censuses and PNAD. From PNAD the subject categories collected were Water Supply, Sewage Treatment, and Solid Waste Destination.

The National Secretariat of Environmental Sanitation (SNSA), which is an institution under the auspices of the MCID, gathers the National Sanitation Information System (SNIS).The SNIS is a national database that presents aggregated data, disaggregated data and municipal data. Categories explored under this database were access to Water and Sewage Treatment as well as Level of Investments.

GHG emissions were extracted from the SIRENE system, under the MCTIC. Categories explored under this database were the national GHG emission profile for Energy; Industrial Process; Agriculture; Waste; and Land Use, Land-Use Change and Forestry (LULUCF). For the Waste category (IPCCC 1996), the data were extracted for Effluents and Solid Waste.

The records were exported from each database into a MS Excel File and subsequently placed into single workbooks according to categories of public services provided. Each workbook contained a macro level of aggregation, and the main analyses were provisions of service to the population in absolute and relative terms, which were divided into the following categories: home location (rural or urban), and national region (North, Northeast, South Southeast, and Midwest).

These data were analyzed through two types of comparison: the first one was through the analysis of the factors that impacted each of the indicators developed in this work over time, in a technique known as time series analysis; and the second one occurred through the analysis of various indicators, in a simultaneous comparison of different regions and of housing location (urban/rural), in a technique known as cross-section.

The combination of both techniques allows a holistic and at the same time detailed understanding of all the qualitative factors that have a relevant impact on the indicators in quantitative terms.

Finally, the National Program for Universal Access and Use of Electric Power, known as the

"Electricity for All" program, was analyzed in order to extract the possible drivers of its success by means of an in-depth investigation of its special project and operational manuals (MME - LpT 2009, 2011, 2015), official reports (MME - LpT 2007, 2008), governmental data, laws, and official releases.

The purpose of using the "Electricity for All" program as an example is based on a technique choice known as benchmark, where a policy or an activity already implemented serves as a parameter or guide to the development of actions in other segments that have similarities between them. Then the authors suggested possible directions for the universal access to sanitation.

RESULTS

The current section shows data analyses for water and sewage, solid waste, and greenhouse gas emissions. Each subsection will present a quantitative and a qualitative analysis. In considering the following data, it is important to introduce the following population overview.

WATER AND SEWAGE

Sanitation in Brazil is regulated by Law 11,445/07 (Brasil 2007), which, by article 52, establishes the need to prepare a National Plan for Sanitation (Plansab), covering "water supply, sewage, solid waste and rainwater management, with cleaning and inspection of the drainage systems, as well as other sanitation actions of interest for the improvement of environmental health, including the provision of toilets and hydro sanitary units for low-income populations". Plansab was approved in 2013, establishing guidelines, targets and actions for the years 2014 to 2033 (MCID 2013), with its latest update performed in 2015 (SNIS 2015).

As detailed below, the plan is far from being fulfilled. According to Plansab, it would be expected to achieve "99% coverage rates in drinking-water supply in 20 years, with 100% coverage rates in the urban area, and 92% in sewerage services, with 93% coverage levels in the urban area. In solid waste, Plansab provides for the universalization of urban collection and the absence of open dumps or dumps in the whole country. For rainwater, another goal is to reduce the number of municipalities where flooding or waterlogging occur, in the urban area of 11%".

The evolution of the national sanitation situation can be verified by the indices of coverage rates for sewerage and water services according to SIDRA and SNIS. According to Table VI, the evolution of access rates to the sewage network shows that its universalization is still very distant for the North region and, to a lesser extent, for the Northeast. Although the North increased the

TABLE V
Total households (in thousands), % of urban households, total residents (in thousands), and % of urban residents.

Region	2005				2010				2015			
	Households	%	Residents	%	Households	%	Residents	%	Households	%	Residents	%
North	3,737	72.6	14,866	71.3	3,977	75.8	15,864	73.5	5,095	75.6	17,524	75.0
Northeast	13,615	73.2	52,090	70.7	14,922	75.1	53,082	73.1	17,837	74.3	56,641	73.1
Southeast	23,802	92.5	78,661	91.8	25,197	93.4	80,364	93.0	29,473	93.5	85,916	93.1
South	8,341	83.4	26,883	82.4	8,891	85.7	27,387	84.9	10,417	86.1	29,290	85.6
Midwest	3,879	86.0	13,151	86.0	4,333	89.1	14,058	88.8	5,215	89.5	15,489	89.8
Total	53,374	84.3	185,651	82.5	57,321	85.9	190,756	84.4	68,037	85.7	204,860	84.7

Source: Authors, based on data from PNAD 2005 and 2015, and 2010 Census (IBGE 2005, 2010, 2015).

service index for the ten-year period for the total and urban population, the attendance rate in 2015 was still 8.7% for the total population and 11.2% for the urban. Considering that in the North there was the greatest total and urban population increase in recent years, the services did not follow the growth of the number of inhabitants or the expansion of the urban spot (Table II). The volume of sewage treatment generated in the region is low (16.4%), but presents a high percentage of treatment of sewage collected (83.9%).

The North presents the lowest investment values when compared to the values of the other regions for the three-historical series (Table VI). It also presents the lowest numbers of sewage connections nationally (Table VII). The Northeast presented a low increase in coverage rates of the total (6.1%) and urban population (6.3%) in the last ten years, as well as the investment volumes and the number of sewage connections; and, there was a decrease in the treatment volume of the sewage collected (-12.9%) and generated (-4%). Nationally, in 2015, only the Southeast presented more than 50% of the properties with access to the sewage network for the total population (77.2%) and, for the urban population, only the Southeast (81.9%) and the Midwest (54.7%) presented more than 50% of coverage level in 2015 (Table VI).

Table VII shows the evolution of extensions connected to the main sewage distribution network. Numbers show more than 2 million inactive connections in 2015. According to SNIS (2015), those inactive connections are the ones that "although registered as users of the services, are not fully operational". More investments are possibly needed for the maintenance of these facilities.

As shown in Table VIII, the worst coverage rates for water supply are again in the North. In 2015, it was the region with the lowest service attendance rate of the total population (56.9%) and the urban population (69.2%). The amounts invested in this region are the lowest nationally as well as the number of connections to the water supply network (Table IX). The largest losses in distribution are also in this region (46.3%), followed by the Northeast in losses (45.7%).

The South has the best rate of service for the urban population (98.1%) followed by the Midwest (97.4%), both regions of more recent urbanization than the Southeast, which presents a lower urban service, of 96.1%, a lesser index probably because there are areas within the urban area that do not receive basic services, especially in the subnormal clusters scattered around the city (favelas).

Except for the Midwest, all other regions showed a decrease in water loss in the distribution in 10 years (Table VIII). Despite this, all regions present significant losses in distribution, exceeding 30%. This index is important for analyzing the quality of water distribution by indicating quality of management and infrastructure (SNIS 2015). The regions with the greatest financial investment in the water supply network are the Northeast and Southeast regions, which are the regions with the highest number of active water connections (Table IX). Apart from the Southeast, all regions experienced a decrease in the urban population's service attendance rate in the last ten years, even though they increased the attendance of the total population, probably due to a significant increase in the urban population in all regions and a decrease in the rural population.

Table IX shows the evolution of extensions connected to the main water pipeline. Numbers show more than 5.5 million inactive connections in 2015. As seen in the sewage data, more investments are possibly needed for the maintenance of these facilities.

According to Table X, almost 10 million households do not have access to the water supply system or use other types of water supply. The North presents the worst situation. However, in absolute values, the Northeast is the one with the largest contingent of people without access to the

TABLE VI
Evolution of service levels – coverage rates for sewage.

Indices in %		2005	2010	2015	Variation 2005 - 2010	Variation 2005 - 2015
Sewage network - total population	North	3.3	8.1	8.7	4.8	5.4
	Northeast	18.6	19.6	24.7	1.0	6.1
	Southeast	55.5	71.8	77.2	16.3	21.7
	South	24.2	34.3	41.0	10.1	16.8
	Midwest	44.4	46.0	49.6	1.6	5.2
	Total	34.9	46.2	50.3	11.3	15.4
Sewage network - urban population	North	4.4	10.0	11.2	5.6	6.8
	Northeast	25.9	26.1	32.2	0.2	6.3
	Southeast	61.5	76.9	81.9	15.4	20.4
	South	30	39.9	47.5	9.9	17.5
	Midwest	50.1	50.5	54.7	0.4	4.6
	Total	42.6	53.5	58.0	10.9	15.4
Sewage treatment index - sewage collected	North	56.6	91.9	83.9	35.3	27.3
	Northeast	91.4	86.2	78.5	-5.2	-12.9
	Southeast	62.9	61.2	67.8	-1.7	4.9
	South	93	78.6	94.3	-14.4	1.3
	Midwest	82.5	91.1	92.6	8.6	10.1
	Total	73	68.2	74.0	-4.8	1.0
Sewage treatment index - sewage generated	North	10	22.4	16.4	12.4	6.4
	Northeast	36.1	32.0	32.1	-4.1	-4.0
	Southeast	32.6	40.8	47.4	8.2	14.8
	South	25.3	33.4	41.4	8.1	16.1
	Midwest	39.7	43.1	50.2	3.4	10.5
	Total	31.7	37.8	42.7	6.1	11.0
US$mi/year		**2005**	**2010**	**2015**	**Variation 2005 - 2010**	**Variation 2005 - 2015**
Investments made	North	7,542	42,563	44,785	464%	494%
	Northeast	41,886	255,247	230,156	509%	449%
	Southeast	228,581	729,478	867,522	219%	280%
	South	69,758	197,976	248,494	184%	256%
	Midwest	37,879	88,859	119,943	135%	217%
	Total	385,647	1,314,124	1,510,899	241%	292%

Source: Authors, based on data from SNIS.

TABLE VII
Evolution of service levels – sewage main connections.

Connections		2005	2010	2015	Variation 2005 - 2010	Variation 2005 - 2015
Total (active + inactive)	North	53,904	172,226	504,887	220%	837%
	Northeast	1,412,647	2,415,424	3,520,341	71%	149%
	Southeast	6,675,020	16,165,224	19,681,107	142%	195%
	South	1,110,829	2,246,580	3,077,269	102%	177%
	Midwest	799,972	1,480,804	2,205,285	85%	176%
	Total	10,052,372	22,480,258	28,988,889	124%	188%
Active	North	48,692	151,340	334,035	211%	586%
	Northeast	1,319,811	2,282,439	3,300,747	73%	150%
	Southeast	6,351,479	15,223,820	18,344,112	140%	189%
	South	1,007,110	2,127,839	2,915,286	111%	189%
	Midwest	743,656	1,383,147	1,970,724	86%	165%
	Total	9,470,748	21,168,585	26,864,904	124%	184%

Source: Authors, based on data from SNIS.

TABLE VIII
Evolution of service levels – coverage rates for drinking-water.

Indices in %		2005	2010	2015	Variation 2005 - 2010	Variation 2005 - 2015
Water service – Total population	North	54.5	57.5	56.9	3.0	2.4
	Northeast	71	68.1	73.4	-2.9	2.4
	Southeast	86.2	91.3	91.2	5.1	5.0
	South	82.7	84.9	89.4	2.2	6.7
	Midwest	88.1	86.2	89.6	-1.9	1.5
	Total	78.8	81.1	83.3	2.3	4.5
Water service – Urban population	North	72.9	71.8	69.2	-1.1	-3.7
	Northeast	97.8	87.1	89.6	-10.7	-8.2
	Southeast	95.3	96.6	96.1	1.3	0.8
	South	100	96	98.1	-4.0	-1.9
	Midwest	99.3	95.3	97.4	-4.0	-1.9
	Total	96.1	92.5	93.1	-3.6	-3.0
Distribution loss index	North	57.6	51.2	46.3	-6.4	-11.3
	Northeast	50.3	50.8	45.7	0.5	-4.6
	Southeast	43.5	34.4	32.9	-9.1	-10.6
	South	37.9	35.4	33.7	-2.5	-4.2
	Midwest	34.7	33.8	35.5	-0.9	0.8
	Total	44.4	38.8	36.7	-5.6	-7.7

TABLE VIII (continuation)

US$mi/year		2005	2010	2015	Variation 2005 - 2010	Variation 2005 - 2015
Investments made	North	12,245	58,507	53,902	378%	340%
	Northeast	105,184	285,746	265,097	172%	152%
	Southeast	172,604	453,111	1,028,951	163%	496%
	South	76,074	109,887	193,074	44%	154%
	Midwest	72,379	89,531	100,262	24%	39%
	Total	438,486	1,993,563	1,641,286	355%	274%

Source: Authors, based on data from SNIS and Banco Central 2017.

TABLE IX
Evolution of service levels - drinking-water connections.

Connections		2005	2010	2015	Variation 2005 - 2010	Variation 2005 - 2015
Total (active + inactive)	North	1,090,552	2,104,059	2,396,000	93%	120%
	Northeast	7,923,799	11,058,398	13,385,518	40%	69%
	Southeast	10,815,876	20,906,972	24,705,115	93%	128%
	South	4,758,269	7,137,762	8,234,656	50%	73%
	Midwest	1,961,228	3,747,992	4,679,363	91%	139%
	Total	26,549,724	44,955,183	53,400,652	69%	101%
Active	North	842,887	1,717,827	2,046,168	104%	143%
	Northeast	6,637,474	9,453,959	11,361,438	42%	71%
	Southeast	10,469,008	19,568,680	22,643,678	87%	116%
	South	4,352,433	6,601,850	7,566,976	52%	74%
	Midwest	1,779,568	3,417,930	4,220,187	92%	137%
	Total	24,081,370	40,760,246	47,838,447	69%	99%

Source: Authors, based on data from SNIS.

water supply, with almost 12 million people without the service (by cross-calculating Table V by the percentages in Table X). In a ten-year period, there was an improvement in national the coverage level of 3%, from 82% to 85%; which is a residual value, evidencing low investment rates in the sector.

In Table XI, the classification under "other types" includes cesspools, rivers, ditches, other types not specified, and had no access. In fact, these destinations are not suitable for sewage and, according to Atlas de Saneamento 2011, "far from representing alternative solutions are, rather, confirmation of the unsteadiness of sewage collection in the country" (IBGE 2011).

Another issue to consider is that rainwater drainage is considered as part of the sewage network infrastructure; so even when sewage is directly released into this rainwater system, it is considered under the national index as an appropriate destination. A technical issue regarding this consolidated infrastructure is that the combined sewer system is not usually projected to support the load of the heavy rains (Reda 2006, MMA 2009), resulting in flooding, cross-contamination,

and spread of diseases. On the other hand, there are also systems projected to receive only sewage (separate sewer systems), but these illegally and clandestinely receive effluents from domestic and industrial sources (Dias 2003)

Even with these caveats, in 2015, almost 28 million households did not have access to the sewage network – by considering other types and the usage of septic tank (Table XI). The worst index is again in the North, with 14% of the households covered, but the Northeast has the largest number of households without adequate access.

Usually, the worse indexes, in any region, are recurrent in irregular settlements in urban areas or in pristine areas in rural areas. The proper provision of public services for these locations would have to consider their realities by means of implementing special projects, as will be discussed in this article. The search for regularization of the informal settlements would not be a solution for this problem because the main issue is usually the location per se (top of hills, hard-to-reach places, alleys, and/or violent communities). Moreover, if the government stand still until the settlements are regularized, it will be a never-ending situation. The rural electrification program is a show-case that demonstrated that the solution must fit in with the realities of the country. If the conditions are appropriate, irregular connections of sewage and water must be regularized as efforts of public policies.

In a decade, there was no significant improvement in water supply in rural areas, and the main type of supply is still, in 2015, the artesian well. Considering that the sewerage network and waste management are also incipient in the rural area, artesian wells are in danger of frequent contamination. The main form of water supply in the urban environment is access to the general network; however, it has not yet been universalized even in ten years of providing services to the population, with little variation in the historical series (2.7%). As can be seen in Table XII, the water supply coverage levels for the rural area,

TABLE X
Access to water services.

Service	Region	Households (in thousands)		Households (coverage level in percentage)		
		2005	2015	2005	2015	Variation 2005 - 2015
Public network	North	2,001	3,069	53%	60%	7%
	Northeast	10,062	14,223	74%	80%	6%
	Southeast	21,753	27,165	91%	92%	1%
	South	7,000	9,199	84%	88%	4%
	Midwest	3,033	4,470	78%	86%	8%
	Brazil	43,849	58,126	82%	85%	3%
No Access/Others	North	1,736	2,026	46%	40%	-7%
	Northeast	3,553	3,614	26%	20%	-6%
	Southeast	2,049	2,308	9%	8%	-1%
	South	1,341	1,218	16%	12%	-4%
	Midwest	846	745	22%	14%	-8%
	Brazil	9,525	9,912	18%	15%	-3%

Source: Authors, based on PNAD/SIDRA/IBGE.

for the 2005-2015 historical series, showed an improvement in the coverage of services by 17.7%, but remained below 50% in 2015.

Corroborating the information from the series of previous indicators, it is concluded that the greatest challenge of sanitation in Brazil is sanitary sewage (Table XIII). According to Table XIII, in 2015, a little more than half of urban properties have access to sanitary sewage networks (68.0%); and in ten years there was only a small improvement in the service coverage area from 56.3% to 68.0%. The urban population still uses, in 2015, precarious forms for its destination (12.4%) despite improvement in the last ten years. Considering that 85% (Table II) of the population is urban (approximately 173.5 million inhabitants), this volume is significant.

The worst picture refers to the rural population, in which only 5.4% of the population has access to the sewage network, and most of the sewage is released in inappropriate ways (61.3%). There was an increase in sewage disposal in septic tanks in the rural areas (of 17.5%), remembering also that this sewage is released in natura, that is, without any type of previous treatment (Table XIII).

According to the IBGE, of the 5,570 Brazilian municipalities, 2,495 do not have access to the sewer system (IBGE 2011). Both the water supply and the sewage network and treatment are precarious in Brazil, and have a direct impact on the economy, education, the environment, and health. The unsteady system contributes to the increase of GHG emissions in the country because more methane and other greenhouse gases are released into the atmosphere (IPCC 1996).

SOLID WASTE

Waste management is regulated by the National Solid Waste Policy (PNRS), which includes Law 12,305/2010 (Brasil 2010a) and Decree 7,404/2010 (Brasil 2010b). Like the water and sewage sectors, the waste sector is also operationalized by Plansab (MCID 2013), because the plan systematically encompasses sanitation services. According to this

TABLE XI
Access to sewage services.

Service	Region	Households (in thousands)		Households (coverage level in percentage)		
		2005	2015	2005	2015	Variation 2005 - 2015
Rainwater drainage or sewer system	North	149	691	4%	14%	10%
	Northeast	3,691	6,727	27%	38%	11%
	Southeast	18,400	25,254	77%	86%	8%
	South	2,157	5,098	26%	49%	23%
	Midwest	1,285	2,432	33%	47%	14%
	Brazil	25,681	40,201	48%	59%	11%
Septic tank	North	1,780	2,445	48%	48%	0%
	Northeast	2,650	4,863	19%	27%	8%
	Southeast	2,282	2,040	10%	7%	-3%
	South	4,218	4,033	51%	39%	-12%
	Midwest	438	1,279	11%	25%	13%
	Brazil	11,368	14,660	21%	22%	0%

TABLE XI (continuation)

Service	Region	Households (in thousands)		Households (coverage level in percentage)		
		2005	2015	2005	2015	Variation 2005 - 2015
No Access/Other types	North	1,808	1,959	48%	38%	-10%
	Northeast	7,274	6,247	53%	35%	-18%
	Southeast	3,120	2,179	13%	7%	-6%
	South	1,966	1,286	24%	12%	-11%
	Midwest	2,156	1,504	56%	29%	-27%
	Brazil	16,325	13,175	31%	19%	-11%

Source: Authors, based on PNAD/SIDRA/IBGE.

TABLE XII
Evolution of the coverage levels of the drinking-water network per household (in percentage and by location).

Indices in % Urban		2005		2015		Variation 2005 - 2015	
		Rural	Urban	Rural	Urban	Rural	
Public network	North	66.9	18.0	72.2	23.1	5.3	5.1
	Northeast	90.4	29.0	92.5	42.7	2.1	13.7
	Southeast	96.5	28.1	96.7	26.6	0.2	-1.5
	South	94.7	30.0	96.6	37.0	1.9	7.0
	Midwest	88.4	15.4	94.1	14.1	5.7	-1.3
	Brazil	**92.5**	**26.8**	**95.2**	**44.5**	**2.7**	**17.7**
No Access - Others	North	33.1	82.0	27.8	76.9	-5.3	-5.1
	Northeast	9.6	71.0	7.5	57.3	-2.1	-13.7
	Southeast	3.5	71.9	3.3	73.4	-0.2	1.5
	South	5.3	70.0	3.4	63.0	-1.9	-7.0
	Midwest	11.6	84.6	5.9	85.9	-5.7	1.3
	Brazil	**7.5**	**73.2**	**4.8**	**55.5**	**-2.7**	**-17.7**

Source: Authors, based on PNAD/SIDRA/IBGE.

Law, article 54 (Brasil 2010a), open dumps should have been closed in 2014, with the possibility of being charged financial penalties due to this environmental crime, as provided by the Law of Environmental Crimes (Law 9,605/1998, art 54). However, this deadline has been subsequently postponed and, still in 2017, "the 3,000 open dumps identified in Brazil affected the lives of 76.5 million people, bringing an economic loss of US$ 1 billion to the public coffers" (ISWA/Abrelpe 2017). Consequently, despite the Laws, the PNRS and the Plansab, the following data describe the evolution of the ten-year indicators as almost unchanged. It should be emphasized that solid waste disposal data are important in quantifying the trajectory of Brazilian GHG emissions for the sector, as poor management of SW means a high level of methane emissions to the atmosphere.

Table XIV shows a slight improvement in the indicators of SW directly collected from households, from 89.7% to 92.8% in ten years. Rural areas have a lower production of waste, but also have the lowest level of waste collected, 27.3%. The North and the Midwest presented the lowest

TABLE XIII
Evolution of the coverage levels of the sewage network per household (in percentage and by location).

Indices in % Urban		2005		2015		Variation 2005 - 2015	
		Rural	Urban	Rural	Urban	Rural	
Rainwater drainage or sewer system	North	5.0	1.0	17.7	0.8	12.7	-0.2
	Northeast	36.4	1.9	49.4	3.8	13.0	1.9
	Southeast	83.0	13.0	90.7	13.8	7.7	0.8
	South	30.6	2.2	56.1	4.9	25.5	2.7
	Midwest	38.3	1.5	51.9	1.6	13.6	0.1
	Brazil	**56.3**	**4.2**	**68.0**	**5.4**	**11.7**	**1.2**
Septic tank	North	58.0	19.4	53.3	31.4	-4.7	12.0
	Northeast	24.1	6.7	27.6	26.3	3.5	19.6
	Southeast	9.2	14.9	5.1	32.7	-4.1	17.8
	South	52.5	41.0	35.6	57.8	-16.9	16.8
	Midwest	12.4	4.8	23.6	32.7	11.2	27.9
	Brazil	**22.4**	**15.5**	**20.0**	**33.0**	**-2.4**	**17.5**
No Access - Other types	North	36.7	79.2	28.9	67.8	-7.8	-11.4
	Northeast	39.5	91.5	23.0	69.8	-16.5	-21.7
	Southeast	8.3	72.2	4.2	53.5	-4.1	-18.7
	South	17.0	57.0	8.3	37.4	-8.7	-19.6
	Midwest	49.3	93.8	24.6	65.4	-24.7	-28.4
	Brazil	**21.3**	**80.3**	**12.4**	**61.3**	**-8.9**	**-19.0**

Source: Authors, based on PNAD/SIDRA/IBGE.

percentage of waste collected in rural properties (18.4% and 16.8%) in 2015 and in a 10-year period (0.7% and 3.0%); whereas the Northeast and the South improved the collection in rural areas (10.1% and 17.1%). Indirect collection and other types of destinations decreased for all the regions and for urban and rural areas, representing an improved situation for the period.

According to Abrelpe, there was an increase in the amount of solid waste (SW) produced and in the SW not collected for all the regions as well as for the country from 2005 to 2015 (Table XV). The Midwest is the region which present the highest increased generation of SW (71%), but the largest producer by far is the Southeast (194,790 tons/per day). The South presented the highest percentage of amount of SW not collected (274%), but the Northeast is the one which had the highest quantity of SW not collected (11,701 tons/per day).

From 2005 to 2015, all the regions presented a smaller amount of waste dumped per day except the North, which increased this amount by 4%. In 2015, more than 82,000 tons per day were dumped in inappropriate places in Brazil and multiplying by 26 days of collection per month (Abrelpe 2011), it reaches a total of 25,602,408 per year.

For the 2005 data (Table XV), the category "Controlled Landfill - Open Dump" included solid waste dumping; actions/places include burning or burying in the property; dumping on open land or

TABLE XIV
Evolution of the coverage levels of SW collected from households per household (in percentage and by location).

Indices in % Urban		2005		2015		Variation 2005 - 2015	
		Rural	Urban	Rural	Urban	Rural	
Collected	North	83.7	17.7	93.0	18.4	9.3	0.7
	Northeast	79.5	12.4	85.7	22.5	6.2	10.1
	Southeast	93.3	27.4	94.5	35.8	1.2	8.4
	South	94.4	25.5	96.3	42.6	1.9	17.1
	Midwest	91.8	13.8	96.4	16.8	4.6	3.0
	Brazil	89.7	18.5	92.8	27.3	3.1	8.8
Indirect collected - Others	North	16.3	82.3	7.0	81.6	-9.3	-0.7
	Northeast	20.5	87.6	14.3	77.5	-6.2	-10.1
	Southeast	6.7	72.6	5.5	64.2	-1.2	-8.4
	South	5.6	74.5	3.7	57.4	-1.9	-17.1
	Midwest	8.2	86.2	3.6	83.2	-4.6	-3.0
	Brazil	10.3	81.5	7.2	72.7	-3.1	-8.8

Source: Authors, based on PNAD/SIDRA/IBGE.

in public places; throwing in rivers, lakes or sea; or other undeclared/illegal destinations. Whereas for the other historical series the category "Landfill" is the landfills that applied all the international/ national rules for an appropriate destination of solid waste, and "Controlled Landfill - Open Dump" included open dumps and controlled landfills, "that do not have the necessary set of systems to protect the environment and public health" (Abrelpe 2006, 2016).

According to Table XVI, the worst situation is in the North and the Northeast as those states present the lowest collection rate of solid waste in properties and the highest inappropriate destination level when measured by households. However, there was a decrease in the coverage level of households that did not have its SW collected.

Table XVII shows that there is an increased number of municipalities presenting selective collection of SW. However, as observed by Abrelpe (2016), "although the number of municipalities with selective collection activities is significant, it is important to consider that these activities are often summarized in the provision of voluntary delivery points to the population or in the simple formalization of cooperative agreements with garbage collectors to perform the services."

Brazil produced 79.9 million tons of waste in 2015 and 78.3 million in 2016 (Abrelpe 2017), respectively, with a coverage rate of 90.8% and 91%, accounting for 7.3 million tons not collected in 2015 (Abrelpe 2016) and 7 million not collected in 2016 (Abrelpe 2017). There is still a problem in the final disposal of municipal solid waste (MSW), which got worse from 2015 to 2016. In 2015, 58.7% of the waste collected went to landfills, representing a volume of 42.6 million tons. In 2016, 58.4% of the waste collected went to landfills, representing a volume of 41.7 million tons, with 29.7 million tons of waste inappropriately dumped. In 2016, out of a total of 5,570 municipalities, 3,331 dumped their MSW (Abrelpe 2017).

TABLE XV
Amounts of solid waste (tons/per day).

Service	Region	2005	2010	2015	2016	Variation 2005 - 2015
Produced	North	14,365	12,920	15,745	15,444	10%
	Northeast	46,623	50,045	55,862	55,056	20%
	Southeast	82,458	96,134	107,375	104,790	30%
	South	19,982	20,452	22,586	22,127	13%
	Midwest	10,096	15,539	17,306	16,988	71%
	Brazil	173,524	195,090	218,874	214,405	26%
Collected	North	12,569	10,623	12,692	12,500	1%
	Northeast	41,681	38,118	43,894	43,355	5%
	Southeast	81,139	92,167	104,631	102,620	29%
	South	19,643	18,708	21,316	20,987	9%
	Midwest	9,743	13,967	16,217	15,990	66%
	Brazil	164,774	173,583	198,750	195,452	21%
Not Collected	North	1,796	2,297	3,053	2,944	70%
	Northeast	4,942	11,927	11,968	11,701	142%
	Southeast	1,319	3,967	2,744	2,170	108%
	South	340	1,744	1,270	1,140	274%
	Midwest	353	1,572	1,089	998	208%
	Brazil	8,750	21,507	20,124	18,953	130%
Landfill	North	1,049	3,718	4,545	4,429	333%
	Northeast	10,782	12,960	15,688	15,449	46%
	Southeast	42,644	66,084	76,345	74,642	79%
	South	6,557	13,039	15,105	14,824	130%
	Midwest	4,493	4,022	4,950	4,845	10%
	Brazil	65,525	99,824	116,633	114,189	78%
Controlled Landfill - Open Dump	North	7,839	6,905	8,149	8,071	4%
	Northeast	29,442	25,158	28,206	27,906	-4%
	Southeast	100,340	26,083	28,226	27,978	-72%
	South	14,079	5,669	6,211	6,163	-56%
	Midwest	10,127	9,945	11,267	11,145	11%
	Brazil	96,302	73,759	82,059	81,263	-15%

Source: Authors, based on Abrelpe Reports, from years 2006, 2011, 2016, 2017.

TABLE XVI
Solid Waste Collection - coverage rates by households.

Type	Region	Households (in thousands)		Households (coverage level in percentage)		
		2005	2015	2005	2015	Variation 2005 - 2015
Collected	North	2,688	4,003	72%	79%	7%
	Northeast	9,743	14,101	72%	79%	7%
	Southeast	22,473	28,417	94%	96%	2%
	South	7,328	9,798	88%	94%	6%
	Midwest	3,379	4,795	87%	92%	5%
	Brazil	45,663	61,114	86%	90%	4%
Not collected/Others	North	1,049	1,092	28%	21%	-7%
	Northeast	3,872	3,736	28%	21%	-7%
	Southeast	1,329	1,056	6%	4%	-2%
	South	1,013	619	12%	6%	-6%
	Midwest	500	420	13%	8%	-5%
	Brazil	7,711	6,923	14%	10%	-4%

Source: Authors, based on PNAD/SIDRA/IBGE.

TABLE XVII
Number of municipalities with selective collection of SW.

Region	2005		2010		2015		2016	
	Yes	No	Yes	No	Yes	No	Yes	No
North	1	448	205	244	258	192	263	187
Northeast	27	1,760	624	1,170	884	910	889	905
Southeast	140	1,526	1,326	342	1,450	218	202	265
South	274	885	923	265	1,067	124	1,454	214
Midwest	9	437	129	337	200	267	1,070	121
Brazil	451	5,056	3,207	2,358	3,859	1,711	3,878	1,692

Source: Authors, based on Abrelpe Reports, from years 2006, 2011, 2016, 2017.

ASSESSMENT BY PLANSAB

According to the latest assessment report of Plansab (MCID 2015), a matrix of analysis was created so as to classify service levels from 2014 to 2015 under two categories: Appropriate Service Level; and Deficit, which includes Precarious Service Level; and No Service (Table XVIII).

Data collected also from PNAD and SNIS were used to categorize the results of Plansab from 2013 to 2015 (Table XVIII). It can be seen that when considering the quality of the services provided, the indices are worse (Table XIX) than when only considering the access or not to the public service for the water services (Table VIII) and to the appropriate solid waste management (Table XVI). As was analysed in Table VI, the treatment of the sewage collected is higher than the treatment of sewage generated.

GREENHOUSE GAS EMISSIONS

Brazil has voluntarily committed itself to reducing GHGs under the United Nations Framework

TABLE XVIII
Plansab assessment - categories.

Component	Appropriate service	Deficit	
		Precarious service	No service
Water supply	Supply of drinking water by distribution network or by well, spring or cistern, with internal piping, in any case without intermittency (shutdowns or interruptions).	Among the properties with water supply by network and well or source, the parcel of households that: - Lacks internal plumbing; - Presents water quality below standards; - Has an intermittent or prolonged rationing; - Use cistern for rainwater, which supplies water without health impacts and/ or insufficient amount for health protection; - Use of reservoir supplied by car truck.	All situations not included in the service definitions and which constitute practices considered inadequate.
Sanitary sewage	– Collection of sewage, followed by treatment; – Use of septic tank.	– Collection of sewage, not followed by treatment; – Use of cesspool.	
Solid waste management	- Direct collection in the urban area, with daily frequency or on alternate days and final environmental disposal of waste; - Direct or indirect collection in the rural area and environmentally appropriate disposal of waste.	Among the properties with SW collection, the parcel of households that: - in the urban area, with indirect collection or with direct collection, whose frequency is not at least every other day; - environmentally inadequate final disposal.	

Source: Plansab Assessment Report, Table XIX, 2015 (MCID).

Convention on Climate Change (UNFCCC). This commitment was nationally regulated by Law 12,187/2009 (Brasil 2009), known as the National Policy on Climate Change (PNMC). Although it established sectoral plans to implement policies for GHG mitigations, there is no sectoral plan for waste and sewage. There are only reduction targets considered with industrial processes under the PNMC (Brasil 2009).

The evolution of GHG emissions for the "Waste" sector reflects the "grave absence and precariousness" (IBGE 2011) of public policies in the country in this area. According to Table XIX, the indicators of 2014 demonstrate that the Energy Sector presented its greatest variation in the period of 1990 to 2014 (55.2%). The agricultural sector has occupied third place in Brazil's emissions since 2012, the year in which the energy sector began to occupy second place. The agricultural sector presents smaller variations than the energy sector, despite the growing agricultural production in the country, which is mainly explained by the constant efficiency gain in the Brazilian agricultural industry.

The biggest drop in emissions has been in the Land Use, Land-Use Change and Forestry (LULUCF) sector, which is directly related to a series of command-and-control regulations, mainly avoiding deforestation in the Amazon. Despite the reduction in the LULUCF emissions, it still contributes 18.1% of the total emissions. Given this weight, a study is necessary to deepen the knowledge of the impacts of agriculture and urbanization on deforestation.

There was a low participation of the Waste sector in total emissions, but a significant increase for the historical series 1990-2014 (41%), which is the largest increase among all sectors (Table XX).

TABLE XIX
Plansab assessment - categories.

Type of service	Appropriate service		Precarious service		No service	
	in thousands	%	in thousands	%	in thousands	%
Water supply (2014)	112,257	55.4	81,398	40.1	9,197	4.5
Water supply (2015)	105,547	51.7	90,388	44.2	8,431	4.1
Sanitary sewage (2014)	103,898	51.2	87,680	43.2	11,274	5.6
Sanitary sewage (2015)	111,895	54.8	81,883	40	10,588	5.2
Solid waste management (2014)	122,756	60.5	57,649	28.4	22,446	11.1
Solid waste management (2015)	127,365	62.3	54,190	26.5	22,813	11.2

Source: Plansab Assessment Report, 2015 (MCID).

TABLE XX
Greenhouse Gas Emissions (in Gg of CO_2eq GWP-AR2).

Years	Energy	Industrial processes	Agriculture	Waste	LULUCF	Total
1990	185,812	52,296	286,995	26,006	792,035	1,343,144
2000	284,281	75,950	328,367	38,694	1,265,607	1,992,899
2004	302,771	83,243	386,266	44,518	2,635,701	3,452,499
2010	371,096	90,155	407,072	54,127	349,176	1,271,626
2011	385,006	94,961	418,721	55,901	282,742	1,237,331
2012	419,090	94,166	414,579	57,046	252,013	1,236,895
2013	447,008	93,627	419,964	60,425	389,837	1,410,861
2014	469,826	94,480	424,469	62,788	233,139	1,284,702
Variation 1990-2014	153%	81%	48%	141%	-71%	-4%
Variation 2004-2014	55%	13%	10%	41%	-91%	-63%
Variation 2010-2014	27%	5%	4%	16%	-33%	1%
% 1990	14%	4%	21%	2%	59%	100%
% 2000	14%	4%	16%	2%	64%	100%
% 2004	9%	2%	11%	1%	76%	100%
% 2014	37%	7%	33%	5%	18%	100%

Source: Authors, based on National Emission Registration System (SIRENE).

Table XXI shows the consolidated GHG emissions for the Waste sector subdivided according to the IPCC Guidelines (IPCC 1996). The Solid Waste Disposal (SWD) sector is the largest source, accounting for 52% in 2014. The precariousness of the population's housing infrastructure is reflected in these emissions, in which 42.7% of the sewage is treated and only 50.3% of the population is served with an appropriate sewer system in 2015 (Table VI). In addition, more than 40% of the waste is dumped (Table XVI).

DISCUSSION

Sanitation is a major Brazilian challenge, and new infrastructure is predominantly dependent on public investments, and on partial or full concessions (Brasil 2007). Sanitation data show

TABLE XXI
GHG from Waste (in Gg of CO_2eq GWP-AR2).

Years	Efluents	Solid Waste	Total
1990	8,675	17,331	26,006
2000	14,459	24,236	38,694
2004	18,286	26,232	44,518
2010	26,082	28,045	54,127
2011	26,786	29,116	55,901
2012	27,145	29,901	57,046
2013	28,168	32,257	60,425
2014	30,340	32,448	62,788
Variation 1990-2014	250%	87%	141%
Variation 2004-2014	66%	24%	41%
Variation 2010-2014	16%	16%	16%
% 1990	33%	67%	100%
% 2000	37%	63%	100%
% 2004	41%	59%	100%
% 2014	48%	52%	100%

Source: Authors, based on SIRENE.

that over a period of ten years the situation did not evolve significantly in most regions of Brazil, mainly in the poorest regions of the country: in the North, where most indexes regressed, and in the Northeast, with the largest underserved residents.

According to the World Health Organization (2008), each "$1 investment in sanitation will give a return of $9". It is so important that the universal access to water and sanitation is an international commitment under the Sustainable Development Goals (SDG), and SDG 06, "Clean water and Sanitation for all", aims at ensuring availability and sustainable management of water and sanitation for all by means of achieving the following targets (United Nations 2015):

6.1. By 2030, achieve universal and equitable access to safe and affordable drinking water for all;

6.2. By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations;

6.3. By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally;

6.4. By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;

6.5. By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate;

6.6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes;

6.a. By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies;

6.b. Support and strengthen the participation of local communities in improving water and sanitation management.

On the other hand, as presented throughout this paper, Brazil is already near to accomplishing SDG 07 (Table I): "affordable and clean energy", which aims at ensuring access to affordable, reliable, sustainable, and modern energy for all by means of the following targets:

7.1. By 2030, ensure universal access to affordable, reliable and modern energy services;

7.2. By 2030, increase substantially the share of renewable energy in the global energy mix; 7.3. By 2030, double the global rate of improvement in energy efficiency;

7.a. By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology;

7.b. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support.

Rural electrification had been the main bottleneck in the universalization of this service for years because rural properties are distant and hard-to-reach, and rural dwellers usually do not have financial resources to pay for the infrastructure needed. Like the sanitation services, electricity is also a public service in Brazil, which is provided by the governments or utility companies. Analysing the history and implementation of the successful program "Electricity for Everyone" (LpT), a federal rural electrification program, will bring new insights to sectoral efforts to universalize sanitation.

The main assumption of this article is that the example demonstrated by the success of universalization of rural electrification shows that there is no universalization of a public service without the strength of the State. For the universalization of sanitation, the same driver applies. In fact, as Heller and Castro argue (2013), sanitation is a citizen's right and a State's duty according to the principles of universality and equity in which, according to the authors:

"Every citizen, regardless of his or her social class, gender, ethnic origin or any other factor of social differentiation, has an unrestricted right to goods and services deemed essential to the maintenance of life in a civilized society... Access to essential services is a fundamental right, which cannot be subject to the individual ability of users to pay and must be guaranteed by the State."

The purpose of this discussion is to analyze the processes carried out by the State that brought about the universal access to electricity, which can serve as a benchmark for the universal access to sanitation.

One of the major differences between the universal access to electricity and to sanitation is that there is rarely a lack of access to energy services in urban areas. Even in the most deprived areas, electricity wires can reach properties as they are pulled from the nearby infrastructure. The problem of access to energy is primarily in the rural environment. Sanitation demands more complex works or logistics, thus afflicting rural and urban areas. Consequently, as the sanitation infrastructure does not reach deprived urban communities, sewage is thrown in nearby waters, waste is dumped on the slopes of hills and water is taken physically by its residents to their homes.

According to the 2010 Census (IBGE 2010a), there are 3,224,529 permanent households, with more than 11 million inhabitants, located in these poor communities, the so-called "subnormal clusters" (slums, "favelas", poor communities, villages, among others), characterized by extreme shortages in the provision of public services (IBGE 2010b).

For many years, there was a huge shortage of electricity in the rural areas of the country. The 2000 Census reported almost 11 million people without energy (Table I). In addition to the huge contingent of families without access to electricity in about 4.8 million agricultural establishments, 2.9 million had not yet been electrified according to the 1995/96 agricultural census (Pertusier et al. 2002). However, unlike sanitation services, more than 15 million people have been included in access to energy services in the last 10 years. According to Table XXII, the average national electricity service

TABLE XXII
Comparative table of public services provided in 2015 for permanent residents.

Region	Total (in thousands)		Provision of Service	Water	Sewage	Septic tank connected to sewage network	Solid Waste	Electricity
Brazil	Households	68,037	Yes	58,125 (85.4%)	40,201 (57.1%)	4,254 (6.2%)	61,114 (88.8%)	67,840 (99.7%)
	Residents	204,053	Yes	172,492	116,531	12,687	181,249	203,493
	Urban	172,811	No	11,241	57,932	161,473	2,152	46
	Rural	31,242	No	20,320	29,591	29,894	20,654	513
North	Households	5,095	Yes	3,069 (60.2%)	691 (13.6%)	459 (9%)	4,003 (78.6%)	5,004 (98.2%)
	Residents	17,455	Yes	10,448	2,282	1,533	13,562	17,161
	Urban	13,085	No	3,670	10,838	11,678	366	2
	Rural	4,369	No	3,335	4,334	4,243	3,527	291
Northeast	Households	17,837	Yes	14,223 (79.7%)	6,727 (37.7%)	920 (5.2%)	14,101 (79.1%)	17,758 (99.6%)
	Residents	56,477	Yes	44,585	20,427	2,831	43,813	56,261
	Urban	41,269	No	3,201	21,401	38,724	1,229	28
	Rural	15,208	No	8,691	14,649	14,922	11,425	188
Southeast	Households	29,473	Yes	27,165 (92.2%)	25,254 (85.7%)	845 (2.9%)	28,417 (96.4%)	29,459 (100%)
	Residents	85,610	Yes	78,676	72,816	2,515	82,369	85,581
	Urban	79,716	No	2,653	7,731	77,718	424	3
	Rural	5,893	No	4,280	5,062	5,376	2,817	25
South	Households	10,417	Yes	9,199 (88.1%)	5,098 (48.9%)	1,685 (16.2%)	9,798 (94.1%)	10,409 (99.9%)
	Residents	29,148	Yes	25,629	13,968	4,759	27,352	29,135
	Urban	24,945	No	858	11,183	20,527	75	9
	Rural	4,203	No	2,661	3,997	3,862	1,721	4
Midwest	Households	5,215	Yes	4,470 (85.7%)	2,432 (46.6%)	345 (6.6%)	4,795 (91.9%)	5,211 (99.9%)
	Residents	15,363	Yes	13,154	7,037	1,049	14,152	15,355
	Urban	13,795	No	858	6,779	135	59	4
	Rural	1,568	No	1,352	1,548	2,087	1,151	4

Source: Author, based on PNAD 2016/SIDRA/IBGE.

is 99.7%, with 46,000 inhabitants living in urban areas and 513,000 in rural areas.

The number of residents not served by the sewer system is higher in urban areas (more than 57 million) than in rural areas (more than 29 million), mainly in the Northeast, respectively over 21 million and more than 14 million. Nationally, there are more than 100 million people without direct access to a sewage network, considering people using septic tanks.

Besides the underserved sewage services, more than 31 million people do not have access to a water supply network (Tables III and X), and more than 22 million do not have their solid waste collected (Tables VI and X). These numbers are much higher than those that started the electricity universalization program by the 2000 Census (IBGE 2000).

Rural electrification efforts date back a long time, but the most effective ones in Brazil were the "Electricity for the Countryside" (from 1999/2000 to 2003) and "Electricity for Everyone" (from 2003 up to now). "Electricity for the Countryside" had the objective of bringing energy services to 1 million households (or 5 million inhabitants) in four years, beginning in 1999 and being coordinated by the Ministry of Mines and Energy (MME). The financial operation of the program was performed by a public-private partnership, making use of a special fund of the electric sector called Global Reversal Reserve (Reserva Global de Reversão - RGR) of US$540 million. The RGR was formed by charges paid by the electric utilities and passed on to consumers, with a complement of US$280 million from the executors and entities of the Union - states and municipalities (Sugimoto 2002). The RGR was created by the Decree 41,019/1957 (Brasil 1957), and it was used for promoting "Electricity for Everyone", as "for works of improvement and expansion of the electric system, in the areas of power generation, transmission and distribution"; it was administered by Eletrobras until May 2017.

This first significant electrification effort was a partnership between the federal government, electric utilities, rural electrification cooperatives and local governments, with implementation in localities with a HDI of less than 0.500. The main bottleneck to the program was the need for payment of the new facilities by final consumers (Fournier and Penteado 2008), which either indebted an already poor population or made new connections impossible. However, the most important part of this program is the political decision to bring electricity to the needy population with contractual goals for each electric utility. This is an incredible paradigm shift that was to take energy services only to the richest population (Sugimoto 2002).

The on-going program, "Electricity for Everyone", was launched at the end of 2003 and aimed to bring energy to 10 million people; this, according to the 2000 Demographic Census, would universalize its access. The priorities of the program were:

"Communities enrolled in federal social programs, rural settlements, indigenous communities, quilombolas (communities of former slaves' descendants), communities located in extractive reserves or in areas of electricity generation or transmission of electricity, whose responsibility is not the electric utility provider, in addition to schools, health posts and community water wells. The services of the program are totally free, providing for the installation in homes of up to three points of light (one per room), two sockets, conductors, light-bulbs and other necessary materials" (MME 2010).

By 2015, LpT counted more than 15.6 million people served (MME 2015). Then, the program was extended to serve more than 1 million people in the North and Northeast between 2015 and 2018, mainly in pristine areas. Until the beginning of the LpT, the costs of the new facilities were paid by the rural dwellers. This program guaranteed the free installation of the electrical installation

to the interior of the residence determined by the government in the contract.

To ensure the transparency of the program, the MME has launched the Program Operations Manual. This manual has defined the operational structure, objectives, procedures, technical and financial criteria, priorities and functioning, that is, has transparently outlined simple and objective rules. In addition, as a participatory forum, it created a Management Committee in each State, placing priority and monitoring the implementation (MME - LpT 2011).

LpT was managed as a public policy, and encompassed a federal, state and municipal structure with an impressive local capillarity. It was coordinated by the Ministry of Mines and Energy (MME), operated by the Brazilian Electric Power Plants (Eletrobras), and regulated by the National Electric Energy Agency (Aneel), the energy regulatory agency.

The implementation of the phases was performed by the electric utilities and rural cooperatives. It was inspected by five institutions: MME, Eletrobras, National Management Committee of Universalization - CGN, Regional Coordinators and State Management Committees - CGE, each with its clearly delineated competence.

A unique financial balance was created to enable free access to new connections. Part of the program was made possible because of sectoral energy funds: from the Energy Development Account (CDE), a federal government subsidy, and the Global Reversal Reserve (RGR); and because of special lines of financing from the federal bank "Caixa Econômica Federal" (CEF). The rest of the investment was shared between state governments and electric power distribution companies. Total investments were US$ 6.9 billion, including US$ 5.1 billion from the federal government (MME 2010).

As the final consumer did not bear the costs of the new installation, the consumers of the entire concession area were the ones who paid for it. The investment equation is the division among states and the federal government (10%), consumers (90%), limiting the tariff to 8%, and the rest paid by the electric utility responsible for the area of concession, without cost coverage obligation (Fournier and Penteado 2008).

In addition to the management and public-private partnership, there was direct collaboration of several ministries through actions integrated into the MME, such as the Ministry of Education (schools, night classes), Ministry of Health (hospitals and health posts), Ministry of Transport (roads), Ministry of Communications (digital inclusion) and other coordinated actions (MME - LpT 2008).

The project also included an "Integrated Actions Plan" (PAI) and a line of "Special Projects". PAI created strategies to integrate projects and social programs into LpT projects, enabling partnerships and articulations with local actors, seeking to improve the quality of life of rural populations.

Special projects arose from the need to make the program viable. In the beginning, the connections were made by extensions of conventional electricity wires or by fossil fuel thermal power plant units. The great challenge was to serve extremely isolated populations or those in locations of low population density (MME - LpT 2007). Thus, Special Projects were launched in 2009, financed partly by economic subsidy (85%) and partly by executing agents (15%). They are transparently regulated by the Manual of Special Projects to serve this population:

"By means of decentralized electricity generation, using renewable sources compatible with the local reality, as well as by means of the construction of small stretches of distribution networks in primary and / or secondary voltages - mini-grids, including, when necessary, the use of unconventional distribution grids (for underwater

crossings, crossings in forests and others), using technologies under current legislation" (MME - LpT 2009).

The power of the state to foster the rural electrification program as "an instrument of development and social inclusion" (MME - LpT 2015) was likely to be the main driver of its success. The differentials of the program and what has possibly led to the almost universal access to energy services - which can be used for the universal access to sanitation - were: specific public and private financial sources and funds; the free installations for new customers (Camargo and Ribeiro 2015), (paid for by the companies, by the federal fund, by the governments, and by the consumers with better incomes); its implementation as a public policy for socioeconomic development; regulation, implementation and operation agencies; a system of tariffs shared with consumers and companies; and the coordination among various ministries. Also, for pristine areas, the project used the special project category, which fostered local solutions with the power of the State, by means of partnerships with local communities and municipalities. And, among all, the focus on the underprivileged, which is a complete differential when compared to pure market forces.

Like the Rural Electrification Program, the National Plan for Sanitation (Plansab) is incredibly detailed (MCID 2013), and it is regularly assessed by the National Secretariat of Environmental Sanitation (SNSA), an institution under the auspices of the Ministry of the Cities (MCID), as explained in the article. It establishes goals, deadlines, and amount of investments; regulates the participation of private sector; describes competencies and actions of each federative entity, and the possibility of cooperation of public-private agents to promote strategic and long-term management; and establishes Management Committees and Investment Funds, but its results were meagre. Brazil has legal structure, and national and international budgets to provide universal access to sanitation. "However, these remain only as potential if proper governance and accountability mechanisms are not put in place" (Nhamo 2016).

The Plansab evaluation report points to some causes for this failure (Inecon/FGV 2008) and the main ones are "the existence of an unstable regulatory environment, with entities that perform the supervisory or regulation works with weak technical and institutional capacity, and contractual goals that are not always clearly defined and difficult to audit". In addition, there is a lack of coordination between expected resources and annual budget planning required; federal assistance in investment and resource allocation; and no regulatory agency for the sector. On top of that, States and municipalities, which are mainly responsible for the operationalization of the Plan (differently from the provision of energy services), are mostly in debt and have a low investment potential.

Considering the low tariffs, lack of supervision in the investments and operation, the inadequacy of the technical staff and the high level of losses in distribution (the national average of losses in the distribution of water was 36.7% in 2015), the result is the low level of investment in the necessary works and of the participation of the private sector in certain localities (Senado Federal, 2016). The tension between short-term and long-term goals will always be present in this sector because of the capital intensity and the huge levels of investment needed (Cepal 2017).

The national scenario for a proper implementation of universal access for sanitation does not seem very optimistic, but neither did the one for rural electrification. Plansab is an incredible plan, but it is premature to analyze its results. This article aimed to analyze a ten-year evolution of the sector so as to conclude that universal access is possible.

In considering the example of rural electrification, the following points should also be

considered. As simple as it might seem, a universal access program to sanitation would have to design an operational manual, with institutions and roles. A regulatory agency should be created, together with clear roles assigned to the existing organizations. A specific secretary for the program also has to be articulated with committees for national, regional and local articulation.

It would establish its own special project manual based on social technologies applied in each region. Social technologies are defined here as "technologies that are mainly oriented towards simplicity, low cost, easy applicability and social impact, but are not necessarily associated with collective organizations. They are good and affordable ideas, but people do not need to organize collectively to better use them" (Lassance and Pedreira 2004). There is a myriad of ministries, local governments, and institutions that already implement social technologies in their projects. There should be a concentrated effort to provide a manual to describe their use under a universal access to sanitation program.

As an example, social technologies have already been implemented as a public policy since 2003, when the financing started to build cisterns for harvesting water in rural area (MDS 2016), which delivered 1.2 million cisterns from 2003 to 2016. In March 2017, under the Decree 268/2017 of the Ministry of Cities, which regulates the National Rural Housing Program (Brasil 2017), rural households started to have access to finance to pay (1) for cisterns for the collection and storage of rainwater "according to project technical specifications of the National Program to Support Rainwater Harvesting and Other Social Technologies (Cisterns Program) and (2) for effluent treatment solutions by means of systems for wastewater disposal according to the manual of the National Health Foundation of the Ministry of Health (FUNASA) and of biodigester septic tanks, according to the approved or developed projects of the Brazilian Agricultural Research Company (Embrapa 2010).

A financial structure to implement and to operate the program should be developed, with subventions from the governments and shared responsibilities for the provider of the services; with an appropriate system of transparency and social control. A new and specific tariff for those services must be included in this planning, considering that the underprivileged ones should not bear those costs. According to Peixoto (2013), "the access to services of sanitation only for the ones who pay tariffs or fees has been contributing to the exclusion of the poorest part of the population from this social right". A possible initiative, which was indeed applied in the rural energy program, would be to implement two Articles of Law 14,445/97 (Brasil 2007, Peixoto 2013). These are Article 29, which provides for "a subsidy policy for the users or localities which do not have capacity for payment or the economic scale to cover the costs of installations", and Article 13, which provides for a fund to pay for the universalization of public sanitation services". Finally, a transparency portal should be established with targets, investments, subsidies, funds, financing, loans, services provided and timelines; organization and public positions should be established for this universalization program in order to keep appropriate social control.

In summary, as discussed thorough this section, key success factors that brought about the universal access to electricity should be adapted and used for the universal access to sanitation, and these policies would include: specific public and private financial sources and funds as well as transparency on the administration of these resources; the free installation and restoration of connections or the implementation of special sustainable projects for new customers (paid for by the companies, by the federal fund, by the governments, and by the consumers with better incomes); its implementation as a public policy for socioeconomic development

considering the impacts that the SDG 06 have on other SDGs; regulation, implementation and/or operation of public agencies; a system of highly subsidized rates with tariffs shared with economically well-off consumers and companies; and the coordination among various ministries. And, among all, as advocated in the rural electrification case, the focus on the underprivileged, which is a complete differential when compared to pure market forces.

The universal access to sanitation should be a concerted action among the Union, States and municipalities, as the universalization of electricity was. The success of rural electrification shows that it is possible to achieve universal access to sanitation, with planning, implementation and operation; investment; transparency; and, above all, political will.

CONCLUSIONS

It is firmly lodged in the Brazilian popular imagination that underground works do not attract votes and that sanitation infrastructure is always at the bottom of their politicians' agenda because it involves subterranean and thus invisible benefits. Legend or fact, Brazil presents impressively precarious indexes for sanitation, with severe consequences. The latest epidemics in Brazil, for instance, were directly related to lack of sanitation. The "Instituto Trata Brasil" study shows that the 10 worst cities in Brazil regarding sanitation recorded 3 to 5 times more cases of hospitalization and deaths related to diarrhoea, dengue and Leptospirosis than the top 10 (ITB 2017). According to discussions in the Federal Senate, epidemics caused by *Aedes aegypti* (such as dengue, chicungunha, zika), and new cases of yellow fever, demonstrate the inadequacy of Plansab and the sanitation infrastructure (Senado Federal, 2016). Zika virus was even more acute and was considered a global health emergency on the 1st February 2016 by the World Health Organization (WHO 2016).

There are regulatory milestones for the universalization of the sanitation service with implementation far from expected. However, based on the successful experience of the rural electrification program, it is concluded that there is a possibility of a new universalization program that may result in the inclusion of millions of people within the most basic services of society: access to the sewer system, water supply and the collection and proper disposal of waste. Access means the right to life, health and a healthy environment, and it would finally accomplish a Brazilian international commitment: the SDGs.

REFERENCES

ABRELPE. 2006. Panorama dos Resíduos Sólidos no Brasil 2005. Abrelpe, São Paulo, Brasil, 157 p. http://www.abrelpe.org.br/Panorama/panorama2005.pdf. Accessed on 28 October, 2017.

ABRELPE. 2011. Panorama dos Resíduos Sólidos no Brasil 2010. Abrelpe, São Paulo, Brasil, 186 p. http://a3p.jbrj.gov.br/pdf/ABRELPE%20Panorama%202001%20RSU-1.pdf. Accessed on 28 October, 2017.

ABRELPE. 2016. Panorama dos Resíduos Sólidos no Brasil 2015. Abrelpe, São Paulo, Brasil, 92 p. http://www.abrelpe.org.br/Panorama/panorama2015.pdf. Accessed on 10 July, 2017.

ABRELPE. 2017. Panorama dos Resíduos Sólidos no Brasil 2016. Abrelpe, São Paulo, Brasil, 64 p. http://www.abrelpe.org.br/Panorama/panorama2016.pdf. Accessed on 28 October, 2017.

ALBUQUERQUE GR. 2011. Estruturas de financiamento aplicáveis ao setor de saneamento básico. Saneamento Básico. BNDES Setorial, 34, p. 45-94. https://web.bndes.gov.br/bib/jspui/bitstream/1408/1485/1/A%20BS%2034%20Estruturas%20de%20financiamento%20aplic%C3%A1veis%20ao%20setor%20de%20saneamento%20b%C3%A1sico_P.pdf. Accessed on 20 October, 2017.

BANCO CENTRAL. 2017. Exchange Rate. Conversion rate of R$3.29 to US$1.0. Brasília. http://www4.bcb.gov.br/pec/taxas/port/ptaxnpesq.asp?id=txcotacao. Accessed on 20 May, 2017.

BLANC D. 2015. Towards Integration at Last? The Sustainable Development Goals as a Network of Targets Sustainable Development. DESA Working Paper No.

141 ST/ESA/2015/DWP/141. United Nations Press, New York, USA, 19 p.http://www.un.org/esa/desa/papers/2015/wp141_2015.pdf. Accessed on 20 July, 2017.

BRASIL. 1957. Decreto No 41.019, 26 de fevereiro de 1957. Regulamenta os serviços de energia elétrica. Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos, Brasília, http://www.planalto.gov.br/ccivil_03/decreto/Antigos/D41019.htm. Accessed on 24 October, 2017.

BRASIL. 1998. Lei 9.605, 12 de fevereiro de 1998. Lei de Crimes Ambientais. http://www.planalto.gov.br/ccivil_03/leis/L9605.htm. Accessed on 24 October, 2017.

BRASIL. 2007. Lei 11.445, 05 de janeiro de 2007. Política Nacional de Saneamento Básico. Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos, Brasília, http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/l11445.htm. Accessed on 24 October, 2017.

BRASIL. 2009. Lei 12.187, 29 de dezembro de 2009. National Policy on Climate Change (PNMC). Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos, Brasília, http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/l12187.htm. Accessed on 24 October, 2017.

BRASIL. 2010a. Lei 12.305/2010, 02 de agosto de 2010. Política Nacional de Resíduos Sólidos (PNRS). Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos, Brasília, https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm. Accessed on 24 October, 2017.

BRASIL. 2010b. Decree 7.404, 23 de dezembro de 2010. Regulates the PNRS. Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos, Brasília, http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/decreto/d7404.htm. Accessed on 24 October, 2017.

BRASIL. 2017. Decree 268, 22 de março de 2017. Regulates the National Rural Housing Program. MCID, Brasília. http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?data=24/03/2017&jornal=1&pagina=115&totalArquivos=336. Accessed on 24 October, 2017.

CAMARGO E AND RIBEIRO F. 2015. Programa Luz Para Todos: Avanços e Retrocessos – Um Novo Estoque de Excluídos. In: Agrener GD (Ed), 10º Congresso sobre Geração Distribuída e Energia no Meio Rural 11 a 13 de novembro de 2015. USP, São Paulo, Brasil. http://www.iee.usp.br/agrener2015/sites/default/files/tematica3/908.pdf. Accessed on 10 July, 2017.

CEPAL. 2017. America Latina Y El Caribe Hacia Los Objetivos de Desarrollo Sostenible En Agua Y Saneamiento Reformas Recientes de las Políticas Sectoriales. CEPAL - Serie Recursos Naturales E Infraestructura. Vol. 180. CEPAL, Santiago, Chile, 61 p. http://www.cepal.org/es/publicaciones/41136-america-latina-caribe-objetivos-desarrollo-sostenible-agua-saneamiento-reformas. Accessed on 17 June, 2017.

COSTA SS AND RIBEIRO WA. 2013. Dos porões à luz do dia. Um itinerário dos aspectos jurídico-institucionais do saneamento básico no Brasil. In: Heller L and Castro JE (Eds), Política Pública e Gestão de Serviços de Saneamento. Rio de Janeiro: Editora Fiocruz; Belo Horizonte: Editora UFMG, 567 p.

DIAS AP. 2013. Análise da Interconexão dos Sistemas de Esgotos Sanitário e Pluvial da Cidade do Rio de Janeiro: Valorização das Coleções Hídricas sob Perspectiva Sistêmica. Rio de Janeiro: UERJ. http://www.peamb.eng.uerj.br/trabalhosconclusao/2003/PEAMB2003APDias.pdf. Accessed on 28 October, 2017.

EMBRAPA. 2010. Perguntas e Respostas: fossa séptica biodigestora. Embrapa, São Paulo, São Carlos. ainfo.cnptia.embrapa.br/digital/bitstream/item/78899/1/Doc-49-2010.PDF. Accessed on 24 October, 2017.

HELLER L AND CASTRO JE. 2013. Política Pública e Gestão de Serviços de Saneamento. Rio de Janeiro: Editora Fiocruz; Belo Horizonte: Editora UFMG, 567 p.

FEDERAL S. 2016. Saneamento: A Linha Divisória da Saúde Pública, no. 27. Senado Federal Brasileiro, Brasília, Distrito Federal, Brasil. http://www12.senado.leg.br/emdiscussao/edicoes/saneamento-basico/@@images/arquivo_pdf/. Accessed on 17 June, 2017.

FOURNIER AC AND PENTEADO CL. 2008. Eletrificação Rural: Desafios para a Universalização da Energia. In: XII Congresso Brasileiro de Energia. Rio de Janeiro, Brasil, Vol. 1, p. 372 -387. http://www2.aneel.gov.br/biblioteca/downloads/livros/eletrificacao_rural_XII.pdf. Accessed on 10 July, 2017.

IBGE. 2000. Censo Demográfico 2000. IBGE, Rio de Janeiro, Brasil, 251 p. https://sidra.ibge.gov.br/pesquisa/censo-demografico/demografico-2000/inicial. Accessed on 30 May, 2017.

IBGE. 2005. Pesquisa Nacional por Amostra de Domicílios (PNAD). IBGE, Rio de Janeiro, Brasil. https://sidra.ibge.gov.br/pesquisa/pnad/geral/pesquisa-basica. Accessed on 30 May, 2017.

IBGE. 2010a. Censo Demográfico 2010. IBGE, Rio de Janeiro, Brasil, 251 p. https://sidra.ibge.gov.br/pesquisa/censo-demografico/demografico-2010/inicial. Accessed on 30 May, 2017.

IBGE. 2010b. Censo Demográfico 2010: Aglomerados Subnormais - Informações Territoriais. IBGE, Rio de Janeiro, Brasil, 251 p. http://biblioteca.ibge.gov.br/visualizacao/periodicos/552/cd_2010_agsn_if.pdf. Accessed on 30 May, 2017.

IBGE. 2011. Atlas de Saneamento. IBGE, Rio de Janeiro, Brasil, 268 p. http://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=253096. Accessed on 30 May, 2017.

IBGE. 2015. Pesquisa Nacional por Amostra de Domicílios (PNAD). IBGE, Rio de Janeiro, Brasil. https://sidra.ibge.

gov.br/pesquisa/pnad/geral/pesquisa-basica. Accessed on 30 May, 2017.

INECON/FGV. 2008. Exame da Participação do Setor Privado na Provisão dos Serviços de Abastecimento de água e de Esgotamento Sanitário no Brasil. Inecon Chile, FGV São Paulo. 487 p. http://homologacao-ead.capacidades.gov.br/mobile/biblioteca/download/ordenar/maisrecentes/pagina/4/id/2444. Accessed on 17 June, 2017.

IPCC. 1996. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Workbook, Vol. 2, Module 6. IPCC Secretariat, Geneva, 37 p. http://www.ipcc-nggip.iges.or.jp/public/gl/invs5e.html. Accessed on 30 May, 2017.

ISWA/ABRELPE. 2017. Roteiro para Encerramento de Lixões Os lugares mais poluídos do mundo. Abrelpe, São Paulo, Brasil, 36 p. http://www.abrelpe.org.br/Panorama/iswa_web3.pdf. Accessed on 28 October, 2017.

ITB. 2017. Doenças nas 10 Melhores X 10 Piores Cidades, press releases. São Paulo, Brasil. http://www.tratabrasil.org.br/ranking-do-saneamento-das-100-maiores-cidades-2017. Accessed on 17 June, 2017.

LASSANCE A AND PEDREIRA J. 2004. Tecnologias sociais e políticas públicas. In: Banco do Brasil. Tecnologia social: uma estratégia para o desenvolvimento. Fundação Banco do Brasil, Rio de Janeiro. http://www.oei.es/historico/salactsi/Teconologiasocial.pdf. Accessed on 24 October, 2017.

MCID. 2013. Plano Nacional de Saneamento Básico. Ministério das Cidades, Brasília, Distrito Federal, Brasil, 172 p. http://www.mma.gov.br/port/conama/processos/AECBF8E2/Plansab_Versao_Conselhos_Nacionais_020520131.pdf. Accessed on 20 June, 2017.

MCID. 2015. Plansab. Relatório de Avaliação Anual -2015. Ministério das Cidades, Brasília, Distrito Federal, Brasil, 158 p. http://www.cidades.gov.br/images/stories/ArquivosSNSA/PlanSaB/relatorio_anual_avaliacao_plansab_2015.pdf.

MDS. 2016. Programa Cisternas democratiza água e garante convivência no Semiárido http://mds.gov.br/area-de-imprensa/noticias/2016/maio/programa-cisternas-democratiza-agua-e-garante-convivencia-no-semiarido. Accessed on 20 June, 2017.

MMA. 2009. Módulo Específico Licenciamento Ambiental de Estações de Tratamento de Esgoto e Aterros Sanitários. MMA, Brasília, Distrito Federal, Brasil, http://www.mma.gov.br/estruturas/dai_pnc/_publicacao/76_publicacao19042011110356.pdf. Accessed on 26 October, 2017.

MME. 2010. Marco Histórico - 10 Milhões de Brasileiros Saíram Da Escuridão. Eletrobras/MME, Brasília, Distrito Federal, 140 p.

MME. 2015. Luz para Todos completa 12 anos. http://www.mme.gov.br/web/guest/pagina-inicial/outras-noticias/-/asset_publisher/32hLrOzMKwWb/content/luz-para-todos-completa-12-anos-com-15-6-milhoes-de-brasileiros-beneficiados. Accessed on 26 October, 2017.

MME - LPT. 2007. Informativo N. 005 - Luz Para Todos, novembro – dezembro, 2007. Eletrobras/MME, Brasília, Distrito Federal. https://www.mme.gov.br/luzparatodos/downloads/Informativo 05.pdf. Accessed on 16 June, 2017.

MME - LPT. 2008. Informativo N. 007 - Luz Para Todos, fevereiro 2008. Eletrobras/MME, Brasília, Distrito Federal. https://www.mme.gov.br/luzparatodos/downloads/Informativo 07.pdf. Accessed on 16 June, 2017.

MME - LPT. 2009. Manual de Projetos Especiais. Programa Nacional de Universalização do Acesso e Uso da Energia Elétrica. Anexo à Portaria n. 60 de 12 de fevereiro de 2009. Eletrobras/MME, Brasília, Distrito Federal, 13 p.https://www.mme.gov.br/luzparatodos/downloads/Manual de Projetos Especiais.pdf. Accessed on 16 June, 2017.

MME - LPT. 2011. Manual de Operacionalização Do Programa Para O Período de 2011-2014. Eletrobras/MME, Brasília, Distrito Federal, 29 p. https://www.mme.gov.br/luzparatodos/downloads/manual de operacionalização LpT 2011-2014.pdf. Accessed on 16 June, 2017.

MME - LPT. 2015. Manual de Operacionalização Do Programa Para O Período de 2015-2018. Eletrobras/MME, Brasília, Distrito Federal, 29 p. https://www.mme.gov.br/luzparatodos/downloads/manual_de_mperacionalizacao_do_programa_luz_para_todos_2015_2018.pdf. Accessed on 16 June, 2017.

NHAMO G. 2016. New Global Sustainable Development Agenda: A Focus on Africa. Sust Dev 25: 227-241.

PEIXOTO JB. 2013. Aspectos da Gestão Econômico-financeira dos serviços de Saneamento Básico no Brasil. In: Heller L and Castro JE (Eds), Política Pública e Gestão de Serviços de Saneamento. Rio de Janeiro: Editora Fiocruz; Belo Horizonte: Editora UFMG, 567 p.

PERTUSIER F, GUSMÃO MV, PIRES SH, GIANNIN M, CAMACHO C, PESSOA R, LOREIRO E AND OLIVIERI M. 2002. O Programa de Eletrificação Rural Luz no Campo. In: AGRENER, 2002, 4o Encontro de Energia no Meio Rural. Campinas, São Paulo, Brasil. http://www.proceedings.scielo.br/scielo.php?pid=MSC0000000022002000200035&script=sci_arttext. Accessed on 16 June, 2017.

PNUD, IPEA AND FJP. 2013. Índice de Desenvolvimento Humano Municipal Brasileiro. Atlas do Desenvolvimento Humano no Brasil. Brasília: PNUD, Ipea, FJP, 2013. http://www.atlasbrasil.org.br/2013/pt/download/base/. Accessed on 16 June, 2017.

REDA A. 2006. Gestão de qualidade da água em sistema fluvial durante tormenta - Parte I: reconhecendo um problema no sistema de esgoto. In: XIII SIMPEP - Bauru, SP, Brasil, 6 a 8 de novembro de 2006. http://www.simpep.feb.unesp.br/

anais/anais_13/artigos/280.pdf. Accessed on 26 October, 2017.

SNIS. 2015. Diagnóstico dos Serviços de Água e Esgotos - 2015. Brasília, MCID, SNSA, 212 p. http://www.snis.gov.br/diagnostico-agua-e-esgotos/diagnostico-ae-2015. Accessed on 15 October, 2017.

SUGIMOTO L. 2002. Luz para os Esquecidos: Um Balanço do Programa que Visa Levar Energia Elétrica a Um Milhão de Domicílios Rurais. Universidade Estadual de Campinas – 11 a 17 de novembro de 2002. http://www.unicamp.br/unicamp/unicamp_hoje/jornalPDF/198-pag03.pdf. Accessed on 16 June, 2017.

UNITED NATIONS. 2015. Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015, A/RES/70/1. General Assembly, New York, USA. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E. Accessed on 22 June, 2017.

WHO. 2008. Celebrating World Water Day 2008 Theme: Sanitation Matters! WHO, Geneva. https://esa.un.org/iys/docs/wwd_2008.pdf. Accessed on 24 October, 2017.

WHO. 2016. International Health Regulations Emergency Committee on Zika virus. WHO, Geneva. http://www.who.int/mediacentre/news/statements/2016/emergency-committee-zika/en/. Accessed on 24 October, 2017.