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BRAZILIAN WASTEWATER TREATM
MARKET OVERVIEW

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ABSTRACT

Title of the Publication:

BRAZILIAN WASTEWATER TREATMENT MARKET OVERVIEW

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Keywords: Brazil, wastewater market, water treatment, market overview

This thesis is based on an interest in the Brazilian market for domestic and industrial wastewater treatment with the desire of creating a channel for the commercialization of technological solutions for this industry sector. Therefore, the focus of the thesis is to identify the operational regiments, as well as their regulations and market demand.

The purpose of this thesis is to create a theoretical as well as a practical research that can provide an evaluation of the Brazilian wastewater treatment market to identify its market opportunities for CEMIS business development department. The topic of this thesis is inspired by the work that the author has completed in his practical training as part of his bachelor´s degree in International Business at the Kajaani University of Applied Sciences. Having the research questions as: How does the Brazilian domestic environmental factors affect CEMIS to commercialize its technology in Brazil?

To develop a theoretical framework, a review of the existing literature has helped the author with the fundamental knowledge to investigate the objectives of the thesis. Following by analysis guide in the literature on what is marketing research, concept its definition and Internationalization contextual role and, the use of input-mode theories chosen as a unit of analysis.

Thus, the thesis presents an overview of the water treatment industry in Brazil, including detailed information on the environment of the Brazilian wastewater treatment market. Based on the information collected, the investigative research perceives the associated factors of a market expansion for the Brazilian market and how it should be conducted as the recommendation.

The results give the current situation of the target market. It identifies the business opportunities to enter the market by using more clean technology. In addition, this thesis identifies business options for CEMIS to enter into cooperation agreements with the environmental offices of the Brazilian government.

CONTENTS

LIST OF ABBREVIATIONS

ABNT - Brazilian National Standards Organization / Associação Brasileira de Normas Técnicas

ANA - National Water Agency / Agência Nacional de Águas

ABAR - Brazilian Association of Regulatory Agencies / Associação Brasileira de Agencias Reguladoras

ABES - Brazilian Association of Sanitary and Environmental Engineering / Associação Brasileira de Engenharia Sanitária e Ambiental

BNDES - Brazilian Development Bank / Banco Nacional de Desenvolvimento Econômico e Social

BNH - National Housing Bank / Banco Nacional de Habitação

CAESB - Environmental Sanitation Company of the Federal District / Companhia de Saneamento

CEF – Economic Federal Bank / Caixa Econômica Federal

CESBs - State Companies for Water Supply and Sanitation / Companhias Estaduais de Saneamento Básico

CETESB - Environmental Company of the State of São Paulo / Companhia Ambiental do Estado de São Paulo

COFINS - Contribution for Social Security Financing / Contribuição para o Financiamento da Seguridade Social

CONAMA - National Environmental Council / Conselho Nacional do Meio Ambiente

COPASA - Sanitation Company of Minas Gerais / Companhia de Saneamento de Minas Gerais

DAEE - Water and Electric Energy Department (São Paulo) / Departamento de Águas e Energia Elétrica

FGTS - Employment Guarantee Fund / Fundo de Garantia do Tempo de Serviço

FIESP - Federation of Industries of the São Paulo State / Federação das Indústrias do Estado de São Paulo

FUNASA - National Health Foundation / Fundação Nacional de Saúde

IBGE - Brazilian Institute of Geography and Statistics / Instituto Brasileiro de Geografia e Estatística

PAC - Growth Acceleration Program / Programa de Aceleração do Investimento

PIS/PASEP - Social Integration Programs and Public Servant Fund / Programas de Integração Social e de Formação do Patrimônio do Servidor Público

PLANASA - National Plan of Sanitation / Plano Nacional de Saneamento

PLANSAB - National Plan of Basic Sanitation / Plano Nacional de Saneamento Básico

SABESP - Company of Basic Sanitation of the State of São Paulo / Companhia de Saneamento Básico do Estado de São Paulo

SFS - Financial System of Sanitation / Sistema Financeiro do Saneamento

SINGREH - National Water Resources Management System / Sistema Nacional de Gerenciamento de Recursos Hídricos

SNIS - National Information System on Water and Sanitation / Sistema Nacional de Informações sobre Saneamento

SNSA - National Department of Environmental Sanitation / Secretaria Nacional de Saneamento Ambiental

UASB - Upflow Anaerobic Sludge Blanket

WWTP - Wastewater Treatment Plant

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1 INTRODUCTION

This work was elaborated in the analysis of a market research, both environmental and natural market situation. The study develops along a process that involves several phases, from the adequate approach of the problem to the satisfactory presentation of the results. Thereby, identifying business opportunities in the target market.

This work aims to give an overview of the Brazilian wastewater treatment market, providing useful information for pilot projects managed by the Center for Measurement and Information Systems (CEMIS). Consequently, finding the right conditions for Finnish environmental technology companies under CEMIS organization to expand into Brazil. After a market profile report is executed, an analysis could map the current supply types of wastewater treatment in Brazil. Based on the analysis of the data of the industry trade associations and statistics, it observed the need for a more in-depth investigation in the relation of demand in the Brazilian market. The objective of this research is to help CEMIS identify the main factors that may affect creating a commercialization channel and recognize its potential entry point into the wastewater treatment market in Brazil. Having the research questions as: How does the Brazilian domestic environmental factors affect CEMIS to commercialize its technology in Brazil?

The present research is carried out based on different sources and publications of the Brazilian wastewater treatment industry and trade associations. This is the critical foundation of strategy as segmentation and positioning that CEMIS is looking for.

The Center for Measurement and Information Systems (CEMIS) is an institution for research, development, and training center. CEMIS operates in the field of Measurement and Environmental process, Economy, Sport, and Well-being. This also includes Information and measurement systems and Game and Simulators technology.

The CEMIS institution is formed by the Kajaani University of Applied Sciences, Universities of Jyväskylä and Oulu and VTT Center for Technical Research of Finland Ltd (CEMIS 2015).

Market research consists of collecting information about target markets or customers. Focusing on essential data to identify and analyze a market's needs and demands as well as, market size and competition. In a broader scope, it examines all aspects of a business environment, including market structure, government regulations, economic trends and, technological advancements.

For the development of the present work, bibliographical and secondary data is used. The bibliographic research is based on scientific publications in the field of marketing research. The investigation develops in its entirety through secondary data preserving an aligning search. The different types and different forms of the data provided are analyzed. Also, government publications, documents, and government websites, as well as supplementary data from other sources are used to complement official statistics.

Based on the data obtained from the wastewater treatment sector in the Brazilian market and, through secondary data available on the internet, the author concluded his investigation in Brazil. Identifying the main factors in the Brazilian wastewater treatment market, which include the dynamics of demand as well as trends and opportunities related to this industry among others.

Faced with a new market trend, the adoption of technologies it is evident, devices, materials, and techniques employed in the prevention, containment or reduction of pollution are necessary. As well a system minimizes the way its operations negatively affect the natural environment processes, as regulations and other environmentally oriented requirements are in place. This data collection for the market environment is not part of the analytical effort, but it substantially and vitally affects a quality of the potential market. Thus, a possibility of understanding how a company can acquire a competitive advantage in the market through an internationalization process.

This work is essential to realize how highly competitive is the market in this sector as trade associations organize it. Companies that are seeking to operate in this segmentation market should know what to do to, standing among the market of their professional skills for the quality of their services and/or products. Looking for ways to differentiate how a company presents a company its brands. Organizations will need to know the way to position themselves. Showing ways of differentiation to introduce a company and its brands. In addition, they must be aware of their professional competence, when their brand´s image needs maintenance to be feasible in the marketplace. Following this context, the proposal of scientific work aims to present concepts and tools necessary for the decision to innovate in the process of technology commercialization and internationalization. Brazil is a country full of complexity that brings many challenges, but at the same time, it is also a market with enormous potential, making it an exciting market to investigate. Doing business in Brazil can be quite a challenge for foreign companies. Therefore, the research investigation aims to know the size and demand of water and effluent treatment market and, to identify its market opportunities.

The work outline is defined and presented in six chapters, divided as Introduction, Theoretical Background, Water resource in Brazil, Water and Sanitation in Brazil, Brazilian Environmental Technology market, Conclusion, and Recommendations.

The introduction presents the work contents and its development, its importance, and objectives. In addition, it presents the actual situation of the presented market researched and its variables. The second chapter gives a reference background theory for the researcher through its assignment. The following chapter describes the Brazilian water resource and its importance to the country. In sequence, the fourth chapter reveals the current situation of the industry segmentation in the target market, and it challenges. The fifth section gives an overview of the environmental technology market in the wastewater treatment sector in Brazil. The concluding chapter presents the researcher observation and his position on the facts and at last part the recommendations.

BACKGROUND

The Brazilian government has never been more concerned about taking care of its water resources as they are now. The main reasons are the perception that current patterns of natural resources in use are unsustainable. The discovery of our vulnerability, the human race has come face to face with his own actions, and the more significant awareness raised around these environmental issues means they are prepared to take action.

The environmental issue in the last decade has been at the center of attention in Brazil. Especially after the disaster of the tailing dam of Samarco´s mine in Rio Doce (Minas-Gerais) in November 2015, it is causing changes in people´s environmental culture. This catastrophe affects not only the water availability but also the quality of water, whether it is potable or not even if it can be reused. Moreover, the long periods of the drought of the rains due to the climatic changes causing the lower levels of the reservoirs of the main capitals of the country.

This type of water crisis, like any crisis, brings with it risks and opportunities. An inherent risk of water insufficiency to habitual consumption, waste or overcoming of physical structures. This crisis event resulted in a greater awareness that a resource is limited and that the environmental consumption and water management habits should, therefore, be more rational and responsible.

The growing demand for water has made reuse of water the topic of great importance in Brazil (CETESB, 2010). Therefore, creating the need to introduce clean high-tech technological solutions that open an excellent business opportunity for CEMIS.

It is undeniable that the industry uses large amounts of water in its processes, about a quarter of the water consumed in the world. Consequently, there is a massive production of effluents from different types of industries. To be disposed of without damaging the environment, these effluents must be treated and meet the release standards prescribed by the legislation. Also, to follow the instrument of the law on water tariffs, industries are adapting to ensure that they do not lose competitiveness in the rationalization and reuse of water.

Water reuse is more often considered as part of a more rational or efficient usage. The management of waste and residues helps to minimize the production of effluents and consequently water consumption. The government expects that the water reuse policy will encourage private investments in the water treatment sector. Proposing a marketing service campaign in water reuse to be the main alternative source of water supply. According to the Federation of Industries of the State of São Paulo report (FIESP; CIESP, 2004), for the industrial sector, water reuse assumes strategy in the context of adoption a sustainable production practice. Besides, the water scarcity and cost adequacy make desalination and water reuse processes attractive, especially in the sectors with intensive water extractives.

Freshwater is a limited natural element resource with multiple functions. Thus, with different types of uses as for human supply. Water is the raw material for industrial, irrigation activities. Water can be an input and raw material for navigation. Water is a safe bed for waterway transportation, recreation, and leisure activities. Also, water is part of the Brazilian scenic beauty, essential for fishing activities. Water is the aquatic biodiversity element of a natural environment; for the urban and industrial effluents it is a deplete drainage, and for the production of energy its movements transform kinetic energy into electrical energy (GARRIDO, 2000, cited in CNI, 2002). The various types of natural use of water resources have led governors, industries directors, and activists from civil entities and supranational institutions to discuss the subject of which involves conflicting interests.

Among the most controversial environmental issues are freshwater management, a vital asset for all living beings and one of the key resources for the development of nations. However, there is a great state of degradation in many areas of Brazil. Its regulation began in the early 1930s, based on a centralized model and under a strong influence of the hydroelectric power-station sector. Within the current Federal Constitution there is an integrated yet at the same time a decentralized new model of water resources management, such as river basin. It has an administrative unit and collegiate bodies, at different levels and various decision makers.

According to Brazilian Association of Infrastructure and Base Industries(ABDIB), an average large mining project in Brazil needs around 686,6 million euros in water technology and infrastructure. The capital market for water in mining was estimated approximately 3.8 billion euros in 2015. Brazil is predicted to be the fastest global market for offshore water treatment in the oil and gas sector with a combined annual growth rate of 8.5 percent. Also, all the capital expenditures on offshore water systems for sulfate removal reached 163 million euros in 2015 (OECD,2015).

The Brazilian government has prioritized the investment policies in the sector to reduce the infrastructure gaps. The Brazilian sanitation law and implementation plan, Plansab, which pursues to mitigate the lack of investment in sanitation and are intended a formal target of universal sanitation services by 2030. According to Plansab report 2014 of the Ministry of Cities and the National Secretary of Environmental Sanitation, has forecasted investments around 49,349 billion euros. Besides, others 73,809 billion euros in drinking water and wastewater network, treatment technologies, and services are needed to achieve universal connection service. The Brazilian government has provided €190,672 billion euros from their federal funds to municipalities and states governments to develop projects in wastewater treatment and sewerage.

2 THEORICAL BACKGROUND

Marketing research can be defined as any organized and planned way to gather market or customer information and guide decision making or problem-solving in a driven market way (Paurav Shukla, 2008). The International Marketing Research (IMR) is defined as a modern business activity, which conducts the necessary research to expand business operations from the home country toward other countries (Kumar, 2000). A new product commercialization in a new market requires a market study to identify the various characteristics of the market. The variables in this market environment and consequently, to trace the multiple components that can detect opportunities or issue in a respective market that may influence in the commercialization process.

The factors that may drive diversity and changes to the target market make necessary to obtain an insight knowledge of the environment in this research to be analyzed. Gathering information for a market planning and determine difficulties in establishing comparability and equivalence of data, coordinating research and data collection. Thus, to determine the nature of the market, the researcher must examine the variables that relate to the market environment by performing various types of research. Concentrating on identifying problems or solving problems of business ventures, which can facilitate decision making that can lead to better business actions. Thus, developing better strategies and decide the best way to do both, opening a new business and expanding a business established. However, marketing research has a very wide amplitude, which includes product research, packaging research, price research, market research, sales research, etc. It is also used to solve marketing problems and make marketing decisions as defining the marketing policies. Also, it serves as guidance to introduce new products to the market or/and identify new markets. Marketing research can be used to select distribution channels, advertising strategy, sales promotion measures, etc.

According to Smith & Albaum, the research should be conducted in an orderly manner, continuous and dynamic way. To solve the marketing problems that may arise with changes in variables over time is recommended use collecting updated data as the market does not remain static. Therefore, reliable data sources and systematical analyzes, critically and objectively helping the company in many actions. For example, it may help to measure its market share, fight against competition, increase sales and reduce marketing risks. Similar to military intelligence marketing research is a business information gathering activity. Before managers move into a business action, marketing intelligence first makes a systematic study, helping to make quick and correct decisions. Therefore, marketing research is an important tool for decision-making (Smith & Albaum, 2010 pp 7-11)

To expand into a foreign market is essential to study the impact of external forces on the organization. Which include certify about the developing conditions in international markets, governmental policies and regulations, demographic information, new products entering the market and their impact on the company's products.

Marketing research may use three methods to collect data: a process of analysis, a purpose of experiment and way of observation to understand better a problem or an opportunity. The researcher must have collect perceptions from different angles and opinions on an issue to decide how to approach it. To interpret how market interacts with the market environment. Thus, gaining a more exceptional overview of the components that influence the market such as brand, product design, price, placement, and service. Using marketing research to assist overall management as a tool based on the information available to implement a solution. This overall management can help in the marketing function. The marketing manager should prioritize the most critical and urgent issues selected to find a solution. To reach the best possible solution based on available information, implementing a solution, modify the answer by providing additional information and establishing policies to act as a ready solution for any recurrence of the problem.

Marketing research is not an exact science and has its limitations, thus providing only suggestions and not solutions, besides being a costly and time-consuming process (Craig and Douglas, 2000).

According to Journal of Management, Vol. 32,2006; Internationalization can be defined merely as a business activity in a foreign market. The expansion of companies in a foreign market is increasing the order to go with success throughout the internationalization process and consequently must adjust themselves to an international diversification. International diversification is a process by which the company must adapt to be able to compete in the foreign market. By analyzing the factors that influence the environment on the target market including antecedent environmental factors, performance and process outcomes, moderators and the other characteristics of international diversification. Equally, the quest for sustainability in the international business environment has seen unprecedented changes over the past two decades. Thus, global diversification has become an important strategic option for companies seeking a sustained competitive advance.

4 Water resources in Brazil

Water resources are the natural supply of water unrelated to any use that is potentially usable and endowed economic value for agricultural, industrial, domestic, recreational and environmental activities (Rebouças, 2002). Although two-thirds of the area covered by water (360 million km2 out of a total of 510 million km2). More than 98% of the available water is salted, and the 2% of freshwater considered low salinity, more than 68.9% is 29.9% are in deep underground reservoirs and difficult to access. Only 1.2% is available in rivers and lakes (SENRA, 2001, p. 133 as cited in FIESP; CIESP, 2004).

In Brazil, the National Environment Council (Conama) classifies water into three categories: fresh water is the one with a salt concentration of less than 0.5%. The brackish water has a salt concentration ranging from 0, 5% to 30% and salt water has a level of more than 30% (CONAMA, 1986).

Global climate change along with the scarcity of fresh water has been considered one of the most severe and complex environmental problems. (IUCN, UNEP, and WWF, 1991, p.148). In Brazil, the idea of abundance has reinforced the culture of waste in a way that water is used without moderation. The degradation of these resources has provoked a crisis of significant proportions, especially in large urban´s center's areas (REBOUÇAS, 1999, p.201 as cited in Tundisi et al., 2010). With the increase in the concentration of greenhouse gases, particularly in the arid and semi-arid regions of Brazil, combined with a 10% reduction in the rainfall index, it could reduce the annual water flow of the rivers by up to 70% (IUCN, UNEP, WWF 1991, p.149).

The surface water production in the Brazilian territory is 168,790m3 / s, reaching 257,790m3 / s when considering the flow of the Amazon basin from abroad, Peru, Colombia, and Venezuela. (Tundisi, 2014). However, there are ample disparities between water production and population concentration. The Amazon region has the smaller population density between 2 to 5 inhabitants per square kilometer and accounts for 78% of national water production. The São Francisco river basin with population density between 5 to 25 inhabitants per square kilometer corresponds to only 1.7% of the total water discharge. The Paraná river basin with a population density of 25 to more than 100 inhabitants per square kilometer corresponds to 6% of full water production (REBOUÇAS, 1999, p.201). These data show that less than 20% of the national water discharge supplies about 95% of the population, while 80% of this production originates in regions occupied by only 5% of the population. This means that although Brazil has one of the largest reserves of fresh water on the planet, there are regions below the minimum standards, due to the disparities between water production and population density. Although the Amazon has 74% of surface water resources in Brazil, the region is inhabited by less than 5% of the Brazilian population. The lowest mean per capita flow is observed in the Eastern Northeast Atlantic hydrographic region, with an average of less than 1,200 m3 / inhabitant / year. In some basins in this region, values below 500 m3 / inhabitant / year are recorded. Also, in the condition of areas with little relative availability, some basins of the hydrographic regions of the Eastern Atlantic, Parnaíba and São Francisco are highlighted. In the semi-arid portion of these areas, water is a critical factor for local populations, where the drought phenomenon has more serious repercussions (GEO Brazil, 2007).

The urban demographic growth of the last 30 years is an essential factor of pressure on water resources. In the period 1970-2000, the urbanization rate rose from less than 56% to more than 81% (IBGE, 2000). There are 25 urban agglomerations centers with a population of more than 500 thousand inhabitants and 12 other ones with more than 1 million. This change in the spatial distribution of the Brazilian population has become a relevant factor for the country's environmental agenda, especially since the 1990s when the new pattern of population distribution can be considered more important than population growth (IPEA 2015).

In Brazil, four federative units present a prosperous situation, having their condition on balance concerning The World Health Organization (WHO). Considering having an appropriate volume of water for the satisfaction of life in the community and the exercise of human and social activities. Six federative units have an unsatisfactory situation with less than 2,500m3 availability per inhabitant a year, and two have a critical condition of scarcity with availability below 1,500m3 per inhabitant a year. In the Upper Tietê basin, where Great São Paulo region is located, there is already a flow rate higher than the water availability. It means that to be able to supply the water needs in this region it is necessary to transport it through pipelines from other areas of the state. In this case, the water transported collects the water in the catchment basin area formed by the Piracicaba, Capivari and Jundiaí rivers, captured near Bragança Paulista and emptied into the Tietê river basin by the Cantareira dam System. The reason of the need to collect water in another basin are among others, the high demographic index of the Alto Tietê basin, the high pollution of the waters of the Greater São Paulo region and, the low natural availability of the forming river in this region mainly (GEO Brazil, 2007).

According to Integrated Water Resources Management System (SIGRH), the state of São Paulo has four rivers that basins present a critical situation. In the Alto Tietê basin, water availability is 200m3 per inhabitant a year; In the Piracicaba / Capivari / Jundiaí river basin, water availability is 400m3 per inhabitant a year. In the basin of the Turvo and Grande river, water availability is 900m3 per inhabitant a year, and in the Mogi-Guaçu basin, it is 1,500m3. However, experts consider that any utilization index approaching 50% of availability is high.

In a highly industrialized region, such as the Metropolitan Region of São Paulo, the primary use is human supply. In contrast, the region of the Ribeira Valley, a tiny industrialized region, has as main consumption, exactly, the industry. The reason is that the region is sparsely inhabited and public supply systems are still incipient. Thus, the little industrial activity in this basin consumes more water than the population served by the municipal supply systems. In the industrial sector, according to the Environment Department of the State of São Paulo, the beer industry has the primary responsibility for the abstraction of groundwater. Of the total captured, only 20% would use in the production of beer and soft drinks. The other 80% of this extremely pure water is used in cleaning processes.

The State Department of Water and Electric Energy (DAEE) prepared a projection of consumption for the year 2020. The estimated expenditure for that year corresponds to the use of 31.8% of the state's water availability. In principle, the amount of water available remains constant. However, the experts point out the risks of reducing the volume of water in circulation due to several factors, mainly related to the climate change. Pollution of water sources also affects the availability of water. The growing and uncontrolled exploitation of aquifers have been the leading cause for concern. There are also risks of contamination of these reserves.

The water resources management has been used for the implantation of reservoirs as an important tool for attending to the multiple uses of water. However, due to the high growth in demand for electricity and water destined to public, industrial and agricultural supplies, the various uses of water has led to the emergence of conflicts involving environmental and operational aspects, regardless of the main purpose of the reservoir (ANA, 2005).

2.1 The National Water Resources Management System (SNGRH)

The legal framework that instituted the integrated management of water resources was established in item XIX of article 21 of the Federal Constitution of 1988. The National Policy of Water Resources (PNRH), was instituted by the Law No. 9,433, of January 8, 1997, which Regulates the cited article, is based on the following bases:

- Water is a public domain good;
- Water is a limited natural resource-endowed with economic value;
- In situations of scarcity, the priority use of water resources is to attend to human consumption and to water the animals;
- The management of water resources must always guarantee the multiple uses of water;
- The hydrographic basin is the territorial unit for the implementation of the PNRH and the performance of the SNGRH.
- The management of water resources must be decentralized and have the participation of public power, users and the community (article 1).

To implement the National Water Resources Policy and to coordinate the integrated management of these resources, the National Water Resources Management System was created. The National Water Resources Council (CNRH) is part of the Ministry of the Environment (MMA) being the highest decision-making body regarding water resources. The presidency of the council is reserved to the minister of the Environment and the executive secretariat to the Secretariat of Water resources of the same ministry. The number of Union representatives shall be no more than half plus one of the total membership of the Council.

The main attributions of the CNRH are:

- Plan and coordinate the use of water resources, considering state plans;
- Arbitrate conflicts as the last administrative instance;
- Deliberate on projects that impact in more than one state;
- Approve the implementation of basin committees in federal areas; and

- Establish guidelines for granting and charging for the use of water resources.

The river basin committees in general areas have the following composition: representatives of the Union, representatives of the federative units bathed by the hydrographic basin (states, Federal District, and municipalities located in the basin) and representatives of civil organizations of water resources with proven performance in the Watershed concerned. In border committees with other countries, a representative of the Ministry of Foreign Affairs is obligatorily included. In committees located in indigenous areas, it is mandatory to include a representative of the National Indian Foundation (FUNAI). In the basin committees in general areas, the total number of representatives of the public power (Union, states, Federal District, and municipalities) is at most half of the total. The other half is made up of representatives from civil entities and users. Each committee should have a basin agency, which will exercise the functions of the executive secretariat and whose main attributions are:

- Maintain an updated balance of the availability of water resources in the basin, including quantitative and qualitative aspects;

- Maintain a user registry and, by delegation of the grantor, in the case of the National Water Agency (ANA), charge for the use of water resources;

- Analyze and issue opinions on projects to be financed with funds from the collection;

- Manage the national information system on water resources in its area of operation;

- Prepare and propose to the plenary of the basin committee the water resources plan of the basin;

- Framing water bodies into use classes; and

- To recommend to the plenary of the basin committee a plan for the application of the resources collected from the collection for the use of water resources.

The National Water Agency (ANA), created by Law 9,984 of July 17, 2000, is an autarchy linked to the Ministry of the Environment (MMA), with the purpose of implementing the PNRH in its field of responsibilities (art. 3). Among other duties, ANA is responsible for:

- Granting the right to use water resources in water bodies of the Union's domain;
- Control the use of these resources;
- To elaborate technical studies to support the definition (by the CNRH) of the amounts to be charged for the use of water resources of the Union's domain, based on the mechanisms and quantitative suggested by the river basin committees;
- To collect, distribute and apply revenues earned through the collection of water resources (article 3).

The uses of water resources are subject to the control of the public administration. The usage that can be granted are:

- Derivation or capture of a portion of water in a body of water for final consumption; Input of a productive process;
- Extraction of underground aquifer water for final consumption or production process input;
- Discharge into sewage water, treated or untreated, for the purpose of dilution, transportation or final disposal;
- Use of hydroelectric potential and other uses that alter the regime, quantity or quality of water in a body of water.

Some programs such as hydropower generation, national sanitation plan, federal irrigation programs, waterway transport programs, etc., were implemented from the 1940s with high state participation (TUCCI et al., 2001 cited in Geo_Brasil, 2007).

According to article 20 of Law No. 9.433 / 1997, the use of resources water resources subject to granting: derivation or abstraction of a portion of the water; Extraction of Underground aquifer water; Discharge into the body of sewage and other Liquid or gaseous waste, treated or untreated; Taking advantage of potential

Hydroelectric power plants; Other uses which change the regime, quantity or quality of the water in a body of water.

In 2013, ANA launched the National Water Quality Monitoring Network (RNQA) under the National Water Quality Assessment Program (PNQA).

The implementation of the RNQA takes place in partnership with state environmental and water resources management bodies. In addition to the RNQA, ANA launched in 2014 the Water Quality Data Dissemination Program - QUALIÁGUA. These initiatives aim to foster the development of state monitoring networks to fill information gaps existing water quality standards in Brazil and generate significant subsidies. The Water Quality Index (IQA) is an indicator composed of nine physical-chemical and biological parameters: water temperature, PH, dissolved oxygen, biochemical oxygen demand, coliforms Thermotolerant, total nitrogen, total phosphorus, total solids, and turbidity.

The IQA ranges from 0 to 100, and its values are categorized as five Quality bands.

The IQA is a very sensitive indicator of the contamination of by domestic sewage, although it is also influenced by other sources of pollution, as well as other factors. The water shortage, for example, is a factor that can negatively affect the IQA values, a since the volume of water available for the dilution of pollutants is lower in this condition.

The IQA was calculated with the data from 2014 for 1841 monitoring points, according to the methodology adopted by ANA. It is important to stress that not all state networks monitor all the necessary parameters for the calculation of the IQA. In these cases, the information gap does not allow an assessment of water quality through the index. Figure 11 shows the mean values of the IQA for the points with more than two collections made in 2014. For the management of water resources in the country.

3 WATER AND SANITATION IN BRAZIL

Wastewater is water with some residual pollutant originated from some process of use at home, industry, or farming. The wastewater is characterized by containing floating or dissolved solid waste particles of organic, inorganic, chemical or mineral origin that degrade the quality and purity of the water. It must be said that pure water is not found in nature or is purified of any other mineral element of its embodiment. Therefore, any distinction between clean water and polluted water depends on the type and concentration of impurities found in water. In that way, wastewater describes that water is polluted when it contains impurities sufficient to make it inadequate for a particular use, such as drinking, swimming or fishing. Although water quality is affected by fundamental issues, the word "pollution" implies a human activity and source of contamination. Water pollution, therefore, is mainly caused by the drainage of contaminated wastewater into surface or groundwater, and the sewage treatment and one of the leading elements of water pollution control. Wastewater treatment is a filtrating process to remove the impurity and residual pollutant of water before the discharge back to a natural hydric body as rivers, lakes, and oceans (Ency-clopedia Britannica, 2017).

Historically, the Brazilian urban and industrial development occurred along the rivers expecting the availability of water for supply and the possibility of using the river as the receiving body of the effluents. However, with increasing population and industrial activities, several problems related to water scarcity and pollution in large urban centers have arisen. According to the conservation and reuse manual for water industry (FIESP, CIESP, 2004), despite the apparent abundance, the natural distribution of water resources of the country, which correspond to 14% of the fresh water of the planet and 53% of the South American continent. It is quite irregular in the different regions of the country. Currently, in Brazil, about 35 million people still do not have access to treated water in the country, as revealed by the Diagnosis of Water and Sewage Services of 2014. It is evident that the lack of access to this type of basic sanitation still affects a significant part of the Brazilian population (SNSA, 2014).

The Brazilian Institute of Geography and Statistics (IBGE, 2011) points out that small towns, with a population of up to 50,000 inhabitants. With a population density of less than 80hab./km², are the hardest hit by the lack or inadequate provision of basic sanitation services, in particular, the supply of drinking water (IBGE, 2011).

Before 1970 the municipalities provided water and sanitation under the supervision of the National Health Foundation (FUNASA), a subordinate agency of the Ministry of Health (Seroa da Motta & Moreira, 2006,). The current structure in the sanitation sector was established in the 1970s through the implementation of the National Sanitation Plan (PLANASA) by the Military regime (1964-1985) (Brazil, Ministry of Cities, 2004).

Since 1971 all the responsibility for water and sanitation were transferred from municipal to the state authorities and then concentrated power in the hands of states (Heller, 2007). Also, was created 25 new state-owned regional water supply and sanitation enterprises. The estate center of basic sanitation (CESBs, the abbreviation for state utilities), was created and granted concessions from local counties to provide water and sanitation services in their jurisdictions. CESBs were the only ones allowed to obtain funding from the National Housing Bank (BNH) for the water treatment sector (Sabbioni, 2008). The BNH was created in 1964 with the mission of implementing a development policy, only carried out the first evaluation of the sanitation sector three years later (Santejo Saiani & Toneto Júnior, 2010). Although approximately 3,200 municipalities have been granted concessions to state-owned enterprises during that 20-30 years, some 1,800 towns have never joined PLANASA (Sabbioni, 2008).

During the 1980s and 1990s, the state public services lost funding capacity due to unpredictable inflation and failed to finance the necessary expansion of water and wastewater infrastructure (Sabbioni, 2008, Seroa da Motta & Moreira, 2004). The lost decades of the 1980s and 1990s have strongly affected public and private financing in basic sanitation service. Growth in the construction and housing sectors slowed down, and BNH, burdened by debt, and it was abolished in 1986. In the beginning, the National Housing Bank (BNH) managed the Financial System of Sanitation (SFS), created to centralize resources and to coordinate actions within the sanitation sector. The BNH was also responsible for handing out loans with resources from the Guarantee Fund for Employee (FGTS) to finance part of the investments (Santejo Saiani & Toneto Júnior, 2010).

The bank Caixa Econômica Federal (CEF) took over the assets of BNH, and the National Plan for Sanitation (PLANASA) passed to use the Employment Guarantee Fund (FGTS), the workers' pension contributions, as a new source of public funding for sanitation. Given the federal government's budget constraints during the economic crisis, CEF took urban policy, which had no formal and explicit orientation, thanks to its power as the official provider of FGTS, the largest source of public funding for housing and sanitation.

The cut in public investments and the credit restrictions for the public sector, following recommendations of the International Monetary Fund, has presented some intense activities in the industry of sanitation, in particular between the years 1998 and 2002 (Ministry of Cities, 2004).

In 2000, the National Water Agency (ANA) was created as a regulatory agency for the water sector to monitor the use of water resources and the discharge of water resources and the release of wastewater in water basins (TUPPER & RESENDE, 2004). Besides, the Ministry of the Environment has also implemented the National Water Resources Management System (SINGREH) and the National Water Resources Policy. Three years later, the Ministry of Cities and its National Department of Environmental Sanitation (SNSA) was created. The SNSA is committed to, among other things, the universal access to water supply and sanitation (Heller, 2009). The Ministry of Cities is structured to unite the urban development areas of an economic and social factor as well as strategic for the implementation of environmental sustainability and social inclusion (Brazil. Ministry of Cities, 2004).

The CEF Bank plays a crucial role in urban and related policy, considering that the National Development Bank (BNDES) also manages urban policies in specific sanitation and transportation (Brazil. Ministry of Cities, 2004). The Ministry of Cities is responsible for investments in water and sanitation projects in municipalities with more than 50,000 inhabitants - approximately 80% of the population - while FUNASA is responsible for municipalities below this limit and is still under the supervision of the Ministry of Health.

The National Sanitation Law No. 11,445 / 2007 describes the regulatory framework for the sanitation sector in Brazil. The "Article 2 I" declares universal access to basic sanitation for drinking water supply, sanitation sewage, street cleaning, solid waste management and drainage of rainwater as "Article 3 I". The municipalities can delegate the organization, regularization, inspection, and service provision (Article 8). They must design a sanitation plan (Article 9 I) and provide or delegate services and define the entity responsible for regularization and inspection (Article 9 II). Article 52 obliges the Government, under the coordination of the Ministry of Cities, to prepare the Basic Sanitation Plan (PLANSAB).

The National Sanitation Law is undoubtedly the most important legislative innovation in the basic sanitation sector in decades, and as such, the first federal law on Water and Sanitation Services. After nearly 30 years of debate, an innovative initiative fills a historical gap in the sector's legislation, and for the first time in history, it is possible to adopt national guidelines for public policies and management in the basic sanitation sector. According to (Heller, 2009), the quality standards for drinking water are very well developed, and the level of monitoring and implementation in place are acceptable. The wastewater regulatory system has highly oriented towards strict standards based on international standards, rather than available technology and local knowledge. This resulted in years of non-compliance with WWTPs, which only gradually progressively to better ensure quality standards but did not improve their treatment systems (Cas-tro,2007).

The Federative Republic of Brazil is divided into 26 states and the Federal District, where the capital Brasília locates. Each of the states is divided into municipalities, totaling 5,565 local units all over the country. The Brazilian territory compounds into five major regions: North, Northeast, Midwest, Southeast, and South. 95% of the Brazilian population lives in the four areas of the country that contains 27% of the country's surface water availability. Therefore, the resources are not homogeneously distributed, 73% are in the Amazon region and 6% in the Southeast, and are threatened by different socioeconomic factors (Tun-disi, 2014).

The distance between consumers and the primary national water sources, which is in the north of the country, generates water scarcity in large centers, such as São Paulo and Belo Horizonte. However, it creates at least one positive effect that is the preservation of the watersheds of the northern region, since in these places still there is no severe urbanization process (ANA,2005).

According to the National Water Agency (ANA), five of the country's 12 river basins, located between Northeast and South, they are in a critical or worrying state because of pollution or waste. The destruction of a water resource by pollution is something that negatively affects all the regions. Subsequently, the point where the contamination begins, becoming a vector of diseases caused by pathogens such as Infectious diarrhea, leptospirosis, cholera, hepatitis, schistosomiasis, and others. Also, the diseases caused by the ingestion of toxic substances such as lead, mercury, arsenic, pesticides, and many other chemical substances (ANA, 2013).

The treatment of the water supply, the collection, and treatment of the sewage produced is essential for the maintenance of the water resources, surface, and underground. Each municipality must be responsible for the proper management of its waters.

Currently, Brazil has 80% of its population allocated in urban areas. The number of cities with an approximate population of 50 thousand inhabitants is 2000, which 202 cities have a population of superior 100 thousand inhabitants. Brazil has 16 urban agglomerations with more than 1 million inhabitants, with the megacities of São Paulo and Rio de Janeiro leading. In general, all Brazilian cities face the same challenges regarding lack of planning, agrarian reform, and land use and control. Population concentration has been mostly unmatched by the growth needed infrastructure, such as sanitation (Ministry of Cities, 2004, pp. 33-34).

According to data from the National Sanitation Information System (SNIS) and based on the year 2013, 82.5% of the population was served by a water network. The considerable variation among the regions of the country is remarkable: the attendance rate is only 52% in the North Region and reaches 92% in the Southeast Region. In reality, just 48.6% of the Brazilians had sewage collection and an even smaller percentage, 39.0%, had some sanitary treatment. Therefore, by 2013, 41 million Brazilians did not have access to the general water supply network and 107 million had their sewage waste dumped in nature. Thus, each year, nearly 6 billion cubic meters of sewage is discharged directly into the environment without any treatment.

Trata-Brasil, a civil society organization, formed by companies interested in promoting basic sanitation and protecting water resources. Trata-Brasil annually monitors the evolution of sewerage network construction projects and the treatment of wastewater in Brazilian cities with more than 500 Thousand inhabitants. Focusing on contracts for 181 works involving the execution of collection networks and/or wastewater treatment facilities, in 2015 (Trata Brasil, 2015a, p.4).

The evaluation of construction projects to run collection and/or WWTP net-works in Brazilian cities with more than 500 thousand inhabitants is, however, a disappointment (Trata Brasil, 2016). By August 2016, just under half (49%) of sewage works in the first phase of the Growth Acceleration Program (PAC 1) was completed, of the 111 tasks 54 were completed, 34 are underway and 23 are paralyzed. PAC 2 also suffers from delays. In this second phase of the program, it has 55 projects planned for water supply, 33% (18 works) have not yet been started, 7% are stopped, and only one has been completed. Concerning 72 sewage works, 18 actions (25%) have not however begun, and eight works (11%) are stoped. Only four of these projects (6%) were finalized, and almost 30% of works did not start.

Sixty-eight percent (68%) of the projects are in the southeast and northeast regions. The projects selected totaled € 2.98 billion in investments, accounting for almost 25 percent of all investments in the sanitation sector, totaling € 12.5 billion: 111 works in PAC 1 with a total value of € 1.34 billion, and 70 works in PAC 2 with a total cost of € 1.63 billion. Fifty-five percent financed by Caixa Econômica Federal, 28% from the federal budget and 17% from the BNDES. Twenty-five percent of PAC's funding resources are allocated to projects in the state of São Paulo, 11 percent to the state of Rio de January and 10 percent for the state of Minas-Gerais. By 2014, there were 49 Basic Sanitation Regulatory Agencies (ARSBs) in Brazil. According to the Brazilian Association of Regulatory Agencies (ABAR), 26 are statewide, 20 local and three consortia of municipalities.

The great inconstancy of large-scale and long-term investments in the sanitation sector in the 1980s and 1990s reflects the disparity of infrastructure that is currently in the Brazilian sanitation sector (Seroa da Motta & Moreira, 2006, p.185). The Growth Acceleration Program (PAC 1 from 2007 to 2010 and PAC 2 from 2011 to 2014) has "significantly boosted" the investment in wastewater after decades of sub-investment, which had made visible through increased investment from 2008 to 2010 (PAC, 2015). Federal wastewater funding totaled 4.5 billion Euros in PAC 1 and 4 billion Euros in PAC 2, but federal funds are slow to reach their destination (PAC, 2015). On average, investments in water supply and sanitation equaled 2 billion Euros in the period 2004-2014 (SNIS, 2014). Investment programs tend to correct the distortions in resource allocation and to address deficits, and investments are usually executed with less agility than necessary "(SNIS, 2014, p. 49). Federal fundings, in addition to taxations, is the primary source of financial resources for many service providers.

Water and wastewater services amounted to 27.3 billion euros in 2014, € 3,3 billion in investments, € 12,3 billion on revenue and € 11,6 billion on costs according to Pará SNIS (2014). From 2004 to 2014, investments in water supply and sanitation were 2 billion euros on average, with an annual growth rate of 29%. Total investments in the water supply and sanitation sector totaled € 3.3 billion in 2014, of which 42 percent was invested in the water sector and 46 percent in the wastewater sector. Most of the investments (€ 1.7 billion, or 53%) in the financing of service providers, 29 percent were loans, and 18 percent were donations. These investments in the wastewater sector (about 1 billion, or 62 percent) were mostly in the Southeast region, accounting for 29 percent of the wastewater deficit, while the Northeast region accounted for only 13 percent of all investments in the wastewater sector, although it has the most massive wastewater deficit of 32 per-cent.

The investment needs for expansion of the wastewater structure were estimated at € 9 billion for 2016-2020; More than 95% of investments were planned in urban areas, of which only 15-20 percent were planned to rehabilitate existing infrastructure (PLANSAB, 2013). In some large-scale agglomerations of the urban area, ANA recommends focusing on the protection and recovery of surface water. ANA identifies the need to invest € 3.013 billion in wastewater collection and € 1.9 billion in wastewater treatment (ANA, 2010, p.60). The investment needs in basic sanitation are estimated at 88.2 billion euros, with an average of 4.4 billion euros per year (SNIS, 2014, page 72). Due to the recent economic and political crisis, however, projections and expectations are very likely to be reduced.

Table 1 - Service levels for water and sewage of municipalities whose service providers are SNIS participants in 2013.

Region	potable water network service index (%)				Wastewater treatment index (%)	
	water		Sewerage collected		Sewerage generated	Sewerage collected
	Total	Urban area	Total	Urban area	Total	Total
North	52,4	62,4	6,5	8,2	14,7	85,3
Northeast	72,1	89,8	22,1	29,3	28,8	78,1
Southeast	91,7	96,8	77,3	82,2	43,9	64,3
South	87,4	97,4	38,0	44,2	35,1	78,9
Midwest	88,2	96,3	42,2	48,6	45,9	91,6
Brazil	82,5	93,0	48,6	56,3	39,0	69,4

Source: SNIS 2014

Untreated sewage is one of the primary contaminants of water in the country since 44.8% of Brazilian municipalities do not have a sewage collection network (IBGE, 2011). Waters surfaces account for over 80% of the drinking water source in Brazil, but nearly half of the urban population is located near rivers and lakes in adverse conditions, reflecting the high rate of urbanization and neglect of pollutants from human activity. The National Water Agency (ANA), the body that monitors the quality of water, recorded variable parameters of the established water quality index (IQA), verified in more than 7500 analyzes over the all twenty-six states of the country.

In this way, it makes necessary to search for treatment processes that can be applied to this type of effluent. The idea is to obtain an effluent treated with a quality level, feasible to dispose of the bodies of water causing the less environmental impact, which can be reused (Hespanhol, 2008). Thus, new treatment alternatives have been regularly proposed, usually as the association of biological processes and advanced oxidative processes.

To know the physical and chemical characteristics of water is necessary to treat an affluent and choosing the adequate treatment. The composition and concentration of the parameters regarding industrial effluents undergo considerable variations, and it is possible that there is a significant variation even between industries of the same branch of activity. Thus, not always the raw materials used are the same due to the high diversity of industries (CONAMA, 2008).

Water supply and consumption in Brazil

Brazil has one of the highest water resources on the planet, with an average discharge of almost 180,000 m^3 / s, but it is an asymmetric distribution of water resources.

On the other hand, the country has 45% of its urban population concentrated along the coast and with access to only 3% of available water (ANA, 2010). Surface water and groundwater supply 47 percent and 39 percent, respectively, of municipalities in Brazil (ANA, 2010).

By 2014, there were 163.2 million people supplied with water, on average, 93% of the urban population and 83% of the total population, according to the SNIS (2014). The water supply network provided 53.8 million households compared with 36.9 million homes ten years earlier.

A substantial variation in the emerging municipalities, since there were 15.9 billion m3 of water produced and 10.1 billion m3 of water consumed. In Brazil, 37 percent of the water supply is lost in distribution. Most providers that have loss rates above 50 percent are in the north and northeast region of the country.

Loss of water or non-revenue water, which is "one of the main problems" in water supply in Brazil and represents a "waste of natural and operational resources as well as revenue losses for the service provider" (SNIS, 2014, page 34), whose costs are transferred to customers. Over-the-counter water consists of apparent losses and actual losses. Apparent losses refer to water that is consumed efficiently by the customer but is not charged due to inaccuracies in measurement and the theft of water from clandestine connections in the distribution network. Actual or physical losses refer to water produced but lost before it reaches the customer due to leaks and exacerbated usage of poor quality or old pipes, poor quality of the workforce, lack of monitoring, etc.

The rehabilitation of existing infrastructure to reduce the number of physical losses of water receives little attention, in particular, the state's public services prefer to invest in new water supply infrastructures. Daily water consumption per capita was 162 liters in 2014, up from 142.7 liters in 2004. The water crisis in the Southeast led to lower water consumption (SNIS, 2014). After almost continuous growth until 2012, the water consumption rate decreased by 0.7 percent in 2013 and 2.6 percent in 2014.

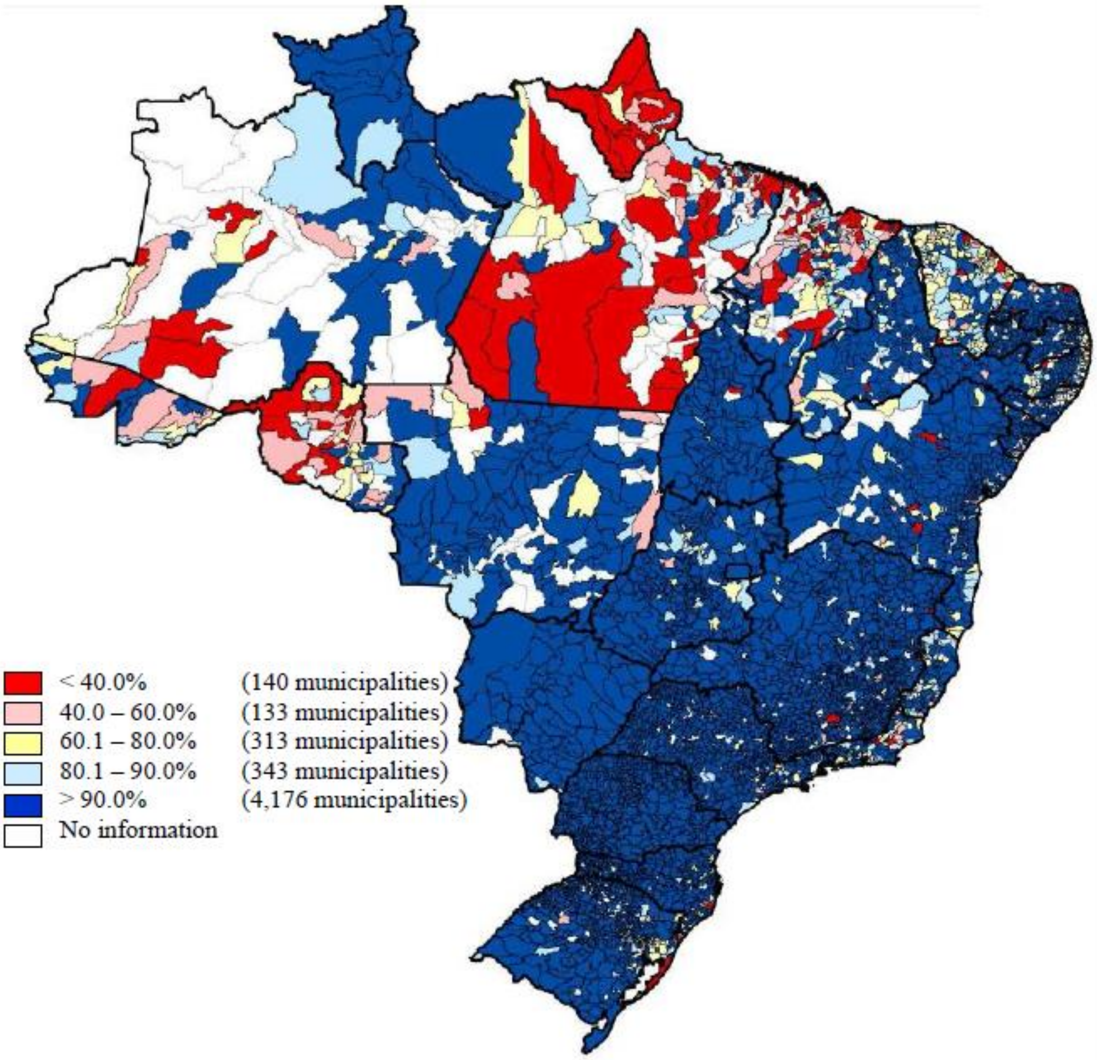
3.1 Water Treatment and Water Supply

Rather than supplying human biological demand, supply water quality is a concern that goes hand in hand with the concern for the well-being of the populations and communities provided. This topic aims to exemplify the monitored parameters, the main consequences of their contempt, from the physical, chemical, microbiological point of view. To ensure that the water supplied is within the internationally defined potable parameters and health, periodic analyzes are performed to corroborate the need for treatment. The main purposes are to reduce excess impurities, reduction of high levels of organic compounds, algae, protozoa and other microorganisms and bacteria removal; considering the elimination or reduction of toxic or harmful substances.

Next, the biochemical oxygen demand (BOD) is a parameter that indirectly indicates the concentration of biodegradable organic material in the water. The BOD parameters correspond to the amount of oxygen consumed in the degradation of organic matter in the aquatic environment by biological processes. The BOD is expressed in milligrams per liter (mg / L). It is the most used parameter to measure pollution. The BOD is a standard test that tries to replicate in a bench the phenomenon that occurs in hydric bodies. For the test, two samples are collected, and one of them is measured dissolved oxygen (OD) shortly after collection. The oxygen in the other sample is measured after five days, at each time the sample is held in an incubator that maintains it at a constant temperature of 20 ° C. The oxygen concentration differential defines the biochemical demand for oxygen. When the water has a significant amount of organic matter and microorganisms, it is necessary to dilute the sample and insert nutrients. In the case of effluent industries that do not have much oxygen or microorganisms, it is required to dilute and introduce nutrients, add a "seed," which is a small amount of sewage with microorganisms and known BOD to correct the result. During five days at 20ºC, about 70% to 80% of the organic matter (domestic wastewater) is consumed (VALENTE et al., 1997).

According to statistics from the Brazilian Institute of Geography and Statistics (IBGE, 2011), cities with up to 50,000 inhabitants are the most affected by the lack or inadequate provision of essential sanitation services, especially the supply of drinking water.

Figure 1: Urban water supply (in % per municipality)



Source: SNIS (2014, p. 28)

3.2 Wastewater collection and treatment

According to the National Sanitation Information System (SNIS) in 2014, there were 98 million inhabitants connected to the sewage system in 2014, this represents 57.6 percent of the urban population and 49.5 percent of the total population, with significant variations among municipalities (SNIS, 2014).

Between 2004 and 2014, the sewerage network grew 8.3 percent a year and today connects to 31.4 million homes. In 2004, only 18.5 million households were connected to the sewage system, and only 31.3 percent of the wastewater generated was treated.

In urban areas and rural areas with more concentrated population, solutions are used for water and wastewater services, including the cost sharing of construction and operation of the network used cooperatively. In rural areas, the community is more dispersed and usually uses specific solutions, and each household has own costs.

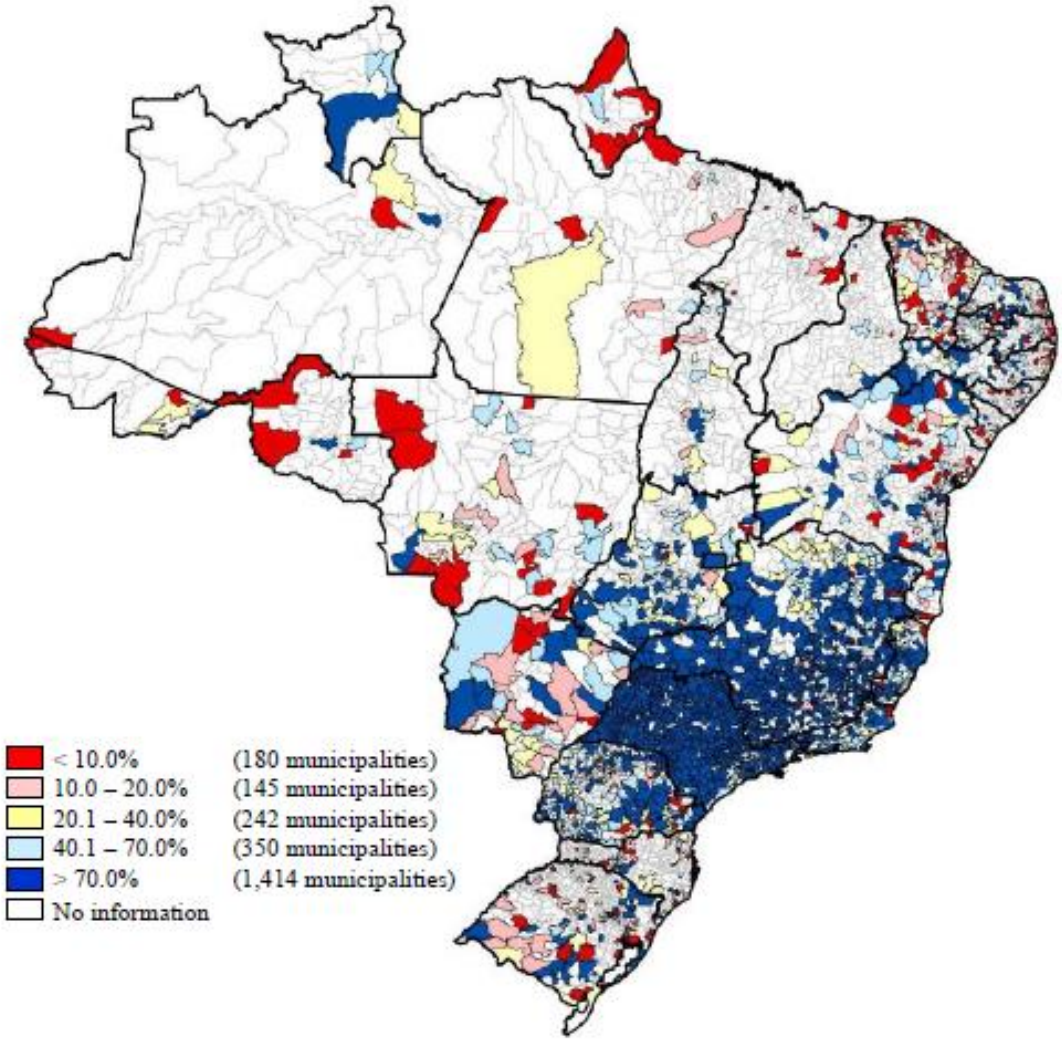
Individual solutions in 2014 served approximately 15.7 million urban residents (about 9.2 percent of the urban population) and 9.4 million rural inhabitants (about 29.8 percent of the rural population).

Individual solutions for wastewater disposal include septic tanks, rudimentary wells, open sewers, the launching of wastewater into watercourses and stormwater galleries. However, only septic tanks are considered adequate in the PLANSAB, including proper planning and construction as well such as septum post-treatment or final elimination unit (SNIS, 2014). 67 percent of the 1,578 municipalities which have individual solutions reported that septic tanks are the main alternative. Corresponding approximately 10.7 million inhabitants is serviced within the northeast, south, and north (SNIS, 2014, pp. 84-85). What is even more irreverent is that there were found 81 municipalities with a total population of more than 50,000 inhabitants that do not have a collective system of wastewater collection (SNIS, 2014, p.86).

Wastewater treatment is mainly based on biological degradation due to the "availability of large areas for the construction of tanks and lakes in addition to long periods of sunlight throughout the year. Biological filters and activated sludge are the most advanced technologies used in Brazil. Aerobic and anaerobic ponds are the most popular method using a mantle of high-speed anaerobic sludge (UASB). The correction of color, turbidity, odor, and taste, reduction of corrosivity, hardness, iron, manganese, are also necessary aesthetically and financially. This type of reactor is very present around the country.

The treatment of activated sludge is more expensive than other anaerobic treatments such as UASB, and anaerobic lakes are more common in São Paulo, Federal District, and Minas Gerais. The estimates of construction costs of the wastewater treatment plants vary BR$ 60 per inhabitant up to BR $ 650 per inhabitant and may vary depending on the treatment process employed. This kind of wastewater treatment plants with anaerobic technology is easy to build (less equipment is required since no aeration devices are needed) and simple to operate and maintain (without aeration regulation). The process uses a minimal energy consumption in the treatment. However, this bioreactor requires concentration of wastewater to be kept at temperatures of at least 25°C to function efficiently and only treat Carbon, not nitrogen or phosphorus (Von Sperling, 2016).

Figure 2: Urban wastewater collection (in % per municipality)



Source: SNIS (2014, p. 31)

3.3 Internal Financial Factors

In the last century, from the 1950s to the end of the decade, investment in water treatment in Brazil took place in some specific periods. Especially in the 1970s and 1980s, when there "was" a predominant view that advances in the water supply and sewage in developing countries would result in lower mortality rates "(Soares, Bernardes and Cordeiro Netto, 2002 p1715). During that period, the National Plan for Sanitation (Planasa) was consolidated, which emphasized the increase of water supply systems. However, it did not contribute to reducing the deficit of sewage collection and treatment, which is still currently verified.

Currently, the sector has received more government attention and dedicating a significant amount of resources to be invested. However, these investments must come in addition to generate the benefits already expected in improving water quality and public health indices. Leading to meet the minimum quality standards, that is defined by specific sector legislation, with the purpose of guaranteeing sustainability.

The available financial resources and access to financing are crucial to expand and maintain the progress of water and sewage sanitation in Brazil. However, it has had an economic boost through the government's PAC programs. Another factor that is widely recognized is the difficulty of small municipalities with a population of fewer than 50,000 inhabitants to have access to these funds. The lack of financial means for them and their necessity is mentioned several times through the channels of communication. The most significant obstacle is the low or non-existent technical capacity in smaller municipalities, often rural and remote location, to present valid project proposals for the PAC program financing. Likewise, not all towns have developed a sanitation plan due to a lack of technical capacity.

The resulting of a large-scale and long-term dropping of investments in sanitation infrastructure represents a significant obstacle to the collection and treatment of wastewater. Wastewater treatment plant (WWTP) usually accounts for one-third of the costs, while the sewage system accounts for two-thirds of the costs.

The small participation of the private sector and the limitation of public indebtedness, imposed on municipal administrations by the Complementary Law No. 101 of May 4, 2000, known as the Fiscal Responsibility Law. These are still the main factors of the scarcity of investments and consequently, for the low efficiency of the sanitation sector in Brazil. To date, the few investments made have been facilitated mainly by specific plans for the industry, such as the National Plan for Sanitation (Planasa). Such action has encouraged the creation and strengthening of local concessionaires and the investments of banks Such as the Federal Savings Bank and the National Development Bank (BNDES, 2008b).

According to (Leoneti et al., 2011), the sanitation sector has received substantial attention and large investments from both governmental and private sector. The relief of rules for the private sector through environmental sanitation policies made possible by public-private partnerships (PPPs) using its resources. As well as from the public sector, through funds from the FGTS, the Workers' Assistance Fund (FAT), the General Federal Budget (OGU) and programs such as the Watershed Cleanup Program (Prodes/ANA), which pays municipalities for the treated sewage efficiently.

The Federal Policy for Basic Sanitation was established through Law 11.445, dated January 5, 2007, to make investments in the political sphere feasible. The chapter IX of the Law 11.445 directs federal government action through the definition of a broad set of guidelines, goals, and targets for the universalization and description of programs, activities, and strategies for investments in the sector (Brazil, 2006).

3.4 Institutional Factors

The institutional framework of the sanitation sector consists of two main factors: vertical and horizontal institutional fragmentation, and stringent norms and standards. Both increase transaction costs considerably. Institutional fragmentation creates high coordination costs among the different entities. The three levels of government at the federal, state, and municipal levels are involved. Thus, the federal government defines national policies and distribute budget resources. The country is usually engaged through state utilities, and the municipality is ordered to provide water and sewage services. The city, as the rights holder, also is who will regulate and if a regulatory agency is established (Brazil, 2008). Among the main obstacles to vertical integration, government and local actors have impacts of fragmentation to the coordination of water policy-making. Leading to have an insufficient assessment of subnational practices, and inadequate evaluation of central government implementations (OECD, 2012).

The Ministry of Cities is responsible for water and sanitation of municipalities with more than 50 thousand inhabitants, and FUNASA is responsible for the smaller districts. Consequently, raising costs of coordination horizontally in each one, several actors are involved in water resources and water services, including wastewater. At the state level, for example, each state has several agencies for the environment and water resources.

Brazil often adopts ambitious legislation norms from industrialized countries or a WHO without comparative analysis or adaptation to local conditions. These strict standards are not high-speed intermediates. Therefore, the outcome of rules that are very rigid and too high standards for the Brazilian reality that are often not met compliance. For example, a regulatory agency of the Environmental Company of the State of São Paulo (CETESB) sets the phosphorus level to 0.01 milligrams per liter, which is almost impossible to obtain. Ambitious legislation can have a signaling effect and increase compliance. It is questionable whether these strict norms and standards can achieve their goals (Hespanhol, 2014).

4 THE ENVIRONMENTAL TECHNOLOGY SECTOR IN BRAZIL

Environmental technology defines the developed application of ecological sciences techniques into devices and materials employed. Human activity with harmful impacts and prevent the natural environment (US Legal website).

The subject that has been gaining increasing featured among Government´s actions and large corporations around the world, and it is not classified as just an environmental initiative. The term, besides being related to the efficient use of technological resources as it also links to the economic, social, and natural environment.

Environmental technology focuses on eliminating or reducing environmental aggression. Thus, it encompasses compliance with environmental legislation, diagnoses of environmental aspects and impacts of activities related to technological techniques, procedures, and action plans. Although, there is still no definition of the term in the Portuguese language.

Although there is no national entity in Brazil, the Environmental Sanitation Technology Company (CETESB) is the agency of the São Paulo state government. CETESB is responsible for the control, supervision, monitoring and licensing of pollution-generating activities, with the fundamental concern to the quality of water, air, and soil. This Agency was founded on July 24, 1968, by Decree No. 50,079. CETESB has become one of the 16 reference centers of the United Nations (UN) for environmental issues, working closely with the 184 countries that integrate this international body. In addition, it has become one of the five World Health Organization (WHO) institutions for water supply and sanitation, as well as a reference body and advice of the United Nations Development Program (UNDP) for waste issues In Latin America. CETESB also have conducted some investigation about the use of environmental technology in the wastewater treatment industry in partnership with the United States Environmental Protection Agency EPA. To exchange information on environmental management and risk reduction in areas of mutual interest (IPEA, 2015).

The Brazilian environmental industry emerged during the 1950s in response to the demand that began in the public and private sectors, mainly in the area of water and effluent treatment. The market at that time did not have any specialization in the industry. The supplied equipment for both industrial processes, treatment of water and effluents that existed were quite small.

Most of the equipment was imported or manufactured by companies already operating in the industry, depending on the volume of their demand. The development of this sector was grown mainly by the needs of the industry, although the public sector has always been the largest buyer of equipment in this segment. The sanitation industry sector expansion started from the decade of 1970 when the federal government instituted the PLANASA (National Plan of Sanitation). At that same time was created the state sanitation companies, like SABESP (Basic Sanitation Company of São Paulo State) And CEDAE (State Water and Sewage Company). Respectively, attaining annual revenues of US $ 2.5 billion and US $ 1.0 billion in 2007.

The development of this sector depends mostly on public resources. Almost 70% of the volume of investments in this market had initiatives of the federal, state and municipal governments responsibilities.

The Growth Acceleration Program (PAC) established by the government of Luís Inácio Lula da Silva at the beginning of his second term in 2007 was a factor that has driven the growth of this sector in the last decade. The program began with investments of € 10.87 billion, from federal resources, private placements and counterparts from states, municipalities, and service providers in general. In addition to the PAC, the new Sanitation Law, federal law 11455/07, sanctioned in 2007, establishing a regulatory framework for the sanitation sector.

According to the Corporate Sustainability Index (ISE-Bovespa), a tool that measures the corporate performance of companies. Applies sustainable practices established by institutions that interact with the economy and natural resources in the field of sustainability and know-how. The ISE-Bovespa was created in Brazil in 2006 in the core of economic studies of the São Paulo Stock Exchange, which seeks to evaluate the companies through questionnaires, based on indicators that measure their sustainable development. There is a demand for environmental technologies in Brazil between multinational corporations, exporting companies and companies with some certification (ISO 9000 and 14000, NBR 16000 and OHSAS 18001). To continually improve their environmental performance. (Bovespa, 2014)

Technology buyers are also buyers of the chemical sector, signatories of "Responsible Care." They have made innovations in their production processes (reduction of emissions, reduction of water use, etc.) with the incorporation of new technologies and methods. The transfer of technology between national and international companies are carried out by the chambers of commerce and consulates. They continuously bring commercial and technical missions to Brazil and lead Brazilian businesspeople in missions abroad. In addition, there are environmental technology cooperation programs between developed and developing countries. For example, such as MITI (the Ministry of International Trade and Industry of Japan) GTZ (German Cooperation Agency) or Technology Partnership Initiative, England (Ipea, 2014).

Another example of cooperation in technology transfers is between local organizations and international organizations such as the United Nations. An example of this is the National Center for Clean Technologies (CNTL), inaugurated in 1995 in Porto Alegre. The project is a partnership between National Industrial Learning Service (SENAI) and Organization for Industrial Development and United Nations Environment Program (UNIDO / UNEP).

The Brazilian market for environmental technologies, including goods and services, is valued around 27 billion euros. Making Brazil the largest market to invest in environmental technology in Latin America (2016 Top Markets Report Environmental Technologies/ U.S department of commerce).

According to the International Trade Administration (ITA), Brazil has the largest volumes of investment in the environmental technology sector in Latin America, followed by Mexico, Argentina, and Chile (ITA, 2016). However, there are no official data on the volume of investments in environmental technologies in Brazil.

As a Brazilian industrial base continues to grow and become more sophisticated, there is a growing demand for water treatment of its industrial processes. Thus, for a specific quality level, as well as for reuse and water efficiency, as industrial consumers of water pay the highest rate per cubic meter for fresh water. Driven mainly by the low water availability characteristic of some Brazilian regions, substantial investments have been applied in new facilities, some of them with a nominal capacity more significant than one cubic meter per second. Despite in Brazil, only about 30% of the sewage collected receives treatment by the municipalities. There is still no integrated policy for the planned use of water resources with wastewater, which are the main obstacles to reuse practice in the country (CNI, 2016).

According to National Confederation of Industry (CNI), municipalities and companies are starting to work more actively with BOT (Build, Operate and Transfer) projects. The BOT financial model contracts is a new trend in Brazil. Customers will pay investors through long-term agreements calculated in meters cubic of effluents. Several autonomous municipalities, such as Itu and Jundiaí, are using BOT. The reasons are usually the lack of the public that does not have the financial resources and the adverse local political conditions (CNI, 2016).

Another model is Off-site when effluents are sent to a treatment plant outside the locality. Customers will pay a monthly fee for their wastewater to be treated. This approach is appropriate for small businesses that cannot invest in wastewater treatment plants.

Technology for non-potable reuse, mainly for industrial purposes has had a great advance in the last years with costs of implantation and operation with the economic tendency.

The creation of the National Water Resources Policy (PNRH) in 1997 has successfully approved the criteria established at the United Nations Conference. The Eco 92, which changed the concept of the water resource management, with a connotation of a finite resource with economic value. Starting to charge the uses of the water resources that it grants and valuing the concepts of conservation and reuse of water. The Resolution of the National Water Resources Council (CNRH)

No. 54 of 2005 is still the specific legislation on a re-use of non-potable water, and this is a modality, guidelines, and general criteria for practice. Currently, the CNRH is committed to creating new resolutions specific to all usage, agricultural reuse, industrial reuse, reuse for non-potable urban ends and re-use in aquaculture, as well as corresponding codes of practice. Followed by the CONAMA RESOLUTION No. 6, SEPTEMBER 16, 1987, which establishes procedures for environmental licensing and requirements for the conditions and standards for effluent release. However, the lack of norms and legislation has not prevented industry initiatives, and the practice of water reuse grows the most in the country. Among the significant companies, 65% already adopt water reuse practices, and 53% adopt water reuse systems of its treated effluents for internal reuse.

TABLE 2- CONAMA´s fixed standards for effluents.

BIOCHEMICAL DEMAND OF OXYGEN (BOD)	• Industrial activity in general	Minimum Removal of 60%
pH	• Industrial activity in general	Between 5 and 9
Oils and Greases	• Industrial activity, mainly food and beverages	• Mineral: 20 mg/L • Vegetal/Animal: 50 mg/L
Metals	• Industrial activities, steel industry	There is a specific maximum level for each metal
Floating Material	• Industrial activity in general	Total absence
Total Phenols	• Industrial activities, steel industry	5 mg/L
Total Cyanide	• Industrial activities, steel industry	1 mg/L
Total Nitrogen (Ammonia form)	• Industrial activities, pulp and paper	20 mg/L
Temperature	• Mainly pulp and paper and steel industry	< 40°C (maximum variation of 3°C in the dumping area)

SOURCE: CONAMA RESOLUTION N430

According to the National Water Resources Council (CNRH), the industrial sector accounts for 17% of the withdrawal flow (313 m3 / s) and 7% of the water consumption flow (69 m3 / s) (ANA, 2009). In addition, most of the water in use in different activities: as an input in the production process, for cooling machines, for sanitary purposes, among others. The lack of reuse of water for industrial activities is considered most related to the waste of water. Emerging initiatives in the industries are investments in technological innovation and continuous improvement of water productivity. The potential for water use in industry varies from 16% to 54%, with an average of 30% to 40%, which can be amortized over a period of less than one year (ANA, 2009).

For the industrial sector, water reuse assumes a strategic importance in the context of adopting cleaner production practices. Therefore, it is necessary to produce more and in the most optimal way. To increase its competitiveness that in-crease productivity indices and reduce input consumption, such as water, energy, raw materials and consequently reducing production costs. Also, they can obtain ISO certifications for quality and process standard. The Aquapolo project in São Paulo is an excellent example of how the industry is investing without fear in the practice of water reuse. Formed by a partnership between Foz do Brasil (Odebrecht Group) and SABESP to meet the demand of the companies of the Petrochemical Complex to resolve the need to seek sources of sustainable water resources to guarantee their production. The venture involved investments of almost 108.92 million Euros with the construction of a tertiary treatment station in an area of 15 thousand meters square within the Sewage Treatment Station ABC of SABESP. To bring the reuse water generated to the Petrochemical Pole in Mauá a 17 kilometers long adductor was built. Also, to provide better quality water, Aquapolo have enabled the Petrochemical Complex to stop capturing water from its current sources, saving a volume of more than one billion liters of water per month. Aquapolo's reuse water production capacity is estimated at 1,000 l / s. The Petrochemical Complex will absorb 65% of this volume, the surplus 350 l / s could be sold to other industries and municipalities in the region (CNI, 2013).

According to ABES, the Brazilian Association of Sanitary and Environmental Engineering, whom best represents the sector. In Brazil and Latin America, the industrial areas demand technologies to attend desalination and water reuse, which most companies have their headquarter offices in São Paulo. The leading customer industries in Brazil for reuse water include aerospace, electronics, oil and gas, petrochemical, mining, metallurgy, textiles, sugar and ethanol, food and beverage, automotive, pharmaceutical and cellulose (pulp and paper). Processed` water has an expected Compound Annual growth rate (CAGR) of 6.2% from 2010 to 2015 with an estimated revenue of US $ 305.6 million in 2016. Industrial effluent laws in Brazil impose high corporate tariffs for the disposal of effluents in hydric bodies, making the tertiary treatment in place with cost-effective for conform-ing industrial facilities (Ansanelli et al., 2017).

The Brazil-Germany Chamber of Environment and Sustainability Department estimates that in 2007 the services and equipment for domestic and industrial effluent treatment moved US $ 2.3 billion. Approximately US $ 230 million, corresponding to approximately 10% of this amount was imported. Brazil's intensive mining operation in Minas-Gerais, a vast inland famous state for its mines in south-eastern Brazil. Support of the growth of construction giants' companies such as Odebrecht and Andrade Gutierrez. Odebrecht Ambiental owns more than 30% of the sanitation market in Brazil and is expanding (ABI, 2012).

According to International Desalination Association (IDA), southern states such as Paraná, Rio Grande do Sul, Santa Catarina and Espirito Santo are home to some attractive and dynamic industrial sectors. However, there are opportunities in the beverage industry, and in water softening for boiler feed, in all 26 states. In addition, there are also opportunities for water reuse in locations such as shopping malls and large office sites throughout the country. By far the sector's largest customer for reuse water is Petrobras, the Brazilian state-owned oil company, which is building oil platforms requiring large sulfate reduction plants. The other industrial giant is mining company Vale.

The pulp and paper industry is also alive, as is car manufacturing, the steel industry, and beer and beverages. The pulp and paper industry concentrated on the center-south of Brazil. Although the pulp and paper sector is highly dependent on water, it still accounts for only 34%. Fibria, Suzano, and Klabin are the most prominent pulp and paper companies in Brazil (OECD,2015).

These environmental issues have changed the course of some organizations, which are committed not to pollute. However, the society does not accept this kind of posture and takes initiatives to promote sustainability and awareness about the natural environment. Companies that seek a competitive advantage in the globalized market adopt in their strategic plan, approaches of corporate environmental management, as a valuable management tool. What emphasizes that pollution prevention and vital are those that bring more significant benefits to companies and the environment. Due to their performance that is unlimited to meet not only the current legislation.

TABLE 3- Brazilian water treatment industry market share 2013

	CAGR 2010-2012
Odebrecht Engenharia Ambiental S.A	32%
Estre Ambiental S.A	92%
Enfil	-9%
OAS Solucões Ambientais S.A	28%
Degremont (GDF Suez)	-21%
Centroprojekt	-21%
VWS BRASIL LTDA (Veolia)	1%
CAB Ambiental (Grupo Galvão)	-23%

source: worldbank.org

4.1 Technologies available in the Brazilian market

Water resources have been the subject of research in the last decade, especially with the climate changes and the frequent shortage of water resources. New technologies aimed at guaranteeing the water quality and develop a better way to use water resources. The demand for new technologies for wastewater treatment of industrial and municipal effluents have increased as the studies and analysis for their efficiencies as well as their capacity to reduce costs.

According to the Ministry of Environment (MMA), industrial processes and agriculture account for a large part of water consumption in Brazil. The most amount of waters used in industrial processes are under poor chemical or physical conditions. Therefore, it may present a diversity quantity of pollutants and residues, high levels of organic load and highly toxic compounds, making it impossible to return to the source. Sewage is the main contributor to pollution, with high organic load concentration and many pathogenic contaminants.

According to National Union of Equipment for Basic and Environmental Sanitation (SINDESAM), the treatment of industrial and domestic effluents currently adopts different physical, chemical, or biological processes. In most cases, it is necessary to use more than one of those treatments to return the effluent under suitable conditions of disposal or to be reused (SINDESAM, 2014).

Source: Trata Brasil “New technologies in the treatment of water and effluents” from 08/08/2014

4.2 Physical-chemical treatment

The physical-chemical treatment of water and effluents is mainly used for pollutants control of the no removed substance by the conventional process. To treat the drinking water in the drinking water treatment plants (DWTP's), reducing the organic load preceding the biological treatment.

The physical-chemical process also removes pollutants such as soluble organic as phosphorus, nitrogen, organic materials, bacteria and viruses, suspended solids, colloidal solids, and solutions that contribute to turbidity. One of the noblest applications is the use to produce drinking water.

Source: Trata Brasil “New technologies in the treatment of water and effluents” from 08/08/2014

4.3 Biological treatment

The biological treatment is used to generate degradation of organic material of the effluents, through the action of biological agents such as bacteria, protozoa, etc. Thus, it can occur in an aerobic process, with oxygen, and anaerobic process, without oxygen.

Source: Trata Brasil “New technologies in the treatment of water and effluents” from 08/08/2014

4.4 Membrane Bio-Reactor Technology (MBR)

The MBR system is among the most advanced in domestic and industrial effluent treatment, with high efficiency and application in various situations. The technology of membrane bioreactors is not a direct ultrafiltration. However, it is a complete biological system in which the ultrafiltration membranes are an integral part of the organic digestion process matter. It is usually used coupled to the aerobic bioreactor and can be installed in existing activated sludge systems, for example. By working with higher solids residues concentrations than common biological systems, it can be used in more small aeration tanks than those used in activated sludge systems.

Treated effluents should be biodegradable, with low organic load, such as sanitary sewers, and also high load effluents, such as from breweries or food industries.

MBR technology is the most stable and safe process to obtain a high-quality final effluent with organic and nutrient load removal. The process has a simple operation, and no need to control the return of sludge.

Currently, in Brazil the most modern technologies in the treatment of domestic and industrial sewage are also modernized variations of the aerobic process of activated sludge. They are all more efficient, generate less sludge and are more resistant to load variations than activated sludge and usually more efficient than conventional bio-filters.

Among the advantages of this process is energy savings over conventional aerobic bioreactor systems. Another positive aspect is that this system promotes the considerable reduction of microorganisms, allowing the reuse of water. Thus, it enables the use of compact reactors and control system remotely by telemetry and automation. Besides, it works increasing the operational capacity of conventional activated sludge.

Source: Trata Brasil “New technologies in the treatment of water and effluents” from 08/08/2014

4.5 Moving Bed Biofilm Reactor (MBBR Technology)

MBBR sewage treatment system technology was developed in Norway in the 1980s through a partnership between Kaldnes Miljøteknologi (KMT), a specialist in domestic and industrial effluent treatment, and the SINTEF Research Institute. The MBBR process consists of a technology adapted to the activated sludge systems. Through the introduction of small pieces of low-density plastic and a large surface area inside the aeration tank, which acts as a support for the development of a biofilm. The bio-film is kept in constant circulation and mixes due to the introduction of diffuse air or due to the existence of mechanized agitators, and there is no need to recirculate the sludge. Aeration is required only for the supply of oxygen to the biomass, and not necessarily for greater mixing as in some MBBR processes (DAE, 2014).

Source: Trata Brasil “New technologies in the treatment of water and effluents” from 08/08/2014

4.6 Biofilters

The biofilter is a wastewater treatment system of both industrial and urban origin. It is a biological system, with an excellent efficiency in eliminating organic matter and with the reach of excellent purification yield.

They are processes with the purpose of treating domestic sewage and industrial effluents, with the performance for an ecological environment, having as conditioning factors light, organic matter, temperature, pH, and oxygen.

In a biological treatment of effluents, after the launching of the dumps, the processes of auto-depuration are reproduced in a certain way, transforming organic elements into products or mineralized components. This type of treatment widely divides into aerobic and anaerobic treatment.

Submerged Aerated Biofilters (BAS), it uses growth microorganism’s attaches, being widely used for the removal of carbonaceous and nitrogenous matter. One of the advantages of the application of this system is compactness, modularity, rapid regime entry, resistance to load shocks and resistance to low temperatures of the sewage.

Source: Trata Brasil “New technologies in the treatment of water and effluents” from 08/08/2014

4.7 Floating Islands / Wetlands

Floating Treatment Wetlands" (FTWs), which bring dirty water back to its pure, reusable state. Scientists have sought a way to clean rainwater ponds, effluent wastewater, and agricultural runoff, and study how floating islands can purify these waters. The term "wetlands" is used to characterize several natural eco-systems that are partially or entirely flooded during the year. Well-known examples of natural Wetlands are the marshes, the floodplains of a river, etc.

In Brazil, the main recommendations for use are for pre-treatment of water for various purposes, secondary and tertiary treatment of urban sewage, industrial and urban water supply, and purification of large volumes of water.

The technique supports the construction of artificial ecosystems, which aim at the same improvement in water quality as a natural wetland can provide. The structure of canals using floating aquatic macro files, also known as water hyacinths, is a wetlands construction and management technique. The aqua-plants contribute to the improvement of water quality because they serve as a filter for the removal of suspended solids and nutrients, nitrogen and phosphorus. Among the advantages, the resistance to the high degree of pollution of the water with considerable variations in much nutrients, pH, toxins and heavy metals stands out. They can be used in many degraded places.

The floating islands are a particularly innovative example of biomimicry. "FTWs can be simple built-up matrices that stay on the surface. Thus, it works as it is covered by a film of microbes that feed on nitrogen and phosphorus in the water as well as other pollutants on its sticky surface. Also, FTWs house many plants and even trees can be beyond the microbial film, as in a natural swamp. Plant stems remain above water level while submerged roots proliferate.

The technology developed by the French company, Phytorestore, having the garden-based method, which is used to treat domestic sewage and industrial effluents. To condition sewage treatment sludge, to produce fertilizer, and to perform soil bioremediation. The technology can revitalize rivers and lakes. The projects realized by the company are based on five principles of the filtering gardens, which is the owner of the patent: Treatment; Landscaping; Biodiversity; Economic and Management. The filtering garden is a solution that presents biological security since it can be assembled with the natural flora of the place, avoiding problems of introduction of new species in a different ecosystem. It is also economically viable, as it does not require major maintenance, producing a treatment plant up to 30% cheaper than conventional stations.

The filtering gardens have also proved to be a greener choice in the treatment of contaminated sludge and, of course, in the recovery and preservation of rivers. In the case of mud, the actions are through the Rhizosphere. Forty types of effluents can be treated, and sludge can become fertilizer. It is possible to obtain an equivalence of volume of treatment with the use of the filter gardens. However, it is a technique that is best suited for environments with good space, such as cities in the interior or places with less concentration of buildings.

Source: Trata Brasil "New technologies in the treatment of water and effluents" from 08/08/2014

4.8 Mobile treatment systems

Mobile treatment systems are also a significant trend in the market and are already available by several manufacturers serving different market segments. However, it must be a great option to treat water by demand, moments of contingencies or seasonal expansions in the treatment system. These filtration systems are usually designed to support customers' needs and ensure uninterrupted operation (avoiding losses).

Source: Trata Brasil "New technologies in the treatment of water and effluents" from 08/08/2014

4.9 Other Systems

Looking for new solutions for the market some industries have already implemented fresh water and effluent treatment procedures. The "Acqua System," which has developed equipment to treat fluorine in waters as well as solvents in effluents. According to the company, although the new equipment is still in development, it is already being used by many industries.

The system called "Acqualise" is a compact and very efficient equipment in the removal of impurities or excess of salt in the water to be potable and effluent purposes according to its manufacturer. There are two types of Acqualysis: Ac-qualise TF (fluoride treatment) used to remove fluoride salts and some electro-negative elements that leave the water salty. The Acqualise TE (effluent treatment) system developed for the removal of solvents and complex organic compounds, as Phenols, BTXE, among others. These compounds suffer a break-down in their parent molecule, and the byproduct of that process is less polluting and more natural to treat than the original molecule.

Source: Trata Brasil "New technologies in the treatment of water and effluents" from 08/08/2014

5 CONCLUSION

As presented throughout this paper, the predominant factors of the Brazilian market environment also involves environmental issues. Therefore, this subject is constantly at the center of the discussions carried out by the society, governments, and companies in Brazil. The problem in sustaining Brazilian water resource has made water reuse a subject of great importance in Brazil. The lack of investment by the Government along the last two decades and the growing uncontrolled exploitation of aquifers has been the leading cause for concern.

The Brazilian Government is looking for solutions to achieve water resources. It therefore provides a great business opportunity for CEMIS to introduce their clean high-tech solutions into the market. The clean-tech solution for ultra-filtration can be adopted to treat the many effluents in the industrial sector, including the petrol and mining industry and urban sewage in towns, under fifty thousand inhabitants.

The Brazilian wastewater regulatory system has been highly oriented towards strict standards based on international requirements lately. Such requirements, gives a competitive advantage for CEMIS to have a superior technology available in that market. One being that clean-tech solutions presented by CEMIS provide a safety method solutions system, which is the most prominent differential advantage to compete. Therefore, based on the analyses of data and indicate four options to enter the Brazilian wastewater treatment market.

The first possible entryway to enter into the Brazilian market is to seize the opportunity of so many towns across the country, with a population under 50 thousand do not have a water treatment supply system or wastewater treatment system that could quickly be provided by CEMIS. Therefore, towns up to 50,000 inhabitants have the most demand for water treatment projects and a supply network(s), from the catchment to water treatment station. Because they are more likely to suffer from sanitation problems being of small size. These towns of course can be selected from different regions according to the strategic implementation plan for that market.

The second option to enter the Brazilian market is the industrial sector such as food and beverages, pulp and paper and chemical. There are different size and demand for a solution to treat the effluents. Most of these companies concentrate in Southeast Brazil, which is primarily economic center such as Paraná, Rio de Janeiro, and São Paulo.

The third option, the involvement through a cooperation agreement in the treatment of degraded areas with current project offices of the Brazilian government. Mainly in Minas Gerais state and some other locations in the north region, which are running projects to treat mining pollution. In particular, the Samarco´s mine tail dam disaster in the town of Mariana, which has a vast territory to most of the projects are related to "Recover Rio-Doce" hydric source. Also, there are many others spots along the Iron quadrangle mining region with similar issues of water treatment.

The Fourth option to enter the Brazilian market is the oil industry as requires more water reuse systems and requiring large sulfate reduction plants including offshore water filtration. The primary operational oil industry centers locate in Bahia, Rio de Janeiro, and São Paulo.

In general, the Brazilian market is favorable to the entry of environmental technology companies of ultra-filtration of residual water. In favor of this, the Brazilian governments have prioritized investment policies in the water treatment sector to help reduce infrastructure gaps. The Brazilian sanitation implementation plan; "PLANSAB," which seeks to minimize the lack of investment in sanitation and expects to be a formal target of universal sanitation services by 2030.

The Brazilian sanitation sector received considerable attention and investments from governmental and private industries, which were made possible by public-private partnerships (PPPs). New environmental sanitation policies for the private sector can help companies enter with clean ultra-filtration technology solutions for water reuse. New technologies for the treatment of drinking water are preferably employed, since the use of aluminum salts has been found to correlate with diseases of mental aging in humans. Currently, there is a significant amount of resources to be invested in sanitation projects. The industrial effluent laws in Brazil impose high corporate tariffs for the elimination of effluents in bodies of water, establishing cost-effective tertiary treatment for conforming industrial plants.

Therefore, how does internal Brazilian environmental market' factors affect CEMIS to commercialize its technology in Brazil?

Some differential facts offer a competitive advantage for CEMIS to enter and compete in the Brazilian market. Despite the economic fluctuation, the market remains active. The industry keeps growing and modernizing to meet the needs of the country. Thus, there is a growing demand for wastewater treatment of its industrial processes, for a specific quality level, as well as for water reuse and efficiency. This is mainly driven by the lower availability of water, which is a major feature of the climatic changes arising in the country today.

6 RECOMMENDATIONS

As a recommendation, I would suggest to the companies operating under CEMIS organization to open a representative office in Brazil for joint projects and marketing. To become a member of the trade association can help with future cooperation. Also, they should attend the business fairs and events organized in the country. They should consider establishing a manufacturing plant in the country to become a truly active player in the marketplace.

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