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Proposal of Water Purification Technologies for the largest cities in Brazil.

BACHELOR'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled Proposal of Water Purification Technologies for the largest cities in Brazil independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague date……..…

Martin Rejmont

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Abstrakt

Brazílie, země bohatá na vodní zdroje. Odhaduje se, že samotná Brazílie disponuje až 13% zásoby světové pitné vody. Ipřesto tento fakt zde docházelo v posledních letech k vážných krizím, kdy docházelo k historicky největším suchům na které nebyli obyvatelé Brazílie zvyklí. Země bohatá na dostatek veškerých surovin potřebných k životu musela v uplynulých letech řešit katastrofické stavy hladin svých nádrží, které napájí jedny z největších měst světa. Nádrže v Sao Paulu dosáhly v nejhorším období pouze 5 % capacity vody a v Riu de Janeiru byla situace ještě daleko horší. Jejich nádrže dosáhli pouze 1 % kapacity.

Po prvním studiu této problematiky se ukázalo, že jedním z velkých problémů byl stav vodovodního potrubí, ve kterém dochází až k 30 % ztrátám. Příčinou těchto ztrát byl velmi špatný stav infrastruktury a nelegální napojení do vodovodního systému. Nedostatek finančních dotací měl za následek tento stav.

Slamy, které vyrostli v blízkosti velkých měst celou situaci pouze zhoršovali. Tyto oblasti ve velké většině stojí nelegálně a bez připojení k vodovodním a kanalizačním systémům. Následkem této situace docházelo ke znečišťování zdrojů pitné vody a omezení možností zásobení měst pitnou vodou. V době krize tyto zdroje nemohli být využity a celou situaci to zhoršovalo.

Jednou z primárních příčin nedostatku vody bylo kácení Amazonského pralesa a tím snižování síly vzdušných řek a jevu známým jako “El Ňiňo”.

Řešením na tyto situace byl boj proti primárním příčinám such, vzdělávání občanů o problematice a zlepšení nakládání s vodou v krajinách a městech.

Klíčová slova:

Brazílie, technologie čištění vody, Sao Paulo, Rio de Janeiro, pitná voda, sucho, zemědělství

Abstract

Brazil, a country rich in water resources. It is estimated that Brazil alone has up to 13% of the world's drinking water supply. Despite this fact, there have been serious crises in recent years, when there were historically, the largest droughts, that were not accustomed to the inhabitants of Brazil. A country, rich in enough raw materials needed to live, in recent years, has had to deal with the catastrophic levels of its reservoirs that feed some of the world's largest cities. The tanks in Sao Paulo had only 5% water capacity in the worst time, and the situation in Rio de Janeiro was even worse. Their tanks had reached only 1% of capacity.

After the first study of this issue, it turned out that one of the major problems was the state of the water pipeline, which accounts for up to 30% of the losses. The cause of these losses was a very poor state of infrastructure and illegal connection to the water supply system. The lack of financial subsidies led to this situation.

Slums that grew up near large cities only worsened the situation. These areas, in the vast majority, are illegal and are without connection to water and sewerage systems. As a result of this situation, the drinking water sources were polluted and drinking water was reduced. At the time of the crisis, these resources could not be exploited, and the situation worsened.

One of the primary causes of water scarcity was the felling of the Amazon forest, and hence the reduction of the strength of the air rivers and the phenomenon known as "El Ňiňo".

The solution to these situations was the fight against primary causes such as education of citizens on issues and improvement of water management in countries and cities.

Key words:

Brazil, water purification technologies, Sao Paulo, Rio de Janeiro, drinking water, drought, agriculture

Contents

List of tables:

List of charts:

List of figures:

List of the abbreviations used in the thesis:

CIA – central intelligence agency

EDI – Electrodeionization

F.B.C.G.S.S.D.G. – From Brazilian Comprehensive Growth Strategy to Sustainable Development Goals

GDP - gross domestic product

HDI – human development index

IBGE - Brazilian Geographical and Statistical Institute

km^2 – square kilometer

LGBT - lesbian, gay, bisexual, and transgender

m^2 - square meter

MRSP - Metropolitan Region of São Paulo

nm - nanometer

PSL - Social Liberal Party

VAT - Value Added Tax

1. Introduction

In 2013-2014, there was one of all the crises that Brazil could experience. In the largest cities such as Sao Paulo, the water reserves were reduced to just 5% and in Rio de Janeiro only 1 % of tank capacity was reached. This situation raised fears of a possible collapse of the system and civil rebellion.

Unfortunately, the new government has not taken the consequences of these crises seriously and encouraged the felling of the Amazon forest. No one really takes the impact of climate change seriously. In connection with the felling of the forest, the government ignored the local natives who lived here. There was nothing left to do, but to integrate into the modern society or to move further into the forest.

The largest cities, such as Sao Paulo and Rio de Janeiro, have used only the acute measures that helped in the crisis, in spite of the crisis. As a result of the crisis, however, they began to build a water pipeline that would bring drinking water away from larger distances, and thus sparked possible future crises. The primary problems that these crises are causing have not been solved for the time being.

Agriculture uses large amounts of water for irrigation from river systems or underground water reservoirs. The use and conservation of water that came into the country during the rainy season, unfortunately, did not work.

The water and sewerage infrastructure are very neglected in the cities. The situation here was far better than it was in smaller towns or villages. Even in this situation, losses in the water system were up to 30%. In the case of sewer cleaning systems, the cleaning stations were not efficiently enough to clean a large amount of production and so most of the waste produced returned to the environment uncleaned and polluted the local environment and possible sources of drinking water for other residents.

2. The Aim of thesis

The aim of the thesis is to describe the consequences of poor water management in Brazil with an impact on Brazil's largest cities in recent decades and to propose a technological solution to the problems that have arisen. Poor water management is described with a focus on the following areas.

Specific objectives:

- The impact of population growth in cities and surrounding areas.
- The impact of agriculture on water availability and use.
- Deforestation and its impact on landscape water sustainability and the availability of water resources.
- Brazil's political scene and its impact on overall management, focusing on the impact of water availability and use.
- To proposed in general the applicable water purification technologies suitable for the largest cities in Brazil.

3. Methods

The information in this bachelor thesis is collected from relevant and published scientific articles, periodicals and papers in English and analyzes what can be learned through collection of data. The used internet databases are: Web of Science, Science Direct, Google Scholar…etc. In addition, relevant and published books related to the topic is included. The bachelor thesis will be relying on previously collected data and information relevant to the own experience of the author in the region.

The quoted information was searched through Internet articles and publications, particularly because of the greater chance of getting the most up-to-date information on the issue.

Their selection was based on the search of the keywords mentioned in the bachelor thesis and their similar terms.

The most common combinations of popular words and phrases were: brazil water, water brazil, water crisis brazil, south east brazil water crisis, brazil land plan, brazil agriculture water problems and so on.

Quoting resources at work was done according to the English language citation rules according to the latest version available on the FTZ faculty web site.

The style of quoting used was a pattern from Conservation Biology.

4. Literature Review

4.1 Background of the Federative Republic of Brazil

4.1.1 Basic information

Brazil is a country located in the East of South America, bordering with French Guiana, Suriname, Guyana, Venezuela, Colombia, Peru, Bolivia, Paraguay, Argentina and Uruguay. The official name of Brazil is the Federative Republic of Brazil and it is a Federal Presidential Constitutional Republic. From January 2018, the President of Brazil is Jair Bulsonaro. (CIA 2019)

The total area of Brazil is 8 514 977 sq km. (Amelia Meyer 2010) Brazil is the fifth biggest country in the world. Countries bigger than Brazil are Russia, Canada, The United States of America and China. (Ronald Milton Schneider 2019) The location of Brazil on the map of the world and its possible comparison with the greats of other countries can be found in the picture below. The capital city is Brasilia, which is located in the Brazilian Plateau. (GraphicMaps 2018) Brasilia has about 2,9 million residents and it is fourth largest city in Brazil. It is located in the center of Brazil, in the state Goiás, 1,100 metres above sea level. The Area of the city Brasilia is 5,802 sq km and was founded in 1960. The largest city in Brazil is Sao Paulo with 11,9 million residents. It is located in the state of Sao Paulo near the East coast and the area is 1 523 sq km. Sao Paulo was founded in 1554. (AboutBrasil 2014) The official language is Potuguese. The total population is 205,8 million. From the whole population, 86,6 % is an urban population, 64,4 % are Roman Catholics and 22,2 % are Protestant. There are 5 ethnic groups. The biggest are white with 47,7 % and mullato (mixed white and black) with 43,1%. (CIA 2010)

Figure 1: Brazil world wide map (Geology 2019)

Most of the population of Brazil lives along or near the East coast. Especially near huge cities like Sao Paulo, Brasilia and Rio de Janeiro. HDI - human development index for Brazil was 0,754. World HDI was 0,728. (Human development reports 2018) The largest cities in Brazil, located mainly on the East coast, can be seen below in the picture, along with the division of Brazil into individual cantons with their capitals.

Figure 2: Brazil political map (World Map Store 2019)

4.1.2 Population in Brazil

In 1960, Brazil had about 72 million inhabitants. In 2017, 209 million people lived in Brazil. This is almost a threefold increase in population over 57 years. To a large

extent, Brazil has not managed such a large increase in population. A large number of people live in straw around big cities. This increase was due to migration from neighboring countries, industrialization of industry and agriculture, and the Green Revolution. Such a large increase in population and migrants resulted in the creation of straw, which is still not at all or only to a small extent built infrastructure. The level of infrastructure and security is very small to slim. (data.worldbank.org 2019)

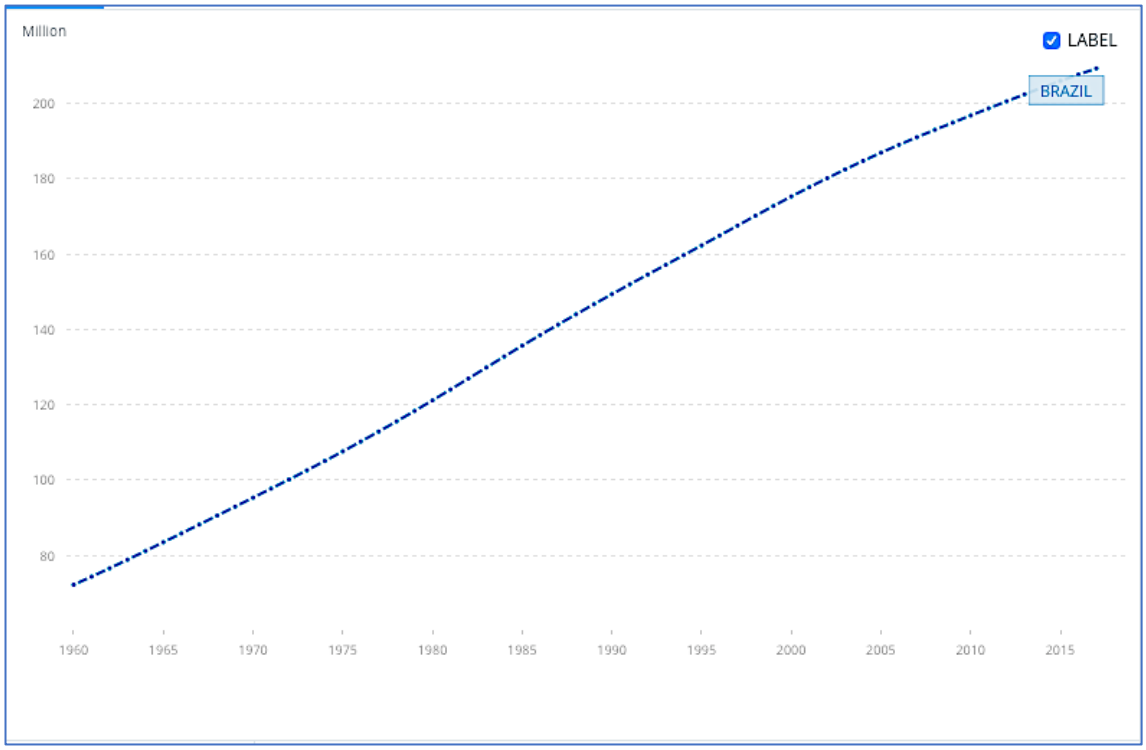


Chart 1: Total population (data.worldbank.org 2019)

4.1.3 Geography

Brazil is divided into five large geographic units called Northeast (Nordeste), Central-West (Centro-Oeste), Southeast (Sudeste), and South (Sul). The division of Brazil into larger units according to the cardinal points can be found in the picture below. Brazil surface area is 8,51 million sq km of which 55 460 sq km is water and 8,45 million sq km is land. Brazil is the fifth largest country in the world and the largest country in South America. Her coastline stretches for 7 491 km and it is an important part of economy. With mangroves, lagoons, dunes and coral reefs it is a sought after objective of tourists. (Luciano et al. 2019)

Figure 3: The regions of Brazil (tes.com 2019)

The highest Brazil point is Pico de Neblina with 2,994 m above sea level. (CIA 2019) The lowest point of Brazil is Atlantic Ocean with 0 m above sea level. (CIA 2019) Brazil is defined as tropical and subtropical. That means humid and hot conditions. Wet and dry seasons can be seen in many areas, instead of four seasons, which are typical for most Brazilian area. (Meyer 2010)

The Northernmost point is located in Roraima bordered with Guyna and Brazil and it is Monte Caburai with 1,465 m above sea level. Monte Caburai was fouded in 1930. In Rio Grande do Sul is located the southernmost point in Brazil. The Barra do Chui is on the border with Uruguay. The westernmost point of Brazil is in state of Acre and it is Serra do Divisor National Park. The park is bound to the west by the Peruvian border and

covers an area of 846,633 hectares. The easternmost point is in Paraiba and it is Ponta do Seixas. Known as a place with several white beaches. (Sharon 2018; CIA 2019)

The most important part of the world, and almost part of Brazil, is the Amazon rainforest, nicknamed as the lungs of the world. The Amazon rainforest is home to an estimated one-third of all known animal species. Rainforests occupy around 60 % of Brazil. The area associated with the Amazon Forest can be seen in the picture below. (Meyer 2010)

Figure 4: Amazon River Map (rainforestcruises.com 2019)

4.1.4 Favelas in Brazil

Favels, alias slums originated in the 19th century. At that time, it was not the way we know it today. They were built by displaced soldiers and later by homeless people who were former slaves. (Duran 2014; Schneider et al. 2019)

The name Favels originated thanks to the soldiers who built these slums. At that time much smaller. The soldiers came from Bahia and the name of the slums according to their local tree, which they call Favela. These trees irritate the skin after touching them. (Duran 2014; Schneider et al. 2019)

The biggest growth of Favel was in the 20th century, specifically those at the age of 70. When it came to many Brazilian people and migrants from other countries. These people wanted to take advantage of the great economic growth that took place at that time. They moved from smaller towns and villages to these favelas, where they had the opportunity to find their place in big cities. Unfortunately, few of these people have found a way to abandon the favela and leave the lowest level of people in Brazil. The favela Rocinha located in Rio de Janeiro is an illustrative example of one of the biggest favel. (Duran 2014; Schneider et al. 2019)

Figure 5: Rocinha, the largest favela in Brazil. (Rio de Janeiro)

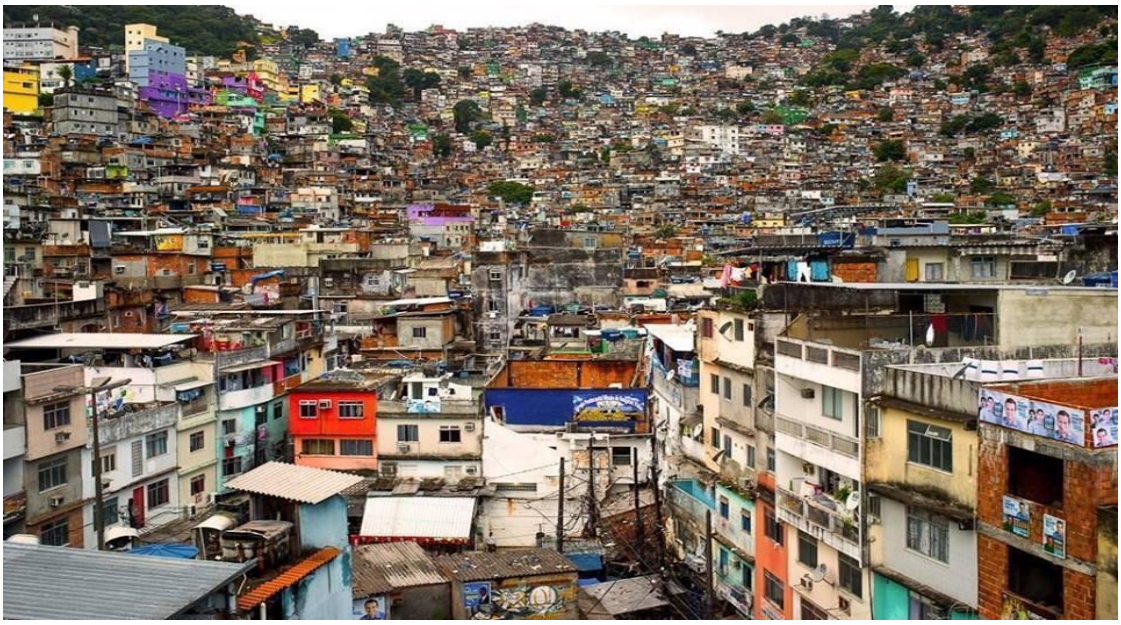


Figure 6: Rocinha, the largest favela in Brazil - Rio de Janeiro (yu/bobbyjetstream 2018)

These sites are in large numbers, controlled by drug dealers and mafias. The government does not have sufficient capabilities to solve this big problem. A large number of sites are illegally connected to a power grid, where masts built in favels are loaded with dozens of electricity-generating cables for which no one pays. It's such a veto against the government. The government does not care enough about these areas and people's safety. Most people, for these reasons, do not meet the government and live at the expense of the whole system. They do not pay any taxes, take electricity for which they do not pay, and much more. This is a complex struggle where, on the one hand, the inhabitants of these poor parts live in the worst possible conditions, and on the other, the government, which does not always work as it does. At the same time, solving these

problems is not at all easy. For decades when this situation has almost not been solved or the efforts to solve were very small or ineffective, it is very difficult to solve this enormous problem. (Duran 2014; Schneider et al. 2019)

4.1.5 History and economy

4.1.5.1 First republic

The year 1889 meant a coup for the Brazilians. Monarchic Brazil failed after many deep problems, which gave chance on revolution. In the year 1889 marshal Deodoro da Fonseca, with a huge army, deprived the monarchic government and declared a new military republic. The first president of new republic was Deodoro da Fonseca, which deprived the monarchic government. Province become individual autonomy states in the military republic. They could make their own decision. (Duran 2014; Schneider et al. 2019)

The Military republic gave hope for residents. Unfortunately, in many ways the system was not perfect. People rebelled for physical violence, higher salaries and for vaccination against smallpox. In 1904, there was a rise in smallpox disease in Brazil. Vaccinating the people was refused. (Duran 2014; Schneider et al. 2019)

4.1.5.2 Second Republic

After many years and many protests and trying to make a revolution, the people were successful. In 1930, after a revolution, an army republic from 1889 become the New Second Republic. It was a manifestation of the struggle for a new democratic republic. Industry grew quickly and the Second republic was a short, but productive era of improving economic systems and building the new capital city Brasilía. (Duran 2014; Schneider et al. 2019)

4.1.5.3 Military dictatorship

The year 1964 is known as the year of military coup. The end of the Democratic Second Republic and the return to the roots of military dictatorship. The new government restricted citizens' freedom. (Duran 2014; Schneider et al. 2019)

In 1969 this system entered to the era of economical growth full of government projects in infrastructure. On the one hand, economic grew about 10%, but on the second hand, poverty, social inequality, invasions of natives and destruction of the environment grew. (Duran 2014; Schneider et al. 2019)

People were tortured, human rights were violated by the Brazilian dictatorship. People across the country were persecuted and disappeared. (Duran 2014; Schneider et al. 2019)

4.1.5.4 Re-democratization

The dictatorship was forced to change after many increasing protests and the growth of government debt. People who were expelled and persecuted, were once again welcome in Brazil. It was a slow and smooth transition from the dictatorial regime to democracy. The new government had an enormous challenge – inflation and social problems. The result of huge debt. (Duran 2014; Schneider et al. 2019)

4.1.5.5 Economy

Concurrently with re-democratization, there had been many attempts to open up the Brazilian market. Reforms changed Brazil currency several times, one effort was to try accepting American dollar currency. This attempt was very criticized. (Duran 2014; Schneider et al. 2019)

The last attempt was successful, and its reform is valid until today. It was officially introduced in 1993 and put into practice in 1994. The new scenario meant major changes

in foreign trade policy and privatization in many industries. (Duran 2014; Schneider et al. 2019)

4.1.5.6 Recession

Brazil struck international crisis in 1999. The economy fell into an economic recession. The government was forced to confront the IMF (International Monetary Fund) and take strict control over public spending. It raised interest rates and reduced public investment. Thanks to this situation, unemployment has risen. From this situation, the country did progress for long, when the country fell into another recession in 2016-2017. (Duran 2014; Schneider et al. 2019)

4.1.6 Country Strategy Plan - F.B.C.G.S.S.D.G.

4.1.6.1 Basic information

The aim of this document is to evaluate and set individual objectives in the battle in the following five areas: 1. “ensure inclusive and quality education for all and promote lifelong learning“ (Foundation 2017), 2. „achieve gender equality and empower all women and girls“ (Foundation 2017), 3. „ensure access to affordable, reli- able, sustained and modern energy for all“ (Foundation 2017), 4. „promote inclusive and sustainable economic growth, employment and decent work for all“ (Foundation 2017), 5. „take urgent action to combat climate change and its impacts“ (Foundation 2017). Describe individual commitments and concrete steps in the areas. Evaluate steps already taken in the past and plans in the coming period. (Foundation 2017)

4.1.6.2 Climate and energy policy

In 2009, Brazil adopted voluntary climate change targets as part of its policy agenda. The goal is to reduce greenhouse gas emissions by 2020. In 2015, Brazil will specify its 2025 next year plan to reduce its greenhouse gas emissions by 37 % compared to 2005. By 2030, emissions will be reduced by 43 % compared to 2015. (Foundation 2017)

4.1.6.3 Reforestation

The proposed measure in this area is the reforestation of 12 million hectares of land by 2030 - that corresponds to half the size of the United Kingdom. Creating new areas for forestry. Non-native monocultures such as palms, eucalyptus, pine and other non-native species are used for afforestation. (Foundation 2017)

The way to address this goal is somewhat unchecked. Non-native species can cause an invasion that can result in disastrous impacts on biodiversity. As early as 2012, around 7 million hectares of forests have been planted in Brazil. In the current situation with water scarcity, climate change and monocultures, these areas are another factor in worsening the problems of adapting Brazil to climate change. (Foundation 2017)

In 2012, the Brazilian government came up with a new forest law to help achieve the afforestation goal. Unfortunately, this new law has become an aggravating factor in the whole situation. The Old Testament gave people the limits and responsibilities of cutting down and managing forests. The new law is bypassing the old law and allowing deforestation over given limits when exchanging assets in the environmental field. (Foundation 2017)

4.1.6.4 Energy

In this area, Brazil is focusing on increasing the origin of energy to renewable sources. The specific objective is by 2030 to increase the share of renewable energy to a minimum of 23 %. The plan adds to the global target to increase the share of renewable energy by 2030. The Brazilian government has launched a $ 186 billion investment program in 2015. This program is geared towards the construction of water, wind and solar power plants, biomass and thermoelectric devices. (Foundation 2017)

A factor in relation to the plan in this area is the impact of building this infrastructure, especially water preserves on the entire ecosystem and society. In the case of the construction of the Belo Monte dam, it was forced to leave their homes and move over 40,000 inhabitants of the locality. This dam has caused a change in an area of 1 500

square kilometers. This interference with the country caused a huge destruction of the country and the people living in the area enrolled in life. (Foundation 2017)

4.1.6.5 Inclusive Growth

In 2010, VAT growth was 7.5 %, when Brazil out ranked India and China as the world's fastest-growing economies. Thanks to these long-term changes, the number of people living in extreme poverty declined by 1 million. (Foundation 2017)

The Bolsa Família program has been recognized by the United Nations as a proven revenue distribution process. The aim of the program is to guarantee the right to nutrition, education and health to the people of Brazil. The program includes 13.9 million families in extreme poverty or poverty. There has been a reduction in inequality and a decrease in the GINI index. The figure was 0.5689 in 2004. Ten years later, the index was 0.490. (Foundation 2017)

Under the Pronatec program, the Brazilian government aims to increase access to qualified vocational training. Between 2011 and 2015, more than 4300 municipalities showed over 9.4 million entries in technical or technical courses. (Foundation 2017)

4.1.6.6 Education and gender equality

The Brazilian strategy in the field of education is primarily focused on the education of children aged 6-14 under the national education plan. By 2024, targeting 10 % of Brazil's GDP for public education and the elimination of illiteracy. (Foundation 2017)

In 2014, at the age of children 6-14, 97.5 % enrolled in elementary school. Prognoses in this area are very positive, given the survey and pace recorded in 2013 and 2014, it is to be expected that the 100% target for the education of children aged 6-14 will soon be achieved. As a result of the political and economic crisis, between the years 2014 and 2015 the literacy rate increased by only 0.3% from 91.7 % to 92 %. As a result of these crises, it will be a difficult challenge to achieve the objective of eliminating illiteracy and investing in public education. At the same rate of growth, it is very unlikely that Brazil will be able to eliminate illiteracy before 2024. (Foundation 2017)

Within the GDP breakdown, only 5 % of the total GDP was spent on education. As a result of a sharp fall in GDP and new tax adjustments, education objectives are at risk. Lack of investment in education threatens the target of reaching 10 % of total GDP and respecting the plans that Brazil has embarked on in the framework of global commitments. (Foundation 2017)

4.1.6.7 Gender

In the field of equality between men and women, Brazil is facing major challenges in the economic, political and social spheres. Wage differences between men and women with the same level of education, place Brazil as the most unequal in South America. Even though the Brazilian Geographical and Statistical Institute (IBGE) found that the pay gap between men and women between 2005 and 2015 has declined, this situation is still uneven and causes Brazil obstacles to fighting poverty and total inequality in the labor market, in the fight for empowerment of women. The average male salary in 2015 was US $ 2,012, and women US $ 1,522. (Foundation 2017)

The Electoral Law adopted in 1997 requires at least 30 % of one sex and a maximum of 70 % of the other on the candidate list of each political party. For the 2016 elections, only 31.6 % of women were included in the Candidate List. That was 155,587 female candidates compared to 336,819 male candidates. Despite the fact that out of the total population in Brazil, more than half of the women's population were elected, only 13 % of the women in elected mayoralties were elected, 10 % of the total seats in the Chamber of Deputies and 14 % of the vacant positions in the Senate. The current number of women in positions in politics came out in Brazil in the world comparison to 154th place out of a total of 194 countries. The order is to determine the percentage of women represented in positions in local politics. Other emerging countries such as China ranked 74th and India 148th. This comparison shows that the increase in the political representation of women in the government is not enough for legislation alone. This issue must also be addressed through initiatives and educational efforts to raise awareness of the importance of women's representation in the political sphere. (Foundation 2017)

In 2006, a law called "Maria da Penha" was adopted, which the UN recognizes as one of the best laws in the world aimed at combating domestic criminality. This law focuses on reducing domestic violence and guaranteeing child protection and social

assistance. Since its adoption, domestic criminality has been reduced by 10 %. Brazil aims to eliminate all forms of violence against girls and women in the private and public sphere. (Foundation 2017)

4.2 How does the Brazilian government affect the lives of not only Brazilians?

4.2.1 Newly elected head of state.

As president he was elected in October 2018. He was elected by the people of Brazil. He took his post on January 1, 2019. (Child 2019)

Jair Bulsonaro is a member of the PSL political party he joined in 2018. He previously served as longtime congressman for Rio de Janeiro. (Child 2019)

4.2.2 A new threat chosen by the people of Brazil themselves.

Right in the first days when Jair Bulsonaro took office, we saw what they could expect in the future. His plans were no longer affecting only the people of Brazil, but even the whole world. (Phillips 2019)

It is incredibly shocking that he has chosen this nation himself. The population has already undergone some weight-bearing trials, most likely in connection with climate change, to return. (Londoňo & Andreoni 2019; Phillips 2019)

Despite his new foreign minister, he canceled the global environmental conference Brazil was supposed to host. (Londoňo & Andreoni 2019)

One of the first steps was the transfer of regulation and creation of new indigenous reserves under the Ministry of Agriculture. Previously, it was under the Ministry of the Environment. This in turn means that the Amazon forest is almost

outspoken, and its deforestation can continue to grow. The valuable, unique ecosystem of the world is in even greater danger and, together with it, thousands of animal species, many of which are found only in the Amazon forest. (Phillips 2019; Londoňo & Andreoni 2019)

As a result of this move, there is also a strong disruption and threat to the indigenous people of the Amazon rule. They have no liking for the new president and risk destroying their natural environment without compensation. Their future in the eyes of the President is integration into the common Brazilian population. In connection with this attitude, violence against indigenous peoples, who are hindering their lives and their original lifestyles, is increasing. (Phillips 2019; Londoňo & Andreoni 2019)

This is also related to the attitude towards the LGBT population, which is very homophobic. There has been a major reversal in this area when in recent years this population has been promoted and equated to the level of heterosexual couples. (Rozsa 2019; Londoňo & Andreoni 2019)

The new president poses a major threat to Brazil's future, especially in the water cycle. With the new president, water problems in the landscape can be deepened, thereby increasing the chances of a potentially stronger and more disastrous water crisis than Brazil has experienced so far.

4.3 The El Ňiño phenomenon

This is a very complex phenomenon that has not yet been fully described and understood. It is repeated in irregular 3-6 years cycles in which it is also otherwise strong. It affects the weather in South America and Australia. South America arrives in December around Christmas. The continent brings a lot of precipitation, which is very important for the survival of the entire continent. (Novikov 2005; Sinimbu & Jade 2017)

The occurrence of this phenomenon is related to the currents of water that interact in the sea depending on the phenomenon and influence it. This is only related to

air currents. Air currents and water currents are very much related to this phenomenon, which makes it so influential throughout the continents. (Novikov 2005; Sinimbu & Jade 2017)

5. Water situation in Brazil

5.1 Water uses in the Brazilian population

It is estimated that Brazil has up to 13 % of the world's drinking groundwater. The weather in Brazil is influenced by the phenomenon called "El Nino" coming from the ocean through the Amazon forest to the rest of the continent, where rain is rich. Brazil is also home to one of the world's great rivers, the Amazon River, a rich source of drinking water and an important part of the great ecosystem. It flows through the great Amazon forest, located in the northern part of Brazil. Forests are an important part of the "El Nino" phenomenon, supporting its growth and the transfer of more water to the rest of the continent. (Ribeiro 2018)

Of the total amount of water Brazil has, its water is used in irrigation agriculture at 54 %. Livestock consumes 6 %, cities 23 %, and industry 17 %. (FAO 2015)

The number of people using drinking water, people who have access to safe drinking water, have increased in 2000-2015. In 2000, access to treated water had less than 94 % of the population. By 2015 it was about 97 %. These values apply to urban areas. In rural areas, the situation is quite different. Here, access to treated water was more than 74 % in 2000, and it was less than 87 % in 2015. The total amount of water per one person of all renewable water is 43,155 m3 per year. (JMP 2015)

The big difference is access to sewerage to which the population has access. In 2000, access to complete high-quality sewerage had less than 26.5 % in the urban area. In 2015, it was just under 39 %. In the case of data, a method which is not a very good for sewer systems, the most basic sewer systems are valued for 2000 less than 53.5 % and for the year 2015 the figure is 50.5 %. (JMP 2015)

In rural areas, from a statistic point of view, we can not talk about a high-quality and fully-fledged sewerage system. This system is not introduced at all from the point of view of statistics until 2015. In 2000 there was a situation with the basic sewer system with less than 36 %. In 2015, it was already 58 %. (JMP 2015)

From these data we can see that the situation in access to treated drinking water is not entirely satisfactory. There are very large differences between urban and rural areas. The suggestion for improvement is to increase investment in drinking water systems. This will increase the overall health of the population and will potentially endanger the health of people from potentially contaminated waters. (JMP 2015)

In the area of sewerage, the situation is very troublesome. In this area, the need for investment is the most important. The situation can cause very easy ozmah of civilization diseases, which can subsequently get into drinking water and endanger the lives of many people. (JMP 2015)

5.2 A nationwide problem with international overlap

The main problem of the whole of Brazil is the lack of water, which began in 2012 and affected mainly the regions of the southeastern and middle-west parts of the country. As a result of these droughts, the worst water levels occurred, and a number of cities were almost at the point of drying with the water system. (Ribeiro 2018)

People are forced to dispose of water gently and to adapt to crisis plans in the worst cases such as the reduction of drinking water supply, the closure of public buildings such as schools. Restrictions on the operation of restaurants and much more. (Spring 2018)

The Brazilians have always been accustomed to living in abundance and sufficiency. Whether it's water or food. Unfortunately, it has been lately shown that this situation is changing, and people will have to change their behavior and approach. An illustrative example of comparing the display of water shortages in Brazil compared to

the seasonal problem and the long-term problem of water scarcity can be seen below. (Spring 2018; Ribeiro 2018; THE WORLD BANK 2016)

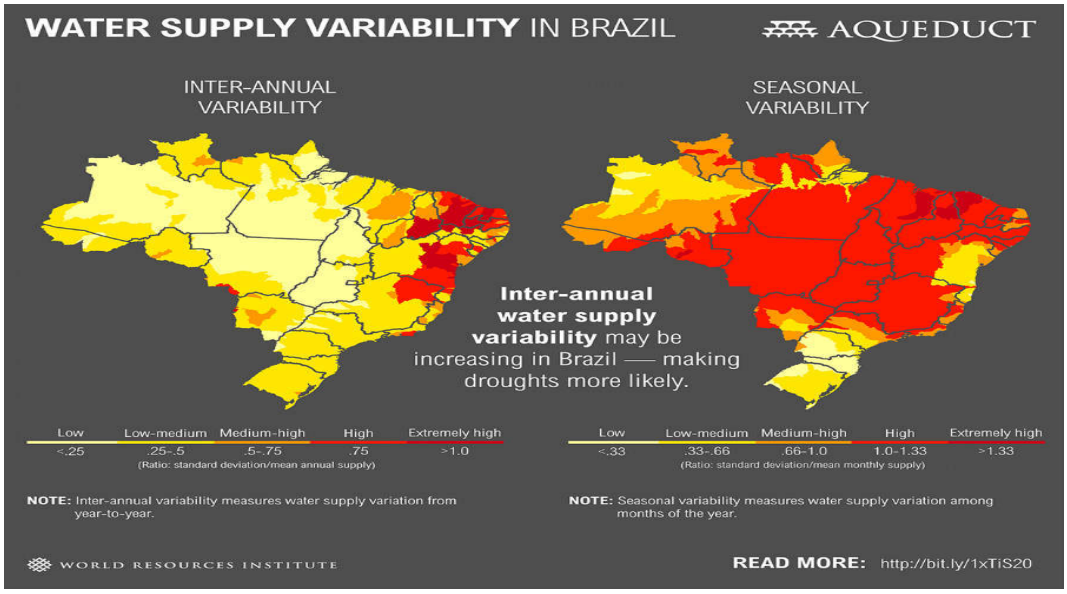


Figure 7: Comparison of water scarcity problems in the season and several years. (Andrew Maddocks et al. 2014)

Due to the drainage of groundwater into irrigation systems, the groundwater level decreases. Subsequently, the amount of water that is in the rivers decreases and the landscape is slowly drying up. Due to the small amount of water in the rivers, there is not only a threat to urban populations, which are predominantly supplied from tanks and rivers, industry is also at risk. Due to reduced river flow, electricity production may be reduced. Most are produced in dams. In the case of extreme droughts, therefore, the generation of electric energy will be affected, which will affect absolutely every citizen. (Ribeiro 2018)

The rivers are pumping water on a massive scale even to the industry, which uncontrollably releases the recovered water back into the rivers. This is causing environmental pollution, as well as water that Brazilians inhabit not only their fields but also consume them. (THE WORLD BANK 2016)

The impact on the decline in water in the country is also affected by the deforestation of landscapes. There is wood extraction and spreading agricultural land that

is intensively managed and unable to retain water in the countryside for a long time. (Ribeiro 2018)

5.3 How Brazilian Agriculture Affects Water Availability.

Brazilian agriculture accounts for 41 % of Brazil's total area. This corresponds to about 16.5 million hectares. Of the total, that is, from the whole of agriculture in Brazil, large farms are already around 47.5 %. Large farms are enterprises with an area of more than 10 000 hectares. There are, therefore, more than 2,400 of these large enterprises, which own about 52 million hectares across the country. Brazilian agriculture contributed to GDP growth in 2017 from 23 %. (Ribeiro 2018)

The main products of Brazilian agriculture are maize, bananas, manioc, soybean and sugar cane. The animal products are products such as cattle, poultry and bison. (Ribeiro 2018)

Agriculture in Brazil consumes around 54 % of water from all water resources. From the point of view of animal breeding, the use of water is 6 %. One of the methods of irrigation in Brazilian agriculture can be seen in Figure 7. (FAO 2015)

Figure 8: Brazilian growers rely on fieldnet to maintain the balance between agriculture and the environment (zimmatic.com 2018)

The total irrigated area in 2010 was estimated at 5.4 million ha. Irrigated area with a view of development is growing enormously. In 1960, the irrigated area was just

under 500,000 hectares. 15 years later, in 1975, the 1-million-hectare border was crossed. In 1985 it was already an area of less than 2 million hectares. In 1996 it was over 3,1 million hectares. (FAO 2015)

Due to the strong soils, coffee plantations have been greatly damaged, leading to a decrease in the production of this commodity and the increase in its prices. For Brazil, this is another big problem because it is one of the largest exporters of coffee. (FAO 2015)

5.4 SouthEast of Brazil and their biggest cities

5.4.1 Basic information

The southeastern region of Brazil includes states such as Espírito Santo, Minas Gerais, Rio de Janeiro and Sao Paulo. The region's three richest counties are Brazil, accounting for around 60 % of GDP. The region is rich in the diversity and variety of animals, especially the Vale do Ribeira Valley. The area is rich in a large number of caves. Some caves are the source of water for a large number of rivers that supply the countryside with water and water. At the same time, these rivers serve as a source of electricity, the largest of which is a large number of hydropower plants. The region is also significant due to its large supplies of iron, gold and precious stones. (Sinimbu & Jade 2017; Schneider et al. 2019)

5.4.2 Crisis in the southeastern region of Brazil

One of the worst water crises hit Sao Paulo in 2014-2015. It was the pro-seasonal climax of the worst drought that this country had encountered. The level of tanks that supplies this city with drinking water has reached its lowest limit of 5 % of its total capacity. This made the supply of water for only one month. The situation in Rio de Janeiro has reached an even greater crisis, in the water supply system of Paraiba, which supplies the city with water, the water level reached only 1 %. During the journey from the tank to the final consumer there is a loss of water up to 31 % due to poor infrastructure and illegal connection to the network. (Watts 2015)

Due to the situation, there were severe restrictions on water supplies and excessive water consumption was fined. There has been a drop-in pressure in the pipeline. The people were looting in this situation and the crisis broke out here. Many municipalities around Sao Paulo itself, declared a state of emergency in order for troops to be assisted. People protested and robbed houses and shops, where they stole bottled water. (Watts 2017)

Many businesses had been shut down or severely restricted their offer of services. Consumers were motivated to receive a financial reward in the event of a reduction in water consumption. In this way water consumption was reduced and the crisis managed to survive even with this minimum water. This motivation had the positive effect that, after the wave of rainfall and the filling of the reservoirs into the states that were here before the crisis, the total consumption decreased by 10 % - despite the fact that water was distributed without restrictions. (Watts 2017)

The consequence of this crisis was that the government and city management began investing money into infrastructure that would, in the event of a crisis, have to join another water supply network that already exists to power other areas and to use other sources of drinking water. A more effective solution has not been supported here - support for afforestation, reuse and cleaning of sewage and sewage. (Watts 2017)

5.4.3 Lack of electricity

A large proportion of electricity comes from renewable sources, especially from hydropower plants located in dams. At the time of the crisis, electricity supply was also jeopardized due to a drop in water. The worst has not happened, but in the case of ongoing crises and larger ones, there could be serious shortcomings in energy supply and energy could even be delivered after allocations. The drought in 2001 forced the government to start producing more power in coal-fired power plants. (Watts 2017)

As a result of heavy heat and drought, electricity shortages in several cities have been overshadowed by increased energy consumption by air conditioning. In response to

this problem, the government had to confront problems with electricity supplies and increased electricity supplies to neighboring countries. (Watts 2017)

Due to power outages, the operation of one metro line and the functionality of the Internet were interrupted. (Watts 2017)

5.4.4 Sao Paulo

5.4.4.1 Basic Informations

Sao Paulo is located in the state of Sao Paulo near the coast with the ocean. It has over 12 million inhabitants. It is the largest city in Brazil, and also the 7 largest city in the world. (Sao Paulo Population 2018)

In 1900, the city had only 240,000 inhabitants. By the year 1950 there was an increase of about 2 million people. In 2010 there were already more than 10.7 million inhabitants. In 2016, the population density in the city per square kilometer was 7.216. Together with counting the population around the city, it will reach about 22 million inhabitants of the city and the surrounding area. (Sao Paulo Population 2018)

5.4.4.2 Slums in Sao Paulo

In Sao Paulo lives up to one third of the inhabitants of the slums with no proper access to drinking water, sewerage and other infrastructure. The area where the city is located is formed by a hill and exposed to a rainy season. This particularly threatens the sources of drinking water and the very health of the population. During the storm, the water flowing from the hills, not only gets into homes that do not have good foundations and masonry, it flushes all the dirt and rubbish with it. (Wallenfeldt 2016; Hoque 2018)

The reason for the rise of slums is essentially uncontrollable migration from rural and neighboring countries, especially because of better working opportunities and nowadays, even escaping the financial crisis that some South American countries have fallen. (Wallenfeldt 2016; Hoque 2018)

City administrations are trying to improve these areas especially in the framework of hygiene and access to drinking water. In areas where drinking water has been introduced, up to 30 % of drinking water losses occur during transport to the destination. (Wallenfeldt 2016; Hoque 2018)

A major problem for slums is their uncoiled growth. In non-circumstantial cases, they are already involved in water resources for the city itself, which leads to pollution of the tank that supplies most of the city with water. (Wallenfeldt 2016; Hoque 2018)

5.4.4.3 Water crisis in Sao Paulo

In 2014 and 2015, the city was threatened with total collapse. In the main tank that supplies the city with drinking water, only 3 percent of the water was in the worst time. This represented the city's water capacity for less than 20 days. Thanks to the extreme limitations of water management and water repairs, we have managed to survive this crisis until the sittings have changed. (Ritter 2018)

Regrettably, after returning to the normal state, the functioning of the city has returned to its normal mode. All water-based restrictions have been canceled. It does not seem to have been learned by the people or the city leadership in this crisis. (Ritter 2018)

5.4.4.4 Water infrastructure of Sao Paulo

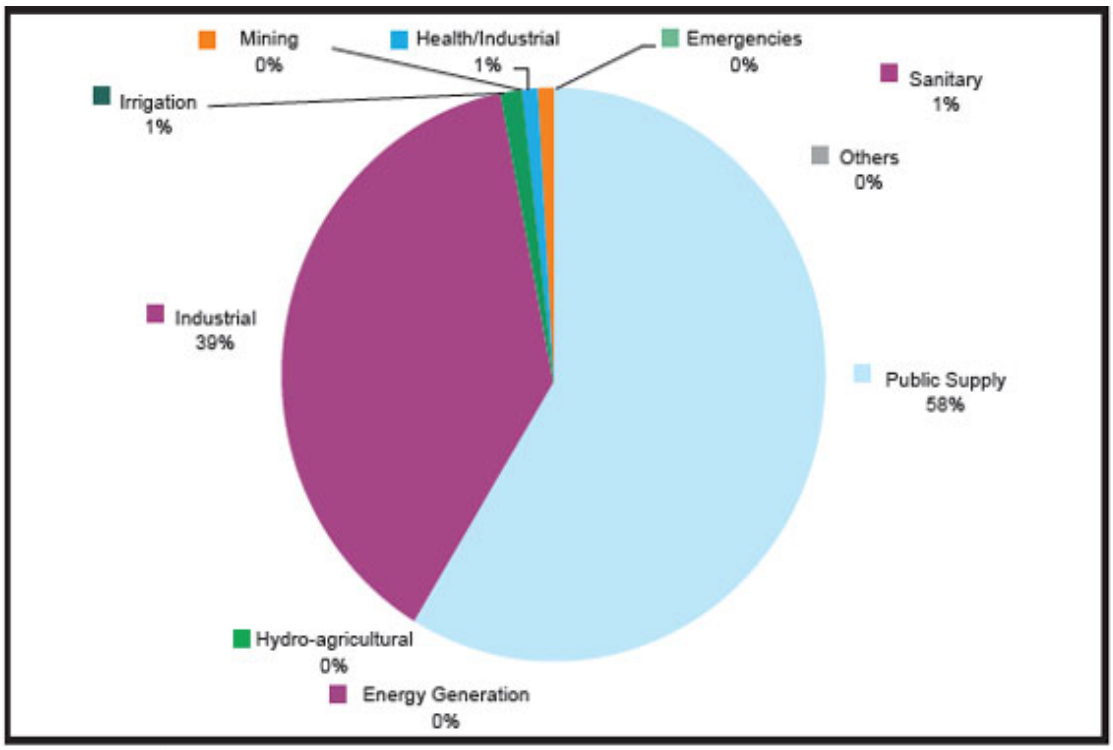
The main water sources for the city and its surroundings are Cantareira, Upper Tietê, Rio Claro, Upper Cotia, Lower Cotia, Grande, Billings / Guarapiranga. The individual amounts of production and total water production in these systems are reviewed in the table below. A unified example of water production in individual sources important to Sao Paulo can be seen in Table 1. (Ribeiro 2011)

Table 1: Water treatment production by above ground water sources for Sao Paulo. ($m^3.s^{-1}$) (Wagner Costa Ribeiro 2011)

Production system	Production – Sabesp (m3/s)
Cantareira	33
Upper Tietê	10
Rio Claro	4
Upper Cotia	1
Lower Cotia	0.9
Grande	4.8
Billings/Guarapiranga	14
Total	67.7

Source: Fusp (2009).

The use of water from these systems is very uneven. Water supply systems have a wide range and are of great importance throughout Brazil. The individual areas and their percentage utilization of the Upper Tietê River water system can be seen in the graph below this paragraph. (Ribeiro 2011)



Source: Fusp (2009).

Chart 2: The use of water within Sao Paulo and its source of water Upper Tietê River (Wagner Costa Ribeiro 2011)

A large number of 39 % of the industry involved in the overall use of water, is concentrated in the areas along these resources and have a very significant impact on the quality and purity of these resources for the city's inhabitants and the surrounding area. (Ribeiro 2011)

Water systems providing water for residents and industry have, in many cases, more use than just water. Large dams are built here, forming water reservoirs and water sources. Most dams are used to produce electricity. (Ribeiro 2011)

About 31 % of water is lost in the water pipe during transportation from the source to the end user. (Ribeiro 2011)

5.4.4.5 Effects of deforestation

Extensive water systems supplying the city and its surroundings use the great benefits of wooded landscapes that have an impact on water circulation. The wooded landscape is able to increase the moisture in the landscape and retain water. (THE WORLD BANK 2016)

The impact of the forest stands around the watercourses and the water supply systems are great. In addition to water retention in the countryside, forests are used as a parcel of purifiers that we build on water treatment and purification. Forests filter water. The water that gets into the systems is much cleaner. The best example of deforestation can be seen in the picture showing the situation in the Amazon Forest. (THE WORLD BANK 2016)

Deforestation in Brazil was the worst from August 2017 to July 2018 and since 2008. The area was calculated based on satellite imagery. The amount deforested at this time was 7,900 km^2. This area is slightly larger than the Pilsen Region in the Czech Republic. Compared to the previous period, this is a 13.7 % increase. This situation could be made worse by the newly elected president, who supports deforestation with the prospect of growth in Brazil's economy. Deforestation has an impact on greenhouse gas

production. As deforestation increases, the amount of greenhouse gases released into the air is also increasing. (Phillips 2018)

Figure 9: Deforestation in the Amazonia (Amazoniasocioambiental.org 2015)

At present, many of these forests are cut off. It's not just a problem here, but a general problem that is set by government and governing bodies that promote deforestation and tree harvesting for their profits regardless of the consequences. (THE WORLD BANK 2016)

In places where the landscape is deforested, the water in the systems is far dirtier, it contains a large number of sediments and other substances that have been washed out of the soil. It is necessary to clean this water so that it is health-friendly and can be used for the needs of the industry and the concern. (THE WORLD BANK 2016)

5.4.4.6 Reuse of water in Sao Paulo

Sao Paulo cleanses only 70 % of the sewage that leaves the city. The rest drains back into rivers and pollutes water that could be used in other places like drinking. (Kelman 2015)

5.4.4.7 Restrictions on water use

The average water consumption in Sao Paulo is 180 liters per person per day. For example, the average water consumption in Switzerland is 162 liters per day per person. For comparison, the average daily water consumption in the Czech Republic per person per day is 88 liters. (Gnehm 2012; The World Bank 2012; Eagri 2019)

The city has struggled to tackle water scarcity and has a system that affects water prices by consumption. High-water users pay much more for water than people who save and consume little water. They are trying to motivate people to save on water consumption. (Spring 2018)

The question is another limitation in the water consumption that the city would introduce and prevent any water shortage. The water scarcity crisis may be repeated, and the situation may be far worse. Any further restrictions will be more pronounced in the ordinary life of the population. (Spring 2018)

5.4.4.8 Water Pollution in Sao Paulo

The Billings Reservoir near Sao Paulo is polluted like a number of other tanks connected to the systems. This tank is one of the most polluted tanks. For decades, its water is not used to power the city. It is not even used for recreation. An example of pollution of the rivers in Sao Paulo is this picture, where heavily polluted water with chemicals and other substances has caused a huge foaming of water. (Schneider 2015; Kozacek 2016)

Figure 10: River in São Paulo, Brazil is covered in foam caused by pollution. (u/gsmaciel reddit 2016)

Pollution of this tank has occurred so far, that the water is dangerous to life. The slums and houses that grew up around this reservoir fill this tank with human feces. (Schneider 2015; Kozacek 2016)

Due to insufficient development of the city's infrastructure, tens of thousands, perhaps hundreds of thousands of people, are cut off from the canal and the water supply. This problem only aggravates the whole situation in the lack of water. Accelerating droughts threaten lives and the lives of many people. In tanks connected to populated areas and the city, there is water, and people are forced to limit water consumption and thus limit their living standards. There are reservoirs full of water that could hinder this situation. Unfortunately, the water in these localities is so dirty that it can not be used to resolve and delay this problem. (Schneider 2015; Kozacek 2016)

Another problem in drinking water sources, is that it is contaminated with minerals and fabrics, produced by factories that operate around the source and flow of this water. Mines that are located in this area are contaminating water with minerals that can spoil water quality and make it unusable for use in homes. (Schneider 2015; Kozacek 2016)

Factories and manufacturing enterprises can discharge waste materials into these streams and thus contribute to deterioration of water quality and its usability. (Schneider 2015; Kozacek 2016)

Another source threatening these resources and water flows, are the people living in the localities where the water source is located or in the vicinity of the streams. The city's management and management are not able to develop its infrastructure to keep up with the growth of slums. Their growth has been enormous in decades and, in most cases, they are illegal constructions without the building permission of the town or municipality. These slums are full of garbage and are a nest for possible major diseases. Most of these slums are not connected to sewerage and water supply. When the rain comes, the water that flows through the streams and rivers, take all the dirt and fumes. This endangers the water quality and the human lives of the people themselves. (Schneider 2015; Kozacek 2016)

5.5 Drinking water source in Sao Paulo

The Pardo River is considered one of the possible other sources of drinking water. A study on the concentration of herbycides and metals in water has been conducted in this water source. The results of this study, which worked with water and sediment samples from a total of 6 sites and compared drought and rain periods, showed that the Al, Cd, Cu, Mn and Zn elements were above the limits set by Brazilian legislation. (Machado et al. 2012)

Above-limit values for Mn, Cu and Zn elements can be associated with the application of micronutrients on agricultural soils to improve soil properties. There are about 70 % of acid soils in Brazil. (Machado et al. 2012)

For Arsenic, Cr, Pb, Cu, Mn, Zn and Cd, higher concentrations were measured during the rainy season. The reason for the higher concentration may be soil contamination in agriculture associated with the application of land parcels, mine activity in the vicinity of the river, the transfer of these elements by air and subsequently rain delivery to the river or surface runoff from cities. (Machado et al. 2012)

The occurrence of aluminum in the sediment was highly irrespective of the period. A possible source may be due to excessive industrial and agricultural activity. In the case of Cu, Pb and Zn, the values for freshwater sediments in the dry season were exceeded. This data suggest urban and industrial pollution. (Machado et al. 2012)

In the field of herbicides, the most abundant herbicide was Atrazine during the mild period. The origin of this herbicide was from agricultural land from which it entered the river as a result of the rain. Other herbicides were measured in the water, the concentration of which was permitted or slightly above the limits. (Machado et al. 2012)

The occurrence of metals in the river in some of the monitored areas was higher than the maximum permitted limits, the source for these metals was urban waste water, fertilizers used in agriculture and other activities. The herbicide in the river, especially during the rainy season, was caused by agricultural contamination and subsequent flooding into the river. (Machado et al. 2012)

As a result of this water pollution, drinking water sources are reduced, and cleaning is necessary before connecting this source to drinking water systems. An important consequence is the influence of the environment, where the contaminated water also affects the animals living in it and thus the inhabitants themselves, who are dependent on this river. Consumption of animals living in this contaminated water may not be healthy, and any contamination that the animals have gotten into them can also get into people when they eat. At the same time, this water can be a danger to reproduction and possible deformation or mutation of animals, or even to humans in the case of really long-term consumption – rather than pregnant women. (Machado et al. 2012)

5.5.1 Rio de Janeiro

5.5.1.1 Basic information

About 12.3 million people live in Rio de Jenairo. It is the sixth most populous city in Latin America. The city, together with the region, generates 5 % of Brazil's GDP. It is Brazil's second largest economy, just behind Sao Paulo. There has been a lot of

investment in Rio in the last few years, mainly due to the expected big events that have taken place or will be held. In particular, the 2012 United Nations Conference on Sustainable Development, the 2014 World Cup and the 2016 Olympic Games. The investments were mainly made in infrastructure to accommodate the high influx of visitors. (Latin American Green City Index 2015)

Rio de Janeiro is interested in monitoring and managing the environment. The city also works very well in the areas of energy, land use and buildings. Environmental standards for the construction of new buildings were very important in Rio. Conversely, in the areas of transport, waste, hygiene and air quality, the city only reaches average ranks. However, the overall Ria score is very marked in the water area, due to the high-water leakage from the water supply systems. (Latin American Green City Index 2015)

The urban average of CO2 production per person is 73 kg. The city achieved this result thanks to the high share of renewable energy sources in electricity generation. A total of 88% of the electricity in the city comes from renewable sources, mainly from hydropower. (Latin American Green City Index 2015)

5.5.1.2 Waste in Rio de Janeiro

Waste generation in the city is 525 kg of waste per person per year. Although the city collects and disposes of all waste, most of it is landfilled. Despite promoting environmental standards for landfills, the city is unable to dispose of hazardous household waste and separate household waste (ordinary municipal waste) from chemical and pharmaceutical waste. (Latin American Green City Index 2015)

5.5.1.3 Water use and sanitation in Rio de Janeiro

In the water area, the city is very bad at it. Due to poor infrastructure, the city will lose up to 58% of water in the water network. The State Water Company estimates that it will lose up to 15% of its losses due to illegal connection to water mains in settlements and large houses. Water consumption per person is 301 liters in the city. The system of using drinking water and gray water is almost non-implemented in the city. (Latin American Green City Index 2015)

For example, the average water consumption in Switzerland is 162 liters per day per person. This is almost twice less. For comparison, the average daily water consumption in the Czech Republic per person per day is 88 liters. (Gnehm 2012) (Eagri 2019)

Only 83% of the population has access to sanitation in the city. This value is not high. In the area of wastewater treatment, the value in the city is 85%. (Latin American Green City Index 2015)

5.5.1.4 Water Polution in Rio de Janeiro

The watercourses around the big cities are very polluted. Guanabara Bay can be proof of this. The Olympic Games in Rio de Janeiro were held in 2016, and this bay was called an open sewer. Despite this event, the Olympic Games took place here. From the lake where rowing races took place, they had to first remove about 40 tons of dead fish. (Wheeland 2015)

There are around 16 million inhabitants around Guanabara Bay. It is the second largest bay in Brazil with a total area of 384 km^2. There are about 50 rivers in the bay. (Giovana et al. 2015)

Water pollution in this bay comes from both household and industrial waste. As a result, organic substances, nutrients, hydrocarbons, heavy metals and a large number of suspended solids are found in the bay. Domestic waste releases into the bay organic matter and pathogenic microorganisms. On average over 50 % of households are connected to the waste water system in the catchment area of this bay. Of that in Rio de Janeiro it is over 78 %. Most households that are not connected to waste systems come from the surrounding area, whether straw or a village without these systems. Even 14 % of households do not have their own bathroom facilities - bathrooms and drinking water. The consequence of these non-hygienic conditions is that in the poorest areas, child mortality is around 24 %. Large-scale constraint with areas that are connected to waste systems and hygiene levels are much higher than in poor areas. The illustrative water pollution in Guanabara Bay can be seen in the picture below. (Giovana et al. 2015)

Figure 11: Pollution in Guanabara Bay in 2016 (Jenny Barchfield 2016)

Interestingly, the information about the difference between wastewater produced and processed is remarkable. When the 2007 data was based on the following: the cleaned waste was 7 $m^3.s^{-1}$ and the untreated waste was 20 $m^3.s^{-1}$. Looking at the events that has been in much of conspiracy with the 2016 Olympics, it is more than clear, that the situation has not changed, since the exposure of this data on a large scale. Particularly at the beaches of Copacabanna beach which is directly adjacent to this bay. (Giovana et al. 2015)

The daily environmental load is estimated at 150 tonnes of industrial waste water, which comes from 17,000 industries - from the pharmaceutical industry to the refinery. The sector around the bay is responsible for the entry of about 20% of organic matter and most toxic substances into the bay. There is also a large amount of solid waste in the bay that comes to local beaches for recreation. The water in this bay is not suitable for swimming. This pollution affects the almost everyday activity of people. Especially in the areas of fishing, leisure, recreation, tourism, domestic fauna and aesthetic aspects. The water's transparency decreases with the dirt of the bay, which is a useful indicator for people not to enter this water. In this area, water transparency is up to 0.7 meters. (Giovana et al. 2015)

Estimates have shown that the entire 45 % of the people around this bay are people from poor areas that are not largely connected to waste systems. This means that roughly 4 million people live in areas without hygiene. All waste water from these areas is either taken directly into the bay or into the tributaries of this bay. This situation leads to serious environmental and human health problems. 65 % of hospitalized residents in

hospitals are caused by water-borne diseases. In addition to the heavily polluted water, the bay's water is full of bacteria that cause serious health problems. (Giovana et al. 2015)

See Chapter 4.9 for more information on Guanabara Bay pollution.

5.6 Pollution of Guanabara Bay in Rio de Janeiro

As already mentioned in chapter 4.8.1.4., the pollution of this bay is a huge problem, which is not due to insufficient infrastructure in the surrounding populated areas of straw and possible insufficient treatment of industrial wastewater. (Giovana et al. 2015)

Many contaminants from many sources enter the bay – untreated sources from households to industrial waste. Thanks to these resources, large amounts of organic matter, nutrients, heavy metals and hydrocarbons are being introduced into the bay. On average, around 50 % of households around the Gulf basin are connected to a waste system. Around 78 % of households are connected to the sewage system in Rio de Janeiro itself. These figures include only "permanent households". A large number of straws, in which a relatively large population of people lives, are not counted in these statistics. Of the households that are not connected to the sewage systems, all the waste generated goes to the Gulf basin and ends up in a bay where all the waste accumulates. (Giovana et al. 2015)

In addition to heavy metals, nutrients and organic matter, water in the Gulf also contains a considerable amount of faecal coliforms due to its unprocessed animal content. The amount of these bacteria in the Gulf is above the limit during the year, which can result in major health problems for people who come into contact with this water. (Giovana et al. 2015)

Figure 12: Guanabara bay and pollution (David Biller and Michael Smith 2016)

The worst situation is in the northwestern part of the Gulf, where water is not so much influenced by the tide currents of the ocean as in other parts of the Gulf, where this is much higher. As a result of lower water mixing, more waste, metals and other substances are accumulating, causing pollution and the quality of water being much worse than in the rest of the bay. As a result of higher water pollution in the northwestern part of the Gulf, due to the effects of denser populations and higher built-up areas, there is insufficient or no infrastructure connection to reduce or prevent the pollution produced in the form of free waste and faeces released into the landscape. (Giovana et al. 2015)

One of the effects that is exacerbating work to improve this situation, is the fact that collecting data that could be used for scientific work and projects to improve this situation, is not regularly collected and therefore, it is not possible to have regular and detailed data with which could be disposed of to improve the situation. (Giovana et al. 2015)

The water in the bay contains a large amount of dangerous bacteria, for example, in the bay there are bacteria Pseudomonas, Clostridium or Bacillus. Some of these bacteria have increased resistance to bacteria, which may increase the chances of disease in people who would come into close contact with water from the bay. This resistance was mainly due to excessive and inappropriate use of antibiotics. The sources of these organisms are sewage into which these bacteria get from human organisms and subsequently accumulate and spread through the basin into the bay. Even several strains, due to their high resistence, have been described as super resistant bacteria due to their up to 600 times higher drug tolerance than clinical levels. In the case of the viruses present in this bay, we cannot know any official information and accurate data. (Giovana et al. 2015)

Another influence that occurs in the bay due to its contamination is the algae and cyanobacteria, which are abundant here. According to individual occurrences, we can easily distinguish water quality levels. In the worst cases, large amounts of cyanobacteria and algae, catastrophic consequences can occur, consuming all possible oxygen from the water, killing all living aquatic organisms dependent on the supply of oxygen dissolved in the water. The cause of the large amount of algae and cyanobacteria was the large nutrient content of the creek, along with other influences. (Giovana et al. 2015)

As a result of the great pollution of the bay, the fishing yield declined to 10% compared to three decades ago and a large number of beaches around the bay prohibit bathing and are not recommended for recreation. At the turn of October and November 2014, there was a big fish death in the bay as a result of several influences at the same time. At that time, at least 80 tonnes of dead fish were cleared. Due to the heterogeneity and adequate monitoring before and during the event it was not possible to determine the exact causes of fish death. The algae flower was found in one of the mortal sites when the fish was cleared, which could have been one of the causes of fish death. In another major fish death in February 2015, another source was discovered where the algae found algae. One of the other possible causes of fish death. These findings suggest that there are two groups of microorganisms in the bay - toxic algae and pathogenic bacteria - that have the potential to kill fish. Their role in these events could be explored under the condition of

regular and detailed monitoring, which was lacking in this bay for a long time. (Giovana et al. 2015)

6. Water Purification Technologies convenient to the Brazil conditions

6.1 Design of water purification technologies from sources intended for drinking water.

Drinking water sources, especially the Pardo River, need to be cleaned to make the water source safe for end consumers. The solution for cleaning this water would be a capacity water treatment plant to which all water resources destined for the urban water supply system would be fed. An illustrative example for illustrative processing and reading of drinking water sources can be seen in the figure below.

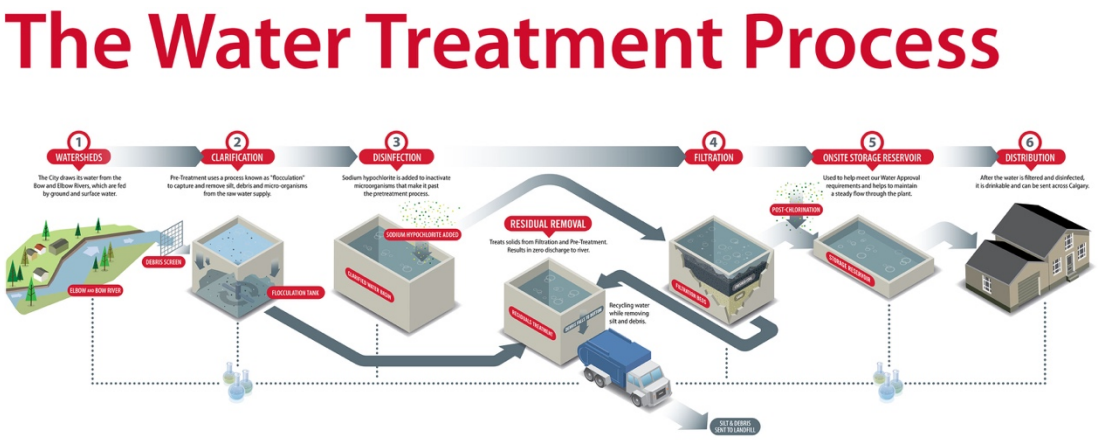


Figure 13: The Water Treatment Process (Calgary 2018)

Point number one is the source of water, which in our cases is the river, the river. In the second phase, microorganisms and mud are removed from the water from the river system. The mud is further processed to get as much water as possible, which is returned to the second phase. Subsequently, the mud is dried and sent for further processing. (Calgary 2018)

In phase three, chlorine is added to the water, which has been commonly used for water purification since the 20th century. In this way we remove all microorganisms and viruses from the water – the potential sources of disease. (Calgary 2018)

In the next step, the mud residues are removed from the water by filtration. (Calgary 2018)

The next step is to store water in the reservoirs from which it is distributed to final consumers. (Calgary 2018)

The technologies that we could use to improve water purification efficiency are described below. Resources and water quality are crucial to human health and children's development. If the water sources were contaminated and polluted, we could endanger a large number of lives. Especially because of diseases that could spread at a very fast pace. In addition, care must be taken to ensure access to water resources for the poorest people, especially favel areas, which suffer from a major lack of access to drinking water.

6.1.1 Activated Carbon

This technology contains a maze of small pores with a size of 500 to 1000 nm. The surface area is about 1,000 m^2 per gram. The surface of this coal allows the absorption of organic impurities from water and catalyses the decomposition of free chlorines and slower chloramines in water. This process is particularly suitable in processes for the removal of chlorine and chloramine. (elga veolia 2019)

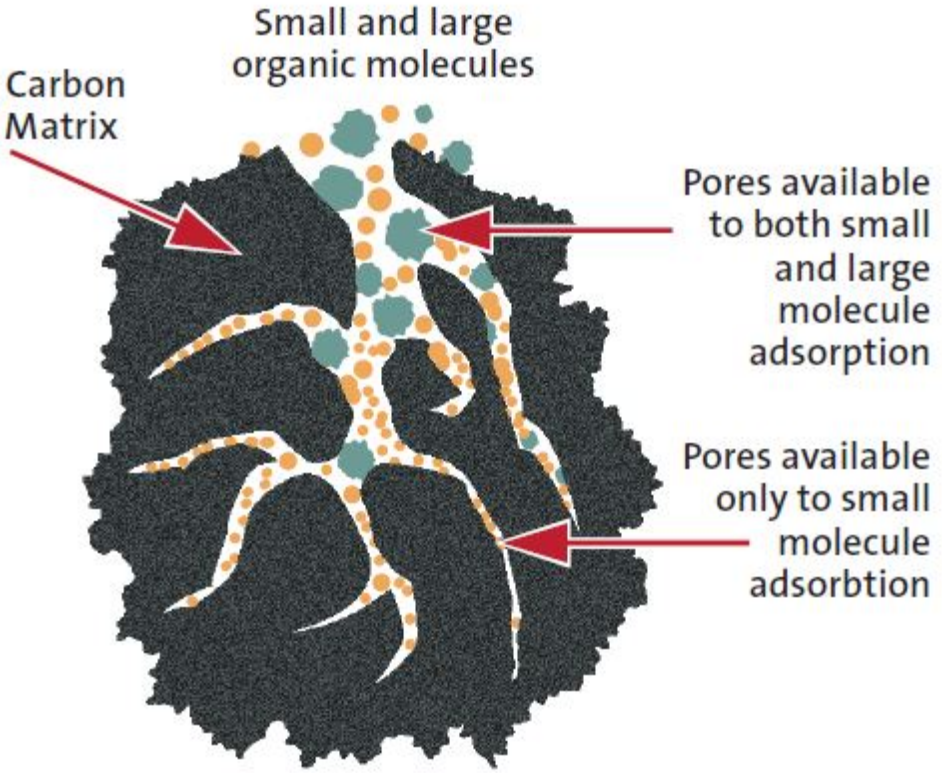


Figure 14: Activated Carbon (elga veolia 2019)

6.1.2 Electrodeionization – EDI

Electrically powered water treatment technology that uses electricity to exchange ions and pryski for its operation to remove ionized species from water. By combining ion-exchange resins and ion exchange membranes, they are used to transfer ionic impurities to waste or concentrate water streams and thus produce pure water. (elga veolia 2019)

The impurities leaving the system in the concentrate water do not deplete the resin, thereby extending the life of the resin. In this way, the EDI unit can work for several years before it has to be replaced. (elga veolia 2019)

The function of this technology is based on the entry of water into the EDI module, where the applied current forces the ions of motion through the resin and in front of the membranes found in the technology. These ions, which pass through, are collected

into the concentrate streams and discharged from the device. Such deionized water can already be used directly or can be further processed and purified to improve purity. (elga veolia 2019)

This technology removes inorganic compounds very well from water. (elga veolia 2019)

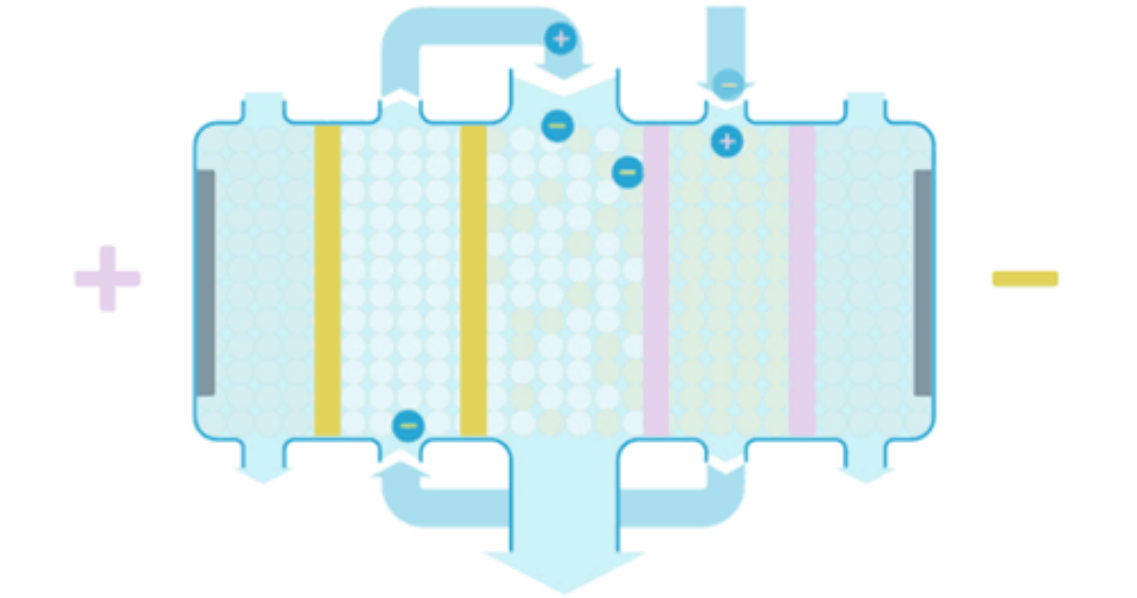


Figure 15: Electrodeionization – EDI (elga veolia 2019)

6.1.3 Ion Exchange

Ion exchange is the exchange of ions with ionized species in water with ion exchangers, ie H+ and OH- ions. The process is reversible and can be regenerated by washing with excess ions. (elga veolia 2019)

The principle of this technology is as follows. Water flows through the bed of ion exchange resins where the ions in solution migrate into the beads. Here, depending on the relative densities of the changes, they compete for exchange sites. The resins are 1 mm thick porous particles made of highly crosslinked, high ion exchange sites with high ion exchange rates. (elga veolia 2019)

Deionization beads are cationic or anionic and exchange either H+ ions for cations, which may be Na+, Ca 2+, or OH-ions for anions, which may be Cl-, NO 3-. The hydrogen ion from the cation exchanger is combined with the hydroxyl ion exchanger to form clear water. (elga veolia 2019)

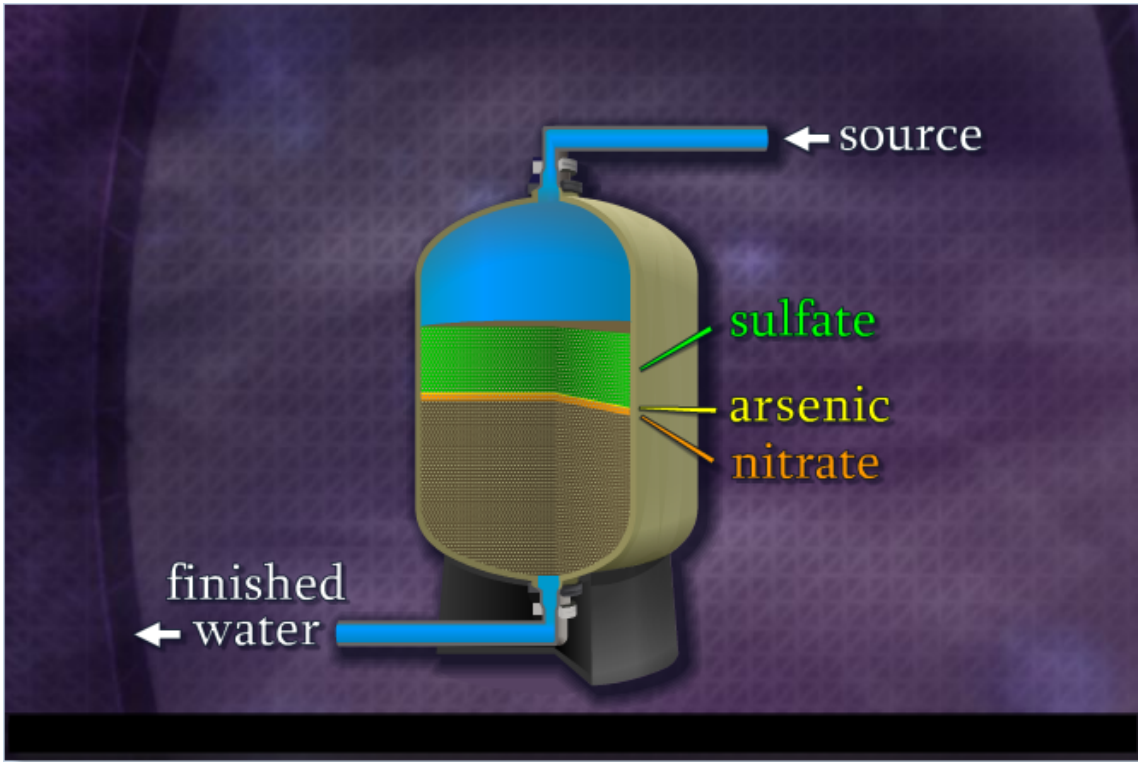


Figure 16: Ion Exchange (EPA 2015)

The ion exchange resin beds are available as containers and are commonly used for some time before replacement. This occurs when cations and anions have replaced most of the active sites H+ and OH-. Once depleted, they can be regenerated by washing with excess desirable ions using strong acids and bases. This reverses the process and removes unwanted cations and anions. This process requires the use of chemicals. (elga veolia 2019)

6.1.4 Reverse Osmosis

This technique is an effective way to remove impurities from water using a semipermeable membrane. It is a process in which water flows through a membrane under pressure. This method removes up to 99 % of impurities. (elga veolia 2019)

During reverse osmosis, the feed water is pumped around the inlet side of the reverse osmosis membrane under pressure – this is 4 to 16 bar. Normally 15-30 % of the feed water passes through the membrane as permeate and leaves the membrane as a concentrate that contains most of the salts, inorganic substances and other particles. (elga veolia 2019)

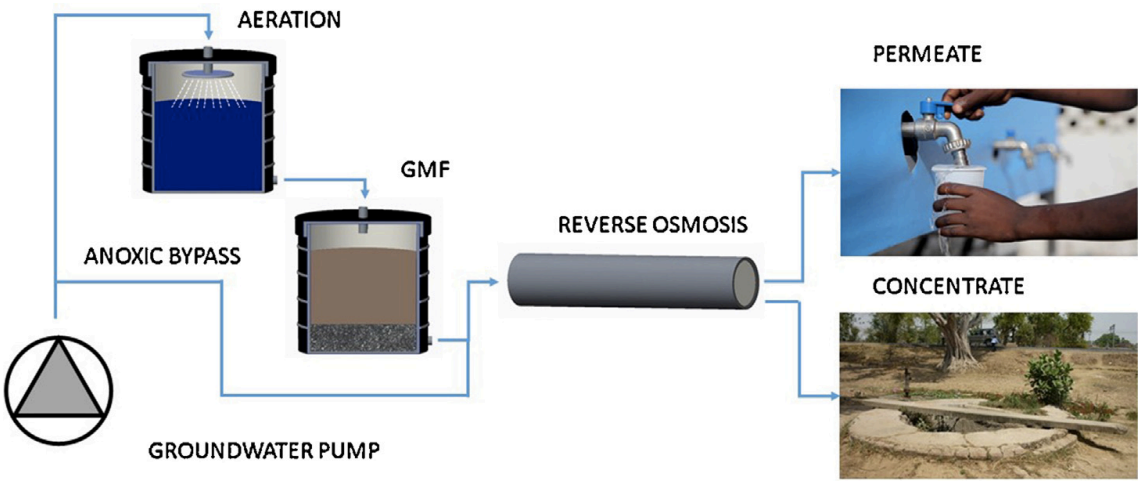


Figure 17: Schema of reverse osmosis (Schmidt et al. 2016)

Reverse osmosis is a typical thin film polyamide and is stable over a wide pH range. However, it may be damaged by oxidizing agents such as chlorine. Before using this method, it is necessary to clean the water from all possible oxidizing agents. Reverse osmosis is used to remove contaminants from water and water pollution that is less than 1 nm in diameter. More than 90 % of the ionic impurities, most organic impurities and almost all particles, bacteria and bio-molecules are removed from the filtrate or water permeate. (elga veolia 2019)

This technology is suitable for removing inorganic compounds, microorganisms and bacteria, organic compounds and particles from water. (elga veolia 2019)

Figure 18: Reverse Osmosis (Blending Technologies 2016)

6.1.5 Sub-micron filtration

The filtration works in the same way as the strainer and provides a physical barrier based on the pore size of the particles in the purified water systems. This technology uses filters with pore sizes of 1 to 10 nm, which can remove particles as small as protein macromolecules. Ultrafiltration is a great technology to ensure consistent high-purity water quality with oled particles, bacteria and pyrogens. (elga veolia 2019)

The flow is directed in one of two ways - either directly through the membrane or by a transverse flow method, where a portion of the inlet water flows through the membrane surface to reduce contamination. This technology is usually installed near the outlet of the water purification system to reduce the concentration of microorganisms and large organic molecules. The filters must be regularly maintained to ensure their patency and efficiency. (elga veolia 2019)

This technology is suitable for removing microorganisms and bacteria together with organic compounds and particles. (elga veolia 2019)

An important solution that could accelerate the restoration of the bay if there is no further pollution by the environment and industry in the Gulf basin is to clean the bay water itself. Mechanical cleaning of the bay from all accumulated waste. The rest of the processes would have to be left to nature to clean the bay of all the harmful microorganisms that appeared here due to the great pollution. Technologies that would destroy all microorganisms dangerous to aquatic organisms and other organisms living outside the Gulf are not yet invented. The question remains whether it is worthwhile to invent some technology to a very high cost of operation and a technologically extremely demanding process that would work efficiently and achieve a targeted effect without any side effects.

6.1.6 Ferrate water purification

This technology is suitable for the removal of heavy metals, pharmaceuticals, inorganic and organic contaminants, pesticides, disinfectants and lotion in water and is therefore not only ideal for removing substances after application of pesticides and fertilizers in fields that are subsequently washed away in rivers, but also in other issues with polluted water. These substances must be removed from the water for reasons of drinking water safety. (Ferrate Treatment Technologies 2017)

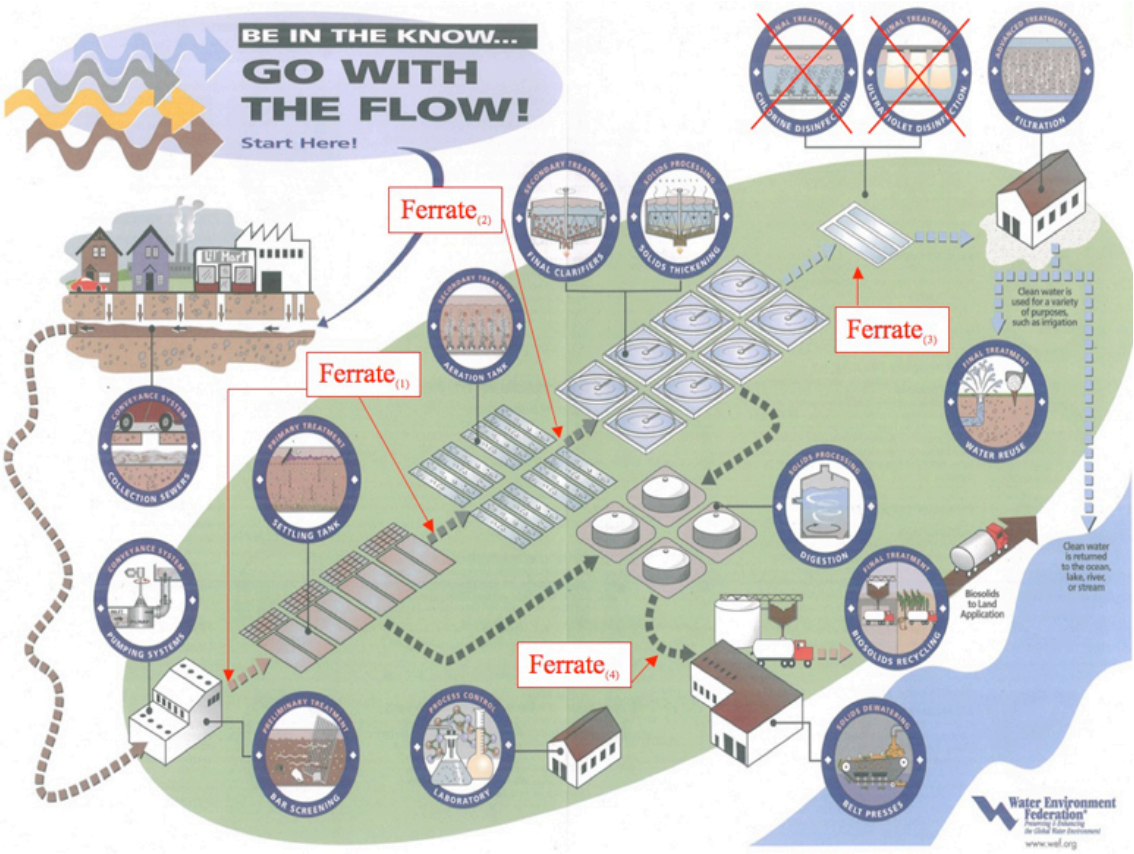
Ferrates are iron molecules in which iron is in a higher oxidation state than VI. They do not produce any by-products, are environmentally friendly and are able to cure very heavily infested water. It is also one of the cheapest and most effective water purification options. (Ferrate Treatment Technologies 2017)

In a single dose, ferrate can act as a coagulum, oxidant, and disinfectant at the same time. They are stronger than other oxidants, such as ozone or sulfur dioxide. It can also replace coagulants such as ferric chloride. It can also overcome disinfectants such as UV, hydrogen peroxide and chlorine. Removal of organisms can be much greater than with chlorine. (Ferrate Treatment Technologies 2017)

Ferrate is a potent, fast-acting, low-dose formulation that produces products such as ferric hydroxide, iron and other non-toxic and environmentally friendly compounds.

Based on proficiency tests, ferrate has been found to treat water, antibiotics, hormones, pesticides, and other personal care products that end up in sewage and go through urban wastewater treatment plants. (Ferrate Treatment Technologies 2017)

Ferrates offer an economical and ecological alternative to conventional water and wastewater treatment technologies. Ferrate synthesis uses commodity chemicals that are already found in most wastewater and wastewater treatment plants. This system uses less real estate and also uses less energy. (Ferrate Treatment Technologies 2017)



1. Odor Control and Pre-Oxidation of Organics
2. Oxidation, Coagulation, Co-Precipitation
3. Disinfection
4. Odor Control and Stabilization

Figure 19: Example of Multiple Ferrate Treatments in a Wastewater Treatment Plant (Ferrate Treatment Technologies 2017)

6.2 Getting drinking water from the sea

Resolving the lack of drinking water in Rio de Janeiro and Sao Paulo, or even other towns that lie close to the sea, would desalinate the sea water from which we would get a huge source of drinking water. This option could completely eradicate the problem of water scarcity that these large cities have encountered in recent years. In the case of Sao Paulo, it would be necessary to solve the problem of supplying drinking water from these facilities. The distance from the town to the sea is about 80 km.

The desalination method is based on the reverse osmosis principle, thanks to which we can produce from seawater, freshwater drinking water. To the principle of drinking water purification, which I mentioned above, with a combination of reverse osmosis and other possible technologies would be a very suitable way to avoid any water shortage.

Israel could be a model for these technologies. (Jacobsen 2016)

Figure 20: Desalination plant in Israel (Zafrir Rinat 2019)

6.2.1 Reverse osmosis as part of desalination technology.

This technique is an effective way to remove impurities from water using a semipermeable membrane. It is a process in which water flows through a membrane under pressure. This method removes up to 99 % of impurities. (elga veolia 2019)

During reverse osmosis, the feed water is pumped around the inlet side of the reverse osmosis membrane under pressure – this is 4 to 16 bar. Normally 15-30 % of the feed water passes through the membrane as permeate and leaves the membrane as a concentrate that contains most of the salts, inorganic substances and other particles. (elga veolia 2019)

Reverse osmosis is a typical thin film polyamide and is stable over a wide pH range. However, it may be damaged by oxidizing agents such as chlorine. Before using this method, it is necessary to clean the water from all possible oxidizing agents. Reverse osmosis is used to remove contaminants from water and water pollution that is less than 1 nm in diameter. More than 90 % of the ionic impurities, most organic impurities and almost all particles, bacteria and bio-molecules are removed from the filtrate or water permeate. (elga veolia 2019)

This technology is suitable for removing inorganic compounds, microorganisms and bacteria, organic compounds and particles from water. (elga veolia 2019)

6.3 Wastewater treatment

Large parts of cities are not connected to sewer systems – especially favel and industrial buildings. We could see this situation especially in Rio de Janeiro and Guanabara bay. The waste caused extreme pollution here and caused the proliferation of very dangerous microorganisms and viruses that could be deadly if they spread further – namely for humans. The impact of this pollution would already be recorded in the vicinity of the bay, where infant mortality and sick people increased sharply.

By linking favel and industrial sites to the sewer system, it would stop polluting the bay and the rivers affected. This would potentially reduce the purification of this water if we wanted to use it for water systems. It would improve the quality of water in rivers and gulfs, which would have a very positive impact on ecosystems.

When connecting these areas to the sewage system, there would be great demands on the use of wastewater treatment plants, which did not even manage the current capacity themselves. For this reason, it is necessary to rapidly expand the equipment and increase the capacity or to build new facilities to cover the wastewater production.

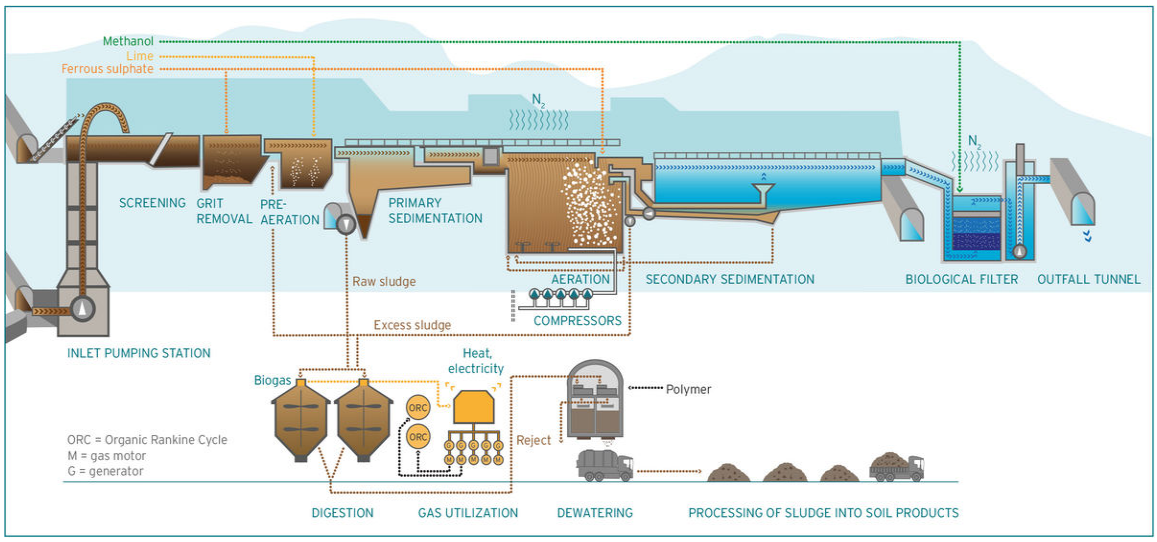


Figure 21: Wastewater plan (HSY 2018)

6.4 Possibilities of improvement in agriculture.

Water use in Brazil is too high. If this trend continues in the coming years, it will not only be a bigger problem for Brazil than it is now. The number of fields that irrigate each year grows. Irrigation uses water from rivers and also from underground sources, which is responsible for lowering groundwater levels.

This concept is not sustainable in the long run with regard to all the consequences that water scarcity can cause. The alternative to improving water use would be to build

channels and gutter systems between fields and meadows, that would collect water at high rains that would otherwise. run off streams and rivers off the landscape. Water trapped in channels and reservoirs would be cleared of all organic residues and possible germs, inorganic substances that could get out of the flooded fertilizers, and also from pesticide residues that could get into these water sources. To these collecting systems, it would be necessary to build a water treatment system in which a combination of technologies would effectively and efficiently clean the water, so that it can be re-used without any problems for irrigating plants without side contamination or introduction of diseases. The possibility of combining technologies that could be used to purify water can be read in the subchapters above, namely subchapters with numbers 5.1.1, 5.1.2., 5.1.3, 5.1.4 and 5.1.5.

Investment in landscaping, building canals and tanks, along with water purification equipment, can climb to the near millions of dollars. With the current state of irrigated area, extensive modifications and a very large network would be needed. The costs associated with the initial construction would be very high, but in view of the future, landscaping would have an unmistakable positive impact. Another possibility of using water treatment is the technology of water treatment plant DUO 5, which offers water filtration from impurities. This technology seems to be very well suited to areas where we would build collection systems. This technology does not require power (in the case of the basic variant) and the maintenance requirement is absolutely minimal. With this technology, we can rely on every location where collecting systems are located. This technology can be built in small dimensions even in large dimensions The disadvantage of this technology is the removal of only organic matter from the water by the microorganisms living in the device. Cleaning of inorganic compounds is absolutely minimal. The condition of this technology is only the gradient that needs to be built between the tanks. This potential problem, which could not be built in flat terrain, can be solved by purchasing pumps that replace the missing gradient. In the case of smaller tanks where small cleaners would work, BF-01UNF (Slany Pumps 2019) could be used in case of insufficient gradient. WB 30 3 "WATER PUMP. (Honda 2019)

6.5 Large metropolitan areas in southeastern Brazil.

A major deterioration of the water scarcity situation was the poor infrastructure, where much of the water was lost before it came to the consumer. In this respect, there was a need to increase investment in the rehabilitation of water pipes and its protection against illegal connection to water pipes.

Upgrading the infrastructure and avoiding illegal connections can save large quantities of water in the system. This can prevent any further deficiencies in drought, as there would be more water in the reservoirs than was the case with the last crises.

Another influence that could help in times of water scarcity is the drinking water sources that are currently polluted. Whether it is rivers where sewerage is being drained, which is 70% clean, or rivers and reservoirs of water, sometimes infiltrated by illegally built favelas, in which the vast majority of water infrastructure is not in place.

An optimal solution would be to build new wastewater treatment plants or to expand existing stations and to renovate their functions with new and powerful systems. One of many solutions is the possibility of a Czech manufacturer. This is a Stählermatic®-System (STM®-System) wastewater treatment plant. It is a systém, which is energy-saving and does not need to use any chemistry to operate it. Functionality depends on aerobic microorganisms, which must be represented in a wide range. There are two forms of sludge in the system, the first is floating sludge and the other is a solid sediment. Both are indispensable for the proper functioning of the cleaning system. Pricing proposals do not specify this city for cities. (Hellstein 2019)

A great benefit for restoring the water cycle and maintaining water in the countryside is the renewal of afforestation that was not supported in the past. Afforestation will keep more moisture in the landscape and prevent it from drying out, which ultimately has a positive impact on mitigating possible water scarcity. Investments that would require changing the concept of segregation and thus returning the landscape to its original function may be high only as a result of the loss of land used differently.

In the case of backward afforestation of the landscape and river banks, we can create a cycle that would retain more water and moisture in the countryside and the countryside. This would also provide us with the benefit of the production of wood, that would be sustainable and would serve as a dental and healthy renewal of afforestation. This concept is only usable in the tens of years, and in the first decades it would be a concept into which you would need to invest.

It is necessary to reflect on the benefits that do not have a financial form in these decisions. In the event that we make a decision to make a positive financial contribution to us, there would be very little or no option to reduce the causes of climate change and the natural crises experienced by Brazil.

7. Conclusion

7.1 Water purification technologies suitable for the largest cities in Brazil

The problem with water is great in Brazil. If the proposed or other steps are not taken in this area, the situation can be greatly aggravated not only in case of water scarcity.

The proposed variations have been designed with quality and requirements in mind to solve the problems found in Brazil. The individual issues that have been in recent years in Brazil are described in Chapter 5.

Individual proposals, which would be the optimal solution to the problems described, are described in detail together with the pictures in separate chapter 6. There are described the modern technologies that would dramatically improve and correct the situation. It would help improve the situation.

The proposed technologies and solutions are subject to other influences that cannot be overlooked and without which it would not be possible to implement these technologies and solve problems. The biggest influence in this respect is politics. If

politicians and officials are not in favor of a solution and working on the causes that lead to problems that Brazil has already experienced, there is very little chance that the situation will change.

Deforestation of the Amazon forest is also related to the policy area, where there is currently a great support for continuing deforestation. This will have a consequent effect on the entire water cycle and the water in the landscape. As a result of deforestation, the water in the landscape is dwindling and the people of Brazil themselves and the whole continent are paying for it. If the current direction does not change in this area, there is a very high risk that the scenarios that have already taken place in recent years will be repeated and may be much worse.

Another effect with which this issue and solution is related is population growth. If the population grows at a high pace, there will be more than a good chance that cities will not be able to pursue growth and the favel areas will expand. This will further aggravate pollution problems and increase the population's illness. The population growth is related to the necessary infrastructure investment, which is already missing or in poor condition in some areas. It is also necessary to extend wastewater treatment plants together with drinking water treatment plants, which at the moment do not correspond to the demands on production and consumption in cities.

The way agriculture is applied has a great impact on the entire urban purification technology. If the concept of agriculture is changed and the nutrients are not leached out of the fertilizer into the water together with the leaching of the used pesticides, it will not be necessary to buy and expensive expensive technologies to clean them out of the water. Until this change occurs, it will be necessary to invest large amounts in drinking water treatment plants, so that people have safe and clean drinking water that does not cause them any health hazards.

Ideally, if purification technologies are met, policy areas, population growth, water use in agriculture, and landscape deforestation will simultaneously be resolved. These all areas are intertwined and there are mutual ties.

7.2 Politics

The election of the new president has meant a great challenge for the people of Brazil, especially if they want to fight climate change and the causes of drought. This area had almost no support by the newly elected president and was a direct threat to everyone in Brazil. Particularly, when it came to the protection of the Amazon forest, where its protection seemed to be re-threatened and the promotion of deforestation and the vision of money-giving, gained a higher priority than the future of the whole country, that would ultimately pay for climate change related to the changes destruction of functioning ecosystems.

The possibilities of changing the course in policy areas to protect important ecosystems, that would prevent the negative impacts of the weather on Brazil's population, appear particularly in the field of education. Familiarizing people with the causes of these situations will lead to an understanding of the problems. The interest of the inhabitants themselves will increase their long-term destiny and the consequences of climate change and destruction of irreplaceable ecosystems.

There are large gaps in this area, especially in educating the population about the individual causes of the crises that have experienced mainly large metropolitan areas in recent years with water scarcity. Fundamental should be education on issues from elementary schools, where children could discuss about individual problems and propose solutions to solve the problem. Older students would have an incentive program between schools where pupils could report on individual problem-solving suggestions and compete for the best proposal most likely to be feasible. This solution is on a longer route, but ultimately would increase the interest of the inhabitants themselves in their fate.

In the case of adult education, it would be a solution to hold meetings where experts would talk about the problems and their causes in the context of climate change. Such as the causes of the great water scarcity that the earth has experienced several times. On this point, it may seem that there might be a problem, particularly in the interest of the population in the interest in this issue. People's interest in resolving and raising awareness about these issues should originate from them and we can not force anyone to

attend a meeting against his will. It is important that these opportunities should be here, and that the interest of people should grow in the future.

Ultimately, when residents have an insight into causes and problems, they would not have chosen a president who encourages deepening of causes and worsening the situation.

Meeting costs should be minimal. It would only be for renting premises and possibly paying a lecturer who would familiarize themselves with the problem. In case of support from the state or individual municipalities or municipalities, it might be possible to rent premises for these meetings free of charge.

In the case of a proposal with education at schools about the problems, the costs could be higher with the need for administrative preparation and possible motivation prices. Even in this area, costs could be saved if the government or city management contributed to this education. It could also help to reduce the costs of individual companies that could themselves support this training and participate in individual costs or the donation of incentives to students.

7.3 Consequences of population growth in Brazil.

The Brazilian population has grown several times in comparison to the 1960s I wrote in one of the chapters of this work. As a result of this population growth, there has been a growing demand for agriculture and its increasing productivity. This resulted in the felling of forests and the Amazon forest to increase agricultural land. Another effect of the increase was the intensity of crop production that had to be produced in agriculture. This had a major impact on the intensity of irrigation of agricultural areas. Irrigation areas increased and irrigation intensity also increased. As a result of changing the landscape in intensive agriculture and cutting down forests and forests, there has been a loss of natural water in the landscape and this has resulted in major water supply crises. The water cycle slowed down through the felling of trees, so the water supply during the rainy season was far less than the infrastructure had foreseen. This problem was not only influenced by Brazil, but by the whole continent, which is dependent on the water cycle. Due to the loss

of water in the landscape and insufficient water supply during the rainy season, the capacity of water in the reservoirs of the largest cities in Brazil, around which straw that has not been connected to the infrastructure and very often exists illegally without any city permission, has grown low over the past decades. These straws have polluted the environment where they were. As a result, watercourses and possible sources of drinking water were contaminated. These sources received faeces and all the dirt from the straw. In the case of water shortages in the reservoirs, the city could not use any water resources that could save the crisis because they were heavily polluted.

7.4 Agriculture and water use

As a result of increasing population growth and food supply demands, as well as increasing exports, the intensity of agriculture increased. In this context, an area requiring irrigation grew not only because of water shortages in the landscape. The sources of water for irrigation were groundwater together with the above ground resources. This resulted in decreasing groundwater levels and drying the landscape.

The use of pesticides and fertilizers negatively affects the entire landscape. Very often residues of substances enter water systems and contaminate rivers. This has the effect of limiting the search for a new water resource for cities, especially in water shortages in supply systems. The costs associated with building infrastructure to clean these polluted water sources can be very high.

7.5 Deforestation of the landscape

The deforestation of the landscape and, in particular, the Amazon forest has several reasons. One of the main reasons is political interests. They are very strong after the last elections in Brazil. Support for deforestation has risen again in favor of corporate firms. Above all, the motive for deforestation is the gain of money.

Another major engine for deforestation is the growing area for agriculture. After felling, the soils have a higher nutrient content than the land that has been farmed for a

long time and is destroyed by intensive farming and the use of all kinds of pesticides that promote soil destruction.

The result of deforestation is the loss of water in the landscape. Forests act as a sponge that is able to suck in large amounts of water and keep it inside. Deforestation slows down the water cycle, which is important for the whole continent and deepens any further water crises, where far worse situations than in the past have occurred and I have written about in this work. Especially the biggest cities in Brazil, which require a large amount of all food and water supplies, will be the most hit by any other crises. These cities cannot function entirely independently and are forced to be dependent on the surrounding regions, possibly on the whole state.

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