Water Optimization in Paraná: Implementation of a Wastewater Treatment Plant

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***Summary*— The city of Paraná is located to the west of the Entre Ríos province. Being situated alongside the Paraná River, the city confronts a pressing problem. Untreated wastewater is being discharged in the Paraná River daily. The purposes of this work are to give awareness about wastewater, show causes and consequences and analyze a solution to the problem. To achieve these purposes, this paper is divided into three different sections that imply an analysis of the problem in context, its causes and consequences, a description of a solution by means of the installation of a wastewater treatment plant and a conclusion.**

Keywords: wastewater treatment plant, wastewater treatment, wastewater management.

***Resumen*— La ciudad de Paraná está ubicada al oeste de la provincia de Entre Ríos. Estando situada junto al río Paraná, la ciudad se enfrenta a un problema urgente. Las aguas residuales están siendo introducidas al río diariamente sin tratamiento previo. Los propósitos de este trabajo son generar conciencia sobre las aguas residuales, mostrar causas y consecuencias y analizar una solución al problema. Para lograr estos propósitos, este trabajo está dividido en tres diferentes secciones que implican un análisis del problema y su contexto, sus causas y consecuencias, una descripción de la solución que requiere la instalación de una planta de tratamiento de aguas residuales y una conclusión.**

Palabras clave: planta de tratamiento de aguas residuales, tratamiento de aguas residuales, gestión de aguas residuales.

I. INTRODUCTION

Water scarcity is a pressing global issue and untreated wastewater represents a missed opportunity for water reuse. Wastewater is any water that has been used and contains various pollutants, contaminants, and impurities because of human activities. It has been recorded that the population of Paraná consumes 1,097,493,600 liters of water per week and disposes of 350 million liters of wastewater into the Paraná River daily [1]. This significant amount comes not only from Paraná but also from larger cities located along the river, such as Santa Fe, Rosario, among others.

Currently, there is no infrastructure that allows the treatment of wastewater in the city of Paraná. With an appropriate treatment, wastewater can be transformed into a valuable resource for important purposes and be reintroduced into the Paraná River in a clean way.

The purpose of this project is to address this issue by means of a wastewater management treatment plant. This involves several stages and processes to remove contaminants and pollutants, to be able to use the various components that are separated from water in different sustainable applications. The primary goal of a wastewater management plant is to protect the environment, safeguard public health, preserve water resources, and promote sustainable development.

To achieve these purposes, this paper is divided into three sections. Section one is going to address the problem currently underway, including the context where it is happening, the statement of the problem itself and the causes and consequences of it. Section two is going to approach a solution to the problem and its strengths and weaknesses. Section three is going to present the conclusion.

II. PROBLEM DEFINITION AND ANALYSIS

A. *Description of the Context*

The city of Paraná is located to the west of the Entre Ríos province. It is the capital of the province and has a population of 1.426.426 inhabitants. Alongside the city runs one of the longest rivers in the world, with a length of 4,880 km, starting in the Amazon river and flowing into the sea. Paraná is divided into four different areas based on its location: the west, the north, the central, the east, and the south areas as it shown in Fig.1.

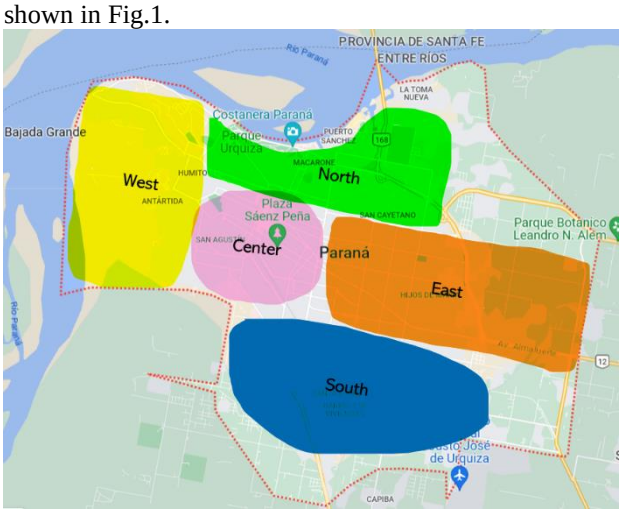

Fig. 1. Paraná areas and Parana River [2].

It is difficult to describe the context as pollution in the water is not confined to a single location. Every day, wastewater from different parts of the city reaches the Paraná River through pipelines. However, the discharge can be found in the west zone, in the Bajada Grande neighbourhood and next to the San Martin neighbourhood, as Fig. 2 shows.

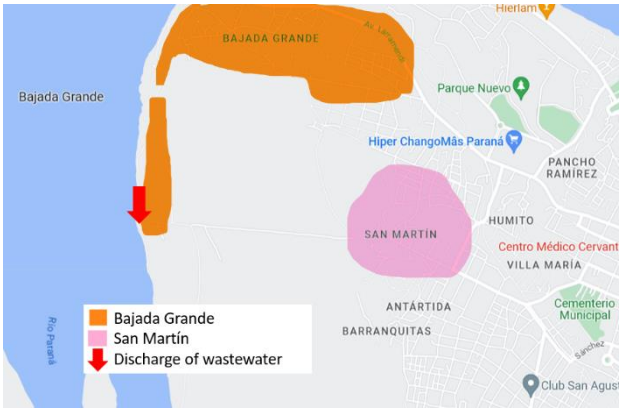

Fig. 2. Discharge of wastewater on the west of Paraná. [3]

Wastewater is collected in the sewer networks, as it can be seen in Fig. 3. It flows through the sewage network towards a main sewer, located in the western area of the city. The main sewer extends to the river and discharges the wastewater.

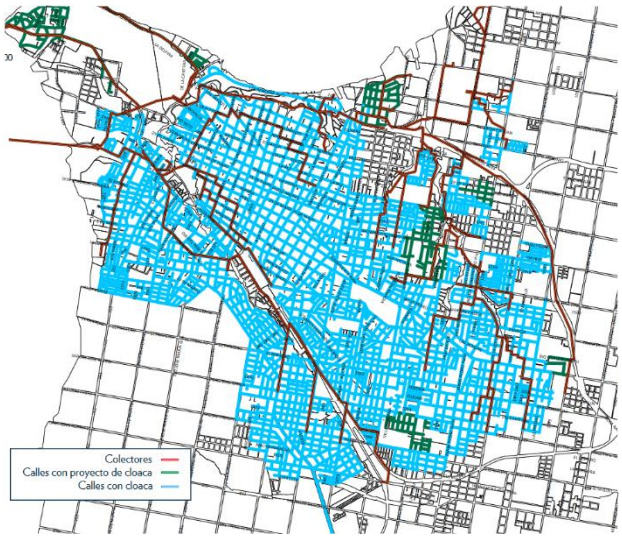

Fig. 3. Sewer networks of Paraná [4].

B. Problem Statement

Wastewater from both industrial and domestic use contains a significant number of pollutants and it is discharged directly into the Paraná River without previous treatment. The contaminants commonly released are organic matter, pathogens such as bacteria and viruses, organic and inorganic chemicals, heat from water used in industries, among others. Without a water treatment system, there is no opportunity to protect the Paraná River from the enormous pollution generated day by day.

C. Description of Scenes that Help Picture the Problematic Situation

Domestic and industrial use of water is the primary source of contamination of the Paraná River. Domestic sewage wastewater refers to wastewater used in the development of daily activities such as laundry, dishwashing, and toilet use, as it shown in Fig.4. Industrial wastewater includes all the liquid released from industrial processes, as Fig. 5 shows. Generally, this last group is the one that contains the highest pollution load, so depending on the cases, a pretreatment before discharge into the network or the river is mandatory (although not always fulfilled), as Fig. 6 shows.

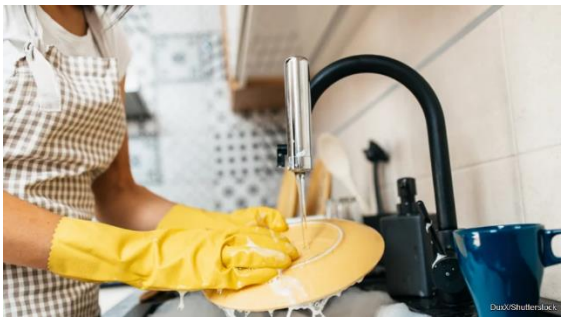

Fig. 4. Domestic wastewater in dishwashing [5].

Fig. 5. Industrial wastewater [6].

Fig. 6. Untreated wastewater accessing the Paraná River. [5]

D. Identification and analysis of causes or factors that give rise to the problem:

There are different reasons why wastewater is not treated. The most relevant cause is the lack of awareness that is seen every day in the amount of water wasted in domestic and industrial activities. A very common example is dishwashing, which not only uses a lot of water but also contains waste. Another example is car-washing services at gas stations, which waste a significant amount of water and are contaminated with fuel. There are also industries that discharge their untreated wastewater into the Paraná River. This lack of awareness does not come from a single person: political sectors do not invest in awareness campaigns to generate it.

Closely connected with this point, another cause is the lack of funding from the government. The significant

environmental problem of wastewater is not given priority. Some reasons for not investing include the high initial investment costs and the low priority given to places like the Paraná River. The expected fees to be paid by city residents also influence this.

Last but not least, there is a lack of infrastructure. This is related to the lack of financial support because it needs ongoing maintenance and technology costs. Geographical limitations in the area due to a lack of suitable land for different projects are also a significant factor.

E. Identification and Description of the Consequences

There are several consequences related to untreated wastewater. One aspect affected by this problem is water pollution, which contains a wide variety of pathogenic microorganisms, nutrients, heavy metals, toxic chemicals, and organic matter. It directly impacts biodiversity through the degradation of aquatic habitats, affecting fish, amphibians, birds, and other species that depend on the river to survive.

Another consequence is related to the impact on water resources, known as eutrophication. The materials discarded into the river, containing high levels of pollution, promote excessive growth of algae. This leads to an increase in algae biomass, oxygen depletion, and dead zones, affecting resources.

An additional consequence is related to diseases. Wastewater contains bacteria, viruses, and parasites that cause waterborne diseases such as cholera, hepatitis, typhoid fever, and dysentery. These diseases are exposed in the Paraná River as the water is directly used for a multitude of activities, including swimming. Not all citizens have access to clean drinking water. Therefore, people who have access to such resources collect water for drinking, laundry, and even bathing.

III. The Way Forward

A. Problem approach

The proposed solution involves implementing a wastewater treatment plant. The techniques used for this treatment can be varied. Considering the conditions of the city, the technique known as activated sludge system is viewed as the most effective and economical. The activated sludge system is a process that relies on the use of microorganisms, which thrive in wastewater and convert dissolved organic matter into simpler products such as new bacteria, carbon dioxide, and water.

The key operational steps of this plant are described below. The first step is related to wastewater collection. This process begins with the collection of wastewater from homes, industries, and other sources in Paraná. This wastewater enters the plant through a sewer system.

The second step is about pretreatment. Before entering the activated sludge process, wastewater goes through this stage. During this phase, larger solid objects are removed and coarse solids are separated using screens and grit chambers.

In the third step, the pretreated wastewater is transferred to the activated sludge reactors. In these tanks, it is mixed with aerobic microorganisms, such as bacteria and protozoa, which feed on the organic contaminants present in the water.

The fourth step deals with aeration and mixing. During this stage, oxygen is supplied to the reactor to maintain aerobic conditions. This allows microorganisms to biologically degrade the organic matter in the wastewater. Continuous mixing ensures the dispersion of microorganisms and oxygen.

The fifth step is about disinfection. To eliminate remaining pathogens and microorganisms, the treated water undergoes a disinfection process. It goes through the application of chlorine or ultraviolet light.

The last step concerns the discharge or reuse of the wastewater. It means, the treated water is finally discharged into the receiving water body or, in some cases, used for irrigation or industrial processes.

B. Strengths and Weaknesses of the Proposal

The first strength of this project is that the system itself does not cost much to install, providing a good return on initial investment. In the second place, the effluent water produced is of high quality. The third strength is that it does not require much room to install and operate the system. The last strength is that there are very few odours or pests involved, which makes it easy to achieve a hygienic, safe and convenient operation.

The first weakness is that the initial capital may be low, but ongoing operating costs can be high. The second is that the sludge can be recycled back into the process but will have to be disposed of after a while, which can cause difficulties. The last weakness concerns the fact that supervision is required to make sure the sludge stays activated because it can affect the process.

IV. Conclusion

Wastewater, filled with pollutants from industrial and domestic sources, is being directly dumped into the Paraná River daily, creating a severe pollution risk. The proposed solution is to build a wastewater treatment plant, with the activated sludge system being the most effective and economical choice for the city. This system uses microorganisms to break down organic matter in wastewater.

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The present project is a skills integration activity in Inglés I at Universidad Tecnológica Nacional, Facultad Regional Paraná, carried out by EFL engineering students. The yearlong project requires students to delve into a problem in the city where they live and to address it by means of a simple project in English. Should the reader have any questions regarding this work, please contact Graciela Yugdar Tófalo, Senior Lecturer, at gyugdar@frp.utn.edu.ar.