

# Prevention of Floods on Almafuerter Avenue in Paraná, Entre Ríos: New Drainage System and Rain Gardens

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**Summary**— Paraná is a big city in Entre Ríos, Argentina. Its climate is generally warm, and its precipitation is about 1137 mm per year. When it rains, the water flows towards the Paraná River but only a part of it reaches the river; the other part stagnates in city avenues like Almafuerter, which is the avenue analysed in this work. The purpose of this document is to propose an innovative solution based on a new drainage system and rain gardens to prevent floods in Paraná, specifically on Almafuerter Avenue. These systems are focused on obtaining an effective decongestion of stagnant water. Recycling the excess water to irrigate the plants is also proposed by means of rain gardens.

**Keywords:** Rain Gardens – Water management – Drainage System – Floods

**Resumen**— Paraná es una gran ciudad de Entre Ríos, Argentina. Su clima es generalmente cálido y su precipitación es de unos 1137 mm por año. Cuando llueve, el agua fluye hacia el río Paraná, aunque solo una parte llega al río; la otra se estanca en avenidas de la ciudad como Almafuerter, que es la avenida analizada en este trabajo. El objetivo de este documento es proponer una solución innovadora basada en un nuevo sistema de drenaje y jardines de lluvia cuyo propósito es prevenir inundaciones, específicamente en la avenida Almafuerter.

**Palabras clave:** Jardines de lluvia – Manejo del agua – Sistema de Drenaje - Inundaciones

## I. INTRODUCTION

Paraná is a big city in Entre Ríos, Argentina. Its climate is generally warm, and the average annual temperature is 19.0 °C. The precipitation is about 1137 mm per year. Almafuerter, the avenue we will analyse in this presentation is a large avenue. It starts in the center and finishes in the industrial park, which is outside the city. This avenue is on an incline. When it rains, the water flows towards the Paraná River but only a part of it reaches the river; the other part stagnates in city avenues like Almafuerter.

The purpose of this document is to propose an innovative solution based on a new drainage system and rain gardens to prevent floods in Paraná, specifically on Almafuerter Avenue. These systems are focused on obtaining an effective decongestion of stagnant water. Recycling the excess water to irrigate the plants is also proposed by means of rain gardens.

To achieve this purpose, this work is organized as follows. First, we are going to describe the context of Paraná city, Almafuerter Avenue and the space which is the focus of this project. There are some images that illustrate this area. After we have described the context, we are going to analyze the problem. Then, there are some descriptions of scenes that help pictures the problematic situation. Those pictures show how this problem affects the traffic and buildings. In relation to the causes and consequences, we are going to mention three of both and we are going to explain some of the factors. Next, we are going to introduce the solution by means of rain gardens. There are some mentions of the strengths and weakness of the solution as well.

## II. PROBLEM DEFINITION AND ANALYSIS

### A. Description of the Context

Paraná is a city located in Argentina. It is the capital of Entre Ríos, and it is the most populated city in this province. Its population is about 300,000 inhabitants. Green spaces are a prominent aspect of Paraná. The site known as *Ex Hipodromo* (former racetrack) of Paraná is one of these green places, located on Almafuerter avenue, as Fig. 1 shows. Today the square called *Plaza de Mujeres Entrerrianas* is there and next to it there is an extensive unused lot, as it can be seen in Fig.1. This square is also on Almafuerter Avenue.



Fig 1. Satellital picture of Ex-Hipodromo, in Paraná. [1]

The problem we are going to address is in this specific area in Paraná. As stated before, this area is located on Almafuerter Avenue, as Fig. 2 shows. It has a lot of

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business shops there and it is a very busy street. The UTN university is on it, so we often walk or drive along this area we are going to analyse. This area has a lot of parks and green spaces, which will be helpful for the proposed solution.

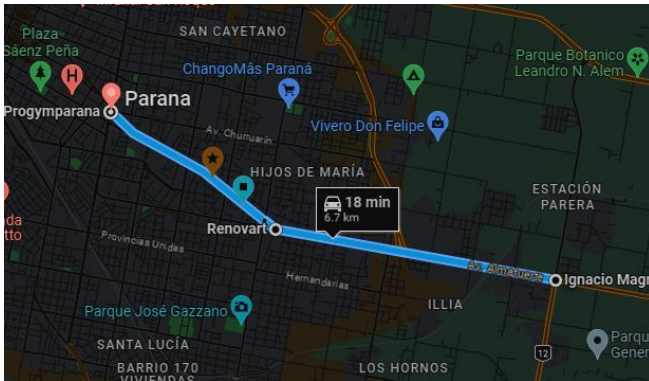


Fig 2. Satellital picture of Almafuerde Av. [2]

Fig. 3 shows a picture of Almafuerde street. It is a sunny day so we can see all the details. In the foreground there are many shops on both sides of the avenue. It is an avenue that ends in the outskirts of the city.



Fig 3. Almafuerde Avenue [3]

Fig. 4 is a picture of the rain frequency in Paraná city, Entre Ríos. It is important to take this picture in the context because it shows the big accumulation of rain per year. Naturally, the season that has the most rainwater in the year is spring.

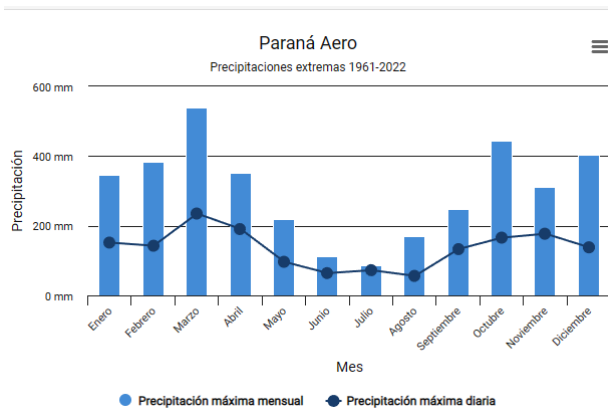


Fig 4. Rain frequency table [4]

This is basically the area we are analysing. This avenue suffers many floods because of its extension and incline.

**B. Problem Statement**

After explaining the context where the problem addressed is, it is necessary to precisely identify the problem. This problem has many causes that are explained in another section.

Parana is a city which has a lot of millimetres of rain per year, as explained before. The area on Almafuerde Avenue is, naturally, also affected. Specifically, the problem is the flooding of the avenue and sidewalks due to the accumulation of water caused mainly by frequent and hard rains. The water accumulation usually produces serious consequences.

**C. Description of Scenes that Help Picture the Problematic Situation**

Fig. 5 is a picture of Almafuerde avenue on a hard rainy day. In the foreground of the picture there are some shops and a lot of water. It is a cloudy day so we cannot see some details. This picture was taken by a man who was driving a car months ago. There are no people walking or cars on the road because of the water accumulation on the sidewalk and the avenue. The problem is clearly identified in this picture.



Fig. 5 Flood on Almafuerde Av. on May 25<sup>th</sup>, 2023

These pictures clearly show the problematic situation. It is now necessary to analyze its causes and consequences.

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

There are many factors that give rise to the problem of floods in an area on Almafuerde Av. The main cause is the



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inclination of the avenue, which produces a ditch effect. This causes water flow to move downwards and then stagnates until it evaporates or drains naturally.

Another factor may be the permeability of the pavement. When it rains, the water cannot flow through it, because the floor is not prepared for this effect. There is a special type of pavement which allows the filtering of water to the subsoil.

The outdated and inadequate drainage system is inefficient to drain the water quickly. The flood takes a long time until it disappears. Poor maintenance can hinder the drain from working properly.

### E. Identification and Description of the Consequences

The consequences of a flood in this area are various. One of it is the damage to the property and the infrastructure. Specifically in the area discussed in this document, there are many businesses, so the economic damage is very high.

A second consequence is that the circulation of people and vehicles is affected too. Stagnant water makes it impossible to circulate safely. A person can get injured, or a vehicle can be damaged with objects under the water.

Pollution and sanitation are two further severe consequences. The water can bring garbage or some contaminated disposal material like hospital or chemical waste. The accumulated water is also a breeding ground for mosquitoes with diseases.

## I. THE WAY FORWARD

### A. Problem approach

As far as the solution is concerned, we decided to use an innovative possibility. After we have explained all the factors that give rise to the problem, the rains, the poor drainage, the inclination of the avenues and the consequences, we must mention a possibility solution. Our proposal is the modification of the drainage system with the implementation of rain gardens. This solution includes an ecological improvement, green spaces, and they have ornamental function.

The idea is to restore and adapt the drainage system to a new rain garden located in one area of the “Ex-Hipódromo” racetrack. The point of this is to manage rainwater and move it to the rain garden to reduce the route and the caudal to the river.

A rain garden is a simple green space that uses and store rainwater. It implies a very big space such a park, green space with trees and plants, and biodiversity. Its function is very easy. It filters the rainwater to increase the quality of it. The filter is a blend of sand and stone, and it uses a grate to prevent the fluid of rocks, plastic, garbage. The purified water speeds up the growth of the plants.

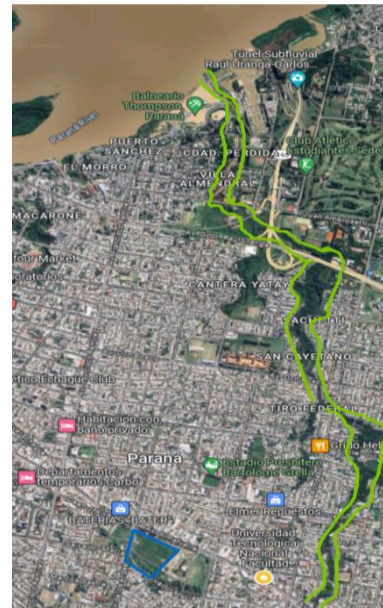


Fig 6. Satellital picture of a part of Paraná. [5]

With respect to the location, we propose using a part of “Ex Hipódromo” (racetrack) enclosed in blue in Fig. 6. When it is filled, the excess water will flow to the river on the marked path in green on Fig. 6.



Fig. 7. Rain garden [6]

Fig. 7 shows an example of a rain garden and how beautiful and easy to maintain it is. There will be a lot of biodiversity in this place and can store a lot of water for later use.

### B. Strengths and Weaknesses of the Proposal

There are advantages and disadvantages of the implementation of rain gardens in Paraná. Rain gardens have become popular in urban landscaping due to their multiple advantages. They contribute to improved water management, effectively reducing stormwater runoff, which, in turn, prevents flooding and safeguards nearby water bodies from pollution. Furthermore, these green spaces offer a haven for wildlife, fostering local biodiversity as they provide shelter and food for insects, birds, and various other animals. Their aesthetic appeal is an extra, enhancing the overall landscape with their attractive designs. Additionally, rain gardens play a pivotal role in cost reduction by decreasing the need for irrigation, as they utilize natural rainwater.

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However, like any landscaping feature, rain gardens have their share of disadvantages to consider. First, they require available space and a proper layout to function effectively, which may not be feasible in all locations. Maintenance is another crucial aspect, as these gardens need regular care to ensure both their functionality and aesthetic appeal. The initial construction and installation can be relatively expensive, encompassing excavation and the selection of suitable plants. Finally, proper drainage is essential; if not designed or installed correctly, a rain garden can experience drainage problems, leading to puddles and erosion.

## II. CONCLUSION

There are several problems hitting our planet, so we must respond creating sustainable solutions. Rain gardens generate a sustainable context and cause an increase of the nature. Currently, solutions will have an environmental protect so we try to support that mind.

A new drainage system in Paraná is an important improvement because there are a lot of problems in relation to the water accumulation. There are a lot of new

technologies to generate a well water manage, and we must take advantage of that.

## ACKNOWLEDGMENT

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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 Tófaló, Senior Lecturer, at [gyugdar@frp.utn.edu.ar](mailto:gyugdar@frp.utn.edu.ar).