

# Landslides in Urquiza Park: The Use of PET Fibers to Avoid the Movement of Hillsides

Bautista Londero<sup>1</sup> – David José Lopez<sup>2</sup>

*Civil Engineering Department, Facultad Regional Paraná, Universidad Tecnológica Nacional  
1033 Almafuerce Av, Paraná Entre Ríos, Argentina*

<sup>1</sup> bautistalondero@alu.frp.utn.edu.ar

<sup>2</sup> joselopez@alu.frp.utn.edu.ar

**Summary**—Urquiza Park is an important green area of the city of Paraná. Currently, it is facing a critical issue related to landslides and erosion. The causes are mainly heavy rains and trees removal, destroying the environment and putting people at risk. The purpose of this project is to address the issue of landslides within the specific area of Urquiza Park. To fulfill this aim, a solution that can be implemented by future civil engineers will be explored and explained, involving the reuse of recycled PET fibers to prevent landslides and erosion of this area. In order to achieve the goal of this work, it is organized as follows. Firstly, the city of Paraná will be briefly described. Then, the Urquiza Park landslides problem will be presented and discussed. Next, some scenes will be described in order to help visualize the problematic situation. Later, the causes as well as the consequences of the problem will be identified and analysed. After this, the solution to address the problem will be discussed. Finally, the strengths and weaknesses of the proposal will be stated. The expected impact of this project is mainly to improve the quality of life and safety of people as well as to preserve an important landmark of Paraná like Urquiza Park. In addition, it contributes to raising social awareness regarding PET recycling.

**Keywords:** geotextiles, landslides and erosion, recycled PET fibers, social awareness

**Resumen**— El Parque Urquiza es una importante zona verde de la ciudad de Paraná. Actualmente, enfrenta un problema crítico relacionado con deslizamientos de tierra y erosión. Las causas son principalmente las fuertes lluvias y la tala de árboles, que destruyen el medio ambiente y ponen en riesgo a las personas. El propósito de este proyecto es abordar el problema de deslizamientos de tierra en el área específica del Parque Urquiza. Para cumplir con este objetivo, se explorará y explicará una solución para que la puedan implementar los futuros ingenieros civiles, que consiste en la reutilización de fibras de PET recicladas para evitar deslizamientos y erosión de esta zona. Para lograr el objetivo de este trabajo, se organiza de la siguiente manera. En primer lugar, se describirá brevemente la ciudad de Paraná. Luego, se presentará y discutirá el problema de los deslizamientos de tierra en el Parque Urquiza. A continuación, se describirán algunas escenas para ayudar a visualizar la situación problemática. Posteriormente se identificarán y analizarán las causas y las consecuencias del problema. Después de esto, se discutirá la solución para abordar el problema. Finalmente se expondrán las fortalezas y debilidades de la propuesta. El impacto esperado de este proyecto es principalmente mejorar la calidad de vida y seguridad de las personas, así como preservar un punto de referencia importante de Paraná como lo es el Parque Urquiza. Además, se contribuye a generar conciencia social respecto al reciclaje de PET.

**Palabras clave:** geotextiles, deslizamientos y erosión, fibras PET recicladas, conciencia social

## I. INTRODUCTION

This project is based on the city of Paraná, which is the capital of Entre Rios Province (Fig. 1). There are four well defined districts in Paraná (Fig. 2), and it has a population of 391,962 spread across them, according to the 2022 Census.

Landslides and erosion in Urquiza Park are part of an environmental problem that affects Paraná. These natural processes can be dangerous because they can damage buildings in the area, hurt people as well as destroy the environment.

The purpose of the project is to address the issue of landslides within the specific area of Urquiza Park, which is located between Laurencena and Luis Etchevehere Avenues. To fulfill this aim, a solution that can be implemented by future civil engineers will be explored and explained, involving the reuse of recycled PET fibers to prevent landslides and erosion of this area.

In order to achieve the goal of this work, it is organized as follows. Firstly, the city of Paraná will be briefly described. Then, the Urquiza Park landslides problem will be presented and discussed. Next, some scenes will be described in order to help visualize the problematic situation. Later, the causes as well as the consequences of the problem will be identified and analysed. After this, the solution to address the problem will be discussed. Finally, the strengths and weaknesses of the proposal will be stated.

The expected impact of this project is mainly to improve the quality of life and safety of people as well as to preserve an important landmark of Paraná like Urquiza Park. In addition, it contributes to raising social awareness regarding PET recycling.

## II. PROBLEM DEFINITION AND ANALYSIS

### A. Description of the Context

To begin with, Paraná is a big city that is situated alongside the Paraná River, as shown in Fig. 1. This is a general view of the city that illustrates the distribution of the different places.

> THIS IS AN ENGLISH AS A FOREIGN LANGUAGE ENGINEERING STUDENT PAPER. READERS MAY MAKE USE OF THIS MATERIAL AT THEIR OWN DISCRETION<



Fig. 1. General map of Paraná city.

As mentioned before, Paraná has four districts as can be seen in Fig. 2. These districts are going to be described until reaching the center of the city, where the problem is located.

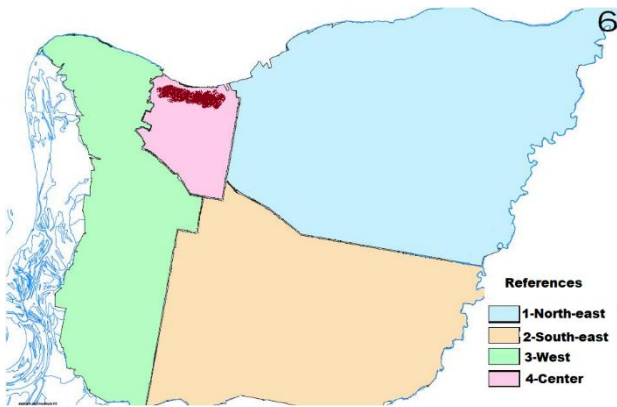


Fig 2. Districts of Paraná city.

In the north-east of Paraná city (Fig. 3), there is a famous football stadium known as Presbítero Bartolomé Grella Stadium, the home stadium for Atlético Patronato Club. Also, there is a green area named as Jardín Botánico, which is a beautiful natural space with a wide variety of flora and fauna, and the Mental Health Teaching Hospital, which is an important healthcare center in the region.

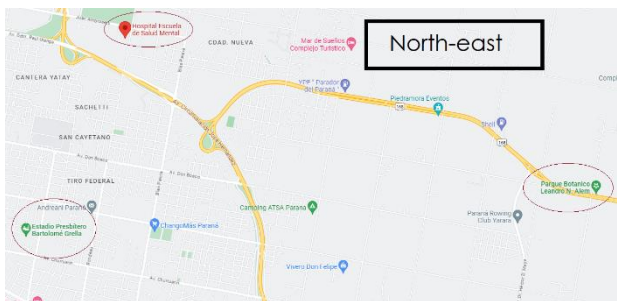


Fig 3. Landmarks in the northeastern area.

As can be observed in Figure 4, the south-east area of Paraná city boasts a variety of interesting places. Among them, many residential and commercial neighbourhoods, as well as numerous event venues, stand out. The most

characteristic places include Gazzano Park, which is rich in vegetation and serves as a recreational area. Additionally, there is an industrial park, which is specifically designated for all industrial activity in the city. Lastly, there is a roadway to Oro Verde, a small town near Paraná.

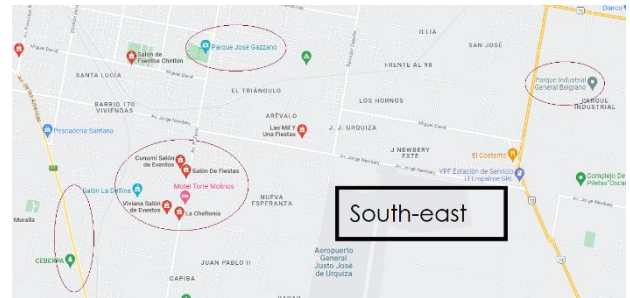


Fig. 4. Landmarks in the southeastern area.

Figure 5 shows the west area of Paraná city, which is characterized by its diversity and important services. In this area, there is the Military Hospital, a healthcare center specialized in providing medical services to military personnel and their families. Additionally, there is the Baxada Hospital, which is a health clinic center. Moreover, there are some neighbourhoods named San Agustín, Bajada Grande, and Pancho Ramírez, which are quite important in the residential areas.



Fig 5. Landmarks in the west area.

The Center area of Paraná city is the main part of the city (Fig. 6). Here you will find a blend of historic buildings, shops, restaurants, and services. The Metropolitan Cathedral of Paraná stands out as an imposing church located opposite an important square named 1° de Mayo Square which is a popular meeting point surrounded by cafes and shops.

On the riverside, there is one of the most important places in the city, the “Costanera”, a beautiful pathway along the Paraná River. Finally, the Urquiza Park (Fig. 7) is located along the eastern bank of the Paraná River. It is a natural area that offers abundant green spaces, breathtaking views, and numerous activities for the citizens.

> THIS IS AN ENGLISH AS A FOREIGN LANGUAGE ENGINEERING STUDENT PAPER. READERS MAY MAKE USE OF THIS MATERIAL AT THEIR OWN DISCRETION<

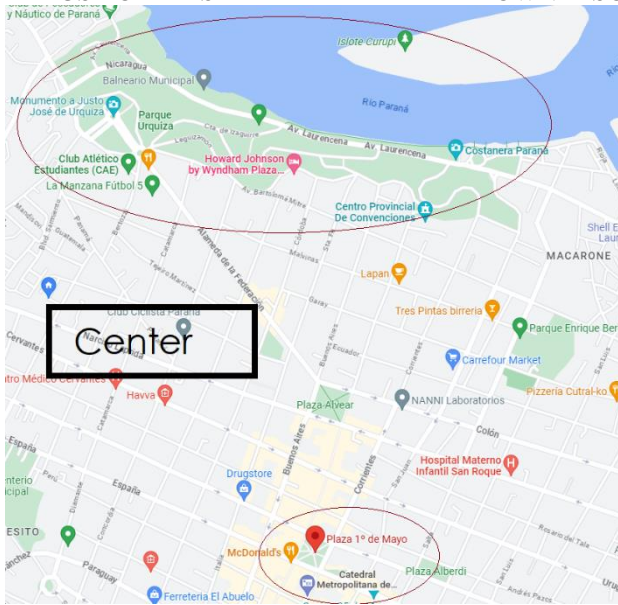


Fig. 6. Landmarks in the center of the city.

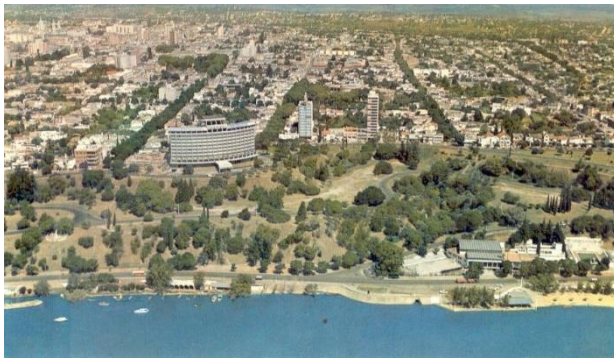


Fig. 7. The Urquiza Park.

This is the specific area where the problem is located. There are numerous hills that are prone to landslides and erosion between Laurencena Avenue and Luis Etchevehere Avenue, as Fig. 8 shows. These hills have an average height of 50 meters and there are many trees and stone stairs on them. Also, a lot of different kind of birds and small animals live in this area, so it is important to preserve the vegetation. The next pictures depict these areas.



Fig. 8. Hills between the avenues.



Fig. 9. Stone stairs and vegetation in Urquiza Park.

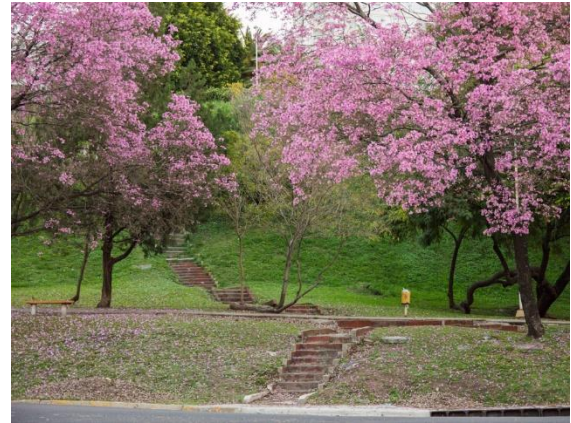


Fig. 10. "Lapachos" trees on the hills.



Fig. 11. Stone stairs and vegetation in Urquiza Park.

As it can be seen in the pictures above, Urquiza Park is an important natural part of the city because there is a lot of vegetation and recreational areas. These places are mostly crowded on weekends by tourists and local people, so it is important to keep this area safe.

### B. Problem Statement

Urquiza Park, an urban green space and recreational area, is currently facing a critical issue related to landslides and erosion. The park, which is situated in a geographically susceptible region, has been experiencing alarming landslides incidents over the last years, implying significant threats to public safety, ecological stability, and the park's overall value.

> THIS IS AN ENGLISH AS A FOREIGN LANGUAGE ENGINEERING STUDENT PAPER. READERS MAY MAKE USE OF THIS MATERIAL AT THEIR OWN DISCRETION<

The main problem lies in the increasing frequency and severity of landslides, which have been occurring due to a combination of natural factors and anthropogenic influences. The park's hilly terrain and inadequate soil retention measures make it particularly vulnerable to failures, putting nearby structures, walking paths, and visitors at risk of harm. Additionally, the erosion of soil and vegetation has intensified the landslides, leading to the degradation of precious green spaces, and negatively impacting the local flora and fauna.

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

As shown in Fig. 12, we can observe Luis Etcheverehere Avenue surrounded by trees. The collapse of the road is evident, with large sections of broken pavement. The scene depicts the consequences of a landslide that has disrupted the calm of the landscape. The once-smooth surface of the road is now completely unusable and there is a big impact on the environment produced by rubble.



Fig. 12. Landslide caused by terrain movement.



Fig. 13. Landslide due to diluvium.

The scenario in Figure 13 is similar to Figure 12. The landslide has caused a large amount of soil and rocks to fall onto the walk path below, which is on Laurencena Avenue. The path, which is made of brick, is covered in mud and debris from the hillside. The tree on the left side of the image is bent and damaged due to the landslide. Fortunately, there were not any people harmed during the incident.



Fig. 14. Rock obstructing Luis Etcheverehere Avenue.

The picture above (Fig. 14) depicts a dangerous situation. There is a large rock in the middle of Luis Etcheverehere Avenue because of a landslide. The hillside behind the road has some sloped trees on it.

### D. Identification and Analysis of Causes or Factors that Give Rise to the Problem

Landslides and erosion are complex geomorphic processes influenced by a combination of natural and human factors. There are many factors that impact negatively on this situation. On the one hand, human activities in Urquiza Park, such as the removal of trees, trigger this environmental problem. The absence of trees means that the soil is not able to absorb as much water as it once could because the tree roots, which used to absorb water, do not exist anymore.

On the other hand, another factor that affects the hillsides is water loss due to pipe breakages. These broken pipes are not visible because they are underground, so it is very difficult to detect and repair them. Also, these networks of pipes are old and belong to the water supply and sewer systems. They can introduce excess water into the subsurface environment, altering the hydrological and mechanical properties of the soil.

In addition, there are other natural factors which have a big negative impact on Urquiza Park. This region is characterized by its retention of underground water in combination with clay soil with high expansion and contraction due to water. These are layers of green plastic clays that have this reaction to water saturation with changes in humidity.

Last but not least are the heavy rains that occur once or twice a year. In these atypical situations, it can rain more than 60 mm/h, which has a direct impact on the soil. Heavy rainfall infiltrates and saturates it. When the soil becomes saturated, it loses its strength and cohesion, making it more susceptible to sliding. These landslides can cause disasters, but they can be prevented from happening again. The consequences are going to be described below.

### E. Identification and Description of the Consequences

Landslides and erosion in Urquiza Park have several consequences related to the environment, infrastructure, and people. The devastation of the environment is one of the major consequences. This can affect the habitats of numerous plant and animal species, disrupting local ecosystems. Species may be displaced, leading to long-term ecological imbalances.

> THIS IS AN ENGLISH AS A FOREIGN LANGUAGE ENGINEERING STUDENT PAPER. READERS MAY MAKE USE OF THIS MATERIAL AT THEIR OWN DISCRETION<

Another remarkable consequence is the danger to people that move around the hillsides of Urquiza Park. Landslides can result in the loss of human lives and cause injuries to those caught in their path. The sudden and often unpredictable nature of landslides can make them particularly dangerous.

There are other sequels related to economic losses and damage. The economic costs of landslides include the expenses for repairing and rebuilding damaged infrastructure and covering emergency response, which can be substantial. Also, tourism can be affected if landslides damage tourist infrastructure, such as hotels, roads, and attractions. For example, the Amphitheater, shown in Fig. 15, which is an iconic place of Paraná, can be destroyed if a landslide takes place. Moreover, landslides can damage utility infrastructure, including power lines, gas pipelines, and water supply systems in Urquiza Park. This can result in power outages, gas leaks, and water shortages, affecting the daily lives of nearby residents.



Fig. 15. Amphitheater located in Urquiza Park.

### III. THE WAY FORWARD

#### A. Problem Approach

First, it is necessary to consider that the solution needs to be split into two stages. The first one starts by researching into the process of recycling plastic in Paraná to produce PET fibers. After obtaining these fibers, it is necessary to melt and mold the PET fibers to produce an adequate geotextile material.

After this, the second stage consists of employing the geotextile to reinforce and readjust the hillsides of Urquiza Park. The project aims to reach this solution, which will be described below, improving the environment and people's safety.

It is known that the amount of plastic discarded daily in Paraná is huge. In this sense, an important part of clean plastic is collected from supermarkets (Fig. 16), such as packaging and empty bottles. Continuing with the process, they are taken into an extruder, as shown in Fig. 17, which chops the bottles into small pieces. The result is plastic flakes, or PET fibers, ready to the next step. These PET fibers are visible in Fig. 18.

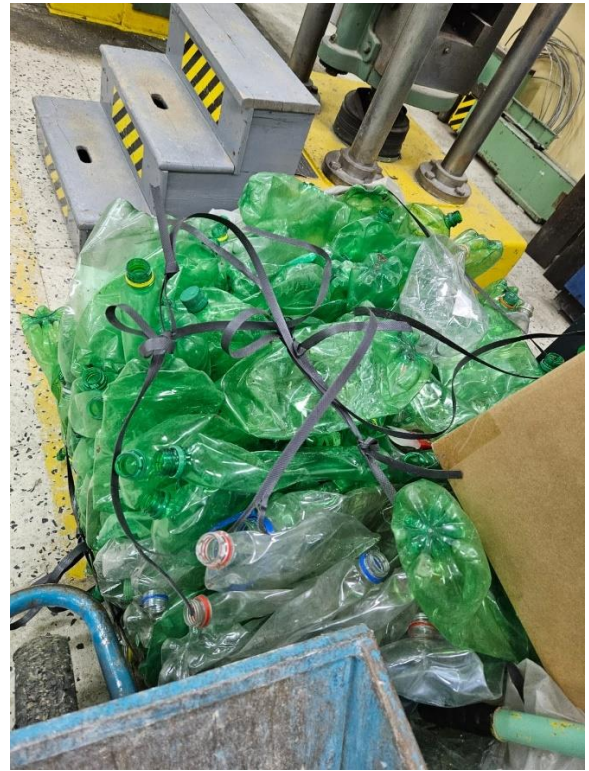


Fig. 16. Plastic bottles collected from supermarkets.



Fig. 17. Extruder from UTN laboratory.

> THIS IS AN ENGLISH AS A FOREIGN LANGUAGE ENGINEERING STUDENT PAPER. READERS MAY MAKE USE OF THIS MATERIAL AT THEIR OWN DISCRETION<



Fig. 18. PET fibers.

The next step involves manufacturing a geotextile. The flakes are carried to the processing plant, located in the Industrial Park in Paraná, where they are melted and molded to create a geotextile. This material is the base for this project because it has important properties that improve the soil, such as high tensile strength and permeability control. Allowing water to drain through it is necessary to prevent soil saturation, which leads to erosion. This is why it is important to stand out this last property. Fig. 19 shows the final manufactured product.



Fig. 19. Geotextile made 100% of PET fibers.

In this way, the second stage continues. Next, the geotextile is applied to the affected areas of Urquiza Park. In order to achieve this, the first thing to do is to remove the top layer of vegetation. Along with this, about 50 centimeters of dirt are removed. Then, the geotextile is placed in individual layers, from bottom to top as illustrated in Fig. 20. After each

layer is placed, the previously removed dirt is re-deposited and compacted using the appropriate machinery.

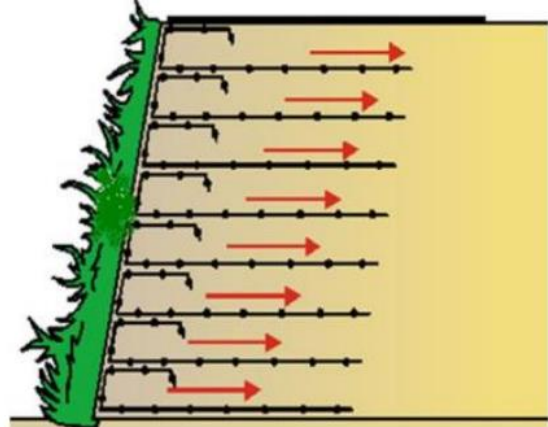


Fig. 20. Schematic way of placement of geotextile.

Finally, it is necessary to carry out a final compaction, seeking to eliminate any underground air spaces that may have remained. Also, hydroseeding is to ensure that the vegetation's roots stabilize the hillsides of Urquiza Park.

#### B. Strengths and Weaknesses of the Proposal

The PET fibers for geotextiles proposed for this solution are easily accessible, as both supermarkets and the waste sorting facility in Paraná continuously provide these materials. Moreover, bottle manufacturing companies also supply clean PET, whether it is from defective products or overproduction, for recycling.

Regarding the attributes of PET fibers, this material offers high tensile strength, permeability control, dimensional stability under load (i.e. minimal deformation when subjected to loads), resistance to chemicals and degradation, ease of installation, and the ability to reduce long-term maintenance costs in geotechnical projects.

Among the main disadvantages of this proposal, it should be noted that, despite having an extruder machine at a UTN laboratory for studying PET fibers, the city of Paraná lacks a recycling facility with the necessary infrastructure for large-scale production of this material. Concerning its usage, it comes with a higher initial installation cost and regular maintenance expenses due to the risk of clogging, as maintenance is required approximately once every two years. Furthermore, it is essential to consider the importance of precise installation and its limited suitability for all geotechnical applications, as they may not be the ideal solution in some cases.

#### IV. CONCLUSION

The issue analysed in this project involves the preservation and improvement of Urquiza Park hillsides, which is the most important tourist area in the city of Paraná. This area holds significant social value, and any changes made here carry immense significance. Also, this project presents an interesting ecological proposal which promotes the recycling of PET materials that could be easily implemented to improve Urquiza Park.

Moreover, this project seeks for a practical, creative, efficient and sustainable solution to address the issue of

> THIS IS AN ENGLISH AS A FOREIGN LANGUAGE ENGINEERING STUDENT PAPER. READERS MAY MAKE USE OF THIS MATERIAL AT THEIR OWN DISCRETION<

landslides in Urquiza Park, using materials that are relatively simple to manufacture or obtain and have a long lifespan. However, considering the capabilities and shortcomings of the city's recycling plant, it is necessary to establish a cost estimate for the plant's repairs and improvements to secure project financing.

In addition, it is crucial to communicate the project details to the citizens to raise social awareness about PET recycling. Furthermore, this project can significantly improve the community's safety and quality of life. Urquiza park is alive.

since a lot of species and vegetation live there. This is why the importance of its preservation should be understood.

#### ACKNOWLEDGMENT

The authors would like to thank teacher Mrs. Edith Walquiria Mercaich Sartore for her collaboration in the writing of this project. It is with sincere gratitude for the ongoing support and guidance.

Bautista Londero is a Civil Engineering student at UTN FRP: [bautistalondero@alu.frp.utn.edu.ar](mailto:bautistalondero@alu.frp.utn.edu.ar). David Lopez is a Civil Engineering student at UTN FRP: [joselopez@alu.frp.utn.edu.ar](mailto:joselopez@alu.frp.utn.edu.ar).

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).