Proceedings of the 21st ICSMGE, Vienna, Austria, 14 – 19 June 2026. Pistrol, Adam & Schweiger (eds.)
Published by: ÖGG, Austrian Society for Geomechanics, Salzburg, Austria, ISBN 978-3-9503898-4-5
https://doi.org/10.53243/ICSMGE2026-2129

Landslide Risk Management in the City of João Pessoa, Paraíba, Brazil: Scenario Analysis and Strategy Development

Geovanna K. S. Simões, Arthur V. F. S. Ramos, Igor F. Gomes
Postgraduate Programme in Civil Engineering, UFPE, Brazil, geovanna.simoes@ufpe.br

Fábio L. Soares
Federal University of Paraiba (UFPB), Brazil

ABSTRACT: This study proposes an integrated approach to landslide risk management in the city of João Pessoa, Paraíba, with a focus on the Roger neighbourhood, an area characterised by high socio-environmental vulnerability. The methodology comprised risk area mapping, geotechnical characterisation of a critical slope, back analysis based on the Morgenstern–Price method, and laboratory testing under two moisture conditions. The safety factors obtained were below the minimum required by the Brazilian standard, indicating seasonal instability exacerbated by soil saturation and vehicle traffic at the crest of the slope. As part of the prevention and mitigation actions, environmental education initiatives were carried out with the local community. The results highlight the importance of multidisciplinary strategies that combine technical analysis, geotechnical monitoring, and social mobilisation to promote risk reduction and protect lives in vulnerable urban areas.

KEYWORDS: Risk management, landslides, slope stability, environmental education, management strategies.

1 INTRODUCTION

The occurrence of landslides in densely populated urban areas represents one of the main challenges for natural disaster risk management, particularly in contexts marked by informal settlements and socio-environmental vulnerability. In the city of João Pessoa, Paraíba, Brazil, the combination of natural factors, such as intense rainfall and local geology, with unplanned human activities significantly contributes to the instability of slopes and hillsides.

Given this scenario, it is essential to develop integrated strategies for prevention, mitigation, and preparedness, involving both the technical analysis of slopes and social mobilisation through environmental education. This article presents a landslide risk management proposal for the capital of Paraíba, focusing on the Roger neighbourhood, an area historically affected by landslides. The adopted methodology includes the mapping of risk areas, the geotechnical characterisation of a critical slope, the performance of back analysis to assess stability, and the implementation of socio-educational actions aimed at building a culture of prevention within the local community.

2 LITERATURE REVIEW

2.1 *Factors Influencing Mass Movements*

Mass movement is defined as the displacement of soil, rock, and/or vegetation along a hillside due to the direct influence of gravity (TOMINAGA *et al*., 2009 *apud* CARDOSO, 2016). The movement can occur slowly or rapidly and can be categorised into different types. These events are triggered and exacerbated by various factors, as described below.

2.1.1 *Water Infiltration in Soil*

According to Lima (2002), there is a direct relationship between accumulated rainfall and the occurrence of landslides, as water infiltration causes soil saturation, reducing its apparent cohesion and angle of internal friction, which consequently decreases the soil's shear strength and increases the risk of landslides. Furthermore, in areas with improper wastewater disposal, the absence or inadequacy of sanitation systems promotes continuous infiltration, leading to soil saturation and potentially causing failures in cuttings and embankments (SILVA, 2016).

2.1.2 *Vegetation*

According to Alheiros *et al*. (2003), the planting of large trees at the crest or along slopes should be avoided, as the combined effect of gravity and strong winds exerts additional stress on the soil, creating a lever effect that can disaggregate the soil and trigger mass movements or tree overturning. It is also recommended not to cultivate banana plants in these areas, as this species exploits the soil's porosity to store large volumes of water necessary for its growth, which contributes to soil saturation and increases susceptibility to landslides.

2.1.3 *Anthropogenic Activity*

Anthropogenic factors are directly linked to risk configuration, as they reflect human interventions and the way the population interacts with its environment. According to Oliveira (2020), this interaction manifests in various ways, such as the execution of cuttings and embankments for housing construction, discharge of wastewater and/or sewage, leaks in water supply and sewage systems, irregular disposal of waste and/or debris, installation of septic tanks, and alterations to vegetation.

2.1.4 *Influence of Vehicle Traffic on Mass Movements*

Vehicle circulation over the crest of slopes generates additional loads that induce vibrations in the soil, increasing the acting stresses. These behaviours can be analysed by considering variables such as acceleration, applied load, slope inclination, and load distribution on the soil (SILVA, 2006).

2.2 *Definition of Risk: Susceptibility + Vulnerability*

According to Casarim (2021) *apud* Simões (2023), risk is defined as the combination of hazard — represented by the susceptibility to mass movements on slopes or hillsides — and vulnerability, which relates to the presence of buildings located near the potentially impacted area, as shown in Figure 1.

Figure 1. Risk: Hazard (susceptibility) and Vulnerability.

2.3 *Risk Management and Its Strategies*

In Brazil, the National Policy for Civil Protection and Defence (PNPDEC) emphasises that disaster risk management performs a critical role in promoting community resilience and mitigating losses and damages caused by disasters. Furthermore, Coutinho *et al.* (2021) state that Risk and Disaster Management require the participation of multiple stakeholders at different levels—local, regional, state, and federal.

According to Brazilian Law No. 12,608 of 10 April 2012, and regulated by Decree No. 10,593 of 24 December 2020, disaster risk management comprises two distinct but interrelated stages: prevention and mitigation, and preparedness.

The prevention and mitigation phase encompasses the continuous assessment and mapping of areas susceptible to landslides, as well as the adoption of measures that reduce vulnerability and control the likelihood of disaster occurrence. The preparation phase, in turn, focuses on the forecasting and monitoring of critical events, the issuance of alerts, and the prior planning of responses, including the technical training of personnel and the population.

Unlike disaster management, which takes place in abnormal situations — that is, during and after a disaster — risk management encompasses all civil protection and defence activities carried out during normal periods, before a disaster actually occurs.

3 METHODOLOGY

The methodology adopted in this study aimed to address the risk management of mass movements in the city of João Pessoa, Paraíba, based on the identification of risk areas, selection of a critical slope for detailed analysis, and the implementation of prevention and mitigation measures through technical and socio-educational actions. Initially, a bibliographic survey was conducted, consulting official documents such as the Municipal Risk Reduction Plan (PMRR), data from the Geological Survey of Brazil (CPRM), and the Municipal Civil Defence. This information was complemented by field visits, taking into account variables such as slope gradient, soil type, land use and occupation, and rainfall indices in the city, with the aim of mapping the areas most prone to landslides.

Based on this assessment, an urban slope located in an area of high socio-environmental vulnerability, previously affected by instability processes, was selected. The geotechnical characterisation of the slope was conducted through visual inspections, soil sampling, and laboratory testing. The slope geometry was defined, enabling the construction of digital terrain models. Subsequently, stability analysis was performed using the Morgenstern–Price method, with the calculation of the factor of safety (FS) under two scenarios: natural soil and saturated soil.

To calibrate the models and validate the geotechnical parameters used, a back analysis of previous instability events at the slope was conducted to estimate the critical geotechnical parameters of the study slope.

As part of the prevention and mitigation strategies, environmental education and awareness-raising activities were planned and implemented with the population residing in the risk area. These actions included lectures at the local school and the distribution of informational materials written in accessible language.

4 RESULTS

For efficient risk management in a city, it is essential to have knowledge of local characteristics, such as settlement history, soil type, rainfall patterns, geomorphology, among other relevant aspects. This information is crucial for an accurate assessment of mass movement risks and for defining appropriate preventive measures.

4.1 *Analysis of the Characteristics of João Pessoa, PB*

The city of João Pessoa, capital of the state of Paraíba, Brazil (Figure 2), has an estimated population of 833,932 and an area of 210.044 km², according to 2022 data from the Brazilian Institute of Geography and Statistics (IBGE).

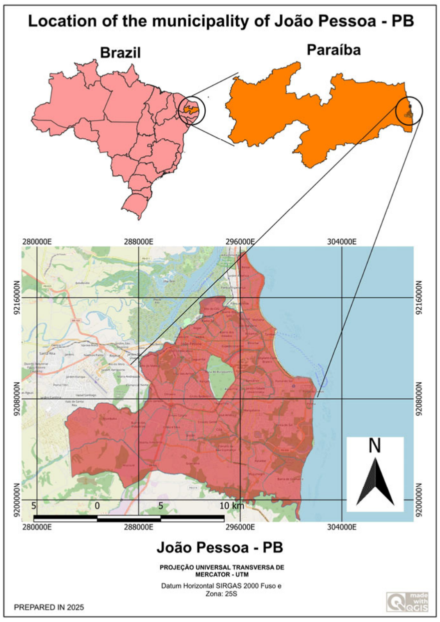


Figure 2. Location of João Pessoa, Paraíba, Brazil.

4.1.1 *Geology and Geomorphology of the City*

The geomorphology of the municipality of João Pessoa is divided into two relief formation groups: the Low Coastal Plateaus, which are part of the Coastal Tablelands and shaped by the unconsolidated sediments of the Barreiras Formation, and the Coastal Lowlands, formed by alluvial deposits (BEZERRA, 2018), as shown in Figure 3.

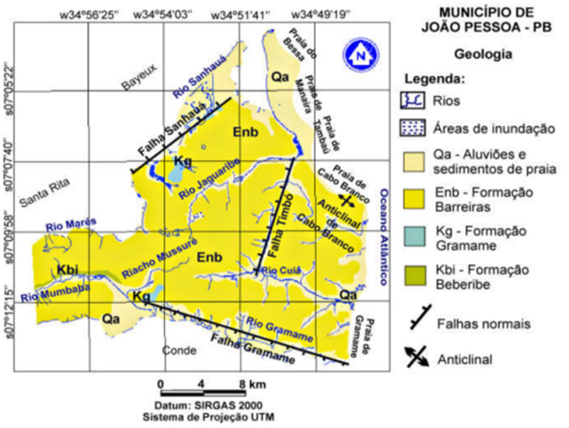


Figure 3. Geomorphology of the municipality of João Pessoa (Brasil, 2002) *apud* (Barbosa, 2015) (in Portuguese).

4.1.2 *Characterisation of the City's Rainfall*

The climate of the municipality of João Pessoa, Paraíba, Brazil, is characterised by its location at low latitudes and close proximity to the Atlantic Ocean. Figure 4 presents the most recent climatological normal, covering the period from 1991 to 2020.

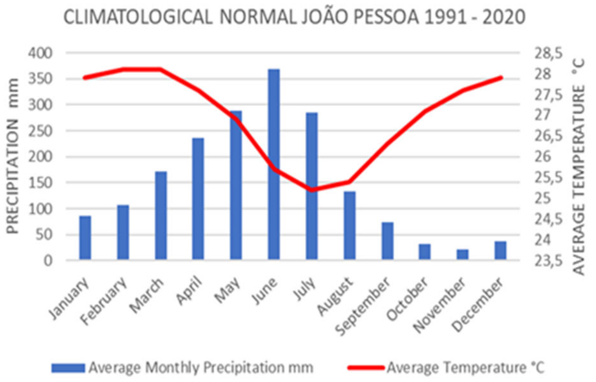


Figure 4. Climatological Normal João Pessoa 1991 - 2020.

As shown in Figure 5, the average annual temperature is approximately 26.9°C, exhibiting little variation throughout the year. The hottest month is March, with an average of 28.3°C, while July is the coldest, with an average of 25.4°C. The average annual precipitation is 1,837 mm, with the wettest period occurring between April and July. November is the driest month, with a monthly average of 25 mm of precipitation, whereas June experiences the highest rainfall, averaging 370 mm.

4.1.3 *Identification of Mass Movement Risk Areas*

The city of João Pessoa comprises 27 risk areas, indicated in red in Figure 5, encompassing approximately 10,000 dwellings and around 40,000 people exposed to some type of disaster risk (SILVA, 2018).

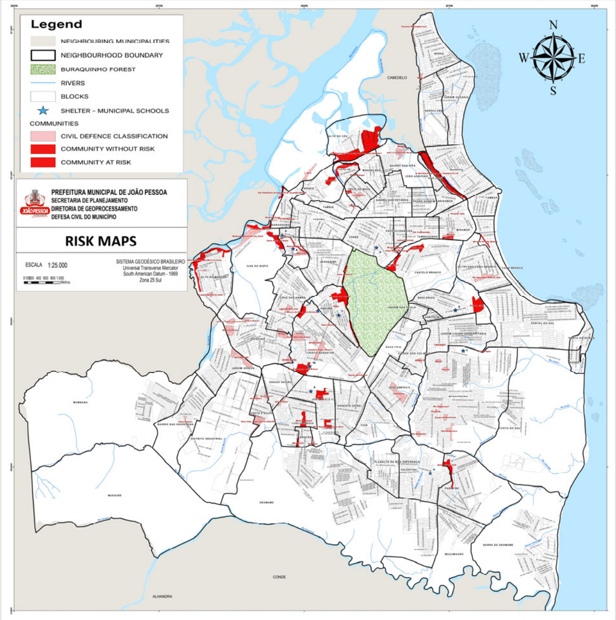


Figure 5. Mass movement risk areas in the city of João Pessoa. (PMJP, 2023).

Table 1 highlights the six neighbourhoods with the highest number of recorded mass movement events between 1983 and 2016, although underreporting of these occurrences exists.

Table 1. Number of Landslide Events in the Main Neighbourhoods of João Pessoa, PB, between 1983 and 2016.

Neighbourhood	Number of Landslide Events	Percentage (%)
Trincheiras	13	19,12
Castelo Branco	9	13,24
Cabo Branco	8	11,77
São José	8	11,77
Bancários	5	7,35
Roger	4	5,88
Total in João Pessoa-PB	68	100,00

According to the Municipal Civil Defence, among the six neighbourhoods with the highest history of landslides, the Roger neighbourhood stands out for having residences located at the crest, along, and at the toe of the slope, which exacerbates the risk of loss of human lives.

4.2 *Study Neighbourhood: Roger*

Based on data provided by the João Pessoa Civil Defence and observations made during field visits, the Roger neighbourhood emerges as one of the areas requiring the greatest attention for mass movement risk management, due to the vulnerability faced by residents in this locality.

Thus, the landslide risk map for the neighbourhood was prepared by GEGEO/UFPB, Figure 6, using the methodology of the Ministry of Cities, which allowed classification into three categories—very high (purple), high (red), and medium (yellow)—based on parameters and weights established by Soares and Pereira (2017). Furthermore, through geoprocessing software and information from the João Pessoa City Hall, it was possible to quantify the number of residences in each zone and obtain the contour lines of the studied neighbourhood.

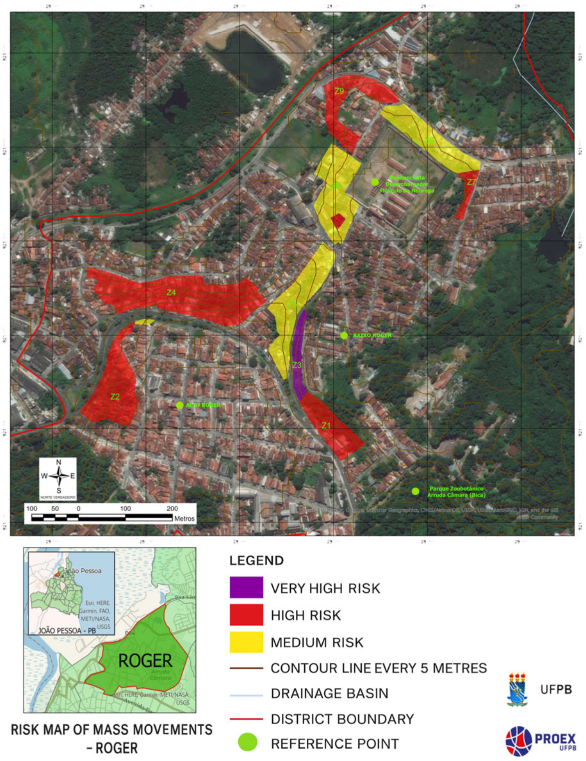


Figure 6. Mass Movement Risk Map of the Roger Neighbourhood, João Pessoa, Paraíba – Brasil.

4.2.1 *Characteristics of the Roger Neighbourhood*

The neighbourhood is subdivided into Alto and Baixo Roger, according to the Atlas Filipéia/SEPLAN/PMJP (2021). This subdivision highlights marked contrasts, as the division is not limited to geographical location but primarily reflects socioeconomic differences. Baixo Roger is predominantly inhabited by a low-income population, whereas Alto Roger is characterised by a lower-middle-class population.

4.2.2 *Relief of the Roger Neighbourhood*

According to the Atlas Filipéia/SEPLAN/PMJP (2021), Alto Roger has predominantly flat relief, with only slight inclinations in the transition areas to Baixo Roger. In the Baixo Roger portion, the terrain becomes irregular, with steep slopes extending in a succession of embankments, increasing the risk exposure of communities living in vulnerable conditions.

4.3 *Study of the High-Risk Mass Movement Zone*

After the preparation of the landslide risk map, it becomes essential to analyse the areas with the highest probability of occurrence, in order to quantify the Factor of Safety and assess the stability of the slope in the region.

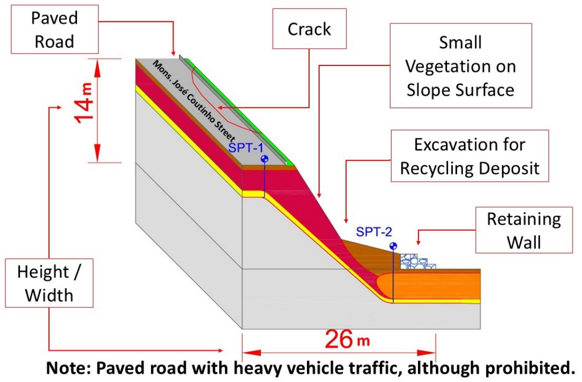
4.3.1 *Critical Slope of the Study Area*

The purple zone (Z3), classified as very high risk, extends up to the crest of the main access road to Baixo Roger, Rua Monsenhor José Coutinho, Figure 7. This road experiences heavy traffic of both light and heavy vehicles, generating additional load at the top of the slope, Figure 7. Previously, a sign prohibiting the circulation of large vehicles was in place, but it was vandalised, allowing trucks and other cargo vehicles to pass. In 2023, new signage was installed; however, the practice of disregarding traffic restrictions still persists at the site.

Figure 7. Drone survey of the main access road to Baixo Roger, Paraíba, Brazil.

4.3.2 *Geological Profile of the Analysed Soil*

The geological profile of the study area, Figure 8, was defined based on data obtained from Standard Penetration Test (SPT) boreholes carried out in the embankment area in 2009 and provided by a Brazilian geotechnical company.



Note: Paved road with heavy vehicle traffic, although prohibited.

Figure 8. Sketch of the geological profile and the cross-sectional profile of the study slope.

According to the interpretation of the borehole logs, the stratigraphic layers were classified as follows: brown layer – fill; red layer – clayey sandy silt with hard laterite, varied in colour; yellow layer – silty sandy clay with hard laterite, varied in colour; orange layer – slightly clayey silty sand with gravel, ranging from loose to medium-dense, light grey in colour; and grey layer – material or layer depth unknown, limited by the depth reached by the boreholes.

The upper borehole (SPT1) advanced to a depth of 4.34 m, where a lateritic layer was identified that proved to be impenetrable to percussion, thereby interrupting further advancement of the borehole. The SPT2 borehole advanced to a depth of 6.85 m, reaching the top of the limestone bedrock.

4.3.3 *Crack at the Crest of the Slope*

Since 2021, the behaviour of the crack at the crest of the slope has been monitored. Using images from Google VIEW, it was observed that the fissure began in 2017 and has exhibited, to date, a seasonal pattern of widening during rainy periods. Thus, Figure 9A depicts the first visit to the neighbourhood in 2021, Figure 9B shows the progression of the crack in 2023, and Figure 9C illustrates in 2024 the application of an asphalt layer over the crack to facilitate traffic in the area, although without stabilising the slope, creating a false sense of security for local residents.

Figure 9. History of the Crack in the Study Slope.

4.3.4 *Geotechnical Investigation Campaign*

During field visits to the slope instability area, slow and seasonal movement was observed, with displacements of a few centimetres per year during periods of accumulated rainfall, presenting a well-defined rupture surface marked by the crack. In this context, it became essential to carry out a detailed soil characterisation to understand the terrain dynamics. For this purpose, three undisturbed samples and approximately 4 kg of disturbed samples were collected, Figure 10.

Figure 10. Soil Sampling in the Study Slope.

The samples were carefully transported to the Geotechnical Engineering Laboratory of UFPB – GEGEO/UFPB. Among the procedures carried out were particle size analysis, determination of Atterberg limits, measurement of natural density, and direct shear tests, all of which are fundamental for identifying the soil's mechanical properties.

To obtain the geotechnical parameters, such as cohesion and friction angle, direct shear tests were conducted under two distinct conditions — natural and saturated —simulating the moisture variations to which the soil is subjected throughout the year. The results of these tests are presented in Table 2.

Table 2. Geotechnical parameters results.

Layer	Friction angle (°)	Cohesion (kPa)	Unit weight (kN/m^3)
Natural (unsaturated)	36°	15	17
saturated	22°	10	18

Regarding particle size distribution, without the addition of deflocculant, the soil was classified as SM, that is, silty sand, according to the Unified Soil Classification System (USCS).

4.3.5 *Results of the Back Analysis*

A back analysis was performed to determine the soil parameters that resulted in a Factor of Safety (FS) numerically equal to 1, the condition under which the soil fails, in order to estimate the geotechnical parameters leading to slope failure. Using this approach, it was possible to estimate the geotechnical parameters responsible for the observed instability.

The stability analysis of the hillside was conducted using GeoStudio 2023.1 (student license), employing the SLOPE/W module. Two distinct scenarios were considered:

- Scenario 1: soil under back-analysed condition (unsaturated);
- Scenario 2: soil in its natural moisture condition (unsaturated).

For both cases, the Factors of Safety (FS) were estimated, the investigation employed the Mohr–Coulomb stability criterion, and the analysis was carried out using the Morgenstern–Price limit equilibrium method, Figure 11. This approach allowed for a comparison of the variation in the Factor of Safety caused by changes in the soil’s apparent cohesion due to climatic seasonality, highlighting the influence of suction on the overall behaviour of the slope.

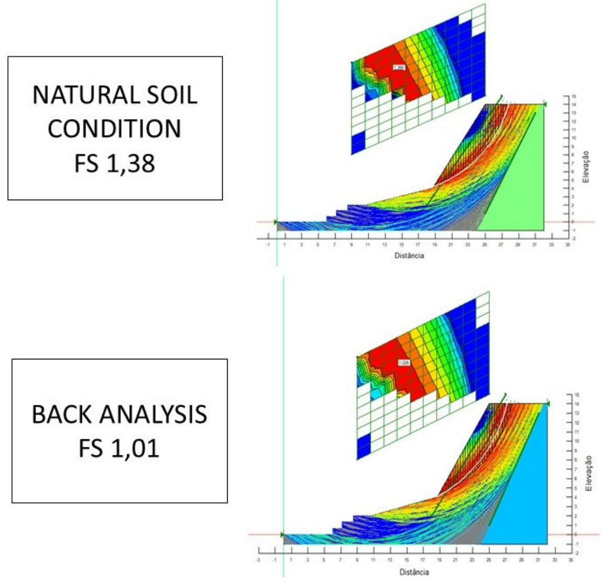


Figure 11. Minimum Factor of Safety Results from the Analyses.

The Factors of Safety (FS) obtained for the back analysis and for the natural soil condition were 1.01 and 1.38, respectively. It is observed that, for the natural soil condition, the values are close to the minimum limit of 1.3 established by NBR 11682 (ABNT, 2009). This low FS explains the gradual movement of the slope recorded since 2017, characterising a seasonal instability process that intensifies during periods of higher precipitation and accumulated rainfall. With seasonality and the increase in infiltrated water volume over the seasons, the FS exhibits significant variations, reflecting the direct influence of climatic conditions. In these situations, the soil tends to become saturated, increasing its apparent weight, while soil suction decreases, resulting in a reduction of apparent cohesion.

4.4 *Risk Management Strategies*

4.4.1 *Environmental Education and Community Awareness Initiatives*

Based on the information obtained from the risk mapping, described in Section 4.2, it is possible to identify the areas most susceptible to landslides and direct practical environmental education interventions to the analysed locality, aiming to raise awareness and reduce the hazards associated with mass movements.

Environmental education aims to address four fundamental axes which, together, seek to prevent disasters, protect lives, and promote environmental preservation and the population’s quality of life:

- Raising awareness and engaging residents in risk areas to foster dialogue on recommended practices, with the aim of promoting the environmental conservation of slopes;
- Dissemination of appropriate procedures and techniques for settlement and construction in slope areas;
- Encouragement of collaboration between governmental entities and communities in the design of preventive solutions to avoid risk situations and mitigate existing ones;
- Promotion and training of residents so that community members, regardless of age, can act as active agents.

The implementation of preparedness measures involves carrying out environmental education activities in the studied neighbourhood. These activities, conducted especially at the school located in the highest-risk area, aim to encourage community engagement in building a culture of prevention and adopting safe behaviours in daily life.

By adequately training the population, collective awareness of landslide risks is strengthened, contributing to the development of a culture focused on safety and the prevention of these natural phenomena. Through activities such as lectures, distribution of informational materials (posters, educational booklets), and recreational activities like memory games, guidance was provided on self-protection, safe land use, and preventive and mitigation practices targeted at the susceptibility factors identified in each community.

Specifically in the Roger neighbourhood, the environmental education initiative involved approximately 107 children and adolescents, significantly contributing to raising awareness of the risks and promoting the adoption of safer practices.

4.4.2 *Monitoring*

Monitoring the high and very high landslide risk areas is an important tool to prevent tragedies, given the presence of dwellings in these zones. One measure adopted is the annual visual monitoring of the settlement of the crack at the crest of the slope.

However, more detailed monitoring can be carried out through instrumentation that records horizontal and vertical displacements, as well as tracking local geotechnical parameters. Since the soil in the region contains a significant proportion of fines, the soil water retention curve can be determined in the laboratory, allowing for monitoring of suction and moisture in the slope. Additionally, it is possible to estimate, using the water retention curve and the infiltration rate, critical accumulated rainfall values that reduce the soil's Factor of Safety to critical instability levels, enabling the issuance of alerts to residents in the risk areas.

Furthermore, local authorities were informed about the situation in the neighbourhood.

4.4.3 *Contingency Plan*

Although, to date, no specific contingency plan has been developed for the analysed region — only at a local level — it is necessary to present fundamental guidelines that can inform future risk management and emergency response actions related to mass movements for this particular neighbourhood. In this context, the contingency plan should provide clear and effective procedures to guide responses to emergency situations, ensuring coordination among the various stakeholders involved, such as competent authorities and the local population. Another essential component is the identification and preparation of suitable locations to serve as temporary shelters, equipped with appropriate infrastructure to accommodate affected residents and provide basic emergency supplies.

5 CONCLUSIONS

The study conducted in the Roger neighbourhood, João Pessoa – PB, Brazil, highlighted the complexity of the factors involved in urban slope instability, emphasising the importance of mass movement risk management. The technical analysis allowed for the quantification of the Factors of Safety of the studied slope under different moisture conditions, demonstrating that soil saturation directly contributes to the reduction of slope stability.

Furthermore, the implementation of environmental education initiatives with local residents promoted community engagement and strengthened collective awareness of risks and self-protection measures. The results indicate that integrated strategies—combining technical knowledge, geotechnical monitoring, and social participation—are essential to prevent disasters and preserve lives. Thus, this work contributes to the advancement of risk management practices in vulnerable urban areas and reinforces the importance of public policies supported by technical diagnostics and effective educational actions.

For future studies, it is recommended that complementary investigations be carried out, including the soil–water retention curve of the slope area, local permeability, in situ suction tests, and long-term analyses, in order to enhance the understanding of the hydromechanical behaviour of slopes in urban environments subject to strong climatic seasonality. In addition, it is important to analyse slope stability considering the additional load imposed by vehicle traffic at the crest of the slope, given the known influence of this variable on the factor of safety.

6 ACKNOWLEDGEMENTS

This work was supported by the Coordination for the Improvement of Higher Education Personnel (CAPES), to which the authors express their gratitude for promoting research and academic training. We also thank the Geotechnical Engineering Group at UFPB – GEGEO. The authors further express their gratitude to the Human Resources Training Program of the National Agency for Petroleum, Natural Gas and Biofuels (PRH-ANP) for the support of this research, especially PRH-ANP 35/UFPB – Energy Transition, and Brazilian National Council for Scientific and Technological Development (CNPq) for its support of the project under grant numbers 308489/2022-5 and 445040/2024-6.

7 REFERENCES

Alheiros, M.M., *et al.* 2003. Manual for the Occupation of Hills in the Metropolitan Region of Recife. *FIDEM*, Recife-PE, Brazil (in Portuguese).

Barbosa, T. S. 2015. Urban Geomorphology and Geomorphological Mapping of the Municipality of João Pessoa – PB, Brazil. *Graduate Dissertation*, Graduate Program in Geography, Federal University of Paraíba, Brazil (in Portuguese).

Bezerra, J. M. B. 2018. Characterization of the Barreiras Formation in the City of João Pessoa Based on SPT Soundings and Geotechnical Study of a High Landslide Risk Slope. *Graduate Dissertation*, Graduate Program in Civil Engineering, Federal University of Pernambuco. Recife, Brazil (in Portuguese).

Cardoso, G., and Cardoso, C. 2016. Risk Management Associated with Mass Movements. *Revista Ordem Pública*, 9(1), Jan./Jun., Brazil (in Portuguese).

Coutinho, S. M. V., Malheiros, R., Jacobi, P. R., Sulaiman, S. N. 2021. Governance and social participation in Risk and Disaster Management. C*aderno Técnico de Gestão Integrada de Riscos e Desastres*. Brasília, Brazil (in Portuguese).

Filipeia. Municipal Atlas of João Pessoa. [Online] Available at: < https://filipeia.joaopessoa.pb.gov.br/files/atlas/Perfil_de_bairro.pdf > [Accessed April 2025].

GEGEO/UFPB, Geotechnical Engineering Group of the Federal University of Paraíba.

GeoStudio (2023). Slope/W for slope stability analysis (2023.1), computer program.

Google. 2023. Google Earth. [Online] Available at: <https://www.google.com/earth/versions/#earth-pro/>.

IBGE (2022). *Brazilian Institute of Geography and Statistics,* João Pessoa-PB, Brazil, (in Portuguese).

Lima, A.F. 2002. Geomechanical behavior and stability analysis of a slope in the Barreiras Formation within the urban area of Recife. *Master's Thesis*, UFPE, Recife, Brazil (in Portuguese).

NBR 11682/2009 – Slope Stability. *ABNT*, Rio de Janeiro, Brazil, 33 p. ISBN 978-85-07-01702-8 (in Portuguese)

Oliveira, C. A. 2020. Mapping of Mass Movement Risk in João Pessoa – PB through a Quali-Quantitative Risk Classification Methodology. *Undergraduate Thesis in Civil Engineering, Federal University of Paraíba*. João Pessoa, Brazil (in Portuguese).

PMJP (2023). Community Map. *Planning Secretariat*, Civil Defense of the Municipality of João Pessoa, Brazil (in Portuguese).

Silva, F.T., and Ávila, J.I.S.L. 2006. Vibrations in slopes caused by vehicle traffic. *Master's Thesis*, Graduate Program in Civil Engineering, UFPE, Recife, Brazil (in Portuguese).

Simões, G.K.S. 2023. Risk Management of Mass Movement in the City of João Pessoa-PB. *Undergraduate Program in Civil Engineering*, Federal University of Paraíba, João Pessoa, Paraíba, Brazil (in Portuguese).

Soares, F.L., and Pereira, N.N.T. 2017. Proposal of a Methodology for Geological-Geotechnical Risk Mapping of Landslides in João Pessoa-PB. XII *Brazilian Conference on Slope Stability, COBRAE, ABMS*, Rio de Janeiro, v.1, Brazil (in Portuguese).