Perception of the resilience concept applied to the urban environment

Percepção sobre o conceito de resiliência aplicado ao ambiente urbano

Ana Luiza Pagani Thomal[1]; Daniela de Castro Soares[2]; Thiago Vinicius Louro[3]; Heliana Barbosa Fontenele[4]; Carlos Alberto Prado da Silva Júnior[5]

Abstract

Resilience is a term largely applied to the urban environment due to the need to absorb impacts toward minimizing possible damages caused by adversities, such as floods. This research aimed to study the perception of a population sample about the term resilience and its implications for the daily lives of citizens. A conceptual project was proposed to render resilient a region in the city of Londrina, PR, Brazil, periodically affected by this calamity. It consists of lowering a riverside park in order to create a buffer basin into which water is drained on days of heavy rain and prevented from reaching the streets and houses in the region. The sample's perception was obtained from surveys applied on-site. The collected data indicate that 54% of the respondents have prior knowledge of resilience, 46% out of whom are younger than 30 years old. A total of 87% of the respondents are for the proposal, with the negatively affected ones being more likely to support the idea. The main hindrance is the difficulty in moving around on flooding days, according to 46% of the sample. The theoretical knowledge of the term resilience is greater among the younger ones, but it is not linked to its actual use, as residents and business owners in the region who did not know the word present resilient measures developed by the need for adaptation. Suggestions provided by the participants can be useful for a more in-depth study on means to make a riverside location resilient to flooding.

Keywords: Resilience. Flooding. Population perception. Public support.

Resumo

Resiliência é um termo difundido na aplicação do ambiente urbano devido à necessidade de absorção de impactos, a fim de minimizar possíveis danos ocasionados por adversidades, como as inundações. A presente pesquisa teve como objetivo estudar a percepção de uma amostra populacional sobre o termo resiliência e suas implicações relacionadas ao cotidiano dos cidadãos. Foi proposto um projeto conceitual para tornar resiliente uma região da cidade de Londrina, PR, periodicamente atingida por essa calamidade. Ele consiste no rebaixamento de um parque ribeirinho de forma a criar uma bacia de amortecimento para qual a água escoe em dias de chuvas fortes, de modo que a água seja impedida de chegar às vias e casas da região. A percepção da amostra foi obtida a partir de questionários aplicados in loco. Os dados coletados indicam que 54% dos entrevistados dispõe de conhecimento prévio sobre resiliência, e destes, 46% possuem menos de 30 anos. Posicionaram-se a favor da proposta 87% dos entrevistados, sendo que os prejudicados apresentam maior tendência a aderir à ideia. O principal prejuízo é a dificuldade de circulação em dias de alagamento, declarado por 46% da amostra. O conhecimento teórico do termo resiliência é maior entre os mais jovens, entretanto, não está atrelado com seu desempenho na prática, pois moradores e comerciantes da região que não conheciam o vocábulo apresentam medidas resilientes desenvolvidas pela necessidade de adaptação. Sugestões registradas pelos participantes podem ser úteis para um estudo mais aprofundado sobre as maneiras de tornar um local ribeirinho resiliente às inundações.

Palavras-chave: Resiliência. Inundação. Percepção da população. Apoio público.

[1] Graduanda, Depto. Construção Civil/CTU, UEL, Londrina, Praná, Brasil, E-mail: analuiza.thomal@gmail.com
[2] Ms., Depto. Construção Civil/CTU, UEL, Londrina, Praná, Brasil, E-mail: danielacastro@uel.br
[3] Ms., Depto. Construção Civil/CTU, UEL, Londrina, Praná, Brasil, E-mail: tvinicius.louro@uel.br
[4] Profa. Dra., Depto. Construção Civil/CTU, UEL, Londrina, Praná, Brasil, E-mail: heliana@uel.br
[5] Prof. Dr., Depto. Construção Civil/CTU, UEL, Londrina, Praná, Brasil, E-mail: cprado@uel.br

Introduction

According to a report released by the United Nations, the world's urban population jumped from 30% in 1950 to 55% in 2018; this rate is expected to reach 68% in 2050 (BOCQUIER, 2005), which indicates that cities will tend to have increasingly larger populations. Urbanized areas represent a major challenge for urban planners, especially when it comes to the emergence of risks and vulnerabilities. Among the 1,146 cities with more than 500,000 inhabitants in 2018, at least 679 were exposed to the occurrence of some type of natural disaster, such as cyclones, floods, droughts, earthquakes, landslides and volcanic eruptions (ONU, 2018).

With regard to floods, they are phenomena that occur when a watercourse receives a volume of water, due to rain or runoff, greater than it can contain. During the urbanization process of large cities, these watercourses have been piped in order to free up space for the construction of urban infrastructure, such as streets and avenues. Over time, it was possible to observe that these pipes had negative effects, which resulted in floods and the destruction of houses, shops, leisure areas, problems in the transport system, etc., thus generating socioeconomic and environmental losses (SANTIS; MENDONÇA, 2000). Additionally, due to climate change, floods have been occurring more frequently and are currently responsible for one third of the economic losses caused by all-natural disasters (WEHN *et al.*, 2015).

As for piping, according to Tucci (2007), the impact of increasing the maximum flow on the rest of the basin is usually not assessed by designers or required by the municipality. After a work is executed, the available solutions, such as piping, dikes with pumping, reversals and dams, is costly for public authorities. When the latter do not control urbanization or do not expand the macrodrainage capacity, floods become more frequent, resulting in social and economic losses (SANTIS; MENDONÇA, 2000).

The problem becomes even greater when the margins of waterbodies are occupied by groups of people. This occupancy represents an increase in the amount of waste disposed of in inappropriate places, which ends up obstructing water drainage places (manholes and storm drains). According to Santis and Mendonça (2000), the disorderly and predatory occupancy of riverside areas causes the impermeabilization of drainage basins, which increases water flow during rains and, consequently, the likelihood of the place being hit by floods. Therefore, public authorities need to implement structural measures (engineering work) and non-structural measures (regulating land use and occupancy; implementing alert systems; promoting environmental education). These measures are key for the city to become resilient to flooding. Structural measures must not be taken without non-structural measures being implemented in parallel. The latter can be promoted independently by means of social-interest actions that seek to change the population's behavioral patterns (CANHOLI, 2014).

As for resilience, it can be defined as the capacity of a system to absorb a certain impact and have its original function restored. This term is used in several fields, such as psychology, social sciences, materials science, infrastructure, and others.

Researchers from the MCEER – Multidisciplinary Center for Earthquake Engineering Research – (BRUNEAU *et al.*, 2003), proposed the R4 system, which is a set of characteristics that compose the properties of resilience:

- **Robustness**: ability to withstand a stress level without significant damage;

- **Redundancy**: existence of substitute systems, such as alternative routes and transport, in the specific case of mobility;

- **Resourcefulness**: ability to diagnose and resolve problems in order to restore functionality;

- **Rapidity**: capacity to avoid prolonged disruptions; it depends on the other three. Thus, a resilient transport network reduces the likelihood of failures, their consequences and recovery time.

The diagram in Figure 1 organizes the main causes and consequences of urban floods, in addition to suggesting possible solutions.

The term resilience can also be used when it comes to the transport system, in order to identify its weaknesses and how they should be resolved. Structural or operational measures can be implemented to reduce the impact caused by climate-related events on urban mobility (LEOBONS; CAMPOS; BANDEIRA, 2017).

A transport system deemed resilient has the ability to adapt to the adversities of the environment in which it is inserted, in such a way that the impacts caused by unexpected events do not affect the proper functioning of the system. Climate-related phenomena and an increase in the fleet of individual motor vehicles are examples of factors that can generate an imbalance in the transport system (MARTINS; SILVA, 2017).

Figure 1 – Mind map of urban flooding problems.
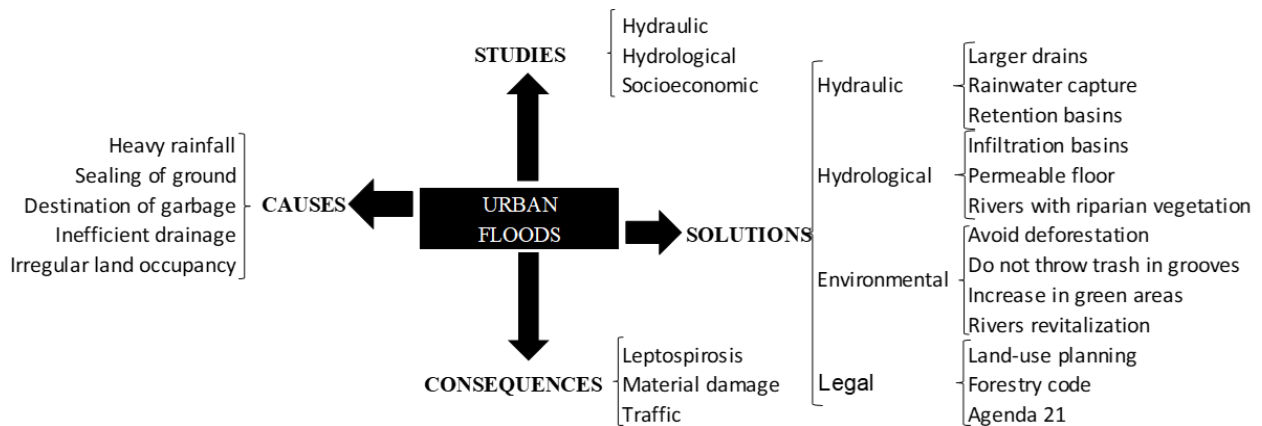
Problems referring to urban mobility can affect the economic, educational, health and leisure sectors, to name a few. The impossibility of commuting causes delays for business owners and students, prevents residents of the affected region from carrying out their daily activities, and reduces the flow of people in shopping areas and nearby establishments. The faster the system resumes its original function, the less damage is done, and the fewer the people harmed. A solution to mitigate the impact on vehicles is the creation of an alternative route that does not significantly increase travel time. In their turn, the residents and business owners of the region have no alternative but to wait for the region to return to its natural state. In this case, resilience is worked on by seeking means for the environment to solve the problem as quickly as possible or absorb it completely so that the population is not affected.

Considering the context presented, the theme of urban resilience needs to gain ever-increasing importance so that our cities can be prepared for more frequent climate-related events of major impact. Thus, this research sought to analyze the perception of a population sample about the concept of resilience applied to urban areas. In addition, the interviewees were presented with a conceptual project for the region of the Igapó Lake Park, Londrina-PR, which is periodically hit by floods. This project consists of lowering an area to drain the water and not prevent activities from being developed in these spaces.

Methodology

The research was developed from the following steps: i) Study site selection and characterization; ii) Designing of the conceptual project; iii) Survey preparation and application; iv) Analysis through Pearson's chi-squared test.

Study Site Selection and Characterization

The region selected for the conduction of the study was the Park of Igapó Lake, which is part of the drainage microbasin of Cambé Creek and is located in the city of Londrina-PR. The site was chosen for its strategic position in the urban fabric and its use, which can be considered intense due to the number and diversity of its users, mainly in search of a better quality of life (BORTOLO, 2010). Igapó Lake is known as Londrina's "postcard", and its complex is an area frequently visited by its residents, besides attracting many tourists (LORENZO, 2011).

Igapó Lake, officially inaugurated on December 10, 1959, was designed as a solution to the drainage problem of Cambezinho Creek. The solution was to dam Cambé Creek. Igapó I, II and III then emerged (INSTITUTO DAS ÁGUAS DO PARANÁ, 2015). The Igapó Lake complex is a place of great social and environmental interest in Londrina and has already received numerous proposals for revitalization and desilting of its four divisions. However, the cost and high environmental impact did not allow some alternatives to be carried out. Therefore, it would be more effective to identify and prevent more sediment from being dumped into the lake by resorting to inspection and awareness.

The region is relatively dense; the land is mainly used for residential purposes and has an urban infrastructure composed of leisure areas, access roads, as well as services in the healthcare, education, hotel and retail fields. The zoning of the region around the Park is ZC-6; the zone is characterized by articles 105 and 106 of Law 12.236/2015 as one that aims to stimulate the concentration of local commerce meant for serving nearby residents (LONDRINA, 2015).

The region is subject to flooding in times of heavy rains, blocking certain streets. Figure 2 shows Londrina's precipitation data (mm) recorded in 2018 by the Agronomic Institute of Paraná - *Instituto Agronômico do Paraná* (IAPAR). It is worth noting that January represents the rainiest month, with a precipitation greater than that for a quarter of the entire year. In addition, according to IAPAR data, there was heavier rain on only 4 of its days, totaling a precipitation of 223 mm. These days are more prone to floods. A relevant piece of data not collected by the institute is the length of the rain, since the shorter the rainfall time, the less water the system can absorb, which increases the possibility of a flood.

Along with high rainfall levels, soil impermeabilization, lack of environmental education and drainage problems are pointed out as causes of the problem as well. Buildings are responsible for decreasing the percentage of infiltrated water, which can lead to a greater accumulation of rainwater on transport roads. Another factor is the obstruction of manholes and storm drains, which raises the percentage of water drained on the streets. Figure 3 shows the situation of a street around the Park in the late afternoon of March 15, 2019, when 16.2 mm of rain fell, according to IAPAR records.

Residents and business owners in the sample are on Prof. Joaquim de Matos Barreto street, on Charles Robert Darwin street, which is parallel to the former, and on Bento Munhoz da Rocha Neto street. This location, represented in Figure 4, was chosen prior to the field research because it was inferred to be the most affected by the floods.

Floods near the Park of Igapó Lake may result in the obstruction of Prof. Joaquim de Matos Barreto and Bento Munhoz da Rocha Neto streets, which negatively impacts urban mobility in the city. These streets are used by Londrina's residents commuting to their work and study places. Prefeito Faria Lima street, which crosses the two streets mentioned, is also on the public transport route of the city, which is responsible for many urban travels. According to Leobons, Campos and Bandeira (2017), an interruption in mass transportation services caused by climate-related events or anthropogenic factors can create mobility problems around Igapó Lake Park.

As long as a large amount of time does not pass, it is possible to change the public transport route. However, businesses in the affected region become inaccessible in times of heavy rain. Gyms, beauty salons, bars, offices and other establishments suffer great losses when they close their doors during business hours. Besides the transport-related problem, the water that crosses Professor Joaquim de Matos Barreto street can damage the residents' houses and vehicles and prevent the access or exit of those who do not have a second entrance through the parallel street. Another portion of the affected population is the one that uses the Park for leisure and sports, one of the main social functions of the place.

Designing the Conceptual Project

The conceptual project was used to present a proposal to make the area near the Park of Igapó Lake more resilient to flooding. The alternative found was to increase the water accumulation capacity of the buffer basin of the Igapó Lake Park in order to mitigate the floods that flow into the urban area. The proposal does not change leisure areas, in quantity and quality.

The project was presented on a printed A4 paper sheet and displayed an illustration of all the steps necessary to carry out the work.

Survey Preparation and Application

Three types of surveys were developed to be applied at the study site. The objective was to capture people's perception of the addressed topic. The types of surveys targeted local residents, regulars and business owners. All types had questions about the respondents' socioeconomic characteristics and about the proposal presented. Moreover, it included questions about the usual mode of transportation of the respondents and how often they used the streets around the Park. In addition to the questions, the respondents were invited to leave a free comment at the end, which enriched the survey data.

The surveys meant for the residents contained questions about number of residents, the characteristics of their properties, and the impact that floods have on their lives. The surveys for business owners included questions about the average number of workers and of customers that they serve, and about the extent of the impact that floods have on their commercial activities. As for the surveys targeting the general public that goes to the Park of Igapó Lake, they contained questions about the impact that floods have on their daily trips to the Park or through surrounding streets. The survey was applied by means of a printed A4 paper sheet during five periods of different days, and with the help of three volunteer interviewers. Besides the surveys, the interviewers also had an image of the flooded site and the conceptual project to present to the respondents.

Figure 2 – Londrina's rainfall data (mm) recorded in 2018 by the Agronomic Institute of Paraná (IAPAR).
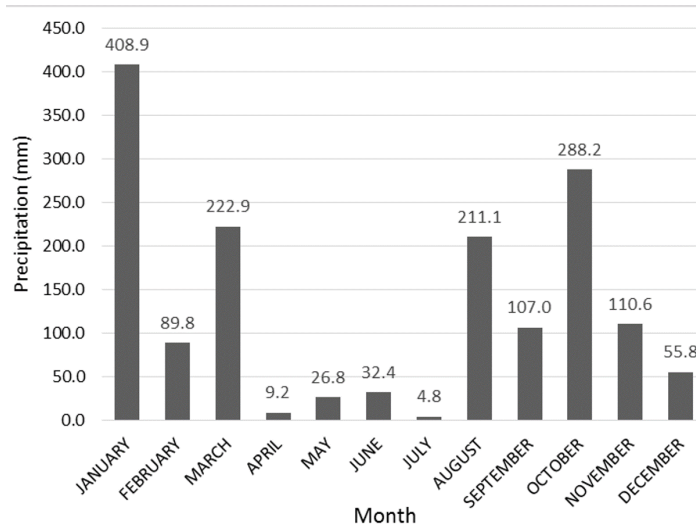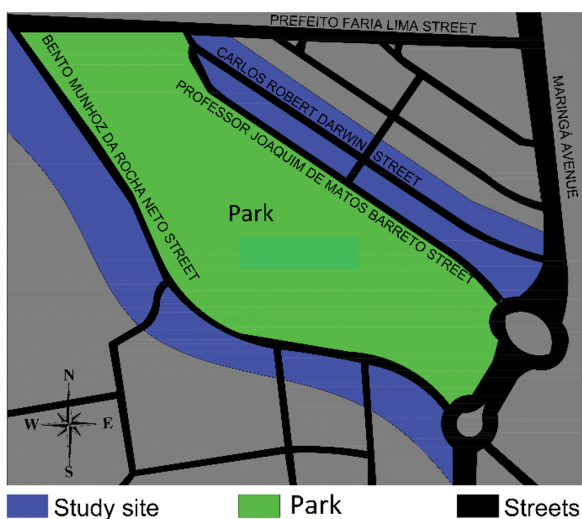

Source: IAPAR (2020).

Figure 3 – Flooding on Prof. Joaquim de Matos Barreto street on 15/03/2019.

Source: The authors.

Figure 4 – Study site.

Source: The authors.

Analysis through Pearson's Chi-Squared Test

To check whether there are influences between variables, the data were analyzed through Pearson's chi-Squared Test. The analyzed data were made up of independent variables, namely: prior knowledge of the concept of resilience, prior experience with flood events in the studied region, favorable or contrary stance on the execution of the project to make the region resilient to flooding, contribution or no contribution to the project, losses or absence of losses with the floods, and socioeconomic data.

To apply the test, a significance level of 5% was adopted. The hypothesis is that the two categories tested are not correlated; it is rejected when the value calculated through the test is greater than the tabulated value, indicating a correlation between them.

Results

The results of this survey are presented in this section in the following order: i) respondents' socioeconomic profile; ii) survey answers; and iii) chi-squared test application.

Respondents' Socioeconomic Profile

The interviewed sample was composed of 142 people, with 72% of regulars, 10% of business owners and 18% of residents. Regarding age, the youngest age group prevails, which can be seen in Table 1. Concerning gender, the sample comprised 52% of men and 48% of women. Their economic classification was determined in accordance with the Brazilian Economic Classification Criterion of

149

the Brazilian Association of Research Companies - *Associação Brasileira de Empresas de Pesquisa* (ABEP, 2018). The ABEP relates each social class to an average household income. The economic class with the highest number of representatives was B2, which, according to the ABEP criterion, has an average family income of 5,363.19 BRL. The distribution of respondents by social class is displayed in Table 2.

For the control of the respondents and of the population sample in relation to the total, the region with the greatest concentration of residents and business owners near the Park was drawn, as shown in Figure 5. In addition to these places, two women who sell sugarcane juice on the sidewalk of Professor Joaquim de Matos Barreto street were interviewed, and so were three out of eight businesses located southwest of the Park. Therefore, 46% of the households and 54% of the commercial establishments were interviewed in the study region.

Survey Answers

Just over half of the respondents, 53.5%, have heard about the concept of resilience in several fields. The greatest responsible for spreading the word are the fields of Psychology and Social Sciences, as shown in Figure 6. In this sense, resilience is related to one's individual preparation to deal with life's adversities. Analyzing the groups, regulars are those who have the most knowledge of the term, as seen in Table 3, with 59.8% of the respondents stating that they already knew about resilience.

The stance on the conceptual project presented differed among the groups of residents, business owners and regulars. The group of residents was the most resistant to the building of the buffer basin at the lake's Park, as one can see in Figure 7.

Several variables contributed to this stance among the residents. This group is mostly composed of older people who have lived in the place for many years. In the course of time, many proposals aiming at rendering the site resilient to flooding have been presented. However, none of them succeeded. This was one of the reasons that some of the respondents gave as to why they do not support the conceptual project. Another factor identified is that most households have been adapted to mitigate the losses caused by floods, which shows that the residents have raised their resilience levels in the face of the adversities, even though only 38.5% of these people knew about the term resilience. This adaptation proved to be positive for the residents,

so much so that they are the group with the least significant history of flood-related losses, as shown in Table 3. Another reason that makes residents resistant to the implementation of the project is the absence of a sewage system in the region. Several residents pointed out the need to prioritize this problem over the proposal to minimize flooding. As for the business owners' opinion, everyone was for the implementation of the proposal. This can be explained by the high loss rates for this group, as shown in Table 3. Regulars also showed a significant percentage of history of losses, representing 67.6%, and were favorable to the implementation of the proposal.

With respect to the possibility of contributing and how to do so, the residents once again stood out as the group most resistant to contributing in any way to the execution of the work, as displayed in Figure 8. The group of business owners was the most willing to cooperate in some way, for being the most affected one. Among regulars, high rates of contribution were found too, with 15% of the respondents in this group stating that they would contribute financially, 54% through volunteering, and 8% by helping in both ways. In general, 33% of the respondents claimed not supporting the proposal by any means. The main explanation for this stance was that they believe that the duty is solely the city's. Nonetheless, 49% of the respondents said that they support the execution with volunteer work, 15%, through financial donations, and 3%, in both ways.

Figure 9 shows that 91 out of the 142 interviewed people claimed having faced problems related to urban mobility in that place. This is the main form of hindrance experienced by the respondents, with restricted flow of people in shops, residents having trouble arriving at and leaving their houses, and the impossibility of reaching the Park being the main variables that make up this item. Other types of hindrances identified in the region can also be seen in Figure 1. Most of the regulars use the Park for recreational purposes and sports, which may explain the fact that the second biggest hindrance concerns this portion of the sample. The number of answers to this question is greater than the number of respondents because the latter could select more than one alternative.

By collecting information from the respondents, it was possible to delimit the space effectively affected by the presence of water when it reached the buildings or the street in front of them, which is highlighted in Figure 10.

Table 1 – Distribution of respondents by age group.

Variable	Values				
Age Groups (Years)	< 30	30 to 39	40 to 49	50 to 60	> 60
	34%	20%	19%	11%	16

Source: The authors.

Table 2 – Distribution of respondents by social class.

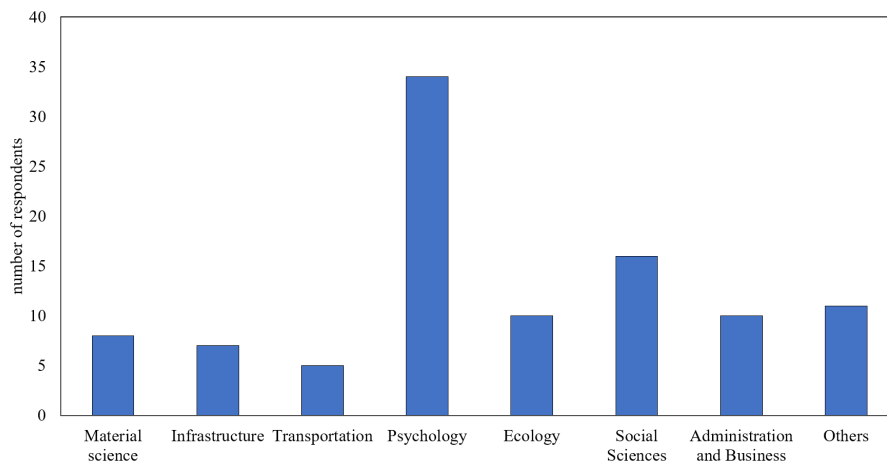| Variable	Values					
Social class	A	B1	B2	C1	C2	D
	23%	13%	35%	20%	7%	2%

Source: The authors.
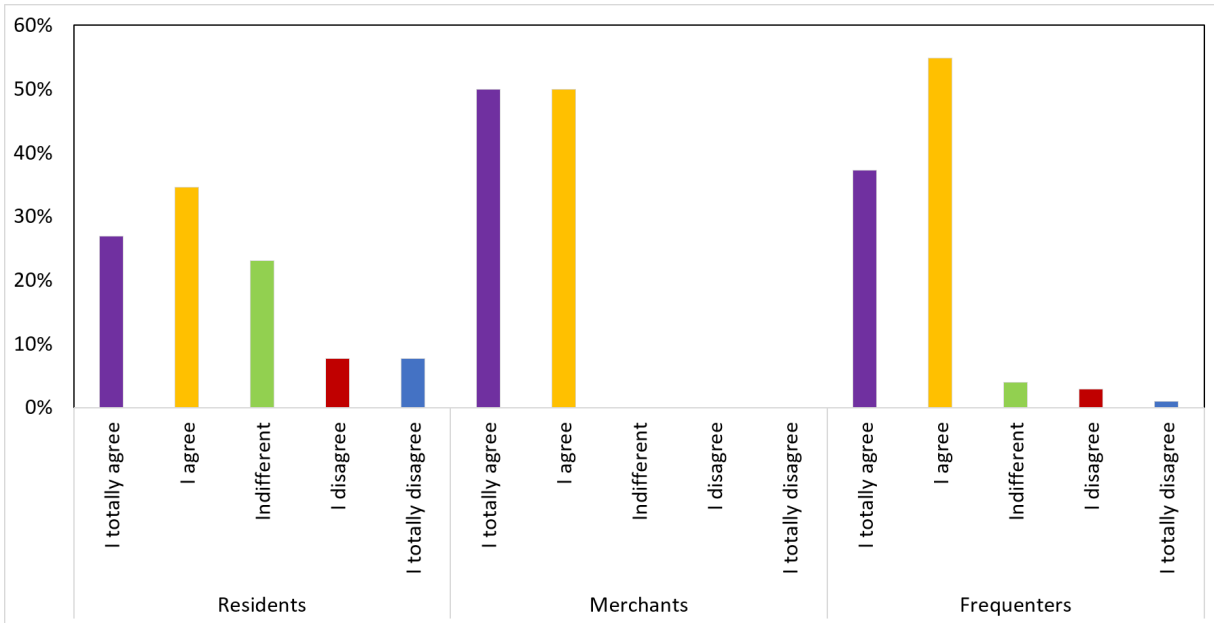
Figure 5 – Study site type.

Source: The authors.

Figure 6 – Field in which the respondents have heard about resilience.

Source: The authors.

**Figure 7 –** Respondents' stance on the proposal presented, separated by group.

Source: The authors.

Table 3 – Respondents' knowledge about resilience and history of loss by group.

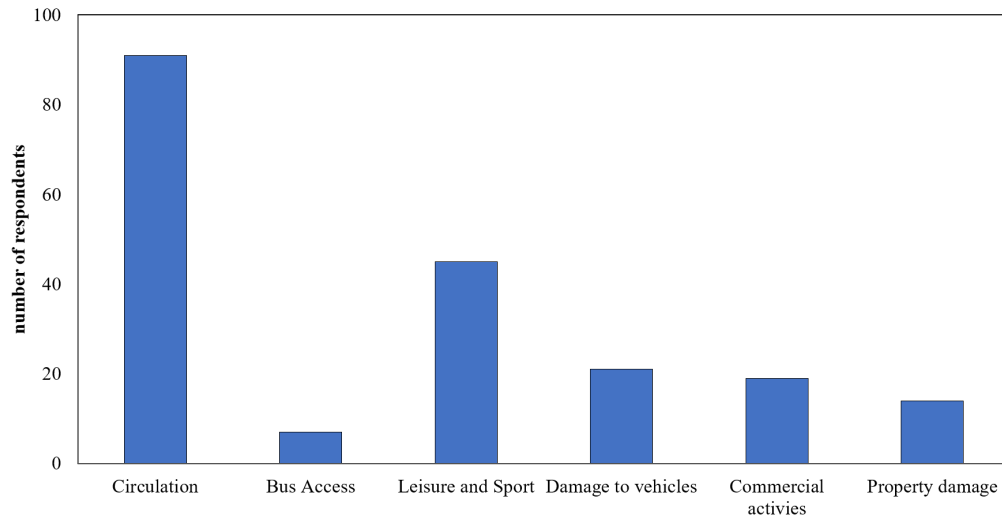|	Respondents	Yes
Knowledge of the term		
	Residents	38.5%
	Business owners	35.7%
	Regulars	59.8%
History of loss		
	Residents	53.8%
	Business owners	92.9%
	Regulars	67.6%

Source: The authors.

Figure 8 – Display of the respondents' contribution to the execution of the work, by group.
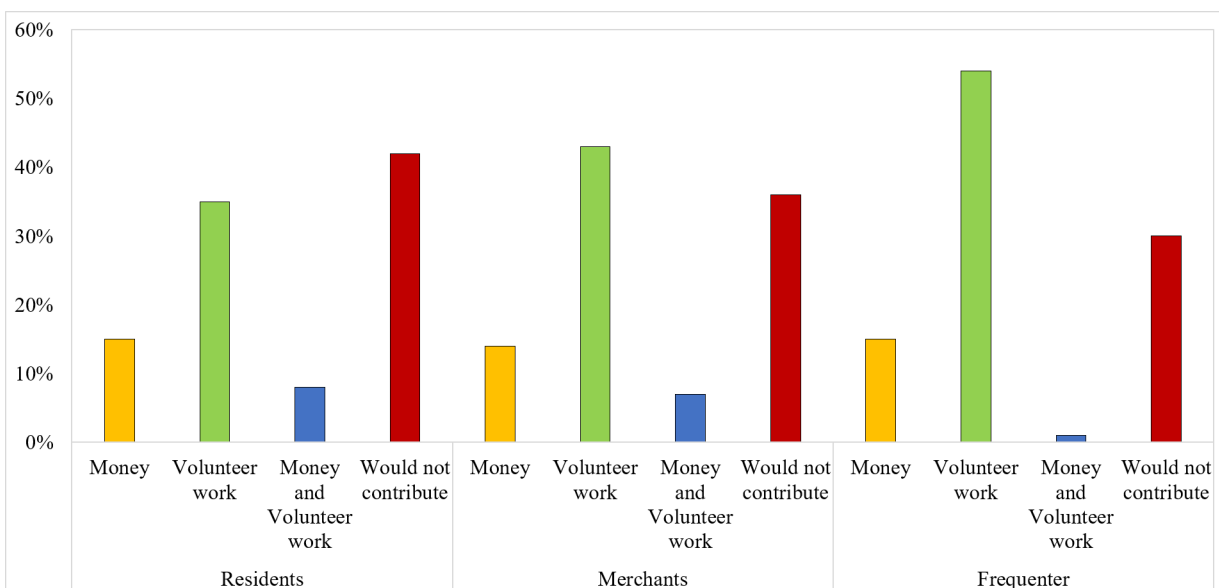
Source: The authors.

Figure 9 – Types of hindrances experienced by respondents at the study site.

Table 4 – Chi-squared test result.

	Perception about resilience		Stance on the project		Contribution	
	x^2c	x^2tab	x^2c	x^2tab	x^2c	x^2tab
Perception about resilience	-	-	6.51	9.49	1.33	5.99
Perception about floods	0.51	3.84	2.46	9.49	0.86	5.99
Loss	0.05	3.84	14.20	9.49	9.77	5.99
Gender	0.65	3.84	5.71	9.49	9.50	5.99
Age	14.72	9.50	38.24	26.03	21.35	15.30
Economic Class	8.73	11.07	36.88	31.41	15.65	9.49
Group	5.84	5.99	21.56	15.30	2.15	9.49

Figure 10 – Region effectively affected by the floods.

Chi-Squared Test

The results obtained using the chi-squared test are summarized in Table 4. The variables that showed correlation are highlighted in yellow. It is possible to notice that the only variable that correlated with knowledge of the concept of resilience is age. A possible explanation to this is the fact that resilience is a term that has been structured and defined recently, which facilitates the access of younger people, especially in the educational context. Age was the only variable that correlated with all analyzed items. As in the previous item, younger people were also more favorable to the execution of the project and willing to contribute in some way to its realization.

As for favorable or contrary stance on the project, some variables, in addition to age, correlated as well, such as: history of loss with floods, economic class, and interviewed group. Therefore, those people who are or have

been affected by the floods tend to stand in favor of the project. Furthermore, higher social classes presented a greater rate of acceptance toward the project.

Regarding the respondents' contribution, history of loss and social class are variables related to intention to contribute, with the most affected people and those from higher social classes being more willing to contribute to the project. Thus, it was possible to notice that the index of indifference among those who have never felt the impacts of floods in the area is significant. As for gender, women were more likely to cooperate in some way, which corroborates the correlation between gender and contribution.

Conclusions

The sample that answered the survey is socioeconomically characterized by a younger age group, balanced as to gender, and by higher social classes. It is deemed representative for comprising approximately half of the residences and businesses in the study region. Bearing in mind that this audience is limited, the majority of the respondents are regulars.

Analyzing the survey answers, it is possible to observe that most of the respondents know about the term resilience, and the main field responsible for its dissemination is Psychology. Additionally, most of the sample declared to be in favor of the presented project. The group of business owners was the most supportive to the proposed project, the group of residents was the most resistant, while the group of regulars stood in between both.

The resistance of the residents can be explained by the fact that most of them have already adapted to the occurrence of floods with resilient attitudes, and by the average age group of the region's inhabitants, who have lived in the area for longer and know about past projects that were not effective in solving the situation. Another point to be highlighted is that most of the interviewed residents are from Charles Robert Darwin street and, because the water of the floods does not reach that street, the majority claimed no losses. It is noticeable that the absence of a sewage collection system in the region overshadows the importance of containing floods for some of the respondents, because it is seen as the current priority.

The means of contribution reported most often was volunteer work. In addition to the realization of the conceptual project, this aid could be useful for promoting educational events, which could be employed as a tool to raise awareness in the local population or to raise funds. The predominant explanation among those who answered that they would not help in any way is that the city government should solve the problem without the help of residents and business owners.

Among the impacts of floods on the respondents' lives, the most frequently mentioned was their difficulty in moving around in the region. As previously stated, the streets around the Park are roads used daily by many business owners, college students and those who go to the Park for leisure practices. Due to the socioeconomic loss, urban mobility in a system exposed to the risk of flooding was identified as its main vulnerability, affecting the resilience of the location.

In conversations with the interviewees, matters such as construction time and cost, as well as the extra capacity acquired by the basin were frequently questioned, usually by people who were suspicious of the effectiveness of the work. Therefore, a detailed and in-depth project would offer a greater degree of reliability and encourage a greater collaboration and interest from citizens.

The chi-squared test indicates that the main correlation factor is the age of the respondents, as it is the only variable linked to the other three studied: perception of resilience, stance on the project, and contribution.

The statistical test showed that the 'stance on the project' variable does not correlate with the population's knowledge of resilience or of the floods at the Park. Because it is a term that was structured and defined scientifically around the 1950s and 1960s in the last century, younger people know more about the meaning and possible implications of the concept. However, it was identified that most residents and business owners at the study site, despite not knowing the term, practice some measure that reduces the impact of floods on their lives, such as raising houses, the existence of another exit on the back street, and staying at home on days at risk of heavy rain. Thus, the theoretical knowledge of resilience is not linked to its actual use.

On the other hand, the test proves that the stance and contribution toward the project correlated with the respondents' losses, which shows that those who are affected in some way tend to be favorable to the project. The test also indicated correlations between stance and contribution toward the project with the respondents' age and social class. The surveys confirm this analysis, as respondents over 50 years old presented low contribution rates, as to both money and volunteering, whereas among the younger

one's rates were higher. Furthermore, it can be observed that the social classes referred to as "A" and "B" were the most willing to collaborate in the execution of the work. The correlation between contribution and gender indicates that women were more receptive to the project. Finally, the correlation between stance and group corroborates the analysis carried out about the resistance of residents against the presented project.

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