

WHEN THE WATERS RISE: THE FINANCIAL IMPACTS OF FLOODING ON SMALL BUSINESS IN THE SÃO PAULO METROPOLITAN REGION (RMSP)

1 INTRODUCTION

The rapid growth of micro, small, and medium-sized enterprises (MSMEs) in Brazil reflects a dynamic entrepreneurial environment, yet these businesses remain highly vulnerable to climate risks, especially floods in urban areas. This study examines the financial impacts of flooding on MSMEs in the São Paulo Metropolitan Region (RMSP), where intense rainfall causes material losses, business interruptions, and recovery challenges. In line with Brazil's climate policies (Law No. 12,187/2009; Law No. 14,904/2024), the research underscores the need for accessible insurance solutions. Parametric insurance emerges as a promising tool, ensuring rapid compensation for businesses unable to withstand prolonged revenue interruptions. The analysis also considers the role of governments in supporting resilience and adapting international experiences, such as Italy's mandatory disaster insurance, to reduce socioeconomic impacts in Brazil.

2 THEORETICAL FRAMEWORKS

Micro, small, and medium-sized enterprises (MSMEs) drive Brazil's economy and have expanded rapidly in recent years; however, they remain highly vulnerable to climate-related risks in urban areas prone to extreme weather events. Limited access to reserves and traditional insurance increases business fragility, whereas parametric insurance offers rapid, objective compensation, which is crucial for enterprises facing prolonged disruptions.

2.1 THE RELEVANCE OF SMALL BUSINESS IN BRAZIL

In 2023, Brazil's TEA reached 33.4%, or 47 million entrepreneurs, with established firms rising from 8.7% in 2020 to 13.2% in 2024, ranking 6th worldwide; 48 million Brazilians also intend to start a business, placing the country 5th globally (Agência Sebrae de Notícias, 2023). MSMEs account for 99% of Brazilian firms (Sebrae, 2013) and play a key role in jobs and income. GEM (2013) showed a 15% TEA, with 52% of new businesses led by women. Female entrepreneurship faces barriers to credit (Santos da Silva & Mainardes, 2016), and competencies such as management and networks are critical (GEM, 2015; Barazandeh et al., 2015). Access to finance remains costly (Sebrae, 2016), heightening vulnerability in crises. Floods disproportionately affect small firms, mainly through lost profits (Santos, 2013). Adaptation studies remain scarce (Hankinson, 2018), and compound disasters amplify risks, though diversification and digitalization show potential (Cann et al., 2025).

2.2 FLOOD RISK AND CLIMATE EXPOSURE: CHALLENGES FOR MPMEs

The São Paulo Metropolitan Region (RMSP), with over 20 million inhabitants, is highly exposed to floods due to dense urbanization, impermeable soils, and weak drainage infrastructure (Nobre et al., 2011; Marengo & Alves, 2021). Heavy summer rains cause direct losses—damage to assets, inventory, and infrastructure—and more severe indirect losses such as business interruption. Micro and small enterprises, dominant in the RMSP, are particularly vulnerable given limited credit, scarce insurance, and reliance on local clientele (Santos, 2013; Perez, 2020; Wagner, 2025). Informality further heightens fragility, as workers lack contractual protection and operate in precarious spaces (Wagner, 2025). Adaptation policies, including the National Climate Change Adaptation Plan (MMA, 2016) and Law No. 14.904/2024, promote financial instruments such as parametric insurance, which provides rapid liquidity (Vieira, 2025). Literature stresses that lack of adaptation threatens insurability (Herweijer et al., 2009), while insurance innovation and wider penetration enhance resilience (Maynard, 2008). The literature review shows opportunities to overcome this challenge, as presented in Frame 1.

Frame 1. Insurance solutions and government support for small businesses in the face of climate-related disasters

Country/Region/ Paper	Proposed Solution	Role of Insurers	Role of Government
United Kingdom/EU (Herweijer, Ranger, & Ward, 2009)	Parametric insurance and risk-based pricing to encourage prevention and provide rapid post-event liquidity	Development of innovative products (parametric), risk-based pricing, and prevention communication	Investment in flood defenses and integration of adaptation policies with the private sector
Caribbean (Maynard, 2008)	<i>Caribbean Catastrophe Risk Insurance Facility (CCRIF)</i> : collective risk pool for immediate liquidity	Provide parametric coverage triggered by objective events, sharing risks across countries	National governments contribute resources to the CCRIF and coordinate rapid access to emergency financing
India (Mumbai) (Hankinson, Kuruppu, & Schaer, 2018)	Financial and operational structures for resilience in urban MSMEs	Development of microinsurance and technical support for businesses in critical areas	Local public policies for incentives, international partnerships, and subsidies for urban resilience.
Australia and developed countries (Sadeghi, 2022)	Simplified continuity plans and subsidized insurance premiums for MSMEs in risk areas	Provide accessible products tailored to the size of businesses	Subsidize insurance premiums, promote access to climate information, and train small businesses

Source: authors.

Evidence shows rising MSME engagement with ESG practices. A national survey found that 91% of firms value adopting them, yet only one-third face external pressure, revealing limited institutionalization of climate and resilience agendas (Sebrae, 2023). Similarly, Sadeghi’s (2022) review highlights that literature on small business continuity under flood risk remains fragmented but can be grouped into four axes: continuity planning, adaptation measures, resilience structures, and recovery strategies. In summary, empirical and theoretical evidence converges into three main findings, as displayed in Frame 2.

Frame 2. Key Findings on Small Business Vulnerability and Adaptation to Floods

Dimension	Description	References
Vulnerability to floods	Small businesses are disproportionately vulnerable to floods, mainly due to business interruption, limited access to credit, and lack of structural preparedness.	Santos (2013); Sebrae (2016); GEM (2013, 2015)
Female entrepreneurship	Female entrepreneurship emerges as a significant force in Brazil but faces additional restrictions in access to financing and institutional support, reinforcing gender inequalities in business resilience.	Santos da Silva & Mainardes (2016); GEM (2013, 2015)
Innovative instruments	The adoption of innovative instruments, such as parametric insurance and ESG practices, appears promising to accelerate recovery and enhance MSME resilience to climate-related disasters.	Herweijer, Ranger, & Ward (2009); Maynard (2008); Vieira (2025); Sebrae (2023)

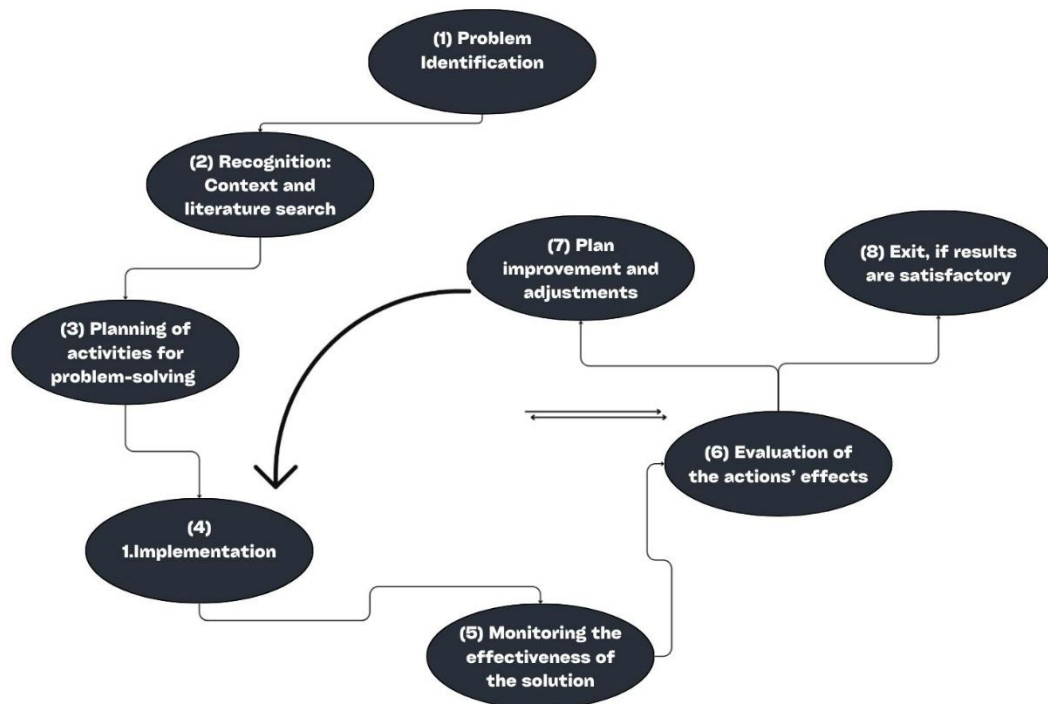
Source: authors.

These findings reinforce the need for integrated adaptation policies that combine financial instruments, gender inclusion, and sustainability to strengthen the flood response capacity of urban MSMEs.

3. METHODOLOGICAL PROCEDURES

This study presents a preliminary mapping of the effects of extreme rainfall and flooding on small businesses in the São Paulo Metropolitan Region (RMSP). The research followed an action research approach, guided by the eight steps proposed by Costa, Politano, and Pereira (2014) which highlighted the need for eight steps, outlined in Figure 1 below.

Figure 1. Step-by-step action research



Source:: Remade from Costa, Politano, and Pereira (2014)

3.1. Data Collection:

Data was collected through student-led interviews with entrepreneurs in flood-prone areas, mainly in Osasco, using an anonymous public opinion survey. Between May and June 2025, students from UC4950 – Financial Mathematics (EPPEN/Accounting) organized in small groups (pairs to quintets) conducted fieldwork, administering an electronic form to local small businesses including the following information: (i) business identification (type of activity and zip code); (ii) flood history; (iii) Material losses; (iv) lost profits; (v) availability of insurance and (vi) Perceptions of risk and resilience.

This survey was designed not only to map flood impacts on small businesses in the São Paulo Metropolitan Region (RMSP) but also to offer students applied learning. By engaging with local entrepreneurs, they contextualized theory, built research skills, and understood real-world challenges of vulnerable firms. The activity also introduced potential career paths in urban planning, risk management, sustainability, and public policy, linking academic training to professional practice.

4 ANALYSIS AND DISCUSSION OF RESULTS

The interviews confirmed MSMEs' vulnerability to floods, with reports of major financial losses, long business interruptions, and even closures across RMSP areas such as Barueri, Osasco, São Paulo, Franco da Rocha, and Itapevi/Jandira. Businesses without insurance faced the most severe impacts: a handicraft store in Barueri lost R\$120,000 in stock and closed; a beverage vendor in Jardim Pantanal endured six floods in two years, with losses of R\$7,000 per event and three months of downtime. Others, including ice cream shops, pet shops, and clothing stores, suffered smaller yet

recurrent losses. Some owners sought self-adaptation—such as barriers in Osasco after R\$30,000 in damages—but policies later contracted excluded climate coverage. By contrast, insured firms showed greater resilience: a shopping mall with CHUBB reduced downtime to 15 hours, a market in Osasco quickly replaced equipment, and a fitness store in Brás recovered R\$75,000 per event with Itaú Insurance (Table 1).

Table 1 – Comparison of Interviewed Businesses

Business / Location (ZIP)	Occurrence/Frequency	Financial Impacts	Climate/Parametric Insurance
Pet Shop – Osasco (06122-170)	8 times in 2 years (~4/year)	R\$980 (Year 1); R\$530 (Year 2); damages to furniture, stock, structure	None
Market – Osasco (06013-006)	~1.5 invasions/year	Damages to furniture, equipment, stock, structure; values not measured	Yes (activated)
Beverages & Grocery – Osasco (06010-030)	1 event in 2 years	R\$30,000 losses + 2 days downtime	Yes (Bradesco, no climate coverage)
Clothing – South Zone SP (– absent –)	Frequent (summer)	R\$2,000 in 2 years + 5 days downtime	None
Shopping Mall – North Zone SP (02240-000)	5 events in 2 years	Material losses + 14.3% of expected sales; 15h downtime	Yes (CHUBB Insurance)
Beverages – Jardim Pantanal SP (08072-220)	6 events in 2 years	R\$7,000 per event + R\$10,000 lost revenue; 3 months downtime	None
Handicraft – Barueri (06401-160)	2 events in 2 years	R\$120,000 in stock + R\$12,000 lost revenue; 4 days downtime	None
Ice Cream Shop – Franco da Rocha (07802-190)	Once a year (January)	R\$6,500 equipment/structure + R\$5,600 lost revenue; ~1 week downtime	None
Fitness Clothing Store – Brás (03011-010)	~3 times/year (6 in 2 years)	R\$75,000 goods + R\$35,000 lost revenue per event; ~2 days downtime	Yes (Itaú Insurance)
Real Estate – Mirandópolis, Av. Jabaquara (– absent –)	3–4 events/year	R\$25,000 (Feb/24) and R\$18,000 (Jan/25); lost revenue R\$30–35k and R\$20k; 3–4 days downtime	Initially without flood coverage; later Porto Seguro (climate)
Ice Cream Shop – Vila Mercedes, Itapevi/Jandira (– absent –)	3 events in 2 years	No material losses; R\$50–150/day lost revenue	None
Jewelry Shop – Osasco (06013-003)	+10 events in 2 years	R\$10,000 per occurrence in goods; no shutdown	None
Restaurant – Carapicuíba (– absent –)	~4 events/year	No material losses; extra cleaning costs; daily revenue lost	None
General Store – Osasco, Rua Antônio Agú (06013-003)	+10 events in 2 years	R\$20,000 per occurrence goods/structure; lost revenue not estimated	None
Bearing Shop – Pompéia, SP (05024-030)	Up to 5 times/year (Dec–Jan)	R\$5,000 per event furniture, stock, equipment; 1 day downtime	None
Warehouse – East Zone SP, Av. Itaquera (– absent –)	1–2 times/year	R\$15,000 per event (~R\$27,000/year); 3+ days downtime; ~R\$2,000/day lost	None

Business / Location (ZIP)	Occurrence/Frequency	Financial Impacts	Climate/Parametric Insurance
Grocery – Osasco, Downtown (– absent –)	4 events in 2 years	~R\$8,000/year losses + R\$5,000 lost revenue; 16 days downtime in 2 years	None

Source: Field interviews (2025).

The evidence gathered from interviews with small and medium-sized businesses in the São Paulo Metropolitan Region (RMSP) revealed a consistent pattern of vulnerability to floods. Although the magnitude and frequency of impacts vary across sectors and firm sizes, three key dimensions emerge from the data. (i) the disproportionate vulnerability of uninsured businesses, (ii) the role of insurance as a decisive factor for resilience, and (iii) The persistence of structural constraints, such as informality and limited financial resources.

Besides, the small businesses visited by research teams in different RMSP locations displayed three similar pathways of resilience against floods after severe storms: This strengthens the call for integrated adaptation policies that combine (i) financial instruments such as parametric insurance, (ii) structural public investments in drainage and urban infrastructure, and (iii) capacity-building programs for small-scale entrepreneurs.

It is worth mentioning that this study provides insights into the financial impacts of flooding on MSMEs in the São Paulo Metropolitan Region (RMSP) but has limitations. Data were collected through a student-led public opinion survey without identifiers, relying on self-reported losses prone to bias. The sample was small and concentrated near UNIFESP campuses, limiting representativeness, and did not fully differentiate formal from informal enterprises, despite the latter’s heightened vulnerability (Wagner, 2025). Future research should use larger, stratified samples, integrate field surveys with secondary data, and adopt longitudinal designs to track resilience. Testing parametric insurance pilots could demonstrate its effectiveness (Vieira, 2025), while addressing informality, gender, and ESG practices would strengthen adaptive capacity (Santos da Silva & Mainardes, 2016; Sebrae, 2023). These limitations underscore the preliminary nature of the study but point to promising avenues for comprehensive investigations.

5 FINAL REMARKS

This study demonstrates the disproportionate vulnerability of micro, small, and medium-sized enterprises (MSMEs) in the São Paulo Metropolitan Region (RMSP) to recurrent flooding. The evidence highlights that beyond direct material damages; business interruption and lost profits represent the most severe impacts. These findings reinforce the need for standardized indicators to measure financial consequences and guide targeted adaptation policies.

Parametric insurance emerges as a promising instrument, offering rapid liquidity based on objective triggers, which is particularly valuable for MSMEs unable to sustain long periods without revenue. However, insurance penetration remains limited, and gaps in coverage persist. Thus, integrating such mechanisms into broader public policies for urban resilience is crucial.

The study also identifies several business-level strategies that can mitigate impacts, including infrastructure adjustments, inventory diversification, financial preparedness, community cooperation, digitalization, and employee training. Yet, the effectiveness of these measures is constrained by structural vulnerabilities, notably informality, limited credit access, and the high costs of adaptation for small firms.

The coordinated action of federal, state, and municipal governments is essential. Investments in resilient infrastructure, early warning systems, emergency credit lines, and business training must complement private-sector innovations. Insurers, in turn, should expand engagement with MSMEs by developing affordable, tailored products linked to public risk reduction initiatives.

In conclusion, strengthening MSME resilience to climate-related disasters in the RMSP requires a multi-actor approach that combines standardized impact metrics, innovative financial instruments, firm-level adaptation, and coordinated public policies. Advancing this agenda is fundamental not only

to protect local enterprises but also to sustain employment, income, and urban economic stability in the face of increasing climate extremes.

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