

International Journal of Environmental Science (IJES)

Identifying Flood Vulnerability Factors of Informal Sector Businesses in Sri Lanka

Vindya Hewawasam and Kenichi Matsui

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Vindya Hewawasam

Postdoctoral Fellow, Graduate School of Global Environmental Studies, Sophia University, Japan



Kenichi Matsui

Associate Professor, Faculty of Life and Environmental Sciences, University of Tsukuba, Japan

Article History

Received 20th December 2025

Received in Revised Form 27th January 2026

Accepted 24th February 2026



How to cite in APA format:

Hewawasam, V., & Matsui, K. (2026). Identifying Flood Vulnerability Factors of Informal Sector Businesses in Sri Lanka. *International Journal of Environmental Sciences*, 9(1), 29–58. <https://doi.org/10.47604/ijes.3660>

Abstract

Purpose: Informal businesses contribute to more than half of employment and livelihoods in developing countries, but we do not know much about the extent to which natural disasters affect them. In Sri Lanka, informal businesses arguably represent 96% of commercial establishments although there have been questions about who they are and their flood vulnerability in terms of loss and damage. This paper attempts to better understand informal businesses of Sri Lanka with more details, revealing current data discrepancies. It also clarifies what factors affected past flood loss and damage.

Methodology: To better understand informal business owners' perceptions about flood vulnerability, we conducted a questionnaire survey among 180 small business owners in Colombo and Gampaha districts from February to March 2023. The questionnaire was designed based on the vulnerability function developed by IPCC and had 32 questions. The participants were randomly selected from six divisional secretariat divisions (DSDs) in each district. Additionally, interviews and online discussions were conducted among the main government stakeholders before and after the questionnaire survey. The data were analyzed using Microsoft Excel and SPSS and presented in descriptive forms, including tables, figures, and graphs.

Findings: The results show that Gampaha business owners had relatively higher flood vulnerability than Colombo, mainly due to low education achievements, single-owned businesses, lower annual turnover and asset value and lack of mitigation measures. We found that business registration practices at government agencies played a significant role in leaving many businesses informal, and our survey shows that only 16.7% in Colombo and 12.2% in Gampaha had operated registered/formal businesses. We calculated an annual average flood loss and damage among these businesses to be in the range of LKR 50,000-100,000 per business. Those businesses that had experienced higher loss and damage exhibited low disaster risk awareness/preparedness and financial difficulties. Our factor analysis found that education, ownership and size of businesses, registration status and availability of government compensation led to regional differences in terms of flood preparedness and vulnerability.

Unique Contribution to Theory, Practice and Policy: This study shows the specific vulnerability factors faced by informal business owners in dealing with floods. To better reflect the community vulnerability to floods, it is recommended to incorporate the above vulnerability factors in disaster loss and damage assessment and related policies and strategies. Further, it is necessary to adopt a more flexible framework for business registration and formalization to minimize disaster vulnerability.

Keywords: *Flood Vulnerability, Informal Sector Businesses, Business Registration, Flood Mitigation, Insurance, Sri Lanka*

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INTRODUCTION

Informal businesses are a significant contributor to the economies of developing countries, yet they are highly vulnerable to disasters. These businesses account for 90% of establishments, 70% of employment, and one-third of GDP in emerging markets and developing economies (WB, 2022; Benhassine et al., 2016; IIED, 2016). Approximately two billion people make their living in the informal sector (Juan et al., 2018). The registration status is the most common indicator that differentiates them from other small and medium-sized enterprises (SMEs) (UNDP, 2022; UNISDR, 2020; GIZ, 2014; UNDP, 2013; WB, 2007; GIZ, 2005). Some scholars identified them as small or micro businesses (WB, 2007; GIZ, 2005). The majority of them are operated by poor and marginalized groups in disaster-prone, suboptimal lands, without government support, coping strategies, or disaster risk reduction (DRR) measures, thereby increasing their vulnerability (UNDP, 2022; UNISDR, 2020; IIED, 2016; GIZ, 2014; UNDP, 2013; Bradley, 2013; ILO, 2008; WB, 2007). For example, the 2010 floods in Pakistan affected more than 300,000 small businesses, many of which were self-employed and located in immediate floodplains without insurance and preparedness measures (Asgary et al., 2012).

Although many past studies and reports emphasized that informal businesses in developing countries were highly vulnerable to climate change impacts, the question remains as to what particular factors are mainly attributable. Some studies claimed that small business size (Sakai and Yao, 2023; Patankar, 2019) and insufficient resource/capacity (Benhassine et al., 2016) are the main factors. International organizations tend to emphasize poor flood preparedness (e.g., adaptation measure, mitigation strategy, insurance) and public safety nets, including the availability of impactful government measures (WB, 2022; UNDP, 2022; Devanathan, 2015; Onaopepo et al., 2015). Equity related vulnerability factors, such as poverty and gender, were additionally emphasized by some of these organizations (UNDP, 2022; GIZ, 2014).

Case studies that attempted to identify flood vulnerability factors tend to expose authors' hypotheses or preconceived notions in selecting these factors, but it is not clear if these are widely applicable or region/community/context specific. Analyzing the loss and damage of the 2005 floods to informal businesses in Mumbai, for example, Patankar and Patwardhan (2016) identified limited resources, poor technical and financial capacity and an absence of insurance mechanisms. In Cape Town, South Africa, flood vulnerability was explained by limited government support and services along with locations (Shale, 2015). In Kampala, Uganda, small business size, lack of ownership and poor mitigation measures appeared to have exacerbated flood loss and damage among informal businesses (Veeravalli, 2020). In Dhaka, Bangladesh, the absence of social security systems and credit were the main factors (Kaium and Pamela, 2017).

Perception studies were used to understand the flood vulnerability of a specific community or social group (Cruz-Bello and Alfie-Cohen, 2022; Gomez-Cunya et al., 2022; Tauzer et al., 2019; Tanner and Arvai, 2018). These studies tend to focus on residents (Miceli et al., 2008; Kellens et al., 2011; Huong et al., 2014; Isa et al., 2018; Tanner and Arvai 2018; Hewawasam and Matsui, 2022; Iqbal and Nazar, 2023) and business owners (Veeravalli et al., 2022; Leitold et al., 2021). Only several studies examined informal business owners' perceptions of flood vulnerability (Shale, 2015; Parthasarathy, 2015; Patankar and Patwardhan, 2016; Kaium and Pamela, 2017; Hashim et al., 2021). However, these studies have several limitations, such as focusing on a single flood event, being limited to informal settlements, or focusing on a single informal business type. That said, some studies of SMEs have identified informality as a

challenge for micro businesses in dealing with disasters (de Oca 2022; Shale 2015; Parthasarathy, 2015; Kuruppu et al., 2013; UNDP, 2013; Galbraith and Stiles 2006; Gamage 2003). However, many of them do not elaborate on specific issues these businesses face in dealing with floods due to informality (Gunathilake, 2018; Sharif, 2021; Asgary et al., 2012; Auzzir et al., 2017). Moreover, none of them consider how business registration-related issues contribute to increasing flood vulnerability.

Problem Statement

Similar to other developing nations, flood is the most common disaster that affects informal businesses in Sri Lanka. However, past studies about Sri Lanka are not enough to have a good picture about its overall vulnerability factors. Gunathilake (2018) investigated flood impact among 100 formal SMEs in Colombo district by analyzing capital, logistics, labor and market. Another flood vulnerability perception study was done among 116 SMEs in Gampaha, Kalutara and Rathnapura districts (NCF, 2020). Analyzing SME owners' and key informants' perceptions in three districts, including Gampaha, Dale et al. (2022) examined how an enabling environment can incentivize SMEs to adopt resilience measures to cope with floods. These studies explored non-informal business sectors.

Other than these studies on formal businesses, what we know about Sri Lanka's flood vulnerability in urban areas depends largely on government reports. The Climate Risk Summary Report (2022) attempted to understand Sri Lanka's flood vulnerability in association with administrative areas. It found that a large proportion of the informal economy in Western Province, where major urban areas are located, was highly vulnerable to floods. Our past study partially disagreed with it. We demonstrated that some informal communities that were fragmented in flood vulnerable areas were particularly vulnerable than others in the same administrative district (Hewawasam and Matsui, 2023). National-wide attempts were made in 2016 and 2017 to find the loss and damage after devastating floods that affected many parts of the country. However, these data and figures overlooked the informal sector vulnerability due to lack of baseline information such as business registration, turnover, employees and ownership status (PDNA, 2017; 2016). The first-ever economic survey conducted in 2013/2014 found that 96% of business establishments in Sri Lanka are informal (Census, 2017; Atlas, 2014). However, the reliability of the available data is somewhat arguable as the survey was done more than 10 years ago. Further, the definition of informality used in this survey does not comply with the Business Names Act No. 7 of 1987, which provides the legal basis for business name registration in Sri Lanka (Hewawasam and Matsui, 2024; Business Names Act 1987). Our previous study clarifies how discrepancies in definitions and formalization policies intensified flood vulnerabilities among informal businesses (Hewawasam and Matsui, 2024). Moreover, the presence of a large number of informal businesses indicates that the Sri Lankan economy is highly vulnerable to financial risks, ranking it as the 3rd-highest risk factor constraining economic growth (Climate Risk Summary Report, 2022).

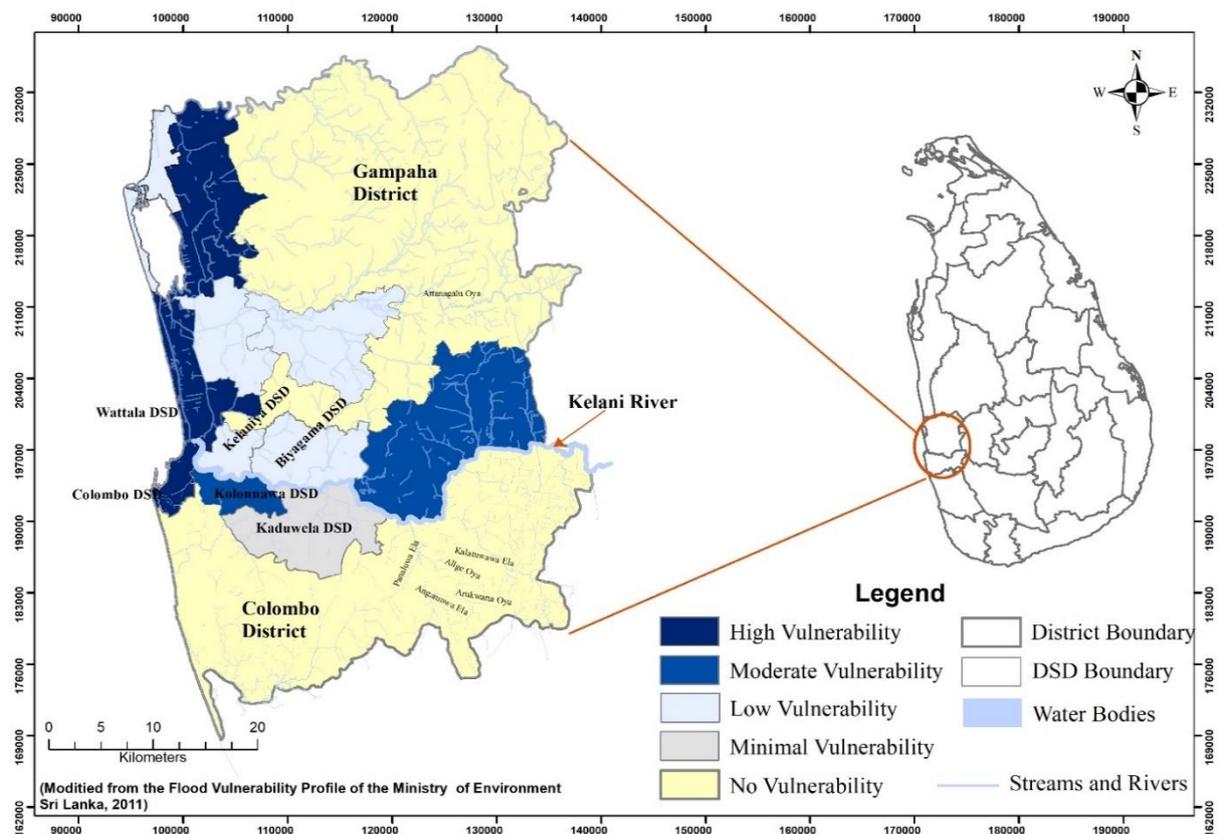
Considering these research gaps, the main objective of this paper is to understand what factors affect flood vulnerability of informal sector businesses in flood vulnerable communities of Sri Lanka and their loss and damage. Understanding the vulnerability of businesses can help develop their capacities to address the unpredictability and severity of flood impacts (Skouloudis et al., 2020). In the following sections, we first explain our study area and the data collection and analysis method. Then, we explore business owners' perceptions based on our field and questionnaire surveys. Finally, we discuss our findings, followed by the conclusion.

METHODOLOGY

Study Location

According to the WHO's *Guidance on Research Methods for Health Emergency and Disaster Risk Management* (2021), a typical research method to help determine flood risks is by using a source-pathway-receptor approach. Drawing on this approach, we selected Colombo and Gampaha districts for our study area. These two districts are the economic hub of Sri Lanka, representing 25% of the population, more than 50% of GDP, and 45% of industries (SEA, 2018; MCUDP, 2018). Here, the source is the Kelani River, the fourth longest river in the country. The pathway is the lower flood plain of the Kelani River Basin. The receptor is the informal business operators. According to the 2013/2014 national survey, which is the most recent available information about the informal sector in Sri Lanka, about 25% of informal establishments existed in these two districts, 12.5% each. Out of the total informal employment in the country (1,757,905), Colombo (14.75%) and Gampaha (12.92%) had the largest concentration of informal businesses in the nation (Census, 2017; Atlas, 2014).

Colombo and Gampaha are known as the most prone to floods in the country (SEA, 2018) due to increasing and intensifying flood incidents in the last 20 years. From 2003 to 2022, 1.29 million people in Colombo and 1.53 million people in Gampaha were affected by floods. In the same period, 15,156 houses were damaged, and two thirds of them were in Colombo district (DMC, 2023). When the most devastating flood in record occurred in 2016, it cost US\$277 million to Colombo and US\$179 million to Gampaha, 63% of the total flood loss and damage of the year (US\$ 723 million). The loss and damage to industry and commerce sectors were US\$63 million in Colombo and US\$87 million in Gampaha. Informal sector loss and damage at both districts were estimated to be about US\$27 million (PDNA, 2016).



Map 1: Study Area Showing Flood Vulnerability Levels By Divisional Secretariat Divisions

Despite these flood vulnerability profiles that justified our survey selection for the receptor within two administrative regions, our past studies raised a fundamental question that would greatly affect the accuracy of results on flood risks. The receptors in these districts consist of various types of businesses, elevations or conditions of the pathway, and proximity to the source. Therefore, we conducted multiple field surveys in these districts and had discussions with responsible Disaster Management Centre (DMC) and National Disaster Relief Services Centre (NDRSC) officials about community-level vulnerability information. As flood vulnerability levels in these districts are identified by divisional secretariat divisions (DSDs), our first task was to identify flood vulnerable divisions based on past flood disaster records. Then we identified locations of informal businesses in DSDs to overlap with flood vulnerability. We found that Colombo, Kolonnawa and Kaduwela DSDs in Colombo district and Wattala, Kelaniya and Biyagama DSDs in Gampaha district were particularly vulnerable with a sizable number of informal businesses. According to the flood vulnerability profiles of Sri Lanka (MoE, 2011), these DSDs represented high (Colombo and Wattala), moderate (Kolonnawa), low (Biyagama and Kelaniya) and minimal (Kaduwela) vulnerability to the housing and urban development sector (Map 1). When we conducted our field surveys in 2020 and 2023, this information was somewhat old. However, this is the only available national flood vulnerability profile, and the Ministry of Environment is currently updating it. Therefore, it is important to conduct more surveys, especially after the 2016 flood, as economic profiles often change in these congested urban areas.

Data Collection and Analysis

To better understand informal business owners' perceptions about flood vulnerability of their businesses, we conducted a paper-based in-person questionnaire survey from February to March 2023. The questionnaire was designed based on the vulnerability function (Vulnerability = Exposure × Sensitivity ÷ Adaptive capacity) (IPCC, 2014).

The questionnaire consisted of 32 questions. It included closed-ended questions with multiple-choice options and five-point Likert-scale questions. In addition, to estimate flood loss and damage, we used a six-point Likert-scale question. Considering what we discussed in the introduction section about what past studies highlighted about vulnerability factors, we divided our questions into six types of factors: (1) socio-demographic characteristics, (2) flood exposure or proximity to flood source, (3) adaptive capacity and mitigation measures, (4) business registration; (5) ownership of business and premises, and (6) insurance or government compensation availability.

In selecting respondents, we randomly selected 180 business owners, 30 from each DSD. In doing so, the locations were selected purposively. First, we made a note of community locations by *Grama Niladhari Divisions* (GNDs), the smallest community-based administrative areas. Before conducting the survey in early February 2023, we had discussions with *grama niladhari* officers, the head of GNDs, and identified the vulnerable locations in six GNDs where informal businesses are largely concentrated. We then employed three NDRSC officials and three NGO members as enumerators. All questionnaires were found valid.

In addition to the questionnaire survey, the lead author had personal interviews with the director and the assistant director of the Small Enterprises Development Division of the Ministry of Youth and Sports in Colombo. The interviews took two hours on the 22nd February and 20th March 2023, before and after the questionnaire survey. The lead author also had an online discussion with the assistant director of the Small Enterprises Development Division of the Ministry of Industry and Entrepreneurship Development on 18th March 2025. This meant to help us more insights on current business formalization and related small business development processes in Sri Lanka.

In analyzing the data, we used Microsoft Excel and SPSS Version 29.0.1.0 (171). For the comparison of the loss and damage data in two districts, we calculated the mean values of a Six Likert-scale question (Table 1). We also conducted Cronbach's alpha coefficient measures to understand the internal consistency among Likert-scale statements. It is widely recognized that the reliability coefficient of 0.70 and above shows a higher internal consistency among statements (Statistics Solutions, 2023; Talukdar et al., 2023; Wang et al., 2021).

Table 1: Mean Value Calculation for Six-Point Likert Scale Question

Six-point Likert scale (LKR)	1=0-1,000	2=1,100-5,000	3=5,100-10,000	4=10,100-50,000	5=50,100-100,000	6=100,000 and above
Mean value range	1-1.83	1.84-2.67	2.68-3.50	3.51-4.33	4.34-5.17	5.18-6.00
Mean value (5/6=0.83)	1.83	2.67	3.5	4.33	5.17	6.00

In addition, we conducted a multiple regression analysis to find significant influences, if any, among such variables as socio-demographic characteristics, distance from flood sources to business, actions to minimize loss and damage, ownership of business name registration given by DSD, and business owners' perceptions of flood incidents. We took business owners'

perceptions of flood incidents as the dependent variable and the rest as independent ones. In conducting the multiple regression analysis, it is necessary to code categories to explain variations in independent variables. Here, we used dummy variables as a numerical representation. For example, in gender, we coded 1 for male and 0 for female (Table 2). To check the multicollinearity of the data, a diagnostic test was carried out. The Variance Inflation Factor (VIF) and Conditional Indices (CI) were examined with no evidence of multicollinearity. The results were presented in descriptive analysis such as tables, figures, and graphs.

Table 2: Description of Variables

Variables	Measurement
Age	Number of years of respondent
Gender	Dummy (1=Male, 0 =Female)
Marital status	Dummy (1=Married, 0=Single)
Education level	0=No education, 1=Primary, 3=Ordinary level (O/L), 4=Advanced level (A/L), 5=University
Types of Business	1=Retail, 2=Mobile, 3= Restaurant & catering, 4=Manufacturing, 5= Service center, 6=Home based production, 7=Other Services (informal self-employment)
Physical structure of the business entity	1=Single floor, 2=Multiple floors, 3=Warehouse, 4=Mobile
Number of employees	Total number of people employed
Estimated annual turnover (LKR)	1=Below 100,000, 2= 100,000-500,000 3=500,001-1,000,000, 4= 1,000,001- 2,000,000, 5=2,000,001- 5,000,000, 6=5,000,001- 10,000,000
Estimated value of your asset & equipment (LKR)	1=Below 500,000, 2= 500,000-1,000,000, 3= 1,000,001- 2,000,000 4=2,000,001- 5,000,000, 5=5,000,001- 10,000,000
Number of daily customers	Number of customers
Average number of your work days per month	Number of work days per month
Years of business experience in this locality	Years engaged in business
Distance from flood sources to business	Distance from flood to business source (m)
Actions to minimize flood loss and damage	Dummy (1= Yes, 0 = Otherwise)
Ownership of business name registration given by DSD	Dummy (1=Yes, 0 =Otherwise)

RESULTS AND DISCUSSION

Socio-Demographic Characteristics

The first section of our questionnaire survey attempted to clarify socio-demographic characteristics of business owners (Table 3). Some past studies emphasized the connection between small business size and flood vulnerability (Patankar, 2019; Sakai and Yao, 2023). In Sri Lanka, the National Policy Framework for SME Development defined micro enterprises as those with the annual turnover of less than LKR 15 million (Industry, 2015). All businesses in our study area were micro businesses. Among our respondents, the annual turnover below LKR

100,000 (equivalent to US\$300¹) constituted 61.1% in Colombo and 62.2% in Gampaha. Those with annual turnover between LKR100,000 and 500,000 (US\$3,00-1,500) consisted of 25.6% in Colombo and 21.1% in Gampaha.

We found that more than half of these respondents in both Colombo (58.9%) and Gampaha (55.6%) belonged to the age group of 40-59. The proportion of this age group was higher than that of the national average, which was 24.2% in 2012, the most recent available national census results (Census, 2012). Those respondents who were older than 60 years old consisted of 25.6% in Colombo and 23.4% in Gampaha. The national average was 12.4% in 2012. This aging trend among our respondents largely follow the trend in these DSDs. Our past study in Colombo district explained about this aging trend that younger generations, after getting education and jobs in the study area, had moved away from informal settlement areas (Hewawasam and Matsui, 2020).

In terms of the proportion of women in doing informal businesses in the study area, female business owners constituted 48.9% in Colombo and 40% in Gampaha. These are higher than the national average of female employment (both employers and employees) in the country, which was 33.9% in 2020 (LFS, 2020). Also, the majority of our respondents were married in both Colombo (86.7%) and Gampaha (96.7%). These results somewhat suggest that married middle age women tend to engage in informal business operations more than those in formal ones. The Post Disaster Need Assessment of Floods and Landslides in Sri Lanka (2016) showed that a stronger presence of women in informal businesses in urban congested areas, such as Colombo and Gampaha.

Several studies found that education played a vital role in minimizing flood risk among communities (Munsaka, 2023; Nakamura and Kawasaki, 2022; Hata et al., 2021; Huong et al., 2014). In our survey, we found that our respondents were less educated than the national average. Those who had completed secondary education, for example, constituted 48.9% in Colombo and 51.1% in Gampaha. The national average in the same education attainment category was 58.7% (Census, 2012). Those respondents who had completed tertiary education consisted of 17.8% in Colombo and 6.7% in Gampaha which were lower than the national average of 18.2% (Census, 2012). Those who had primary education as their highest formal education consisted of 27.8% in Colombo and 34.4% in Gampaha. The national average of those with primary education was 18.4% (Census, 2012). Past studies in Sri Lanka showed that SMEs with lower levels of educational attainment have fewer flood-mitigation measures (Jayakodi, 2024; Hewawasam and Matsui, 2023).

Regarding business types, retail shops were most prominent in both Colombo (33.3%) and Gampaha (43.3%). Micro-scale informal self-employment (other services) was the second largest type in both districts (26.7%). Restaurant and catering (food services) consisted of 13.3% in Colombo and 14.4% Gampaha. None of the respondents in Gampaha engaged in manufacturing activities, and in Colombo it was 4.4%.

These results generally correspond with the national informal business profiles. According to the 2013/2014 national census, retail and wholesale trade (42%) was the most prominent business type among all informal businesses. It was followed by manufacturing (24.1%), food

¹ This survey was done in the peak time of the economic crisis in Sri Lanka (February-March 2023) and the US\$-LKR exchange rate was taken as US\$1=0.003LKR. However, people shared their flood experience and loss and damage based on the previous flood events.

services (8.9%) and other services (8.9%) (Census, 2017). A smaller presence of the manufacturing sector in our survey was possibly due to our sampling locations. We took samples from urban congested areas. In our field visits, we observed that these areas mainly consisted of retail shops. Businesses were normally carried out in single-floor buildings in Colombo (83.3%) and Gampaha (91.1%). About 8.9% of businesses in Colombo and 6.7% in Gampaha were mobile in nature.

In terms of the number of employees, which partly informs about business size for informal businesses, we found regional differences. In Colombo 15.6% of the respondents had two to three employees and 1.1% with 10 or more employees. Those who had one employee consisted of 77.8% in Colombo and 99.3% in Gampaha. The Labour Force Survey (2020) confirmed that the majority of informal employment belonged to self-employment (52.1%) in Sri Lanka. Sakai and Yao (2023) showed that micro-enterprises in the UK with less than five employees had experienced flood damage that cost them 2-4 times more than their monthly income.

Although past studies were silent about the connection between flood vulnerability and business asset value, we attempted to find our respondents' asset value. This was largely because the Sri Lankan government has not done a detailed survey about an overall asset value of informal businesses. This value is important to understand the damage scale of any flood incident. The result of our survey shows that 84.4% of those in Gampaha and 63.3% in Colombo estimated their asset value below LKR500,000 (US\$1,500). Those respondents who possessed assets worth LKR500,000-1,000,000 (US\$1,500-3,000) consisted of 16.7% in Colombo and 13.3% in Gampaha.

During floods, SMEs experienced temporary business closure, incurring revenue loss (Patankar, 2019; PDNA, 2016; Ingirige et al., 2012). To understand daily revenue from their businesses, we asked the respondents to estimate the average number of their business days and daily customers. We found that 53.3% in Colombo and 26.7% in Gampaha operated their businesses every day. Among the rest, 35.6% of both Colombo and Gampaha respondents operated their businesses 21-30 days per month. In terms of daily customers, Gampaha had relatively higher numbers with about 18.9% having more than 50 customers. In Colombo, this rate was 6.7%. More businesses in Colombo (42.2%) had smaller operations with 1-10 daily customers than those in Gampaha (24.4%).

A past study found the connection between longer business experience and higher engagement in disaster preparedness actions (Hashim et al., 2021). Considering this finding, we asked the respondents about the years of their business experience. We found that about 69% in Colombo and 73% in Gampaha had less than 10 years of experience in the same community. About 17.8% in Colombo and 18.9% in Gampaha had 11-20 years of experience.

Some past studies showed that social networks helped reduce flood impact and enhance recovery support within communities (Karunarathne and Gress, 2022; Huong et al., 2014). None of our respondents in Gampaha and only 4.4% in Colombo had joined business association, commercial chamber or local society in the locality.

Table 3: Socio-Demographic Characteristics of the Respondents

Demographics		Respondents (%)	
		Colombo District	Gampaha District
Age	20-29	4.4	3.2
	30-39	11.1	17.8
	40-49	33.3	27.8
	50-59	25.6	27.8
	60-69	17.8	16.7
	Above 70	7.8	6.7
Gender	Male	51.1	60.0
	Female	48.9	40.0
Marital Status	Single	13.3	3.3
	Married	86.7	96.7
Highest Education Completed	No Education	5.6	7.8
	Primary	27.8	34.4
	Ordinary Level (O/L)	48.9	51.1
	Advanced Level (A/L)	16.7	6.7
	University	1.0	0.0
Business Type	Retail Shop	33.3	43.3
	Mobile Shop	8.9	5.6
	Restaurant and Catering	13.3	14.4
	Manufacturing	4.4	0.0
	Service Center	6.7	7.8
	Home Based Production	6.7	2.2
	Other Services (informal self-employment)	26.7	26.7
Physical Structure of the Business Entity	Single Floor	83.3	91.1
	Multiple Floors	5.6	2.2
	Warehouse	2.2	0.0
	Mobile	8.9	6.7
Number of employees (both part-time/full-time)	1	77.8	93.3
	2-3	15.6	1.1
	4-5	2.2	4.4
	6-9	3.3	1.1
	10 or more	1.1	0.0
Estimated Annual Turnover (LKR)	Below 100,000	61.1	62.2
	100,000-500,000	25.6	21.1
	500,001-1,000,000	2.2	12.2
	1,000,001-2,000,000	8.9	4.4
	2,000,001-5,000,000	1.1	0.0
	5,000,001-10,000,000	1.1	0.0
Estimated Value of Your Asset & Equipment (LKR)	Below 500,000	63.3	84.4
	500,000-1,000,000	16.7	13.3
	1,000,001-2,000,000	10.0	1.1
	2,000,001-5,000,000	8.9	1.1
	5,000,001-10,000,000	1.1	0.0
Number of Daily Customers	1-10	42.2	24.4
	11-20	26.7	22.2
	21-30	17.8	18.9
	30-40	6.7	8.9
	41-50	0.0	6.7
	51 or more	6.7	18.9
Average Number of Work Days Per Month	1-10	2.2	8.9
	11-20	8.9	8.9
	21-30	35.6	35.6
	Everyday	53.3	46.7
Years of Business Experience in This Locality	1-5	47.8	32.2
	6-10	21.1	41.1
	11-20	17.8	18.9
	21-30	5.6	4.4
	31-40	5.6	0.0
	41-50	2.2	3.3
Do You Belong to Any Association/Chamber/Society?	Yes	4.4	0.0
	No	95.6	100.0

Flood Exposure and Vulnerability of Businesses

To understand flood exposure of respondents' businesses, we first asked them how often their business is affected by floods (Figure 1). In response, 64.4% of the respondents in both Colombo and Gampaha had experienced floods after every heavy rain. About 34.4% in Gampaha and 20% in Colombo were affected once a year. The Gampaha respondents experienced floods more frequently than those in Colombo. In particular, the 2016 flood was the worst disaster in Colombo (95.6%) and Gampaha (94.4%). Also, this flood caused the worst damage in recent Sri Lankan history (PDNA, 2016).

As proximity to flood sources is an important determinant of floods (Hewawasam and Matsui, 2023; Huong et al., 2014; Wedawatta and Ingirige, 2012), we asked the respondents about the distance from flood sources to their business entity. Slightly more than half of the respondents (51.1% in Colombo and 52.2% in Gampaha) were located within 100m from the flood source. Among the rest, 18.9% in Colombo and 20% in Gampaha were located between 100m and 500m. These percentages roughly correspond with those with frequent flood experience mentioned above. Past studies show that SMEs with severe flood impacts were mostly located in floodplains or close proximity to flood sources although we do not know how this distance should be configured to better assess the vulnerability of residents (Hewawasam and Matsui, 2023; Asgary et al., 2012; Stephens et al., 2023; Ali et al., 2022; Jamshed et al., 2020).

Our results indicate that the flood vulnerability of two districts is somewhat similar to the vulnerability profiles developed by the Ministry of Environment in 2011 (Map 1). Overall, it indicates higher flood vulnerability in Gampaha District than in Colombo, as the majority of high- and moderate-flood-vulnerable DSDs are located in Gampaha (MoE, 2011). However, our previous studies show large disparities in community vulnerability across the DSDs in Colombo (Hewawasam and Matsui, 2022; Hewawasam, 2022). This highlights that the maps need to be updated to reflect the actual conditions of each community in both districts.

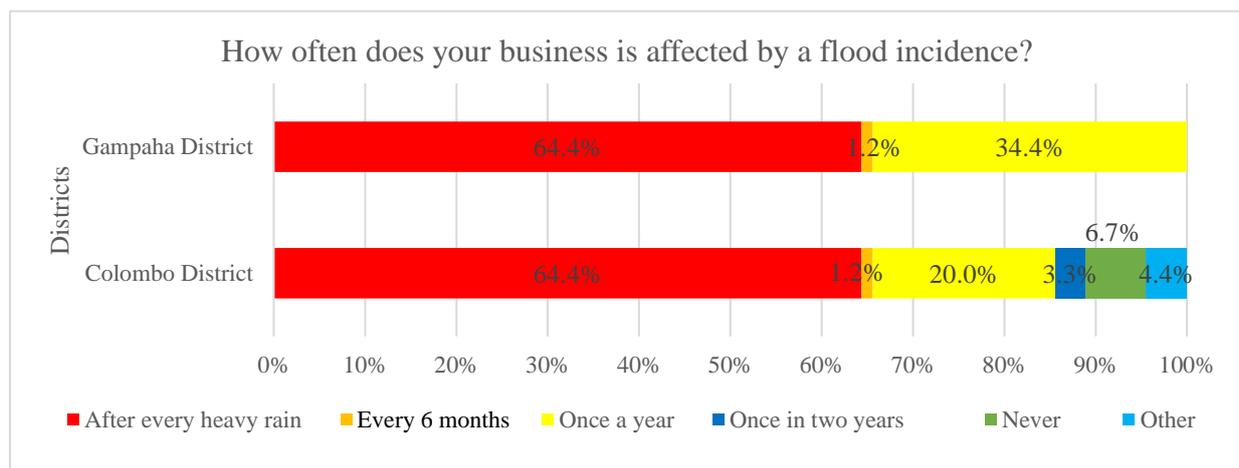


Figure 1: Frequency of Floods in Study Locations

Adaptive Capacity and Flood Loss and Damage

Past studies identified voluntary mitigation actions as one of main factors that minimize flood vulnerability and loss/damage (Sakai and Yao, 2023; Hewawasam and Matsui, 2023; Patankar, 2019; Patankar and Patwardhan, 2016; Adebobola, 2015; Wedawatta and Ingirige, 2012; Ingirige et al., 2012). Accordingly, we asked about their flood mitigation actions. The results

show some notable differences by district. Almost all the respondents in Gampaha had not taken any measures (98.9%). On the contrary, 25.6% in Colombo had taken some measures.

Then we asked what measures they had taken by giving multiple choice options for those who have taken the measures. Accordingly, we found that 12.2% of the businesses in Colombo elevated their business premises to avoid floods. Another 4.4% cleaned drains around the property and some installed flood-resistant storage facilities (4.4%). The rest of them constructed walls (2.2%), bought insurance plans (2.2%), and joined business associations/chambers (2.2%). In Gampaha, cleaned drains around the property (1.1%) was the only measure taken. A previous study found that business owners in Gampaha are unable to access formal financial services, such as bank loans and credit, due to their informality, thereby hindering their disaster risk reduction efforts (Dale et al., 2022). A study in the UK found that SMEs without flood protection measures would eventually close their businesses due to damage to stock, assets and equipment (Ingirige et al., 2012). The fewer mitigation measures among business owners can also be linked to resource poverty and socio-economic vulnerability to floods. Past studies in Sri Lanka and elsewhere show that communities that had low income, low resource ownership, and high exposures tend to have fewer mitigation measures or coping strategies, thereby increasing flood vulnerability (McDermott, 2022; Hewawasam and Matsui, 2020; De Silva and Kawasaki, 2018)

To understand the extent to which our respondents had experienced flood loss and damage annually, we used a six-point Likert-scale by providing a monetary value range (1=LKR 0-1,000; 6=Above LKR100,000). For comparison, we calculated the mean value of two districts. The results show some notable differences by type of loss and damage (Table 4). Similar to a UK study, in which lack of flood protection measures tended to lead to more damage to businesses, we found that the Colombo respondents, who had taken mitigation measures (25.6%), experienced less damage than those in Gampaha. A damage to business structure and walls had the highest impact with the loss of LKR10,100-50,000 (US\$30-150) in Gampaha. In Colombo, it was LKR1,100-5,000 (US\$3-15). A similar trend was seen in the average monthly revenue loss due to business closure. It was LKR5,100-10,000 (US\$15-30) in Gampaha and LKR1,100-5,000 (US\$3-15) in Colombo.

However, we found that flood protection measures alone cannot explain the scale of flood loss and damage. The cost of losing equipment was estimated at LKR5,100-10,000 (US\$15-30) in both districts. Regarding noneconomic losses, our respondents in both Colombo and Gampaha had a relatively low impact. The loss of invaluable items, revenue loss due to flood related sickness or difficulties, an absence of employees, business operation loss and the loss of business records amounted to LKR1,100-5,000 (US\$3-15) for each business. On average, both districts had annual flood loss and damage of LKR50,100-100,000 (US\$150-300) per business. The Cronbach's Alpha coefficients results from the Likert-scale statements above showed higher value than 0.70 in both districts (0.957 in Colombo; 0.912 in Gampaha), showing the good reliability of the statements (Table 5).

Table 4: Flood Loss and Damage of Businesses in Colombo and Gampaha (n=180)

Statements	Colombo District		Gampaha District	
	Mean Value	Interpretation (loss and damage in LKR)	Mean Value	Interpretation (loss and damage in LKR)
Loss to invaluable items that cannot be replaced (e.g., cultural items, memorabilia).	1.00	0-1,000	1.00	0-1,000
Loss to my savings to recover from flood.	1.60	0-1,000	2.53	1,100-5,000
The amount of credit/loan I obtained from relative/friend to reopen the business.	2.00	1,100-5,000	1.19	0-1,000
Revenue loss after flood due to my flood related sickness or difficulties.	1.48	0-1,000	1.59	0-1,000
Revenue loss because of business closure (average monthly estimate).	2.51	1,100-5,000	3.39	5,100-10,000
Loss from absence of employees that affected sales and business operations.	1.60	0-1,000	1.42	0-1,000
Loss of equipment being washed away.	2.72	5,100-10,000	2.73	5,100-10,000
Damaged to my business structure and the walls (including irreparable damage).	2.52	1,100-5,000	3.52	10,100-50,000
Loss from losing my business records.	1.41	0-1,000	1.14	0-1,000
The cost of the annual average flood loss and damage to my business	4.84	50,100-100,000	4.89	50,100-100,000

Table 5: Reliability Statistics for Colombo and Gampaha Districts

Variable	No. of items	Cronbach's alpha	
		Colombo	Gampaha
Flood loss and damage to businesses	10	0.957	0.912
Business registration process and floods	8	0.940	0.948
Flood/disaster insurance policies among business owners	6	0.934	0.909

Perceived Benefits and Disincentives about Business Registration

As informality is defined by lack of registration (ILO, 2024; WB, 2022; IIED, 2016; GIZ, 2014; UNDP, 2013; GIZ, 2005), we asked our respondents whether their businesses were registered under any government institutions. The result showed significant differences by district. More businesses were registered in Colombo (63.3%) than those in Gampaha (32.2%). Then we asked under which government agency they were registered by giving multiple choice options (Figure 2). Those registered at a DSDs office constituted 16.7% in Colombo and 12.2% in Gampaha even though DSDs are normally considered for business registration. The rest of the respondents in Colombo had their businesses registered at municipal councils (28.9%), urban councils (24.2%) and *Pradeshiya sabha* (5.6%). In Gampaha, the rest of them registered at urban councils (22.2%) and *Pradeshiya sabha* (5.6%). *Pradeshiya sabha* is the third-tier municipality coming under the local authorities (*Pradeshiya Sabha Act*, 1987).

Regarding business name registration at DSDs, Business Names Act No.7 of 1987 provides the legal basis (Personal interview, 2022; Business Names Act, 1987). The local authorities such

as municipal councils, urban councils and *Pradeshiya sabha* are liable to collect business licenses and levy tax (*Pradeshiya Sabha Act, 1987*; *Municipal Councils Ordinance, 1947*; *Urban Councils Ordinance, 1939*). Those businesses that do not register their names under DSDs but pay business license fees to local authorities are still considered informal (Personal interviews, 2023). In our questionnaire survey, 16.7% of the respondents in Colombo and 12.2% in Gampaha had formal registered businesses. We noticed that our respondents in Colombo (72.2%) and Gampaha (78.8%) were not aware of the dual business registration systems.

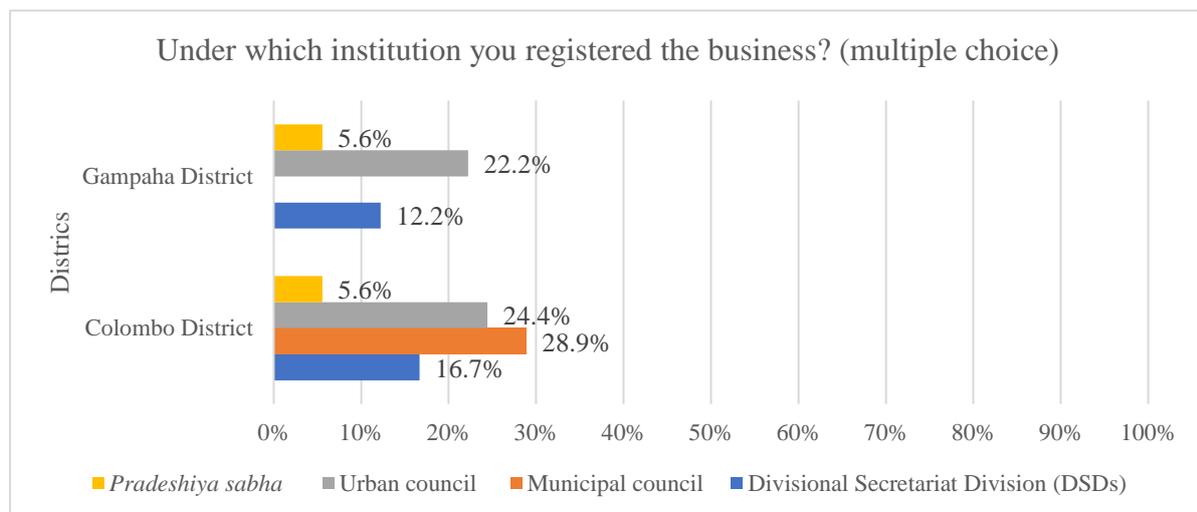


Figure 2: Business Registration in the Study Locations

To understand what difficulties informal business owners perceived about business registration, we used five-point Likert-scale (1=strongly disagree; 5=strongly agree) by providing eight statements (Figures 3 and 4). The Colombo respondents strongly agreed and agreed (58.9%) that the registration process is time-consuming. In Gampaha, only 36.7% strongly agreed but no one selected “agree.” The Colombo respondents (41.1%) were more discouraged from registering their businesses than the Gampaha respondents (28.9%) due to daunting documentation processes. However, only 14.4% in Colombo and 10.9% in Gampaha failed their business registration due to lack of documents. A burden of tax discouraged the Gampaha (73.3%) and Colombo (57.7%) respondents.

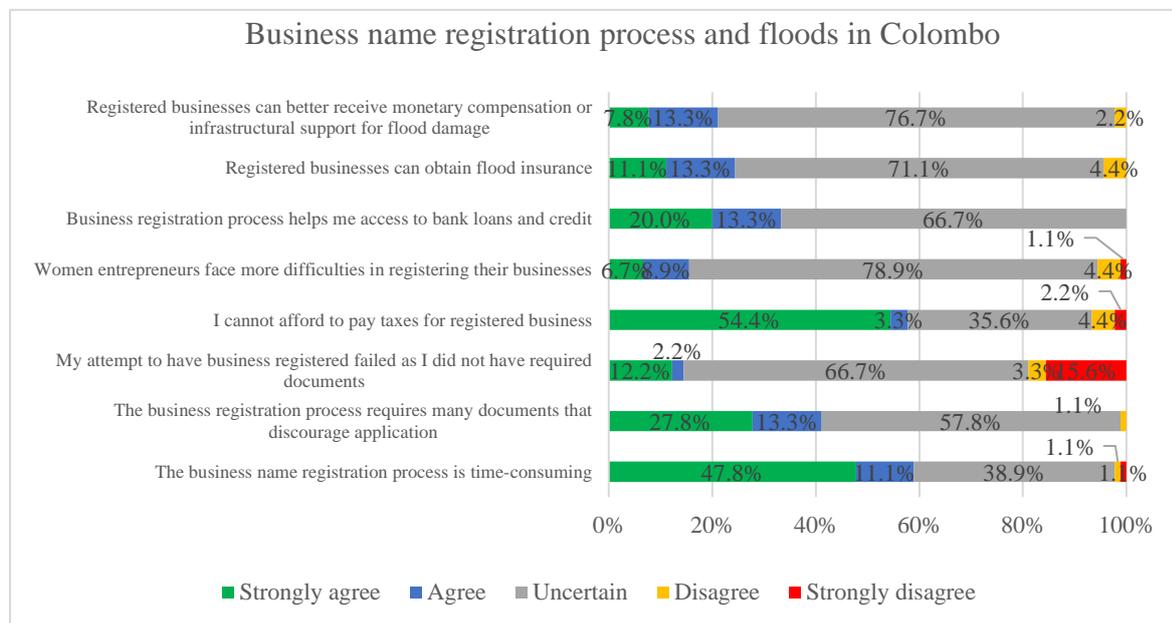


Figure 3: Business Name Registration and Floods in Colombo

This set of Likert-scale questions also revealed that a large proportion of the respondents were uncertain about business registration itself. The respondents in Colombo (78.9%) and Gampaha (72.2%) were similarly uncertain that women entrepreneurs face difficulties in registering their businesses. In response to the statement about time consuming aspects of business registration, almost 40% in Colombo and 44% in Gampaha were not sure. In response to the statement about registration failure due to insufficient documentation, 66.7% in Colombo and 70% in Gampaha were uncertain. About 39% of the Gampaha respondents and 33% of the Colombo respondents strongly agreed and agreed that business registration would help them access bank loans and credits. In addition, those in Colombo (71.1%) than Gampaha (66.7%) expressed their uncertainty about flood insurance support for registered businesses. Even though registered businesses could receive monetary compensation or infrastructural support to recover from flood damage, about 77% in Colombo and 67% in Gampaha were uncertain.

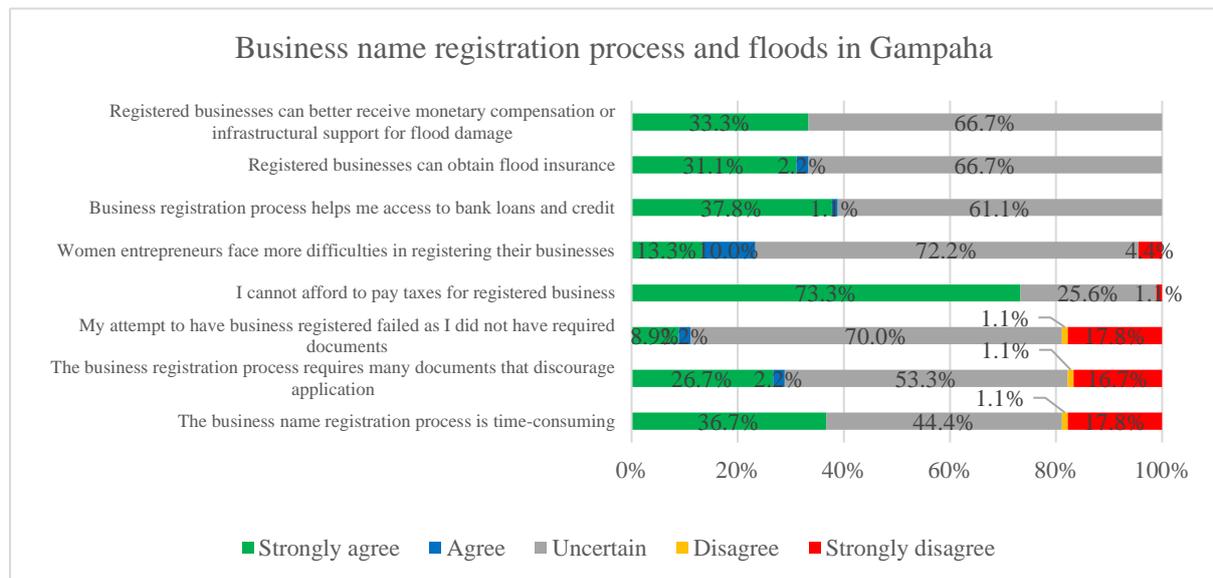


Figure 4: Business Name Registration and Floods in Gampaha

In our interviews with administrators at the Small Enterprises Development Division of the Ministry of Youth and Sports, we were told that many small businesses would avoid registration due to fear of paying tax to the central government and registration bureaucracies (Personal interview, 2023). Our results revealed somewhat different perceptions, in which the respondents were not well-informed about benefits and security of business registration. Considering their aging trend and relatively long business experience at business locations, this low awareness shows a disconnect between government flood policies and informal business owners. The Cronbach’s Alpha coefficients results showed that it was 0.940 in Colombo and 0.948 in Gampaha. As it is higher than 0.70, it says that the reliability of the statements is high (Table 5).

Ownership of the Business Land and Premises and Floods

In Sri Lanka, in principle, the business name registration process requires documents to prove land ownership or the consent of landowner (Personal interview, 2025; EBRSP, 2025; BNR, 2017). Those who failed to do so cannot register their business as formal entities (Personal interview, 2023; 2025). However, under the 13th Amendment (1987) to the Constitution of 1978 (1st list of the 9th Schedule), provincial councils are empowered to register and administer business names by adopting provincial statutes (BNR 2017). Based on this amendment, Uva and North Central provincial councils removed the provision that required land ownership or landowner consent (Personal interview, 2025). However, the other provinces, including Western still keep this ownership provision (Personal interview, 2025; EBRSP, 2025; BNR, 2017).

To understand the relationship between registration and land/premise ownership, we asked our respondents whether land ownership requirements determined their application for business registration. About 30% in Colombo and 42.2% in Gampaha agreed. Our interviews with administrators at the Small Enterprises Development Division informed us that 40% of businesses could not prove one’s land or building ownership (Personal interview, 2023).

Past studies found that, compared to those who rented or leased their business premises, those who operated businesses on their own premises took disaster mitigation measures (Wedawatta et al., 2012; Marks and Thomalla, 2017; Tsinda et al., 2019). To understand if this finding can be true in Sri Lanka, we asked if the respondents owned land/business premises. About half of the respondents (51.1% in Gampaha and 48.9% in Colombo) operated businesses on their own lands/premises. Those who rented consisted of 34.4% in Gampaha and 37.8% in Colombo. The Post Disaster Needs Assessment of Floods and Landslides in Sri Lanka (2016) found that in case businesses in rented places were adversely affected by floods, landowners received the compensation, but not the business owner.

Accessibility to Insurance and Compensation

Insurance is recognized as one of the important risk transfer approaches for minimizing disaster loss and damage (UNFCCC, 2013; Setyawan et al., 2017). Accordingly, we asked whether the respondents had flood/disaster insurance for their businesses. In response, only 2.2% in Colombo and none of the respondents in Gampaha had insurance. Past studies showed that flood/disaster insurance penetration was very low among SMEs in developing countries. For example, the Bangkok flood in 2011 affected half a million SMEs, of which only 14% had flood insurance (Asgary et al., 2012). During the Pakistan flood in 2010, only 1% of affected SMEs had flood insurance (Auzzir et al., 2018). A study in Rwanda (Tsinda et al., 2019) found that only 10% of SMEs had flood insurance.

To identify factors that discourage businesses to obtain flood/disaster insurance, we provided six statements in our five-point Likert-scale question (1=strongly disagree; 5=strongly agree) (Figure 5 and Figure 6). We found that a high premium was the main factor in Gampaha (96.7%) and Colombo (82.3%). In Gampaha, 62.2% did not believe their businesses were in high flood prone areas and insurance companies would not invest in the area. In Colombo 61.1% showed distrust in insurance companies. A past study in Sri Lanka found that insurance companies would not cover SMEs in high flood prone areas (NCF, 2020).

Other inhibiting factors include insufficient information about insurance among 68.9% of the respondents in Gampaha and 61.8% in Colombo. The percentage of uncertainty about the relationship between lack of business registration documents and obtaining insurance was 67.8% in Gampaha and 63.3% in Colombo. About 68.9% in Colombo and 67.8% in Gampaha were not certain about flood risk levels of their business locations. Cronbach's Alpha coefficients results showed that the reliability of the statements in the Likert-scale is high as it was 0.934 in Colombo and 0.940 in Gampaha (Table 5).

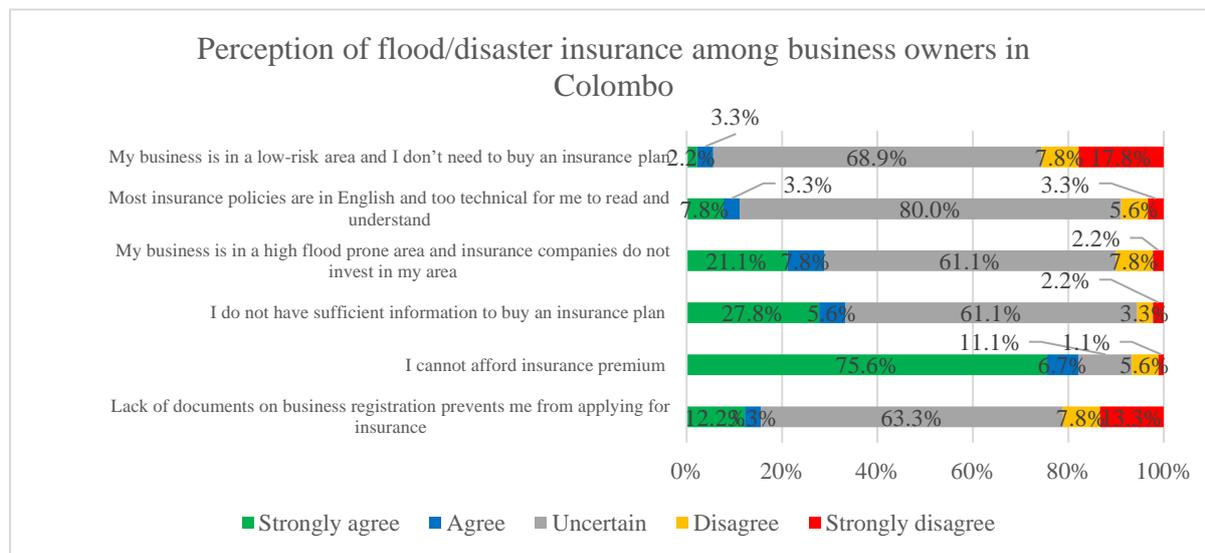


Figure 5: The Respondents' Perception of Flood/Disaster Insurance in Colombo

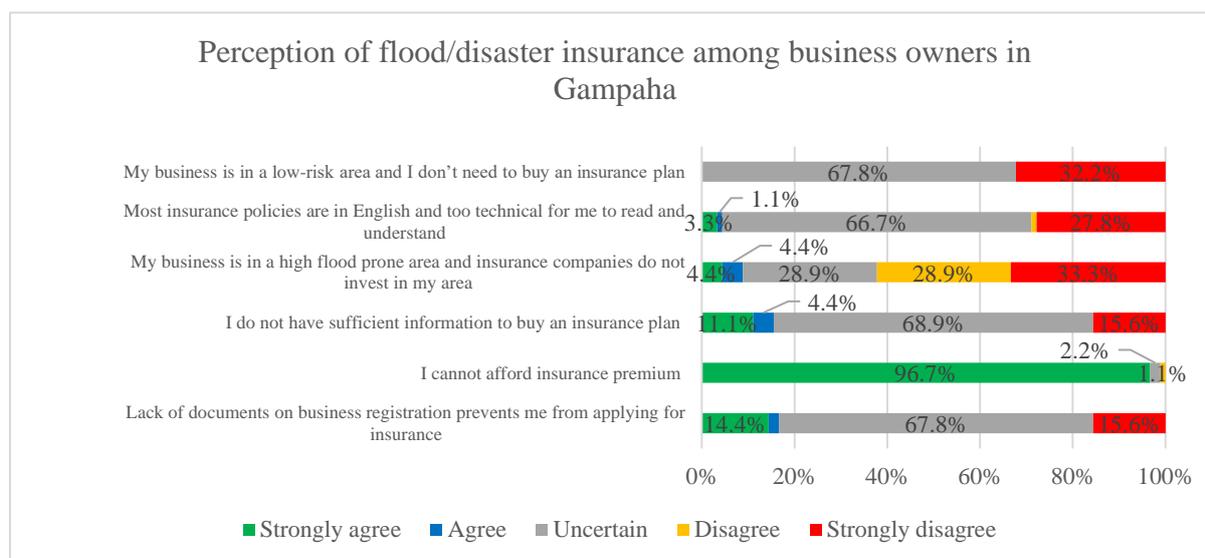


Figure 6: The Respondents' Perception of Flood/Disaster Insurance in Gampaha

To understand respondents' awareness of the National Natural Disaster Insurance Scheme (NNDIS), we provided four statements with multiple choice options (Figure 7). The NNDIS was established in 2016 to cover the loss and damage for households and SMEs with an annual turnover of less than LKR10 million. As to property damage, it covers up to LKR 2.5 million. The death compensation is up to LKR100,000 (SLYCAN Trust, 2019; PDNA, 2016). Our results show that many more respondents in Gampaha (28.9%) were aware of it than those in Colombo (2.2%). These Gampaha respondents had correct information that small businesses with less than LKR10 million of annual turnover would be entitled to obtaining disaster compensation up to LKR 2.5 million.

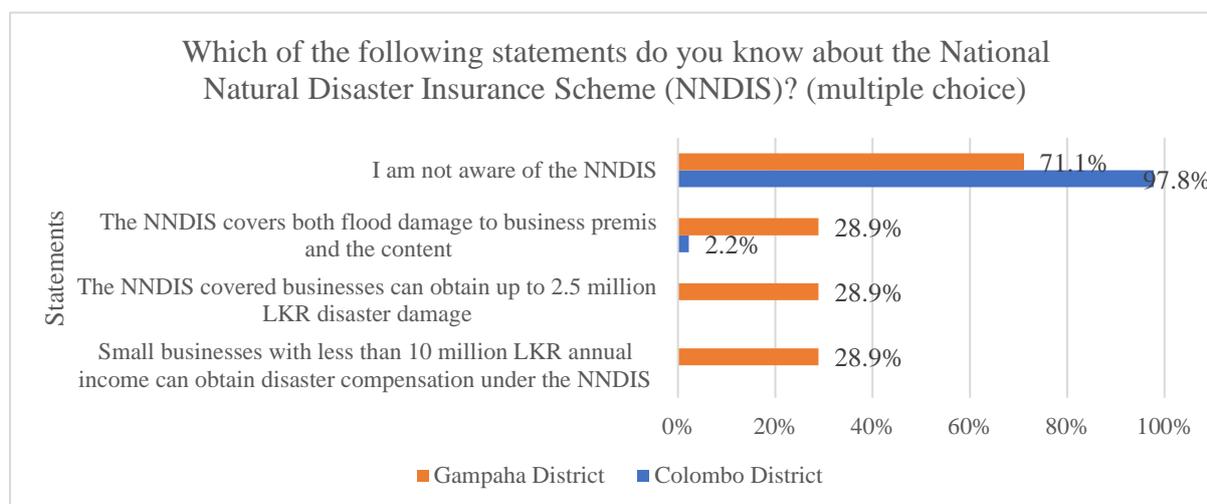


Figure 7: Awareness about the National Natural Disaster Insurance Scheme

Partly due to this higher level of disaster compensation knowledge, 46.7% in Gampaha received disaster relief and daily rations during floods (Figure 8). The NNDIS compensated damages to stocks (20%). Another 10% of the Gampaha respondents had received compensation for damage to their assets and equipment from the NNDIS. In Colombo, 27.8% of the respondents received daily rations and disaster relief during and after floods. For some Colombo (12.2%) and Gampaha (4.4%) respondents, the compensation amount barely helped cover their loss and damage.

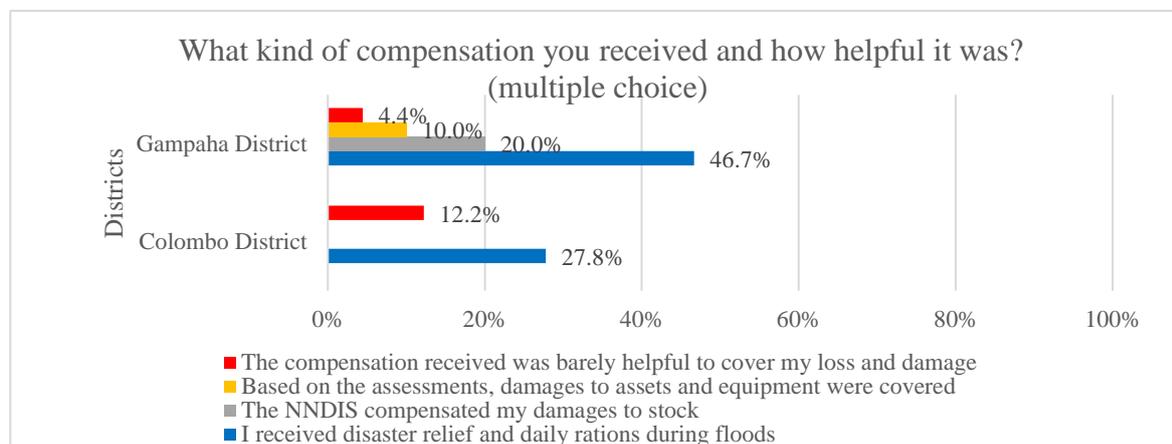


Figure 8: Compensation received from the National Natural Disaster Insurance Scheme

In this survey, we earlier found that 98.9% of the businesses in Gampaha had not taken any mitigation measures, and none had adopted flood insurance. The relatively higher NNDIS awareness and compensation in Gampaha are mainly due to two reasons. The high frequency of floods (Figure 1) often leads them to seek government assistance as they have no other option. So, they had relatively good communication with NDRSC officers in DSDs than in Colombo. Another reason is that, regardless of business type, during the disaster, community members received disaster relief and daily rations from NNDIS. In Colombo, some of the respondents had received disaster relief and daily rations from NGOs and community members.

Hence, they were not much dependent on the NNDIS. The national government found that, after the 2016 flood, informal businesses tend not to claim compensation to the NNDIS partly due to lack of documents to prove their business existence before the floods (PDNA, 2016).

Factors Influencing Business Owners' Perceptions of Flood Vulnerability

To understand what factors and characteristics might have affected the respondents' flood vulnerability, we conducted a multiple regression analysis (Table 6). Here we examined 15 independent variables (age, gender, marital status, education, business type, physical structure of the business entity, employee number, estimated annual turnover, estimated asset/equipment value, daily customer number, monthly work days, business experience in the locality, distance from flood sources to business, actions to minimize flood loss and damage, and the ownership of business name registration given by DSD). Business owners' perceptions of flood incidents were taken as the dependent variable. Goodness-of-fit for the regression model was tested. The F-statistic values for Colombo (133.21) and Gampaha (68.00) districts were statistically significant at $P < 0.05$.

The results show somewhat different factors by district. In Colombo, gender (p -value <0.05), education (p -value <0.05), business type (p -value <0.05), estimated annual turnover (p -value <0.05), estimated asset/equipment value (p -value <0.05) and distance from flood sources (p -value <0.05) demonstrated significant correlations.

In Gampaha, age (p -value <0.05), marital status (p -value <0.05), education (p -value <0.05), business type (p -value <0.05), number of employees (p -value <0.05), estimated annual turnover (p -value <0.05), number of daily customers (p -value <0.05) and distance from flood sources to business (p -value <0.05) significantly influenced business owners' perceptions of flood incidents. Informal micro businesses consisted of 87.8% in our Gampaha samples with low annual turnover and a higher customer base. Here, it is important to note that distance to flood sources negatively correlated with the respondents' perceptions about flood vulnerability, probably due to a lack of mitigation/adaptation measures. We earlier found that 98.9% of Gampaha respondents have not taken any flood mitigation measures.

Table 6: Factors That Determine Business Owners' Perceptions of Flood Vulnerability

	Colombo district		Gampaha district	
	<i>Coefficients</i>	<i>P-value</i>	<i>Coefficients</i>	<i>P-value</i>
Intercept	-0.810	0.126	1.817	4.172
Age	-0.070	0.598	-0.477	0.000*
Gender	0.584	0.010*	-0.345	0.055
Marital status	0.143	0.553	-0.629	0.011*
Education	-0.256	0.032*	-0.409	0.001*
Type of business	0.157	0.042*	0.364	0.000*
Physical structure of the business entity	0.033	0.828	0.132	0.420
Number of employees	0.007	0.963	0.370	0.028*
Estimated annual turnover (LKR)	0.541	0.000*	0.368	0.013*
Estimated value of asset/equipment (LKR)	0.398	0.015*	-0.231	0.109
Number of daily customers	0.014	0.930	0.410	0.000*
Average number of work days per month	0.010	0.945	0.140	0.206
Years of business experience in the locality	0.150	0.160	-0.107	0.279
Distance from flood sources to business	0.328	0.032*	-0.297	0.011*
Actions to minimize flood loss and damage	0.005	0.973	0.000	1.000
Ownership of the Business name registration given by DSD	-0.046	0.841	-0.105	0.544
* p-value < 0.05				
R ²	0.966		0.932	
Adjusted R ²	0.957		0.918	
F-statistics	133.212		68.000	
Prob> F	0.000		0.000	

Conclusion

This paper attempted to understand flood vulnerability factors for informal businesses in Colombo and Gampaha districts on the basis of field interviews, document examination, and the questionnaire survey. Due to the absence of studies about informal business experience during major flood incidents in the recent past, our study first identified what informal businesses mean in Sri Lanka. We identified that many businesses, especially micro- and small-scale-ones, remained informal due largely to complicated business authorization processes, overlapping documentation, and lack of awareness about the dual business registration system. Business Names Act No.7 of 1987 provides the legal basis for registering businesses, authorizing DSD offices to administer. Local authorities are responsible for business licenses and taxation, but this information is not shared with other authorities, including disaster management one. Some businesses are considered informal even though they have licenses and tax payment record due to poor information sharing.

Our questionnaire survey found several regional socio-demographic factors that contributed to the capacity and preparedness of informal businesses in dealing with flood risks. For example, the reason behind Gampaha district having a higher average monthly revenue loss due to the flood-related temporary business closure (LKR5,100-10,000 or US\$ 15-30) than Colombo did (LKR1,100-5,000 or US\$ 3-15) was attributable to a lower tertiary education completion rate (6.7%), micro business dominance (93.3%), low business turn-over (62.2% with less than LKR100,000 or US\$ 300), and low asset value (84.4% below LKR500,000 or US\$1500). Whereas 98.9% of the Gampaha respondents had not taken any mitigation measures against floods, 25.6% in Colombo had done so.

Our factor analysis also found that education, business type, and annual turnover significantly influence the flood vulnerability of business owners in both locations. Here, low education, similar to past studies, increases flood vulnerability and decreases mitigation and adaptive behavior. Those with lower levels of education are more likely to be self-employed, have lower annual turnover, and experience higher flood vulnerability. Distance from flood sources to businesses affects Colombo positively and Gampaha negatively, primarily due to differences in mitigation measures.

Regarding asset value and equipment, we found interesting results. Asset value and equipment are important factors in determining the scale of flood damage and vulnerability among informal businesses in Colombo. However, in Gampaha, the situation is reversed. Results suggest that it depends on the location and other influential factors. However, we also established the link between ownership and the lower asset value of informal businesses. In Gampaha, 93.3% of businesses were operated by a single person, of which 84.4% with less than LKR500,000 (US\$ 1,500) of asset value. These factors are essential to better estimate flood loss and damage among Sri Lanka's micro, small, and medium businesses in the future.

Recommendations

As flood vulnerability depends on many factors, the findings of this study cannot be generalized to the entire country. However, Colombo and Gampaha are the country's economic hubs and have the highest concentrations of informal businesses, as well as high flood impacts. Therefore, these findings can apply to similar locations in Sri Lanka and beyond. It is also recommended to have a more flexible framework for business registration and formalization to minimize disaster vulnerability and increase resilience among small business owners. As many countries are currently developing mechanisms to assess disaster loss and damage, the above flood vulnerability factors can be incorporated into flood loss and damage assessments and related funding distribution strategies to better reflect the regional and community characteristics. Further research with greater representation of larger informal groups helps achieve economic prosperity and disaster resilience in developing nations.

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