

RESEARCH ARTICLE

# Resilience to climate shocks in Guatemala: Disability-related inequalities

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## Abstract

Approximately 16 per cent of the global population lives with a disability, and an important proportion resides in low- and middle-income countries (LMICs), and present higher levels of poverty. Guatemala, classified as a middle-income country, is among the poorest nations in Latin America. It faces the challenges of climate change, including extreme weather events, which may disproportionately affect people with disabilities. This article examines the levels of resilience among households with and without members with disabilities in Guatemala. Using data from the 2018 National Population and Household Census, we constructed a resilience index and incorporated district-level data on precipitation, the number of wet days, and the intensity of those wet days. We analysed the association between the resilience index, household disability status, and environmental variables at the district level. To assess whether households with disabilities in districts with high precipitation or frequent wet days exhibit different levels of resilience than those without disabilities, we estimated a regression model. The results indicate that households with disabilities have significantly lower resilience. Moreover, those in districts with precipitation levels above the national average show even greater reductions in resilience. In conclusion, households with disabilities demonstrate even lower resilience in areas with higher precipitation, making them less likely to recover from environmental shocks. It is therefore essential to include and prioritise persons with disabilities in climate change adaptation strategies.

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## 1 Introduction

Climate change has become one of the most critical challenges of our time. It is expected that 85 per cent of the global population is currently affected by climate change, and persons with disabilities are included in this group [1]. Approximately 16 per cent of the global population lives with a disability [2]; of those, a large percentage live in low- and middle-income countries (LMICs), which are primarily affected

provided the original author and source are credited.

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by extreme weather events such as high temperatures, precipitation, and frequent droughts [1]. People with disabilities living in LMICs may face some of the most negative impacts of climate change.

Unfortunately, to date, limited inclusion of people with disabilities in the international framework related to climate change has occurred. Thus, this group has not been recognised as a priority group in the climate change agenda, alongside Indigenous groups, women, and youth [3]. This limited international recognition has become an important barrier to the inclusion of this group in national adaptation strategies. Although 45 per cent of countries have included persons with disabilities in their national adaptation policies. Most adaptation plans have not provided a detailed analysis of the potential impact of climate change on people with disability, an aspect that increases their vulnerability and fails to recognise their needs [4].

People with disabilities also present a higher risk to the worst consequences of climate or environmental disasters [5]. This is mainly given by the high levels of poverty, stigma, discrimination and socioeconomic barriers that this group faces [5]. In addition, this group face higher barriers to accessing water and improved sanitation services [6], higher levels of food insecurity [7], and higher levels of social exclusion. These aspects increase their vulnerability to environmental shocks.

The United Nations Convention on the Rights of Persons with Disabilities (CRPD) calls for the inclusion of people with disabilities in climate mitigation and adaptation measures [8]. Additionally, the Sustainable Development Goals and the 2030 Agenda acknowledge the importance of including people with disabilities and other vulnerable groups in policies aimed at achieving SDG 13, 14, and 15 (among other environmental-related goals) [9]. However, as mentioned before, people with disabilities have been explicitly excluded from national or international policies to mitigate and adapt to climate change, ignoring their voices and their specific needs [4]. This has increased their vulnerability, and although data is scarce, this group is expected to face the worst consequences of climate shocks.

People with disabilities are disproportionately likely to be poor [6], have lower levels of education and lower labour force participation rates and higher costs of living associated with disability [10]. All these characteristics reduce their resilience to adapt to climate change. Lack of effective access to information, support, and services implemented during environmental emergencies increases the risk that people with disabilities will face a reduction in their livelihoods during an environmental shock [11]. In Guatemala, 13 per cent of the population lives with disabilities, and of these, 57.8 per cent are multidimensionally poor. In this country, people with disabilities five years or older have lower access to education and employment and low levels of access to water, sanitation and electricity [12]. Although Guatemala is a country that faces extreme temperatures and precipitation, and it is vulnerable to climate shocks [13], little information exists on how climate change has affected people with disabilities and their families, or if they face different levels of resilience that allow them to overcome the negative effects of environmental shocks. The analysis of resilience levels to climate shocks provides essential evidence of the capacity that households with disabilities have to prepare

for, respond to, and recover from the impacts of climate events. This article thus aims to increase knowledge on how people with disability and their families have different (higher or lower) levels of resilience compared to persons without disabilities and their families.

## 2 Methodology

### 2.1 Data on disability

To compute the resilience levels of households with and without members with disabilities, we used the National Population and Household Census for Guatemala (2018) (2018 Census in short). This is for Guatemala the most recent population and housing census, which is representative at the district level. The total population of the Census 2018 was more than 13 million individuals. The data was collected between July 23rd and August 16th, 2018.

### 2.2 Disability definition

The 2018 Census included the Washington Group Short Set of Disability questions [14]. Using this data, a person five years or older was identified as a person with a disability if reported to have a lot of difficulty or not being able to do an activity in one or more of the six domains (seeing, hearing, walking, remembering, understanding, communication), this definition follows the recommendations of the Washington Group. Following Hanass-Hancock et al. (2023)[15], we used a more inclusive disability measure as a robustness measure, where we consider persons with any difficulty and persons with some difficulty in any domains. Finally, we created a disability functionality index by summing the answers provided to the WGSS. The index took the value zero if the person had no disability and 18 if the person could not perform any of the activities.

### 2.3 Resilience index

This article computes a resilience index using the Alkire-Foster Method [16]. We defined resilience as the capacity to maintain the levels of development, even when individuals and households face changes or shocks that might affect their well-being [17]. To identify critical aspects of resilience associated with climate change, we conduct a literature review to determine the most common aspects related to household resilience to climate change and climate variability. In addition, we reviewed the National Population and Household Census 2018 and selected dimensions and indicators that aligned with the resilience literature. Based on this, an index of four dimensions and fourteen indicators was created.

The dimensions and indicators are presented in Table 1. The dimensions aimed to capture access to basic services, physical capital, social safety nets, and households' adaptive capacity to overcome environmental shocks or mitigate the potential negative impacts of climate variability and extreme weather. Each dimension has the same weight (1/4), and the indicators within each dimension have the same relative weight. The resilience index was defined as the sum of the resilience levels of households in Guatemala.

### 2.4 Environmental indicators

**2.4.1 Precipitation data.** This study uses rainfall data from two primary sources: (1) INSUVIMEH (National Institute of Meteorology and Hydrology of Guatemala), which provided ground-based precipitation data for 47 out of 340 municipalities, and (2) satellite data from CHIRPS [18], which supplemented the municipalities without data from INSUVIMEH. We used primary data from IN- SUVIMEH, given that it is the official source of meteorological data in Guatemala. The satellite data, provided in GeoTIFF format, covered 333 municipalities, leaving seven municipalities with insufficient data, which were excluded from the analysis. We used data from 2008 to 2018. Data is available on a daily basis, so we computed the annual average to conduct the analysis.

**Table 1. Dimensions, variables, indicators, cutoffs and weights of the resilience index.**

Dimensions	Indicators	A household has resilience if
Basic Services	Access to electricity (1/14)	has electricity.
	Access to a clean source of water (1/14)	has access to a clean source of water according to the sustainable development goals (SDG) standards
	Sanitation (1/14)	has access to an improved sanitation service, which is not shared.
	Access to internet (1/14)	has access to internet service
	Access to education in the same district (1/14)	A school-age child studies in the same village where they live.
	Access to employment in the same district (1/14)	a working-age individual works in the same district.
	Cooking Fuel (1/14)	uses clean cooking fuel, such as electricity or gas.
Physical Capital	Vehicle ownership (1/14)	a household owns a car.
	Housing (1/14)	a household has a house made from good quality materials, which ensures better protection and comfort. Quality housing improves living conditions and safety.
Social Safety Net	Remittances from Family (1/14)	A households receives remittances.
Adaptive Capacity	Literacy Level (1/14)	Household head has completed secondary school.
	Dependency Ratio (1/14)	A household has a number of working members higher than 0.49, meaning that a significant portion of the household members consists of people working in comparison to those who are dependent.
	Household Head Employed (1/14)	The household head is employed.
	Household Head Farmer (1/14)	The household head's main occupation is farming.

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Data from both sources were imported using R libraries, such as *rasterio*, for handling GeoTIFF files. Precipitation values from the satellite data were extracted and matched with corresponding geographical coordinates. To ensure comparability, the datasets from INSUVIMEH and CHIRPS were standardised, ensuring that units, scales, and formats aligned across the two sources. The data processing and cleaning involved aligning the ground and satellite datasets, interpolating missing values where feasible, and verifying consistency across both sources. Priority was given to the ground-based INSUVIMEH measurements for districts with both ground and satellite data. After cleaning, the datasets were merged using district codes as geographic identifiers. Then, three key rainfall indicators were constructed:

- Wet Days:** This indicator represents the average number of wet days per period. A wet day is defined as any day with more than 1 millimeters (mm) of precipitation [19].
- Total Precipitation:** This is the total cumulative rainfall in mm for each municipality over the study period [20].
- Wet Day Intensity:** This indicator measures the average intensity of wet periods, calculated as the total precipitation divided by the number of wet days [21].

Each indicator was calculated to accurately reflect the hydrological conditions of the municipalities, providing robust metrics for subsequent analysis of rainfall patterns and their socio-economic implications.

We also produced other indicators using temperature increases over time. However, it was not possible to work with these variables, given that there was insufficient variability among districts to allow for a comprehensive analysis.

## 2.5 Empirical strategy

To analyse the relationship between the resilience index, the presence of a member with disability in the household, and environmental variables, we estimated the following regression model:

$$y_i = \beta_0 + \beta_1 D_i + \beta_3 E_d + \beta_4 D_i \times E_d + \beta_5 X_i + \beta_6 \sigma_d + \epsilon_i \quad (1)$$

where  $y_i$  represents the resilience index for the household  $i$ , a measure designed to capture the household's capacity to adapt and recover from environmental or economic shocks. The key explanatory variable,  $D_i$ , is a dummy variable equal to 1 if the household has a member with disabilities and 0 otherwise.  $E_d$  captures information regarding precipitation, average wet day or number of wet days in the district, and the interaction term  $D_i \times E_d$  explores whether the households with members with disabilities living in districts with different levels of precipitation, wet days or intensity of wet days are different to those of households without disabilities.

The vector  $X_i$  includes a comprehensive set of household-level controls such as household size, the number of adults aged 60 or older, the number of children under 12, the sex of the household head, the age of the household head, the employment status of the household head, and his/her level of education.

Environmental controls ( $\sigma_d$ ) were also incorporated to account for variations in precipitation over time and across provinces. Using data from 2008 to 2018, we constructed two variables capturing: (1) long-term precipitation trends and (2) precipitation variability. These variables aim to account for the cumulative risk of flooding in each district. Additionally, we included a district-level indicator of high flood risk, as classified by INFORM, to control for baseline vulnerability to environmental shocks. Our primary estimation approach relies on linear regression, leveraging the richness of the dataset to provide robust insights. Standard errors were clustered at the district level to account for within-district correlation.

Different specifications of the environmental variables were used, including the variable in its original units and analysing the distribution of the variable (minimum, maximum, and median). The selected specification was one that assigned a value of 1 if the person lived in a district with a level of precipitation, wet days, or intensity of wet days higher than the national average for the variable, or zero otherwise. In addition, we conducted a regression analysis in each of the quartiles of the environmental variable distribution, aiming to analyse whether households with members with disabilities living in districts with different levels of precipitation, wet days, or intensity of wet days had different levels of resilience.

### 3 Results

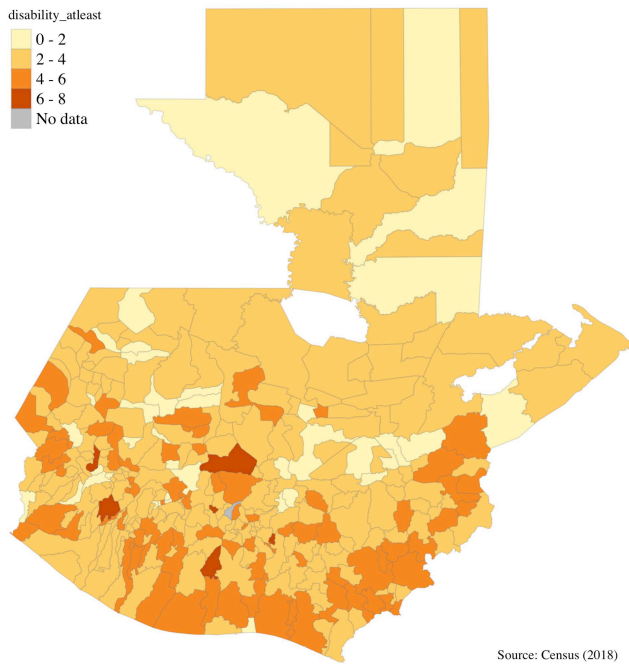
The prevalence of disability by district is presented in [Fig 1](#). The percentage of households with disabilities (adults with at least a lot of difficulty) in Guatemala spans between a minimum of 5.1 per cent in Flores and 16.7 per cent in Asuncion Mita ([Fig 1A](#)). As expected, using the more inclusive measure of adults with some difficulty ([Fig 1B](#)), the prevalence of disability increases, as well as when using the definition of households with adults with any difficulty ([Fig 1C](#)). Irrespective of the measure, southern districts tend to have a larger prevalence of disability compared to districts in the northern region.

[Table 2](#) presents the detailed descriptive statistics for persons with and without disabilities in Guatemala. People with disabilities in Guatemala present lower levels of education (3.45 vs 5.2 years of education), and are more likely to be older than persons without disabilities, with 44 per cent of the population being 65 years or older compared to 7.9 per cent of persons without disabilities. In addition, 26.2 per cent of the population is working, compared to 39.5 per cent of those without disabilities. A larger proportion of households with members with disabilities have a female head of the household (28.9 per cent) compared to households without disabilities (23.7 per cent). In addition, the head of the household is more likely to be older, and households, on average, are larger than households without disabilities and have more members aged 65 or older. When we analysed the resilience index, we found that, on average, households with disabilities have an index 2.52 percentage points (pp) lower than households without members with disabilities (39.8 vs. 42.3). This difference was statistically significant.

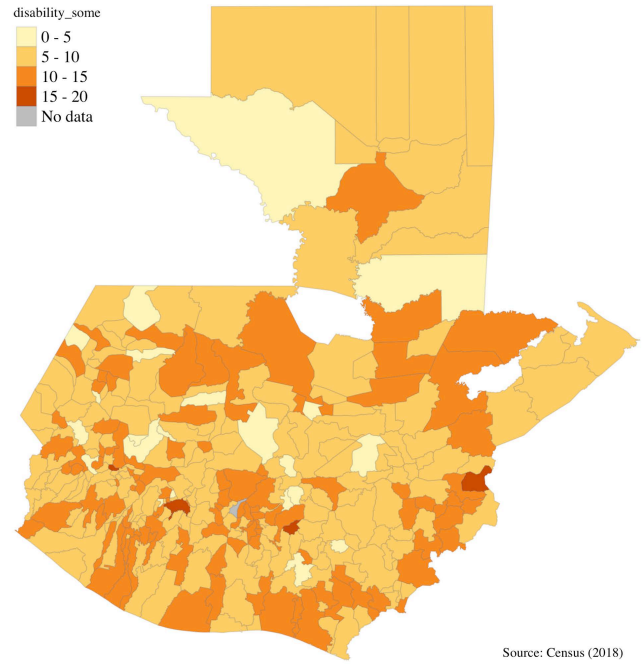
[Fig 2](#) presents the resilience index for households with and without members with disabilities. Households with disabilities had significantly lower levels of resilience in 288 of the 340 districts compared to households without disabilities. In 52 districts, the levels of resilience of households with disabilities were significantly higher than those of households without disabilities.

#### 3.1 Environmental variables

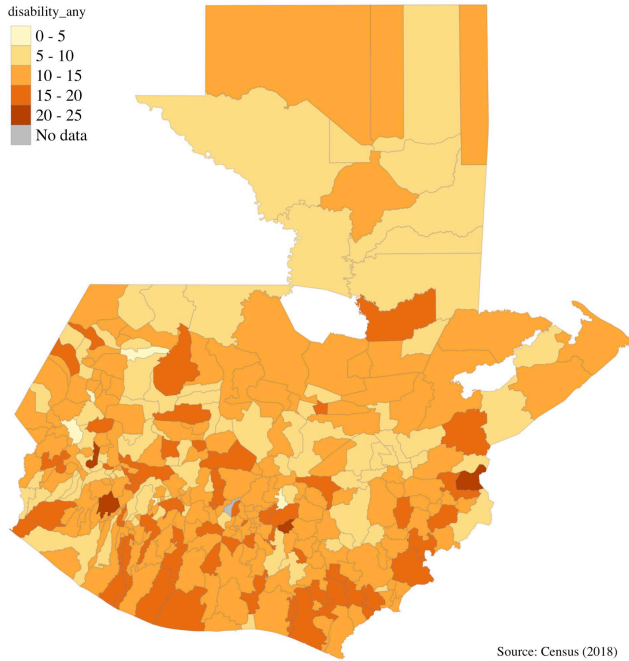
When we analysed the distribution of environmental variables across the different districts in Guatemala, we found that, on average, districts in the northern part of the country have higher precipitation, wet-day intensity, and the number of



(a) Disability at least a lot



(b) Disability some



(c) Disability any

**Fig 1. Prevalence of disability in Guatemala (different defitions).**

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**Table 2. Descriptive statistics of people with and without disabilities in Guatemala.**

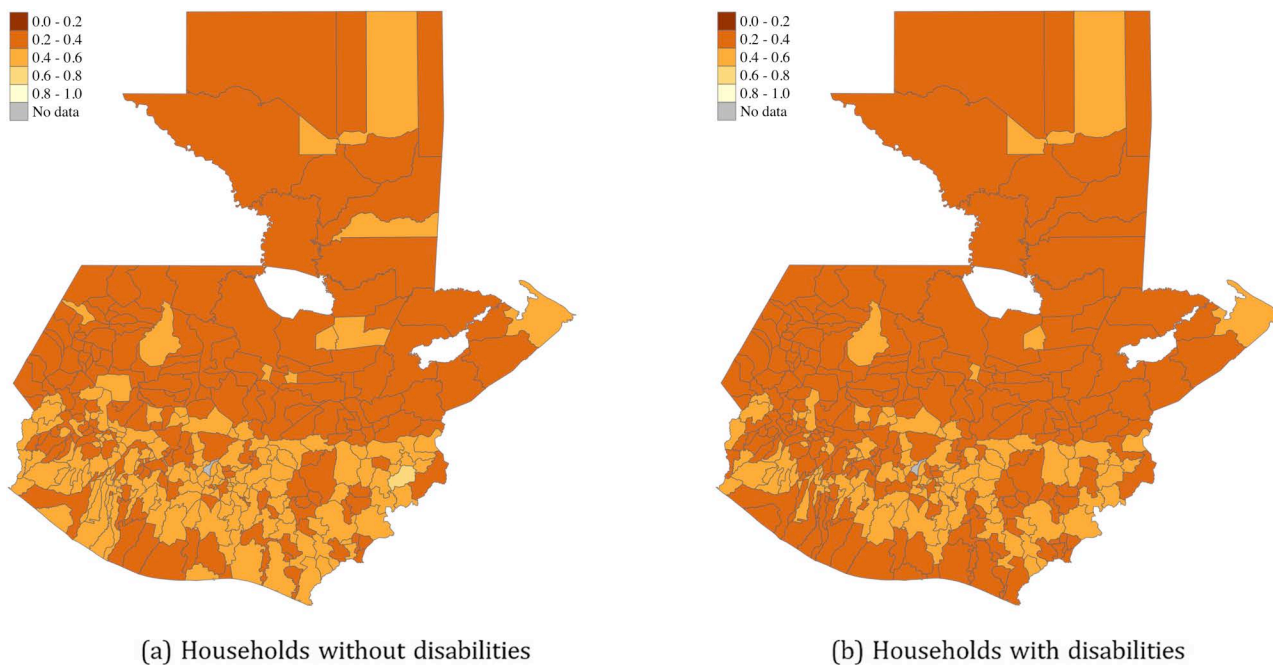
	(1)	(2)	(3)
Variables	PwD: Yes	PwD: No	Difference
<b>A. Individual characteristics</b>			
Female (%)	52.21 (49.95)	51.79 (49.97)	0.41** (0.08)
Urban (%)	58.83 (49.21)	54.25 (49.82)	4.59** (0.08)
Head of Household (%)	39.12 (48.80)	23.95 (42.68)	15.16** (0.07)
Years of Schooling	3.45 (4.60)	5.19 (4.62)	-1.74** (0.00)
Age ∈ [0,15)	10.91 (31.17)	27.15 (44.47)	-16.24** (0.07)
Age ∈ [15,29)	15.91 (36.58)	33.04 (47.04)	-17.13** (0.08)
Age ∈ [30,44)	12.82 (33.43)	20.12 (40.09)	-7.29** (0.07)
Age ∈ [45,64)	16.29 (36.92)	11.75 (32.20)	4.54** (0.05)
Age ∈ [>65]	44.07 (49.65)	7.95 (27.05)	36.12** (0.05)
Employed (%)	26.26 (44.00)	39.47 (48.88)	-13.21** (0.08)
<b>B. Household characteristics</b>			
Female household head (%)	29.98 (45.82)	23.73 (42.54)	6.26** (0.08)
Years of Schooling household head	4.21 (4.74)	5.65 (4.99)	-1.44** (0.01)
Age household head	56.81 (17.03)	44.95 (15.37)	11.86** (0.03)
Household size	4.77 (2.64)	4.52 (2.31)	0.26** (0.00)
Average # of members 12 years or younger	1.07 (1.37)	1.35 (1.37)	-0.28** (0.00)
Average # of members 65 years or older	0.84 (0.84)	0.32 (0.62)	0.52** (0.00)
Employed household head (%)	55.69 (49.67)	72.94 (44.43)	-17.25** (0.09)
Resilience index	39.78 (17.20)	42.30 (17.76)	-2.52** (0.03)

Notes: PwD: People with Disabilities. \* p<0.10;\*\* p<0.05; \*\*\* p<0.01.

<https://doi.org/10.1371/journal.pclm.0000712.t002>

wet days. The North region of the country has the highest average precipitation, the highest intensity of wet days, and the highest average number of wet `days nationwide (Fig 3).

Fig 4 presents the resilience index for households with and without disabilities, grouped by the average precipitation quintile in each district. The figure shows that in the five quintiles, households with disabilities present lower resilience than households without such members.



**Fig 2. Average resilience index for households with and without members with disabilities at the district level.**

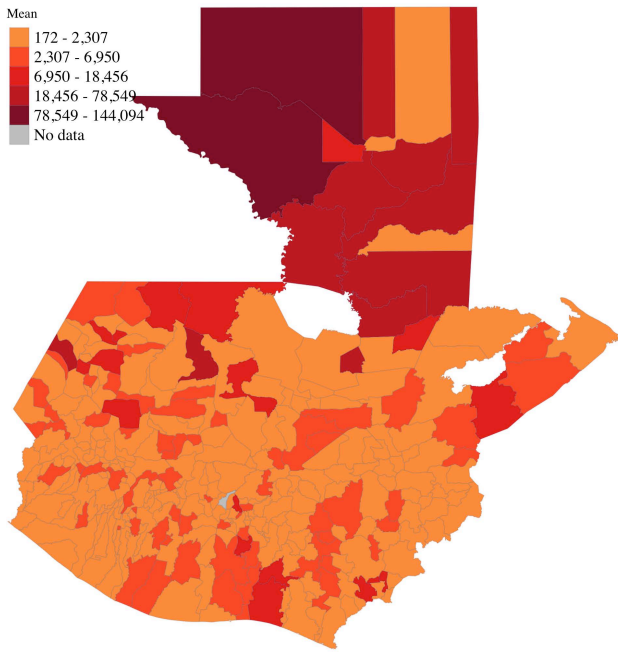
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### 3.2 Regression analysis

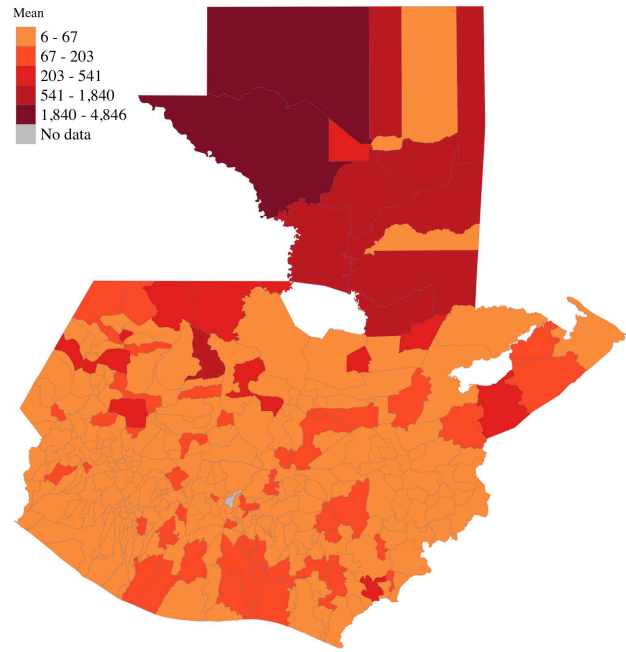
To analyse whether households with members with disabilities have lower levels of resilience, and whether this is associated with the district where they live, we estimated different regression models using wet days, total precipitation, and wet day intensity. Table 3 presents the results of estimating the regression model when considering the association between living in a household with at least one member with a disability and the resilience index. In all models, there is a negative association between disability and resilience, with a reduction of 0.011 pp in the resilience index of a household if that household has a member with a disability compared to households without members with disabilities (column 1 and 3) and a reduction of 13.7 per cent when the household has an increase in one percent in the disability functionality index.

When we analysed the association between resilience and living in a district where the average number of wet days, the average intensity of wet days, or the average precipitation was larger than the mean of the same indicator at the national level, we found that in all models, there is a negative association between the resilience index and the place of residence, with a reduction in 0.03 pp in the resilience index, when the households was located in districts where the number of wet days was higher than the national average; -0.021 if it was located in a district where the average precipitations was higher than the national average and -0.023 if it was located in a district where the intensity of wet days was higher than the annual average (Table 4). The results of analysing the interaction between disability and the three environmental variables revealed that households with disabilities are more likely to have lower resilience in districts where the environmental variable's value was higher than the national average, compared to households without members with disabilities.

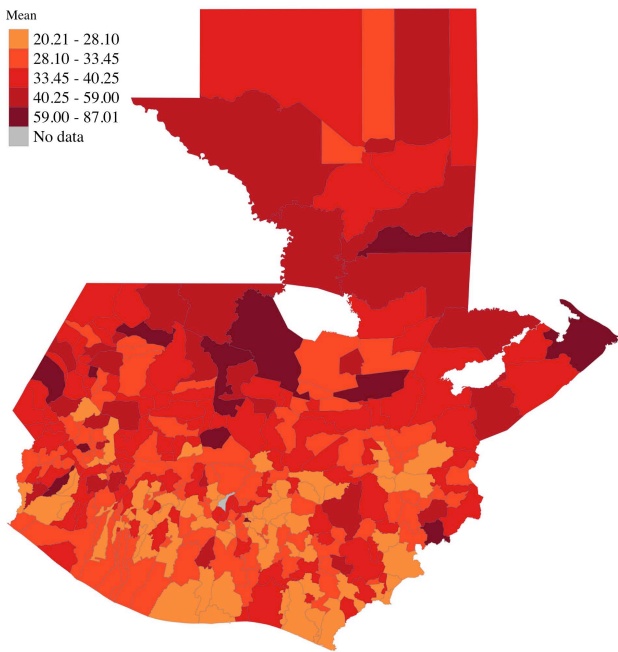
When we computed similar models using the variable for households with at least one member with any difficulty (including people who reported some and at least one functional difficulty), we found that households with at least one member with any difficulty present a negative and significant association with the resilience index. The interaction between disability and the environmental variable was always negative and significant, after controlling for other variables. Thus, households with members who experience any difficulty living in districts with higher average precipitation,



(a) Average precipitation days



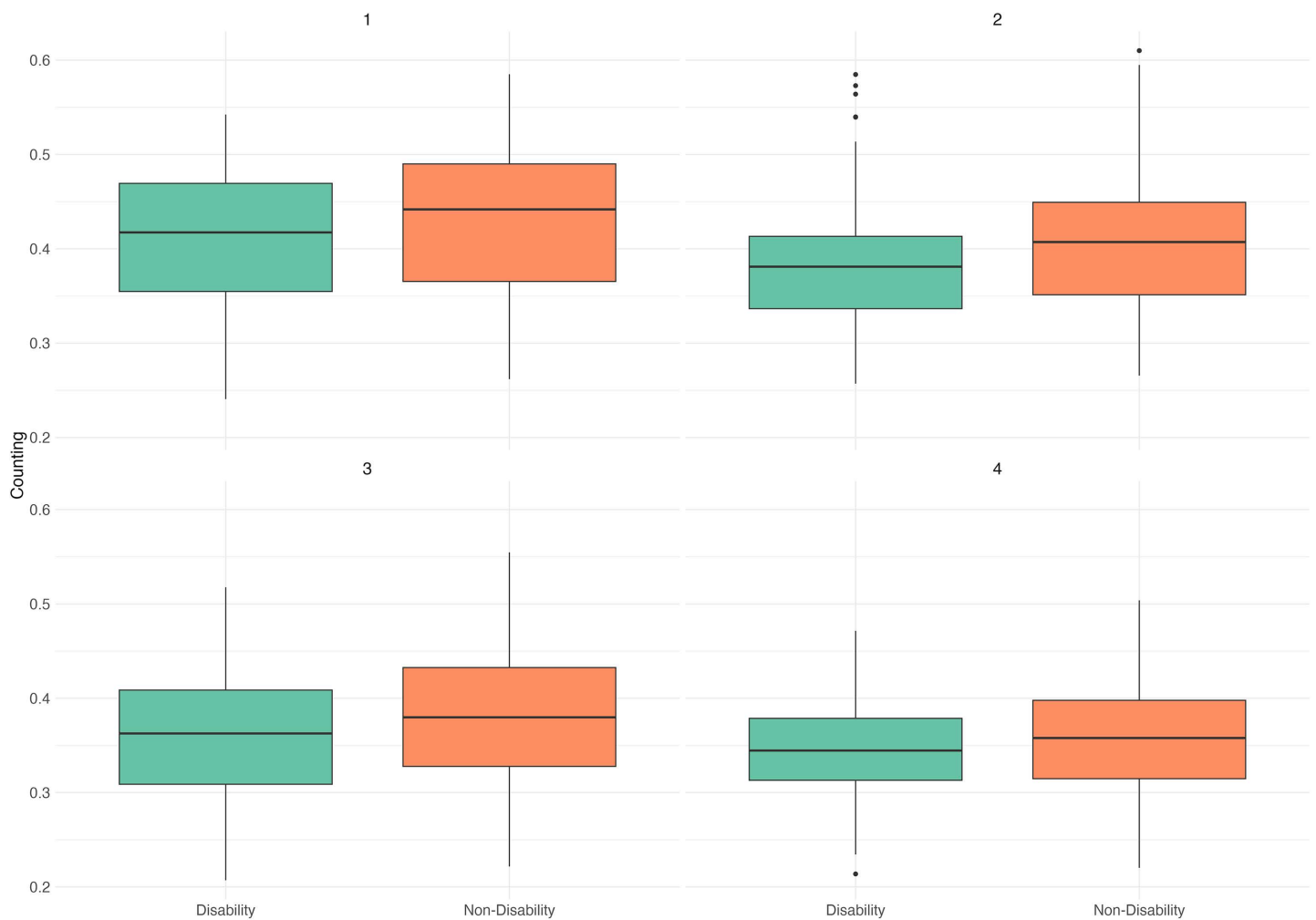
(b) Average intensity of wet days



(c) Average number of wet days

**Fig 3. Distribution of environmental variables by district in Guatemala.**

<https://doi.org/10.1371/journal.pclm.0000712.g003>



**Fig 4. Average precipitation and resilience index for households with disabilities by quintile of precipitation.**

<https://doi.org/10.1371/journal.pclm.0000712.g004>

**Table 3. Results of the regression of the Resilience Climate Index (RCI), Environmental Variables and Disability in the Household.**

	(1) RCI	(2) Log(RCI)	(3) RCI	(4) Log(RCI)
Disability at least a lot difficulty in the household	-0.011*** (0.000)		-0.011*** (0.000)	
Log(Disability functionality index)		-0.178*** (0.002)		-0.137*** (0.001)
Households Controls			✓	✓
Department Controls			✓	✓
Observations	14,802,116	14,810,434	14,802,116	14,810,434

<https://doi.org/10.1371/journal.pclm.0000712.t003>

a higher number of wet days, or a higher intensity of wet days were more likely to have lower resilience than households without members with disabilities in the same districts (S1 Table). In addition, we estimated the regression models using different environmental variables, such as the average length of wet spells or the number of wet spells, and similar results were identified. Thus, households with disabilities are more likely to have lower resilience, and if they live in districts with higher environmental variables than the national average, they are associated with even lower resilience (S2 Table).

**Table 4. Regression results for the resilience index on disability in the household.**

	(1)	(2)	(3)	(4)
<b>Panel A: Wet Days</b>				
Disability at least a lot difficulty in the household = 1	-0.021*** (0.000)	-0.022*** (0.000)	-0.023*** (0.000)	-0.013*** (0.000)
I[r(mean)>Wet Days]=1	-0.049*** (0.000)	-0.007*** (0.000)	-0.006*** (0.000)	-0.003*** (0.000)
Disability at least a lot difficulty in the household = 1 × I[r(mean)>Wet Days]=1	0.020*** (0.000)	0.013*** (0.000)	0.013*** (0.000)	0.006*** (0.000)
<b>Panel B: Precipitations</b>				
Disability at least a lot difficulty in the household = 1	-0.015*** (0.000)	-0.018*** (0.000)	-0.018*** (0.000)	-0.012*** (0.000)
I[r(mean)>Precipitations]=1	-0.087*** (0.000)	-0.024*** (0.000)	-0.028*** (0.000)	-0.021*** (0.000)
Disability at least a lot difficulty in the household = 1 × I[r(mean)>Precipitations]=1	0.009*** (0.000)	0.009*** (0.000)	0.008*** (0.000)	0.005*** (0.000)
<b>Panel C: Intensity Wet</b>				
Disability at least a lot difficulty in the household = 1	-0.015*** (0.000)	-0.019*** (0.000)	-0.019*** (0.000)	-0.012*** (0.000)
I[r(mean)>Intensity Wet]=1	-0.099*** (0.000)	-0.033*** (0.000)	-0.037*** (0.000)	-0.023*** (0.000)
Disability at least a lot difficulty in the household = 1 × I[r(mean)>Intensity Wet]=1	0.012*** (0.000)	0.012*** (0.000)	0.012*** (0.000)	0.007*** (0.000)
Household Controls		✓	✓	✓
Province Controls			✓	✓
Environmental Controls				✓
Observations	14,802,116	14,802,116	14,802,116	14,802,116

<https://doi.org/10.1371/journal.pclm.0000712.t004>

We also analysed whether living in a household with disabilities and the resilience index by quartiles of the distribution of the environmental variable (intensity of wet days, number of wet days, and precipitation). The results revealed that the resilience index was lower in the quartiles with higher precipitation, more wet days, and greater wet-day intensity. It is essential to note that the prevalence of disability is similar across the four quartiles of the environmental variable distribution. When we analysed the coefficient for households with disabilities, we found a negative association, with a 0.9 pp reduction in the resilience index in the fourth quartile of the environmental variable distribution for households with disabilities compared to households without disabilities. In addition, the coefficient associated with living in a household with disabilities changed from -0.012 pp in the lowest quartile to -0.009 pp in the highest quartile, suggesting that the resilience index was more likely to be largest in districts with the lowest values of the environmental variable (Table 5).

Finally, we estimated a similar model using a logarithmic transformation of the disability functionality index and the resilience index. The results suggest that a 1 per cent increase in the disability functionality index is associated with a 17.4 per cent reduction in the resilience index in the first quartile and a 12.5 per cent reduction in the fourth quartile (Table 6).

#### 4 Discussion

The evidence analysing the association between climate change and resilience for households with disabilities is limited. This article aimed to contribute to understanding the levels of resilience of households with disabilities compared to households without disabilities, and how they may vary across districts depending on environmental risks. This article used data from the National Population Census of Guatemala (2018), as well as INSUVIMEH and CHIRPS. The results

**Table 5. Results of resilience index, environmental variables and disability in the household.**

	(1)	(2)	(3)	(4)
	Q1	Q2	Q3	Q4
<b>Panel A: Wet Days</b>				
Disability at least a lot difficulty in the household = 1	-0.012*** (0.000)	-0.010*** (0.000)	-0.012*** (0.000)	-0.009*** (0.000)
<b>Panel B: Precipitations</b>				
Disability at least a lot difficulty in the household = 1	-0.012*** (0.000)	-0.010*** (0.000)	-0.011*** (0.000)	-0.009*** (0.000)
<b>Panel C: Intensity Wet</b>				
Disability at least a lot difficulty in the household = 1	-0.012*** (0.000)	-0.010*** (0.000)	-0.011*** (0.000)	-0.009*** (0.000)
Households Controls	✓	✓	✓	✓
Province Controls	✓	✓	✓	✓
Environmental Controls	✓	✓	✓	✓
Prevalence Disability	2.7%	2.69%	2.88%	2.47%
Percentage of Households with People with Disability	9.710%	9.85%	10.25%	9.6%
Average Resilience Climate Index	43.89%	39.74%	43.17%	35.22%
Observations	4,197,846	3,409,732	4,599,944	2,594,594

<https://doi.org/10.1371/journal.pclm.0000712.t005>

**Table 6. Results of the Log Log regression.**

	(1)	(2)	(3)	(4)
	Q1	Q2	Q3	Q4
<b>Panel A: Wet Days</b>				
Log Disability	-0.174*** (0.002)	-0.163*** (0.003)	-0.103*** (0.003)	-0.125*** (0.003)
<b>Panel B: Precipitations</b>				
Log Disability	-0.146*** (0.002)	-0.126*** (0.003)	-0.124*** (0.003)	-0.164*** (0.003)
<b>Panel C: Intensity Wet</b>				
Log Disability	-0.147*** (0.002)	-0.116*** (0.003)	-0.146*** (0.003)	-0.146*** (0.003)
Households Controls	✓	✓	✓	✓
Department Controls	✓	✓	✓	✓
Climate Controls	✓	✓	✓	✓
Resilience Climate Index	49.08%	38.75%	36.45%	40.43%
Observations	3,731,560	3,679,260	3,717,753	3,641,772

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of the analysis revealed that households with at least one member with disabilities present lower levels of resilience in comparison to households without members with disabilities, and most importantly if those households were living in a district with levels of precipitation, wet days or intensity of wet days higher than the average of the country their levels of resilience were even lower compared to the ones of households without disabilities in the same district. Thus, households with disabilities are at higher risk of having lower levels of resilience, which might reduce their well-being and prevent them from overcoming environmental shocks in Guatemala.

The analysis demonstrates that households with disabilities generally exhibit lower levels of resilience, placing them at heightened risk of environmental shocks. While the average reductions appear modest (0.011 pp), the log-log models

reveal that resilience can decline by as much as 13.7 per cent. These findings underscore the disproportionate vulnerability of households with disabilities to climate-related hazards, aspect that has been recognised in the literature of disability and climate [22,4,23,24]. This evidence highlights the urgent need to prioritise households with disabilities within environmental and climate adaptation policies. Strengthening their resilience requires targeted strategies that explicitly address their needs and ensure equitable access to resources and protective measures as suggested by different international organizations [6]. Such inclusion is essential not only for mitigating the adverse impacts of climate change and for advancing rights-based approaches in climate and environmental policies.

Although districts with higher precipitation are not the ones with the highest prevalence of disability, living in such districts reduces households' resilience. In addition, households with members with disabilities in those districts are more likely to have lower levels of resilience compared to households without members with disabilities. Thus, they are poorer and more deprived than other households and are at higher risk of experiencing larger reductions in their well-being when affected by a climate or environmental shock. This finding is similar to that of Hanass-Hancock et al. (2023) [15], which analysed the levels of multidimensional poverty among people with and without disabilities. It was found that, in general, people with disabilities in Guatemala face higher levels of poverty and deprivation compared to other households.

In addition, districts that experienced higher precipitation, more wet days, or greater wet-day intensity were more likely to exhibit lower resilience. Thus, poorer people are more likely to live in places that are less likely to recover from an environmental shock [25]. Therefore, given that people with disabilities are more likely to be poor, their capacity to overcome the adverse effects of an environmental shock is lower than for other groups. This finding is related to what other authors have identified in Latin America and Guatemala [26,15], and is also associated with the high levels of vulnerability that people with disabilities face in becoming impoverished. This finding reveals the need to articulate climate and poverty policies to protect people with disabilities and guarantee their rights. It is necessary to establish adaptive social protection policies that are inclusive and prioritise this group, aiming to provide support to people with disabilities and their families and guarantee that climate or environmental shocks are not a cause of poverty or impoverishment for these families.

Climate policies in Guatemala need to include strategies for people with disabilities and recognise their specific needs. According to Jodoin et al. (2025) [4], only 17 of 195 countries mentioned the need to disaggregate data collection regarding the impact of climate change on marginalised groups, including people with disabilities. This is fundamental to understanding the real effect of climate shocks on the living standards of this group and their families. In this study, we identified a significant association between households with members with disabilities and those living in districts where precipitation, the number of wet days, or the intensity of wet days exceeded the national average. Nevertheless, it was not possible to analyse whether people with disabilities present a higher risk or are more affected by environmental shocks than people without disabilities. Thus, it is essential to have data that enables the study of the impact of climate shocks on the living standards of people with disabilities and their families in Guatemala and other countries affected by climate change.

We used precipitation, the number of wet days, and the intensity of wet days as the main environmental variables to capture the potential risk of floods in the country [19,21]. Additionally, we included information on the accumulation of flood risk, utilising data on average precipitation, the number of wet days, or the intensity of wet days over the past 10 years. This information allowed us to control for the potential cumulative adverse effect of precipitation on households. Although these variables did not yield relevant results, they provide essential information to understand whether households can accumulate shocks or cope with new ones in the future.

Research on climate and vulnerability has expanded in recent years [27,28,29]. However, much of this work remains limited, focusing primarily on vulnerable sectors [30], indigenous populations [31], or vulnerability in general [28,32,27]. Within this literature, people with disabilities have not been explicitly examined, which restricts the available evidence to understand how climate impacts their lives in the region. This study seeks to address that gap by providing evidence on the lower levels of resilience among people with disabilities and their families, as well as the heightened risks they face when confronted with climate-related shocks.

The results of this analysis reveal vital information to support the association between climate and resilience for people with disabilities and their families; however, it has some limitations. The first one is the source of data used to analyse this association. We were unable to identify a source of information that measured the extent to which people with disabilities and their families have been affected by floods in Guatemala. Second, we measured precipitation, wet days, and the intensity of wet days as proxies for floods; however, we were unable to identify a source of information that would allow us to analyse whether this group has faced environmental shocks in Guatemala. Given the study design, it was not possible to examine the causal effects of environmental shocks on the resilience of households with disabilities; therefore, we were only able to analyse the association between climate and resilience among people with disabilities in Guatemala. Finally, since we do not have information for the same period or unit of analysis, we assume that the living conditions of households with and without members with disabilities in 2018 were, on average, equal throughout the year to those observed at the time of data collection in the Census. Also, the census was conducted over a month, which could affect the comparability and reliability of the data across districts.

## 5 Conclusion

This study provides the first empirical analysis of the association between climate and resilience among households with members with disabilities in Latin America, thereby addressing a critical gap in the literature on climate vulnerability in low- and middle-income countries. The findings reveal that households with disabilities in Guatemala demonstrate systematically lower levels of resilience compared to households without disabilities, particularly in districts experiencing above-average precipitation or a greater number of wet days. These results underscore the disproportionate exposure and limited adaptive capacity of households with disabilities in the face of climate-related hazards. By situating disability within the broader discourse on climate resilience, this study advances understanding of the intersection between social vulnerability and environmental stressors. The evidence highlights the necessity of integrating disability considerations into climate adaptation frameworks, not only to strengthen household-level resilience but also to ensure equity in policy design and implementation. Future research should extend this analysis to other contexts in Latin America and beyond, exploring the mechanisms through which disability interacts with climate risk and resilience, and evaluating the effectiveness of inclusive adaptation strategies. Such work is essential to inform evidence-based policies that uphold the rights of people with disabilities and promote resilience in the face of escalating climate challenges.

## Supporting information

### **S1 Table. Results of resilience index, environmental variables and disability in the household.**

(DOCX)

### **S2 Table. Results of resilience index and disability in the household.**

(DOCX)

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