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Do climate shocks disadvantage household investment in human capital in Benin? An approach based on the endogenous treatment regression model

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Abstract

The increasing number of drought and flood shocks in Benin is causing considerable economic losses and social disruption. This article looks specifically at the effects of these shocks on household human capital expenditure in Benin's three climatic zones, to highlight the effects specific to each zone. The data used come from the Harmonized Survey of Household Living Conditions. A linear regression model of the endogenous treatment is used for the analyses. Findings indicate that climate shocks reduce household capital expenditure and that this impact depends on the household's climatic zone of residence. Investment in resilience infrastructure is suggested, as is a policy of social assistance to disaster-stricken households.

Keywords: Climate shock, Human capital, Endogenous treatment, Climatic zones, Benin

Introduction

Human capital is an important element in the socio-economic development process of countries, as it induces productivity gains (Kafando, 2021). Indeed, differences in investment efforts in human capital formation are generally used in economic literature to explain disparities in wealth levels between countries. Thus, the wealthiest regions are those that have invested massively in human capital, particularly in the health and education of their populations. Investment in human capital helps to build up a stock of human resources capable of innovating, adopting new technologies more quickly, taking an active part in the economic growth process, and, above all, increasing their capacity to generate income (Berthélemy, 2008; Unterhalter, 2009, 2012).

The world's economies, and especially developing countries', are exposed to recurring climatic shocks affecting their capacity to generate income and investment (Hallegatte and Théry, 2007). For Baez et al. (2010), climate shocks affect the education and health system through the destruction of health centers and schools. Furthermore, Caruso et al. (2023) indicate that manifestations of climate change affect economic systems, markets and income-generating activities. These in turn have consequences for investment and the development of human capital. The ability of households to invest in their education or training and to adapt to climate shocks is affected by the deterioration of health infrastructures as a result of climate shocks. Caruso et al. (2023) shows that human capital plays a vital role in effective mitigation and adaptation to climate shocks. Households with low levels of human capital are more exposed to climate shocks.

Since the work of Schultz (1961), there has been a need to direct substantial resources towards investment in human capital, particularly in developing countries, in order to strengthen their resilience. Human capital refers to “the set of productive capabilities that an individual acquires through the accumulation of general or specific knowledge, know-how, etc.” (Becker, 1992). It is essentially acquired by investing in education and health. According to the classics, individuals contribute to growth through their know-how, cultural and intellectual endowment, acquired mainly through their level of education, which makes them more productive and efficient, improving their output (Lamzihri et al., 2023). Muttarak and Lutz (2014) as well as Kafando (2021) have shown that investment in human capital, particularly in education and health, significantly reduces income inequality and poverty, and can reduce vulnerability and improve resilience to natural disasters.

Benin is characterized by three climatic zones and is frequently subjected to climatic shocks. It is the 16th most vulnerable country to climate change (Banque Mondiale, 2023). The main climatic shocks identified in the country are drought, floods, violent winds, excessive heat and rising sea levels. Their impacts are very significant, and are characterized by degradation of natural resources, displacement of populations, coastal erosion and disruption of economic activities, especially farming, with increasingly heavy economic and social costs (Teka et al., 2022; MCVDD, 2021). In 2010, 620 schools through the country were declared flood-affected, including 577 primary and nursery schools and 43 secondary schools. With regard to the state of infrastructure, rapid assessment missions have revealed that around 9.8% of public school buildings (all school levels combined) have been affected by flooding (Hountondji, 2022). These various effects can influence the allocation of household economic resources and impact human capital expenditure.

The aim of this article is to assess the impact of climate shocks on household human capital expenditure in Benin. Its motivation stems from the fact that most studies (Lokonon and Mbaye, 2018 ; Soglo and Nonvide, 2019 ; Akpa et al., 2024) have highlighted in terms of mitigation or adaptation, the vulnerability of agriculture-based livelihood systems to climate shocks (Lokonon, 2019), the effect of climate change on agricultural productivity or yield or income (Hounnou et al., 2019) while obscuring its impact on human capital investment. To fill this gap, this article adopts a climate-zone analysis approach that isolates impacts according to the specific characteristics of each zone, to apprehend the effect of drought and flooding on household spending on education and health. To do this, he uses a methodology based on a linear regression model of endogenous treatment and concludes that drought reduces human capital expenditure in the Sudanian and Sudano-Guinean zones but increases it in the Guinean zone. As for flooding, it reduces human capital expenditure in all three climatic zones, although the effect is not significant in the Sudanian zone.

The concept of human capital (Schultz, 1961; Becker, 1964), postulates that the skills acquired by the individual in the course of his training distinguish him and make him a rare resource (Vignolles, 2013). Marshall (1894) explains that this scarcity is compensated by the individual's training efforts. Becker (1964) shows that households allocate an investment to their training, making a trade-off between the expected benefits of years of education and the implicit costs: direct costs linked to the financing of training and the opportunity costs arising from the fact that years of training are as many years not worked and therefore not paid for the individual. According to Spence (1973), investment in human capital is in fact a way for individuals to signal their abilities to firms, rather than increasing them.

Indeed, individuals with certain capabilities find it easier to acquire knowledge. As a result, only the most productive individuals will find it profitable to make this investment. This selection thus serves as signal to people's abilities (Vignolles, 2013). Beyond being a means for each individual to improve his or her personal economic situation, it is seen as an outcome enabling societies as a whole to be able to capture and use the knowledge and know-how that circulates. As such, any shock that reduces households' ability to spend on human capital would be detrimental to them. The debate on the relationship between climate shocks and human capital has been well-founded in the literature, given the growing number of damaging extreme weather events. Two channels of effect emerge from this debate: direct and indirect.

Direct effects take into account the destruction and depletion of physical and human capital. The destruction of physical capital, such as schools, health centers and household assets, is cited, as is the destruction of human capital, in terms of death, disability, illness and injury (Caruso et al., 2023; Cuaresma, 2010; McDermott, 2011; Sellers and Gray, 2019). Indeed, the direct consequences of climate shocks include injuries and illnesses that prevent people from attending school. In addition, death, which translates into a loss of previous investments in human capital, and the outbreak of disease or epidemics, result from the unhealthy conditions engendered by the shocks. The destruction of physical and human capital increases the marginal cost of acquiring human capital (Baez & De La Fuente, 2010), which will deteriorate its future accumulation and, consequently, the social development potential of the affected regions (Amaya, 2020). Floods and droughts have a direct impact on food crops, livestock and, consequently, food security. Climate shocks can also affect people's mental health and well-being (Caruso et al., 2023).

Climate shocks have also been shown to impact on the educational achievement of individuals, particularly children. Evidence of the negative impacts of climate shocks is highlighted by Cho (2017). He notes that heat waves would reduce performance in university entrance exams. Goodman (2014) further shows that snowfall can disrupt learning by selectively promoting absenteeism among different groups of students. Peet (2021) also finds in the same vein that climatic shocks affect student performance and labor market outcomes. Psacharopoulos and Patrinos (2018) have shown that schooling is important for individual well-being. The effect of climate shocks on human capital in this case is twofold. The first is on schooling, which in turn has an impact on individual well-being.

The indirect effects of climate shocks on human capital are linked to decisions made by households after their occurrence (McDermott, 2012; Valencia Amaya, 2020). Indeed, the loss of household assets, as well as health effects (illness or death), which could potentially reduce their time available to generate income, as well as migration and/or evacuation decisions, reduce household income (Baez and De La Fuente, 2010; Cuaresma, 2010; McDermott, 2011). The destruction of infrastructure caused by climate shocks will require investment decisions on the part of households but will be faced with a lack of financial resources. In such a situation, households will be forced to sell off productive assets to cope with the shock, trapping themselves in a vicious circle. The reduction in productive assets will diminish their capacity to generate income in the future, making them more vulnerable to future climate shocks (McDermott, 2011). Consequently, these income shocks will lead households to reduce their investment in human capital accumulation (consumption of food, health services and education) (Caruso et al., 2023; Amaya, 2020).

Drought induces an income effect whereby households with limited means to smooth consumption disinvest in their children's human capital (Joshy, 2019) In the same vein, Khalili et al. (2021) have shown that households affected by severe drought reduce their health spending more than less-affected households. Food expenditure is also affected by climatic shocks. Drought, for example, has been shown to reduce food consumption by affected households. This jeopardizes their food security and weakens their human capital. Carpena (2019) finds that households spend 1% less per person per month on food. However, other findings suggest that people affected by drought and floods see their healthcare expenditure increase significantly due to the deterioration in their health caused by these shocks (Lohmann and Lechtenfeld, 2015).

Empirical studies provide evidence of the effects of climate shocks on human capital, whether direct or indirect. The main point is that this evidence supports the fact that the net effect of direct and indirect impacts is strongly negative and long-lasting. It should also be noted that very few studies have directly addressed the differential effects according to the characteristics of each climatic zone. In this respect, Sherval et al. (2023) indicate that the impact of climatic shocks can vary considerably from one geographical region to another within the same country. To this end, they recommend a region-specific analysis to build resilient communities in the face of today's climatic extremes.

Methods

Empirical model and definition of variables

To analyze the impact of climate shocks on household human capital expenditure, the model below is used, in a context where households are faced with drought and/or flood. Let the equation be :

$$Dch_i = \beta_1 + \beta_2 chocs_i + \beta_3 X_i + \varepsilon_i \quad (1)$$

Dch_i denotes the human capital expenditure of household i in a given climate zone. $chocs_i$ refers to drought and flood shocks suffered by households; X_i represents the vector of control variables, mainly household characteristics. ε_i represents the error term. Human capital expenditure includes household spending on education and health. Climate shocks are essentially in the case of this work, drought and floods, as being the most recurrent climate shocks experienced by households. The variable $chocs$ is defined as follows :

$$drought = \begin{cases} 1: & if\ the\ household\ is\ affected \\ 0: & If\ not \end{cases}$$

$$flood = \begin{cases} 1: & if\ the\ household\ is\ affected \\ 0: & If\ not \end{cases}$$

The control variables are described in the following Table 1:

Table 1: Definition and measurement of control variables

Description	Modalities/Nature	Justification
Age of head of household	Continuous quantitative variable expressed in years	It can have both a positive and a negative effect on human capital expenditure. This is confirmed by the work of Cutler (1998), who shows that changes in disability and mortality trends reduce medical expenditure for the elderly.
Sex of head of household	0- Male 1- Female	-
Marital status of head of household	0- Single 1- Married 2- Divorced 3- Widowed	Married heads of household may spend more on human capital, as they often have more dependents.
Level of education	0- No level 1- Primary level 2- Secondary level 3- Higher education	An individual's level of education can enhance his or her understanding of human capital issues and therefore influence human capital spending. Also, a higher level of education would require more spending and therefore increase the individual's human capital expenditure.
Household size	Quantitative variable (number of people living in the household)	It can have an impact on the household's human capital expenditure, depending on the presence of children under five (05) years of age and the elderly.
Salary income	Continuous quantitative variable expressed in FCFA	The level of household income strongly influences household spending and coping strategies.
Place of residence	0- Urban 1- Rural	Residence (urban or rural) is also an important variable in assessing human capital expenditure. Living in an urban environment can help reduce healthcare costs, thanks to the proximity of access to healthcare or education services. Also, the availability of sanitary infrastructures, drinking water supply and access to electricity, etc., can reduce the risk of disease.

Well-being	Quantitative variable	Average annual per capita consumption is used to construct this indicator. It takes into account food and non-food consumption of non-durable goods and services, the use value of durable goods and the imputed rent of owner-occupied households and those housed free of charge, thus reflecting the population's standard of living.

Source: Authors, 2024

Estimation strategies

The fact of being affected by climatic shocks or not is not voluntary and may be based on self-selection. In fact, it may depend on certain variables such as living conditions, living environment, location, etc. These specificities may influence the probability of being affected by shocks, leading to self-selection. These specificities can influence the probability of being affected by shocks, resulting in inconsistent and biased estimates. Several techniques are used in the literature to correct this bias. Among others, the Heckman selection model (Pham and Talavera, 2018), the Propensity Score Matching Method (PSM) (Dutta and Banerjee, 2018; Liu et al., 2021), the regime-switching model (Assouto and Houngbeme, 2023; Ifecro et al., 2022). These techniques are widely used in the empirical literature to address endogeneity issues.

The linear regression model with endogenous treatment effects or endogenous treatment regression model is adopted in the case of this article. It uses a linear model for outcome, and a normal distribution and allows a specific correlation structure between unobservable variables affecting treatment and those affecting potential outcomes. Heckman (1978) introduced this model to the modern literature. Maddala (1983) also reviews some empirical applications and describes it as an endogenous switching model. Formally, the endogenous treatment regression model is composed of an equation for the outcome y_j and an equation for the endogenous treatment t_j. Variables X_j are used to model the result. When there are no interactions between t_j and X_j , we have :

$$y_j = X_j\beta + \delta t_j + \epsilon_j \qquad (2)$$

$$t_j = \begin{cases} 1, & if\ w_j\gamma + u_j > 0 \\ 0, & if\ not \end{cases}$$

where w_j are the covariates used to model treatment allocation, and the error terms j and u_j are bivariate normal with zero mean. This model can be generalized to a potential outcome model with separate variance and correlation parameters for treatment and control groups. The generalized model is:

$$y_{0j} = X_j\beta_0 + \delta t_j + \epsilon_{0j}$$
$$y_{1j} = X_j\beta_1 + \delta t_j + \epsilon_{1j} \quad (3)$$
$$t_j = \{1, \quad if\ w_j\gamma + u_j > 0\ 0, \quad if\ not$$

where y_{0j} is the result that the household j is not affected by shocks the treatment 0, and y_{1j} if it is affected. It is not observed at the same time y_{0j} and y_{1j} but only one or the other. It is observed :

$$y_j = t_j y_{1j} + (1 - t_j)y_{0j} \quad (4)$$

When there are no interactions between the treatment variable and the covariates, the model directly estimates the average treatment effect on the treated (ATT) and the average treatment effect (ATE). The model is estimated with the maximum likelihood estimator.

Data

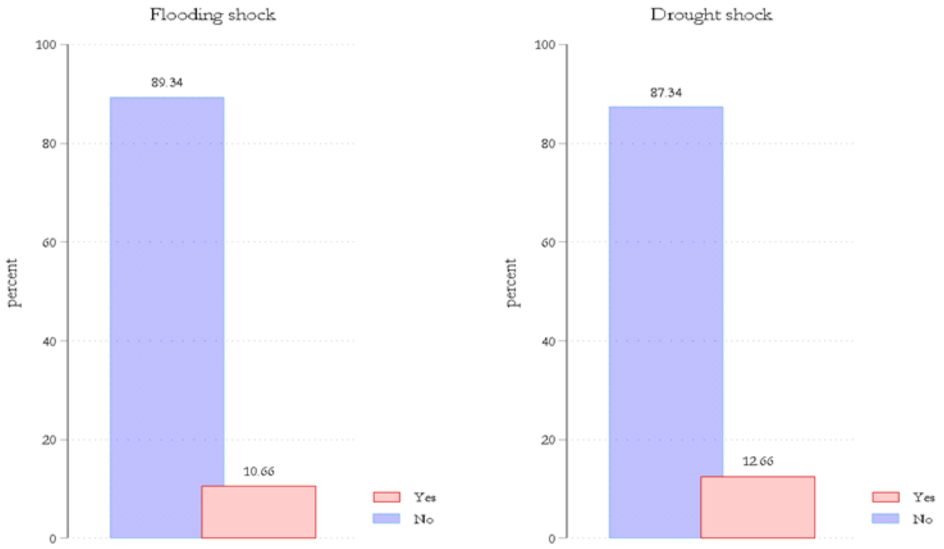
The data used in this study come from the "*Enquête Harmonisée sur les Conditions de Vie des Ménages (EHCVM)".* This is a nationally representative survey conducted in two waves in 2018 and 2019 with financial support from the World Bank and in collaboration with the WAEMU Commission. It is the result of harmonization within the WAEMU, with the same sampling plan being used within each country for data collection. The methodological approach consists of two-stage stratified random sampling. Each region is subdivided into urban and rural parts to form the sampling strata. It provides information on savings, consumption expenditure, food security, production, climate and income shocks, etc... The unit of analysis here is the household. In total, the analysis covered 8012 households spread over three climatic zones.

Results

Presentation and descriptive analysis of data

The first step was to take stock of some of the model's categorical variables in relation to climate shocks, and the second was to analyze the central and dispersion trends of the continuous variables. The following tables and figures illustrate the results.

Figure 1: Descriptive statistics for climate shocks



Source: Authors, 2024

Analysis of the graph shows that around 10.66% of households were affected by flooding, compared with 89.34%. A significant proportion of households were therefore affected by the floods. In addition, households were more affected by the drought, as evidenced by the affected household rate of 12.66% versus 87.34% of unaffected households.

Figure 2: Flood and drought shock by climatic zone

Fig 2.a : Flooding shock

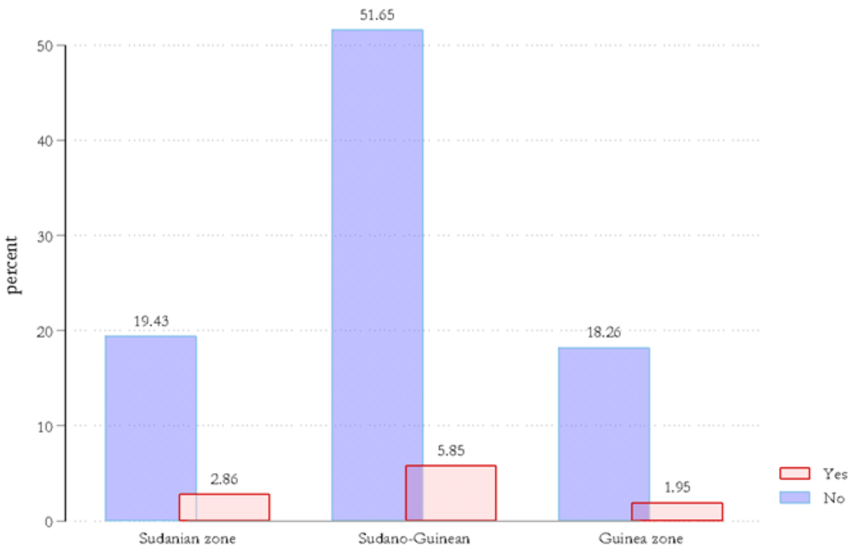
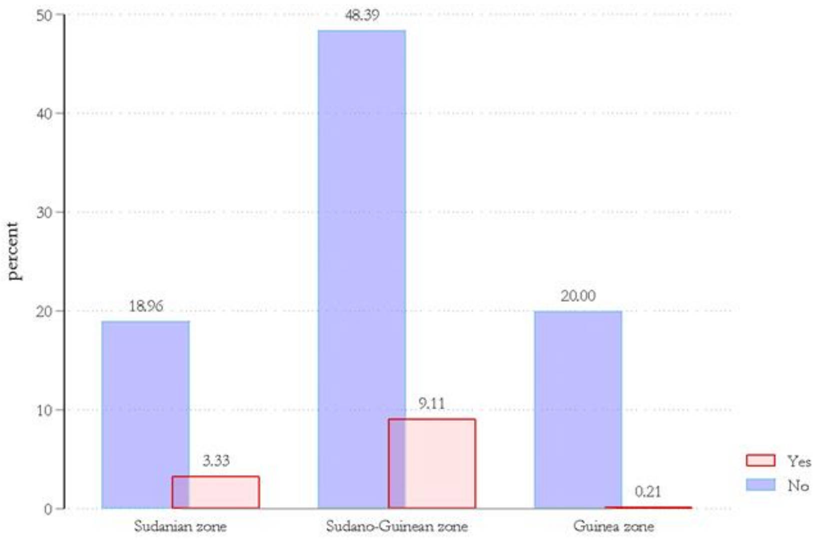


Fig 2.b : Drought shock



Source : Authors, 2024

The graph above shows that the Sudano-Guinean climatic zone (54.92%) is the one most affected by flood. It is followed by the Sudanian zone (26.81%) and, lastly, the Guinean zone (18.27%). As for drought, the Sudano-Guinean climatic zone (71.99%) is also the one most affected by flooding. It is followed by the Sudanian zone (26.33%) and lastly by the Guinean zone (1.68%). The Sudano-Guinean zone is therefore the most affected by climatic shocks.

Table 2 shows that, on average, expenditure on human capital investment in households unaffected by drought and floods is estimated at 20,007.36 CFA francs and 19,045.919 CFA francs respectively. Each drought- and flood-affected household spends an average of 9,356.998 and 15,420.157 respectively on human capital expenditure (education and health). This shows that households affected by climate shocks spend on average less on their human capital than unaffected households. This pattern is also observed when looking separately at health and education expenditure. These statistics therefore reveal a negative effect of climate shocks on household spending on human capital. The econometric results will enable us to examine this effect in greater depth.

Table 2 : Descriptive statistics of human capital expenditure (FCFA)

	Flood		Drought	
	Mean	**Std.dev**	**Mean**	**Std.dev**
No				
Health expenditure	7 536.442	30 514.709	7 805.886	31 030.002
Education expenditure	11 509.477	48 001.385	12 201.473	49 627.541
Total expenditure on human capital	19 045.919	58 546.844	20 007.36	60 105.810
Yes				
Health expenditure	7 331.457	32 632.124	5 504.261	28 637.125
Education expenditure	8 088.7	33 102.344	3 852.737	11 743.473
Total expenditure on human capital	15 420.157	45 979.711	9 356.998	308 97.862

Source : Authors' calculations, 2024

Econometric analysis and discussion of results

Table 3 shows the regression results considering drought shocks. Analysis of the results in the table shows that drought reduces human capital expenditure in the overall sample, as well as in the Sudanian and Sudano-Guinean zones. The opposite effect is observed in the Guinean zone. The negative effect is more pronounced in the Sudano-Guinean zone, amounting to 31,051.164 FCFA, as opposed to 8,446.350 FCFA in the Sudanian zone at the 1% threshold. Households in the Sudano-Guinean zone therefore suffer more from the degrading effect of drought on their investment in human capital. The likelihood ratio test (rho) indicates rejection of the null hypothesis of no correlation between drought assignment errors and outcome errors (human capital expenditure). The positive sign indicates that unobserved variables that reduce observed human capital expenditure tend to occur with unobservable variables that favor being affected by drought. This reveals that the decline in human capital expenditure can be explained by any parameter that increases the probability of being affected by drought.

The results also reveal that living in rural areas increases the probability of being affected by Sudanian and Sudano-Guinean drought. This in turn would lead to lower capital expenditure. This result makes sense, given that farming is more common in rural areas. Drought would have an impact on agricultural yields and therefore on expected household income. Under these conditions, the drop-in income may explain the drop in human capital expenditure. It may also be due to the coping strategies adopted by households. Indeed, as a coping strategy, households may take their children out of school, or opt for traditional, non-formal health care. This argument is supported by the work of Joshi (2019), which reveals that there is an income effect whereby households with limited means to smooth their consumption disinvest in their children's education in response to drought. The present results are in line with those of Khalili et al. (2021), who showed that drought has a significant negative impact on the health expenditure of mainly agricultural households. They explain that, in response to a severe drought, households are more likely to reduce their spending on human capital, particularly health, than less-affected households. This would justify the drop in human capital expenditure observed.

However, the negative sign of rho obtained in the case of the Guinean zone indicates that unobserved variables that increase observed human capital expenditure tend to occur with unobservable variables that disadvantage being affected by drought. This reveals that the increase in human capital expenditure is explained by all variables decreasing the probability of being affected by drought. This is explained by the fact that the Guinean zone is the most urbanized. As a result, agriculture is not the dominant activity. Exposure to drought is explained by economic well-being and wage income. Less well-off households are the ones who suffer from drought. The consequence is an increase in their expenditure on human capital, which may be due to spending on health care following the deterioration in their health caused by the drought, or to greater investment in education to keep children in school. This result corroborates those of Khalili et al (2020), who found that drought-affected households increased their spending on their children's education because this spending was necessary. In the same vein, Lohmann & Lechtenfeld (2015) reported that drought shocks are dependent on a financial burden for many households. They explain that drought induces an increase in health expenditure from 9% to 17% of total consumption.

Table 3 : Effect of drought on household spending on human capital[1]

Human capital expenditure	Global	Sudanian zone	Sudano-Guinean zone	Guinea zone
Age	285.070***	83.382***	160.418***	569.931***
	(47.170)	(25.339)	(50.269)	(191.502)
Male (ref)				
Female	7 902.810***	-1 254.702	4 615.091*	9 600.972
	(2 467.517)	(2 038.842)	(2 646.749)	(7 931.817)
Household size	384.089*	58.130	391.480	616.178
	(210.366)	(101.523)	(261.923)	(744.090)
None (ref)				
Primary	6 398.905***	2 834.289*	3 222.727***	8 289.062*
	(1 123.876)	(1 461.228)	(1 188.488)	(4 708.944)
Secondary	16 967.523***	8 749.868***	8 324.668***	25 960.075***
	(2 033.007)	(1 627.105)	(1 995.330)	(5 744.707)
Higher	53 041.169***	11 181.894**	35 586.922***	59 532.492***
	(6 444.636)	(5 219.385)	(9 695.479)	(9 989.776)
Single (ref)				
Married	-7 195.732*	-8 177.151**	-6 889.981	-10 616.297

[1] The table shows the average treatment effect on treated (ATT), which is the same as the average treatment effect (ATE) in this case because the treatment indicator variable did not interact with any of the outcome covariates.

Human capital expenditure	Global	Sudanian zone	Sudano-Guinean zone	Guinea zone
	(4 094.224)	(4 047.185)	(4 779.772)	(9 242.725)
Divorced	-6 182.240	-6 984.527*	-5 986.651	-4 321.281
	(4 689.661)	(3 737.558)	(5 399.062)	(12 179.373)
Widowed	-6 573.333	-5 854.163	-9 501.361*	105.933
	(5 030.825)	(3 827.682)	(4 978.010)	(13 844.704)
Flooding	**- 47 417.336*** **	**- 8 446.350*** **	**- 31 051.164*** **	**135 948.545*** **
	(6 497.866)	(1 381.320)	(6 614.668)	(19 685.033)
Flooding				
Well-being	-0.000***	-0.000***	-0.000***	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Rural	0.433***	0.346***	0.296***	0.118
	(0.038)	(0.083)	(0.047)	(0.101)
Salary income	-0.000***	0.000	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
athrho	0.446***	0.207***	0.383***	-2.721***
	(0.070)	(0.034)	(0.074)	(0.454)
lnsigma	10.954***	9.717***	10.705***	11.481***
	(0.058)	(0.069)	(0.092)	-2.721***
Constant	7 242.714	10 797.182**	12 524.342**	-1 523.210
	(4 723.156)	(4 266.702)	(5 554.626)	(12 133.742)

Robust standard errors in parentheses
*** p<0.01 ** p<0.05 * p<0.1
Source : Authors, 2024

Like drought, flood has a negative impact on human capital expenditure. Indeed, Table 4 shows that the flood shock reduces human capital expenditure in all three climatic zones. However, the effect is not significant in the Sudanian zone. A positive effect is therefore observed for the overall sample. The negative effect is more marked in the Guinean zone, amounting to 46,282.635 FCFA, as opposed to 19,706.145 FCFA in the Sudano-Guinean zone. Households in the Guinean zone therefore suffer more from the degrading effect of flooding on their investment in human capital. Taken together, these results corroborate the trends revealed by the descriptive statistics, which showed that, on average, households affected by drought and flood shocks spend less on their human capital than unaffected households.

Table 4 : Effect of flood on household human capital expenditure

Human capital expenditure	Global	Sudanian zone	Sudano-Guinean zone	Guinea zone
Age	252.400***	85.293***	168.767***	693.206***
	(37.085)	(25.639)	(50.874)	(209.452)
Male (ref)				
Female	6 287.393***	-1 228.964	4 260.072	14 053.651
	(1 809.365)	(2 061.053)	(2 686.280)	(8 581.699)

Human capital expenditure	Global	Sudanian zone	Sudano-Guinean zone	Guinea zone
Household size	169.770	36.730	255.904	1 619.531
	(180.568)	(103.091)	(262.830)	(994.498)
None (ref)				
Primary	7 309.973***	2 951.606**	3 608.221***	6 986.012
	(1 104.953)	(1 458.952)	(1 177.451)	(4 572.709)
Secondary	17 309.996***	9 051.640***	9 169.954***	28 211.053***
	(1 606.690)	(1 628.210)	(1 978.863)	(5 911.612)
Higher	48 133.999***	11 613.161**	36 928.195***	67 223.185***
	(5 968.198)	(5 256.511)	(9 614.423)	(10 727.967)
Single (ref)				
Married	-7 101.317**	-8 470.872**	-7 445.980	-13 550.399
	(3 595.880)	(4 047.181)	(4 722.079)	(10 513.524)
Divorced	-5 753.350	-7 177.493*	-6 308.635	-6 440.541
	(3 928.736)	(3 747.248)	(5 415.164)	(14 053.173)
Widowed	-5 300.141	-5 989.607	-9 572.293*	-4 401.452
	(4 070.787)	(3 839.277)	(4 915.835)	(15 521.706)
Flood	**84 193.017*** **	**- 1 729.376**	**- 19 706.145*** **	**- 46 282.635*** *
	(4 740.850)	(2 149.874)	(5 701.173)	(19 367.217)
Flood				
Well-being	0.000	0.000	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Rural	0.061***	0.118	0.493***	-0.118
	(0.021)	(0.086)	(0.057)	(0.130)
Salary income	-0.000***	-0.000*	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
athrho	-1.280***	0.061	0.216***	0.284***
	(0.148)	(0.045)	(0.054)	(0.093)
lnsigma	11.024***	9.711***	10.685***	11.479***
	(0.057)	(0.069)	(0.088)	(0.077)
Constant	-4 994.433	10 022.812**	10 183.197*	-5 546.909
	(3 646.638)	(4 236.988)	(5 341.810)	(12 767.835)

Robust standard errors in parentheses
*** p<0.01 ** p<0.05 * p<0.1
Source : Authors, 2024

To sum up, this article has shown that drought and flood shocks reduce household spending on human capital. Specifically, drought impacts negatively on human capital expenditure in the Sudanian and Sudano-Guinean zones, but positively in the Guinean zone. The highest negative effect is recorded in the Sudano-Guinean zone. This implies that households in the Sudano-Guinean zone suffer more from the degrading effect of drought on their investment in human capital. As for floods, they have a negative impact on human capital expenditure in all three climatic zones, although the effect is not significant in the Sudanian zone. The highest negative effect is felt in the Guinean zone, implying that households in the

Guinean zone suffer more from the degrading effect of floods on their human capital investment. The results also confirm the endogeneity of climate shock variables, thus justifying the method employed.

Conclusions

Improving the resilience and well-being of rural households is of great importance to achieving the sustainable development goal of building resilience by reducing exposure and vulnerability to climate-related extreme events, as well as to other economic, social and environmental shocks. Given the frequency of climatic extremes, this article examines the impact of climatic shocks on household human capital expenditure across climatic zones, based on the context of Benin. It estimates a linear regression model of the endogenous treatment applied to data from the Harmonized Survey of Household Living Conditions.

Analysis of the estimation results shows that drought and floods have a reducing effect on human capital expenditure. A disaggregated analysis according to climatic zone indicates that households in the Sudano-Guinean zone suffer more from the degrading effect of drought on their capacity to invest in human capital, while the effect is more pronounced in the case of flooding in the Guinean zone. Based on these results, it would not be an exaggeration to conclude that climate shocks are detrimental to human capital investment, at least in Benin. Several economic policy implications can be formulated to strengthen household resilience for increased investment in human capital. For example, investment in resilient infrastructure through improved drainage and anti-flood infrastructure in Guinean areas could be a measure to minimize flood damage. Social assistance policies could cushion the impact of these shocks on the human capital expenditure of affected households.

Similarly, diversifying households' economic activities to reduce their dependence on agriculture and increase their resilience to climate shocks, notably by promoting sustainable and organic farming practices that can increase product value and reduce environmental costs, can mitigate the effect of shocks on household income. The development and maintenance of early warning systems can help minimize the negative impacts of drought and floods on households.

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