

Gender-specific analysis of the vulnerability of actors in the pineapple production value chain to climate variability and risks on the Allada Plateau

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Abstract: The frequency and intensity of climate variables as indicators of climate risks are increasingly recognized as a global crisis with a significant impact on the agricultural sector and gender. The objective of this study is to analyze the vulnerability of actors in the pineapple production value chain, by gender, to climate variability and risks on the Allada plateau, in order to propose adaptation and resilience strategies for sustainable production in order to include women in climate risk mitigation measures.

The methodological approach based on the choice of indicators was adopted. A structured questionnaire was used to obtain data from three, six and eight indicators of the three vulnerability components of exposure, sensitivity and adaptive capacity. The data obtained were subjected to linear normalization, calculation of unweighted vulnerability index and descriptive and inferential statistics.

The results showed that the actors of the pineapple production chain, whether men or women, are vulnerable to climate variability and risks on the Allada plateau, but female production actors are more vulnerable (0.30) than their male counterparts with an index of (0.26).

The high vulnerability observed among production actresses is due to their degree of exposure (0.66) against (0.55) for men and their high sensitivity to climate risks (0.56) against (0.54) for men, as well as their low adaptation capacities (0.55) against (0.57) for men.

Keywords: Gender; Vulnerability; Exposure; Sensitivity; Adaptive capacity.

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1. Introduction

Climate risks are environmental hazards that have negative impacts on the agricultural sector, communities and economies as a whole.

According to (Menike L. & Arachchi K., 2016), agriculture appears to be the most sensitive sector to climate risks that affect rural agricultural production and communities. It should be noted that the impact of climate variability and risks on agriculture varies according to crops, regions and seasons, but the overall impact is negative on the sector. Regarding pineapple cultivation on the Pineapple Plateau, it is also observed that climatic variations affect production by destroying crops through the increase in climatic risks such as droughts and floods.

These climatic variabilities and the change in the quantity and duration of rainfall have led to a decline in pineapple crop yields and are obligate actors in the pineapple production value chain to abandon their traditional crops in favour of those that can withstand climatic hazards.

Furthermore, the impacts of climate risks on the Allada Plateau pineapple production value chain may increase vulnerability and threaten the livelihoods of several producers, the majority of whom are exposed to various challenges, including hunger, disease and loss of livelihoods.

According to (GIEC, 2014), vulnerability to climate risks can be analyzed from global level, to regional level (Acheampong E. , Ozor N., & Owusu E. , 2014) and to household level (Opiyo, 2014). The IPCC Third and Fourth Assessment Reports (2014)

defined vulnerability as the degree to which a system is susceptible to or unable to cope with the adverse effects of climate change, climate variability and extremes.

In other words, vulnerability is an embodiment of the character, magnitude and degree of exposure of a system to climate change and variability, its sensitivity and its adaptive capacity.

Although pineapple producers in the Allada Plateau are exposed to the same climatic conditions, the magnitude of the effect of climatic stresses varies between men and women, due to differences in their levels of adaptive capacities and sensitivity. These effects have a different impact on gender, including gender roles and coping strategies (Guloba M., 2014).

To address gender differences in climate risk adaptation and mitigation, it is important to put in place significant planning strategies to reduce the gender vulnerability of actors in the pineapple production value chain.

Given the correlation between pineapple production and the income of actors in the pineapple production value chain, whether men or women, the undesirable impact of climate risks on pineapple productivity increases the vulnerability of actors in the pineapple value chain.

Climate risks not only impact the productivity of actors in the pineapple production value chain, but also endanger the livelihoods and food security of their households.

Furthermore, these gender-differentiated impacts are also attributable to gender-differentiated relative powers, roles and responsibilities at the producer level. Socially binding norms and values often lead to increased vulnerability of women and girls to climate risks compared to men.

Recent work on the gendered implications of climate change in agrarian contexts highlights how gender-specific patterns of work and responsibility lead to differential vulnerability (Carr E. & Thompson M., 2014).

Despite growing recognition of the differences in vulnerability, as well as the unique experiences and skills that men and women bring to contribute to development and environmental sustainability efforts, women still have less economic, political and

legal leverage and are therefore less able to cope with and more exposed to the adverse impacts of climate risks.

Furthermore, (Villamor G., Dah-gbeto A., & Bell A., 2015), in her study affirmed that men and women have different coping strategies and perceptions that reflect their activities, social positions and differential access to resources and control.

Based on the above scenario, the objective of this study is to analyze the vulnerability of actors in the pineapple production value chain, by gender, to climate risks on the Allada Plateau. Specifically, it will examine the level of exposure, sensitivity and adaptive capacity of actors in the pineapple production value chain by gender to climate variability and risks on the Allada Plateau using an index-based approach.

2. Materials and Methods

2.1. Description of the study area

The Allada Plateau is located in southern Benin between 6°25'–7°50' North latitude and 2°00'–2°30' East longitude. (Figure 1). It has an area of 2140 km² (Dissou M., 1986). It benefits from a subequatorial climate with a bimodal rainfall regime with two dry seasons and two rainy seasons. A major rainy season that begins in April and ends in July. It is followed by a rainfall recession centered on the month of August which constitutes the short dry season. The short rainy season extends from September to November and the long dry season from December to March. The average annual rainfall is 1200 mm. Relative humidity varies from 85 to 90% and the average daily temperature ranges from 23 to 32°C (8).

The predominant soils are red clayey and clayey-sandy soils (Dissou M., 1986). The major part of the coastal sedimentary basin to which the Allada Plateau belongs is covered with ferralitic soils generally called "terre de barre". They developed on clayey-sandy sedimentary materials of the Continental Terminal (Volkoff & Willaime, 1993). Their clay contents vary from 5 to 15% on the surface and 50 to 55% beyond 60 cm depth (Volkoff & Willaime, 1993). As for permeability, it varies from 5 to 8 cm/h at the level of the superficial horizons and from 3 to 6 cm/h at depth.

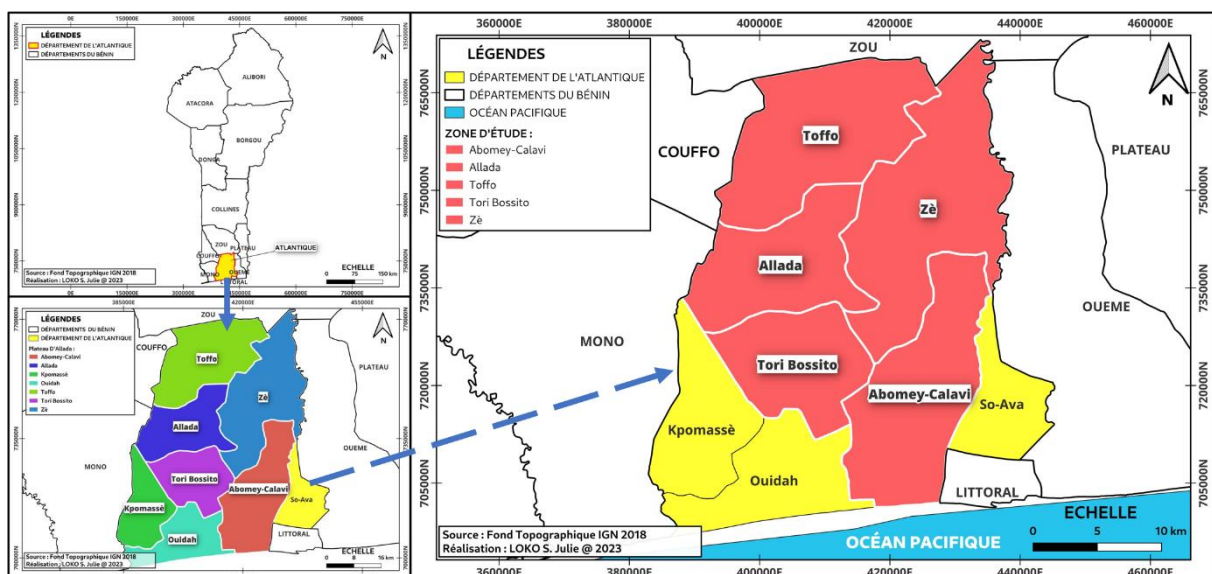


Figure 1: Geographical location of the Allada Plateau

2.2. Methodological approach

A random sampling technique was used to select, according to gender, the actors in the pineapple production and processing value chain on the Allada Plateau to be surveyed.

In total, 194 female producers and 1093 male producers were interviewed as part of this work. The sample size by gender at the level of each Commune is proportional to the weight of pineapple producers in the Communes concerned on the Allada Plateau.

Data were collected from respondents using a questionnaire and analyzed using both descriptive and inferential statistics such as frequency counts, percentages, graphs, mean, standard deviation, vulnerability index and independent sample t-test.

2.2.1 Identification of variables

The measured variables include both independent and dependent variables. The measured independent variables include age, marital status, education level, household size, farm area, farming experience, and producer income.

The dependent variable, namely the vulnerability of pineapple production value chain actors, whether men or women, to climate risks, was measured in terms of exposure, sensitivity and adaptive capacity to climate risks, using an index-based approach.

The different components and subcomponents of vulnerability identified by (Birkmann J., Alexander D., Barbat A., Cardona O., & Carreno M., 2013) were used in the present study. (Table 1).

Table 1: Indicators of the different components and sub-components of vulnerability

Components	Sub components	C/V	Indicators
Exposure	Climate variability	E ₁	Temperature change (as perceived and reported by stakeholders over the past 30 years) E ₁
	Climate risks	E ₂	Number of floods in the last 30 years E ₂
		E ₃	Number of droughts in the last 30 years E ₃
Sensitivity	Demographics	S ₁	Household size of actors in the pineapple production value chain (S ₁)
	Vulnerable group	S ₂	Total number of vulnerable people in the actors' households (S ₂)
	Agricultural activities	S ₃	Crop diversity index (inverse of number of crops grown/ + 1) (S ₃)
		S ₄	Productivity of pineapple crops (Yield in tonnes/ha)/(S ₄)
	Land	S ₅	Number of producers with access to land/(Number of producers with access to land)/(S ₅)
		S ₆	Total area of agricultural land owned (ha) or m ² / (S ₆)
Adaptive capacity	Economic capacity	AC ₁	% of actors with more than one source of income (AC ₁)
		AC ₂	% of actors with access to credit or financial assistance (AC ₂)
	Technological capacity	AC ₃	% of actors using drought-tolerant pineapple shoot varieties (AC ₃)
		AC ₄	% of actors using agrochemical products (AC ₄)
		AC ₅	% of actors practicing irrigation or watering systems (AC ₅)
	Institutional capacity	AC ₆	% of stakeholders with access to climate/meteorological information and training for agricultural technicians (AC ₆)
		AC ₇	% of actors who are members of a pineapple producers' organization or a farmers' organization (AC ₇)
	Technological capacity	AC ₈	% of actors who can read and write (AC ₈)

Adapted from (Birkmann J., Alexander D., Barbat A., Cardona O., & Carreno M., 2013)

2.2.2 Calculation of the vulnerability index

The indicator approach is the method used to calculate the vulnerability of actors in the pineapple production value chain on the Allada Plateau in the context of this study. This method is therefore based on the development of a set of indicators and the selection of some of them through expert judgment (Mbakahya G. & Ndiema A. , 2015).

The vulnerability of any system is considered in terms of three components: exposure to a hazard, sensitivity to that hazard, and the ability of the system to mitigate, cope with, adapt to, or recover from the effects of the impacts of those hazards (Reed M., Podesta G., Fazey I., & Geeson N., 2013), which are called adaptive capacity. According to (Sadiq S., Saboor A., Jamshaid F., Mohsin

A., & Khalid A., 2019), vulnerability can therefore be expressed mathematically as follows:

$$VI = f(E, S, AC) \quad (1)$$

Where

- VI= Vulnerability index ;
- E = Exposure ;
- S = Sensitivity ;
- AC= adaptative capacity.

Using the unweighted approach, normalization of all indicators of the three sub-indices (exposure, sensitivity and adaptive capacity sub-indices) was carried out in order to make all indicator values comparable and applicable using the standardization method.

Standardized scores were calculated for each indicator included in this study in a range from zero (0) to one (1) by linear transformation using the Max and Min functions of MS-Excel. Standardized scores were calculated for each indicator included in this study in a range from zero (0) to one (1) by linear transformation using the Max and Min functions of MS-Excel.

Thus, the normalized value of an indicator (Y) for a household of actors in the pineapple production and processing value chain (i) is given by:

$$V_N = \frac{Max(V_i) - V_i}{Max(V_i) - Min(V_i)} \quad (2)$$

Where ;

- V_N = the normalized variable of the indicator for an actor i;
- V_i = the value of the indicator for an actor i;
- $Max(V_i)$ is the highest value and;
- $Min(V_i)$ is the lowest value.

In this study, each component and sub-component of vulnerability has a specific number of indicators (three for exposure, six for sensitivity and eight for adaptive capacity (Table 1).

Thus, the exposure sub-index is determined by climate variability and climate extremes/risks over a 30-year period and considers: temperature change, number of floods and droughts over the last 30 years and is mathematically expressed as follows:

$$E_i = \frac{1}{2} \left[E_1 + \frac{(E_2 + E_3)}{2} \right] \quad (3)$$

Where

- E_i = Exposure index of an actor i;
- E_1 = Temperature evolution from 1991 to 2020;
- E_2 = Number of flood occurrences from 1991 to 2020;
- E_3 = Number of drought occurrences from 1991 to 2020.

Regarding the sensitivity of actors in the pineapple production value chain according to gender to climate variability and risks, the sensitivity sub-index was calculated by taking into account the household size of actors in the pineapple production value chain, the total number of vulnerable people in the household of the actors, the crop diversity index, the productivity of pineapple crops, the percentage of actors with access to land and the total area of cultivated agricultural land owned by an actor. These variables are expressed mathematically as follows:

$$S_i = \frac{1}{4} \left[S_1 + S_2 + \frac{(S_3 + S_4)}{2} + \frac{(S_5 + S_6)}{2} \right] \quad (4)$$

Where

- S_i = Sensitivity index of an actor i;
- S_1 = household size of actor i in the pineapple production value chain;
- S_2 = total number of vulnerable people in actor i's household;
- S_3 = Household crop diversity index of actor i;
- S_4 = Crop productivity (yield/ha) by actor i;
- S_5 = percentage of actors having access to land;
- S_6 = Area of cultivated land owned by actor i.

As for the adaptive capacity of actors in the pineapple production value chain according to gender, in the face of climate variability and risks, eight indicators were used. These indicators include the

percentage of actors with more than one source of income, the percentage of actors with access to credit or financial assistance, the percentage of actors using drought-tolerant pineapple shoot varieties, the percentage of actors using agrochemicals, the percentage of actors practicing irrigation systems, the percentage of actors with access to climate/weather information and training for agricultural technicians, the percentage of actors who are members of a pineapple producers' organization or a farmers' organization and the percentage of actors who can read and write.

The adaptive capacity is therefore expressed mathematically as follows:

$$AC_i = \frac{1}{4} \left[\frac{(AC_1 + AC_2)}{2} + \frac{(AC_3 + AC_4 + AC_5)}{3} + \frac{(AC_6 + AC_7)}{2} + AC_8 \right] \quad (5)$$

Where

- AC_i = adaptive capacity index for an actor i;
- AC_1 = % of actors with more than one source of income;
- AC_2 = % of actors having access to credit or financial assistance;
- AC_3 = % of actors using drought-tolerant pineapple shoot varieties;
- AC_4 = % of actors using agrochemical products;
- AC_5 = % of actors practicing irrigation systems;
- AC_6 = % of stakeholders with access to information on weather forecasts, information and extension services;
- AC_7 = % of actors who are members of a pineapple producer/processor organization or a farmers' organization;
- AC_8 = % of actors who can read and write.

Starting from equation 1, the vulnerability index (VI) for any actor i in the pineapple production value chain according to gender as developed by (Heltberg R. & Osmolovskiy M., 2011) and adopted by (Sadiq S., Saboor A., Jamshaid F., Mohsin A., & Khalid A., 2019) using the unweighted average of the three sub-indices of exposure, sensitivity and negative adaptive capacity. It is therefore expressed as follows:

$$VI = \frac{1}{3} [E + S(1 - AC)]$$

Où

- VI = Composite vulnerability index of an actor i;
- E = Exposure index of an actor i;
- S = Sensitivity index of an actor i;
- AC = adaptive capacity of an actor i.

The vulnerability index that will be calculated would be between 0 and 1. 1 indicating maximum vulnerability and 0 indicating no vulnerability.

Since climate risks affect women and men differently in the pineapple production value chain in the Allada Plateau, an analytical tool such as the independent sample t-test was used to compare the mean vulnerability indices of pineapple production value chain actors by gender based on their level of vulnerability to climate risks in the Allada Plateau. Since the study sample is large ($N \geq 30$) with a homogeneous population (equal variance) and a normal t-distribution, the Student t-test was used as recommended by Sokal and Rohlf (1987).

The t-statistic is calculated using the equation below:

$$t = \frac{\mu_F - \mu_M}{\sqrt{\frac{\sigma_F^2}{N_F} + \frac{\sigma_M^2}{N_M}}} \quad (7)$$

where, μ_F and μ_M denote the means of the vulnerability indices calculated for the actors in the pineapple production value chain, respectively;

σ_F^2 et σ_M^2 denote the standard deviations of the vulnerability indices for the actors in the pineapple production value chain, whether male or female, respectively and;

N_F and N_M indicate the sample size for pineapple production value chain actors by gender respectively.

The null hypothesis (H_0) for the global vulnerability index is formulated as follows:

- H_0 . There is no significant difference in the means of the vulnerability index for households of actors in the pineapple production and processing value chain headed by a man and a woman ($N_F = N_M$).

The alternative hypothesis (H_1) for the global vulnerability index is formulated as follows:

- H_1 : There is a significant difference in the means of the vulnerability index for the actors in the pineapple production value chain according to gender ($N_F \neq N_M$).

3. Results and Discussions

3.1. Gender-specific analysis of vulnerability sub-indices of actors in the pineapple production value chain on the Allada Plateau

Gender-specific exposure of actors in the Allada Plateau pineapple production value chain to climate variability and risks

In this study, the exposure of actors in the Allada Plateau pineapple production value chain to climate variability and risks was assessed based on the analysis of three indicators. These indicators are the temperature change as perceived and reported by actors in the pineapple production value chain over the last thirty years, the number of floods and the number of droughts over the last 30 years, classified into two sub-components: climate variability and climate risks.

The results in Table 2 present the gender distribution of the responding pineapple production chain actors according to their exposure to climate variability and risks.

Table 2: Gender distribution of actors in the pineapple production chain surveyed according to their exposure to climate variability and risks ($N = 1093/194$)

Component	Sub components	Indicators	Communes	Normalized score		Average of sub-indices	
				Men	Women	Men	Women
Exposure	Climate variability	Temperature change (as perceived and reported by stakeholders over the past 30 years)E1	Abomey-calavi	60.60	12.64	0.4359	0.5123
			Allada	135.58	37.05	0.4723	0.6465
			Toffo	51.44	17.87	0.3983	0.4934
			Tori-Bossito	97.22	17	0.4534	0.5332
			Zè	131.66	31.82	0.4224	0.4965
	Climate risks	Number of floods in the last 30 years (E ₂)	Abomey calavi	87.19	18.19	0.6272	0.6362
			Allada	195.08	53.31	0.5845	0.5956
			Toffo	74.018	25.71	0.5943	0.6454
			Tori-Bossito	139.88	24.46	0.6334	0.3945
			Zè	189.43	45.79	0.6065	0.6543
		Number of droughts in the last 30 years (E ₃)	Abomey calavi	88.45	18.45	0.6354	0.5465
			Allada	197.9	54.09	0.5987	0.5712
			Toffo	75.09	26.09	0.5858	0.6565
			Tori-Bossito	141.9	24.81	0.6124	0.5334
			Zè	192.18	46.45	0.6493	0.4998
Sum of sub-indices	Men			1857.6192		8.3098	
	Women			453.73		8.4153	
Exposure index	Men					0.553986667	
	Women					0.66102	

Source : Field Survey, June 2024

From the analysis of Table 2, it appears that the exposure index of male production value chain actors is 0.55 compared to 0.66 for female actors in the pineapple production value chain. This information reveals a higher exposure to climate risks for female respondents on the Allada Plateau compared to their male counterparts.

 Gender-specific sensitivity of actors in the Allada Plateau pineapple production value chain to climate variability and risks

The sensitivity of the actors in the production value chain of the Allada Plateau was assessed on the basis of six indicators and classified into four sub-components: demography, vulnerable groups, agricultural activities and land.

The results in Table 3 present the gender distribution of actors in the production chain according to their sensitivity to climate variability and risks.

Table 3: Gender distribution of responding production value chain actors according to their sensitivity to climate variability and risks (N = 1093/194)

Component	Sub components	Indicators	Communes	Normalized score		Average of sub-indices	
				Men	Women	Men	Women
Sensitivity	Demography	Household size of actors in the pineapple production value chain (S ₁)	Abomey- Calavi	5,2835	3,983	0,5465	0,6354
			Allada	8,378	4,307	0,5712	0,5987
			Toffo	12,2857	8,123	0,6565	0,5858
			Tori-Bossito	10,196	8,097	0,5334	0,6124
			Zè	12,271	5,765	0,4998	0,6493
	Vulnerable groups	Total number of vulnerable people in the actors' households (S ₂)	Abomey- calavi	3,267	1,307	0,4359	0,5123
			Allada	7,765	0,637	0,4723	0,6465
			Toffo	2,857	1,909	0,3983	0,4934
			Tori-Bossito	1,904	3,567	0,4534	0,5332
			Zè	9,271	2,008	0,4224	0,4965
	Agricultural activities	Crop diversity index (inverse of number of crops grown/ + 1)(S ₃)	Abomey- Calavi	1,5	1,33	0,6272	0,6362
			Allada	1,02	1,25	0,5845	0,5956
			Toffo	1,33	1,02	0,5943	0,6454
			Tori-Bossito	1,016	1,33	0,6334	0,3945
			Zè	1,016	1,33	0,6065	0,6543
		Productivity of pineapple crops (Yield in tonnes/ha)/(S ₄)	Abomey- Calavi	58,54	67,4	0,6362	0,6565
			Allada	68,5	65	0,5956	0,5334
			Toffo	67,4	58,34	0,6454	0,4998
			Tori-Bossito	65	54,4	0,3945	0,4359
			Zè	58,34	65,3	0,6543	0,4723
	Land	Number of producers with access to land /(S ₅)	Abomey- Calavi	466	81	0,3983	0,4934
			Allada	1431	355	0,4534	0,5332
			Toffo	385	135	0,4224	0,4965
			Tori-Bossito	839	103	0,6272	0,6362
			Zè	1345	297	0,5845	0,5956
		Total area of agricultural land owned (ha) or m ² / (S ₆)	Abomey- Calavi	5,2	3,9	0,6493	0,4723
			Allada	8,3	4,3	0,5123	0,3983
			Toffo	12,2	8,1	0,6465	0,4534
			Tori-Bossito	10,1	8,09	0,4934	0,4224
			Zè	12,2	5	0,5332	0,6272
Sum of sub-indices	Men			397,1402		10,9616	
	Women			356,403		11,2874	
Sensitivity index	Men					0,54808	
	Women					0,56437	

Source : Field Survey, June 2024

Table 3 shows that the sensitivity index for men is 0.55 compared to 0.56 for women. This information reveals that the sensitivity of women actors in the pineapple production value chain to climate risks is higher on the Allada Plateau compared to their male counterparts.

 Gender-specific adaptive capacity of actors in the pineapple production value chain of the Allada plateau to climate variability and risks

The adaptive capacity of the actors in the pineapple production value chain was assessed according to gender on the basis of eight indicators and classified into four sub-components, namely: economic, technological, institutional and human capacities.

The results in Table 4 present the gender distribution of actors in the production chain according to their capacity to adapt to climate variability and risks.

Table 4: Gender distribution of responding production value chain actors according to their capacity to adapt to climate and environmental variability and risks (N = 1093/194)

Component	Sub components	Indicators	Communes	Normalized score		Average of sub-indices	
				Men	Women	Men	Women
Adaptive Capacity	Economic capacity	% of actors with more than one source of income (AC ₁)	Abomey- Calavi	82,835	53,127	0,5123	0,5334
			Allada	30,73	67,877	0,6465	0,4998
			Toffo	67,23	45,542	0,4934	0,4359
			Tori-Bossito	23,46	34,09	0,5332	0,4723
			Zè	27,67	47,21	0,4965	0,4934
		% of actors with access to credit or financial assistance (AC ₂)	Abomey- Calavi	68,97	76,42	0,6362	0,5332
			Allada	45,012	47,674	0,5956	0,4965
			Toffo	23,54	12,673	0,6454	0,5858
			Tori-Bossito	34,23	51,346	0,3945	0,6124
			Zè	35,78	67,133	0,6543	0,6493
	Technological capacity	% of actors using drought-tolerant pineapple shoot varieties (AC ₃)	Abomey calavi	56,67	64,521	0,5465	0,4224
			Allada	81,454	45,123	0,5712	0,6272
			Toffo	30,73	23,365	0,6565	0,5845
			Tori-Bossito	67,23	34,084	0,5334	0,6493
			Zè	45,432	23,46	0,4998	0,5123
		% of actors using agrochemical products (AC ₄)	Abomey- Calavi	17,2	13,9	0,6565	0,6465
			Allada	23,3	14,3	0,5334	0,4934
			Toffo	6,2	2,1	0,4998	0,5858
			Tori-Bossito	10,1	8,09	0,6565	0,6124
			Zè	14,2	5,3	0,5334	0,6493
		% of actors practicing irrigation or watering systems (AC ₅)	Abomey Calavi	12,2857	8,123	0,6354	0,4224
			Allada	8,378	4,307	0,5987	0,6272
			Toffo	9,285	4,123	0,5858	0,6565
			Tori-Bossito	10,196	8,097	0,6124	0,5334
			Zè	12,271	5,765	0,6493	0,4998
	Institutional capacity	% of stakeholders with access to climate/meteorological information and training for agricultural technicians (AC ₆)	Abomey Calavi	25,33	15,5	0,4224	0,6565
			Allada	16,25	43,123	0,6272	0,5334
			Toffo	7,02	5,34	0,5845	0,4998
			Tori-Bossito	13,39	9,016	0,6493	0,4359
			Zè	19,314	16,016	0,5123	0,4723
		% of actors who are members of a pineapple producers' organization or a farmers'	Abomey- Calavi	58,54	67,4	0,6465	0,4934
			Allada	68,5	65	0,4934	0,5332
			Toffo	67,4	58,34	0,5332	0,4965
			Tori-Bossito	65	54,4	0,6565	0,6362

		organization (AC ₇)	Zè	58,34	65,3	0,5334	0,5956
	Human capacity	% of actors who can read and write (AC ₈)	Abomey Calavi	5,2835	3,983	0,6354	0,5465
			Allada	8,378	4,307	0,5987	0,5712
			Toffo	12,2857	8,123	0,5858	0,6565
			Tori-Bossito	10,196	8,097	0,6124	0,5334
			Zè	12,271	5,765	0,6493	0,4998
Sum of sub-indices	Men			844,3887		14,3765	
	Women			767,75		13,8344	
Adaptive Capacity Index	Men					0,57792	
	Women					0,550287179	

Source : Field Survey, June 2024

Table 4 shows that the adaptive capacity index of male production value chain actors is 0.57 compared to 0.55 for female actors. This information reveals a higher adaptive capacity to climate variability and risks among male respondents on the Allada Plateau compared to their female counterparts.

3.2 Analysis of the gender-specific vulnerability of actors in the pineapple production value chain of the Allada plateau to climate variability and risks

The results in Table 5 show us the composite vulnerability according to gender of the actors in the pineapple production value chain of the Allada plateau to climate variability and risks.

Table 5: Overall gender distribution of vulnerability of the actors in the pineapple production value chain surveyed to climate variability and risks.

CV Actors by Gender	Exposure index	Sensitivity index	Adaptive Capacity Index	Vulnerability index $VI=1/3[E+S(1-AC)]$
Man	0,553986667	0,54808	0,57792	0,261773424
Woman	0,66102	0,56437	0,550287179	0,304941475

Source : Field surveys, 2024

From Table 5, we deduce a significant vulnerability of female actors in the pineapple production value chain compared to male actors in the production and processing value chain.

Therefore, there is a significant difference between the average vulnerability indices of the actors in the pineapple production chain according to gender. ($NF \neq NM$).

These results lead us to test the superiority between the average vulnerability indices of the actors in the pineapple production chain according to gender. ($NF \neq NM$).

The inequality of the indices will lead us to use the one-sided Student T test to test the superiority and/or inferiority between the two indices: ($NF > NM$; $NF < NM$). Let's test the one-sided hypotheses ($NF > NM$; $NF < NM$).

The null hypothesis (H_0) for the one-sided global vulnerability index is formulated as follows:

- **H₀** : ($NF < NM$) l'indice de vulnérabilité globale des acteurs féminins de la chaîne de production d'ananas est inférieur à l'indice de vulnérabilité globale des acteurs masculin de la chaîne de production d'ananas.

L'hypothèse alternative (H_1) pour l'indice de vulnérabilité globale est formulée comme suit :

- **H₁** : ($NF > NM$) the overall vulnerability index of female actors in the pineapple production chain is lower than the overall vulnerability index of male actors in the pineapple production chain.

The probability associated with the T-Student test is: P-Value = 0.01347, hence the alternative hypothesis H_1 is validated at the 5% threshold.

Therefore, the overall vulnerability index of female actors in the pineapple production value chain is higher than the overall vulnerability index of male actors in the pineapple production value chain. ($NF > NM$).

We note a superiority of the vulnerability index of the female gender compared to the male gender. Consequently, the female actors of the pineapple production value chain on the Allada Plateau are more vulnerable than their male counterparts.

Conclusion

At the end of this study, it was found that women actors in the pineapple production value chain of the Allada Plateau are more vulnerable to climate variability and risks than men actors. The high level of vulnerability of women actors is due to their degrees

of exposure and sensitivity to climate risks as well as their low adaptive capacities.

Thus, we can deduce that climate variability and the sub-indices of vulnerability that are exposure and sensitivity seem to be the main stress factors for female actors and directly influence their pineapple production.

Given that the vulnerability of women actors is higher and their adaptive capacity is low, the study recommends that actors in the pineapple production value chain of the Allada Plateau, in particular women actors, have access to climate/meteorological information and training for agricultural technicians, that they have good access to technology such as drought-tolerant pineapple shoot varieties to improve their pineapple production, which would help improve their adaptive capacity and reduce vulnerability.

Bibliography

1. Acheampong E. , Ozor N., & Owusu E. . (2014): Évaluation de la vulnérabilité de la variabilité climatique du nord du Ghana. *Changement climatique* (Vol. 126).
2. Birkmann J., Alexander D., Barbat A., Cardona O., & Carreno M. (2013): Framing vulnerability, risks and societal responses: the MOVE framework. *Natural hazards* (Vol. 67).
3. Carr E., & Thompson M. (2014): Gender and adaptation to climate change in agrarian environments: current thinking, new directions and research frontiers. *Geography Compass* (Vol. 8).
4. Dissou M. (1986):The People's Republic of Benin: Natural environments, regions, regional agricultural economy. Part one: Lower Benin.
5. GIEC. (2014): Climate change: impact, adaptation and vulnerability. Contributions of working groups I, II and III to the fourth assessment report, Cambridge University Press, Cambridge.
6. Guloba M. (2014): Analysis of adaptation to climate variability and change in Uganda.
7. Heltberg R., & Osmolovskiy M. (2011): Mapping Vulnerability to Climate Change. World Bank Policy Paper.
8. Mbakahya G., & Ndiema A. . (2015): Vulnerability and resilience of farming households to climate change in Nambale sub-county, Kenya. *International Journal of Environmental Science and Technology* (Vol. 4).
9. Menike L., & Arachchi K. (2016): Adaptation to climate change by smallholder farmers in rural communities: evidence from Sri Lanka. *Procedia Food Science*.
10. Opiyo, E. (2014): Climate variability and change on vulnerability and adaptation among Turukana pastoralists of Northwestern Kenya. A Ph.D. Thesis submitted to the Department of Range Management, University of Nairobi, Kenya.
11. Reed M., Podesta G., Fazey I., & Geeson N. (2013): Combining analytical frameworks to assess livelihood vulnerability to climate change and analyze adaptation options. *Ecological economics* (Vol. 94).
12. Sadiq S., Saboor A., Jamshaid F., Mohsin A., & Khalid A. (2019): Assessment of farmers' vulnerability to AGRICULTURA TROPICA AND SUBTROPICA (Vol. 54).
13. Villamor G., Dah-gbeto A., & Bell A. (2015): Gender-specific spatial perspectives and scenario-building approaches for understanding gender equity and sustainability in climate-smart landscapes (Vol. 13).
14. Volkoff, & Willaime. (1993): Degradation and restoration of barren soils (weakly ferrallitic soils) ORSTOM Notebooks, Pedology Series (Vol. 28).