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Women political empowerment and vulnerability to climate change: evidence from developing countries

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Abstract

The objective of this article is to analyze the effect of the political empowerment of women on vulnerability to climate change in 169 countries for the period 1995-2017. The empirical evidence which is based on panel fixed effects regressions shows that: i) the political empowerment of women as well as its components (i.e. civil liberties of women, participation of women in civil society and participation of women in political debates) reduce vulnerability to climate change. ii) The underlying effect is most pronounced in upper middle income, Latin American, small and fragile countries. iii) Public spending on education, the effectiveness of governance and education are the real transmission channels through which vulnerability to climate change is affected by women's political empowerment. The findings are robust to alternative estimation methods such as the Tobit, the dynamic fixed effects, and the generalized method of moments regressions. Policy implications are discussed, *inter alia*, the need for sampled countries to encourage women's political empowerment in order to reduce risks linked to climate change.

Keywords: climate change; vulnerability; political empowerment
JEL Classification: Q50; Q54; Q58

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1. Introduction

The recognition of women as major actors in environmental protection was officially recognized by the 1985 United Nations conference in Nairobi. However, women's role in addressing concerns pertaining to vulnerability to climate change has received less scholarly attention as opposed to scientific and technological solutions (Gaard, 2015). This article enriches the literature on climate change by integrating gender into adaptive policies of developing countries. Specifically, the study examines the effect of women's political empowerment on vulnerability to climate change in 169 countries around the world. To achieve this objective, two dimensions of the economic literature are taken into account: the first pertains to the determinants of climate change as substantiated by the works of Watson et al. (2013); Hansen and Stone (2015); Martin and Saikawa (2017); Raftery et al. (2017); Miller et al. (2018) and Sarkodie and Strezov (2019). The second is informed by the literature on "feminist political ecology" which encourages the integration of gender in adaptive policies with an emphasis on the political empowerment of women. This strand of the literature is substantiated by the studies of Goebel (2004); Alber and Roehr (2006); Alaimo (2009); McCright (2010); MacGregor (2010); Nellemann et al. (2011); Ergas and York (2012); Goh (2012); Yavinsky (2012); Resurrección (2013); Israel and Sachs (2013); Nwoke and Ibe (2014); Alexander et al. (2016) ; Yadav and Lal (2017) ; Asongu and al. (2020) ; Morsy (2020) and Asongu and al. (2021).

To the best of our knowledge, no study has empirically examined the importance of the political empowerment of women in resilience strategies following a climate shock. Our hypothesis postulates that the political empowerment of women reduces vulnerability to climate change. In other words, the participation of women in political and administrative decisions improves adaptation to climate change. Thus, this article enriches both the literature on the determinants of climate change and the importance of gender in adaptive policies.

According to a Care Canada (2010) report, about two-third of women in the world are exposed to climate shocks. Statistics on casualties after climate-related disasters sufficiently show that women are more exposed than men. For example the 1991 floods and cyclones in Bangladesh showed that 90% of the victims were women. The 2004 tsunami in Aceh long after, accounted for 75% of female victims. Moreover, Cyclone Nargis in 2008 in Mayanmar according to the work of Gaalya (2015) confirm the underlying given that 61% of victims were women. This result is correlated with a political under-representativeness of women within the bodies that drive the destiny of society. Indeed, since the 1990s, the representativeness of women in political decision-making bodies throughout the world has

remained low. Some governments of countries such as Guinea-Bissau; the Comoros; Hungary and Azerbaijan long before 2020 did not have women on board. Reports from the Parliamentary Union also state that only 23.3% of elected representatives are women in developing countries.

These stylized facts corroborate the work of Aguilar (2007) who specifies that gender inequalities increase the vulnerability of women and children to climate change 14 times more than that of men. Garrd (2015) shows, moreover, that excluding women from decision-making bodies, warning and awareness of the risk of climate change explains the high number of victims during recent natural disasters. In other words, the integration of women into steering committees within society can mitigate the consequences of climate shocks. Moreover, the involvement of women in governance in the sense of Ergas and York (2012) has a positive impact on environmental results. However, these analyzes are limited to theoretical assertions. This is consistent with the hypothesis underpinning this study that the political empowerment of women reduces vulnerability to climate change throughout the world. In other words, increasing women's freedoms, their participation in civil society and in political decision-making bodies promotes good adaptation to climate shocks.

The place of women in the political spectrum is increasingly important in economic literature. Sundström et al. (2017) define the political empowerment of women in three dimensions. The first integrates civil liberties, the second takes into account participation in business and society. Lastly, the third is concerned with the political representativeness of women in decision-making bodies. Women's political empowerment therefore becomes a process of increasing women's freedoms, their ability to influence political ideals and their participation in the organization of civil society.

The political empowerment of women in addressing vulnerability to climate change is important for several reasons. A politically autonomous and responsible woman has a positive impact on social economic conditions and the institutional framework (Swamy et al., 2001). Indeed, when women occupy strategic positions on the political and administrative level, they tend to direct the income of their activities in the maintenance of the family and in the training and sensitization of young girls against certain scourges. Dollar al. (2001) show that the strong representation of women in parliamentary and executive institutions is negatively correlated with corruption. In other words, integrating women into public administration can ensure that public choices are adapted. For example Svaleryd (2002) asserts that countries with a high representation of women in the administration tend to increase public spending on health and education, which can improve the health conditions of the population as

demonstrated by the work of Al Riyami et al. (2004). Similarly, Doepke and Tertilt (2018) report that women's social empowerment reduces unwanted fat and sexually transmitted diseases. In other words, responsible women promote enhancement of social conditions.

The political empowerment of women in the implementation of adaptive policies linked to climate change is more justified since women constitute a very vulnerable social layer. Yadav and Lal (2017) articulate that in arid zones in Asia, women are generally more affected than men following a negative shock caused by the climate. The reasons for this reality, according to the authors, are justified by the fact that women are poorer, less educated and benefit from limited access to information, institutions and decision-making bodies which affect the destiny of society (Goh, 2012). Yavinsky (2012) also demonstrates that certain degrading customs characterized by certain prohibitions or practices increase the vulnerability of women after a climate shock. Women are also the most exposed to climatic shocks because of the great responsibilities they often have with families. The work of Nwoke and Ibe (2014) underlines that natural disasters caused by climate change reduce women's ability to collect firewood and obtain drinkable water in arid areas. In Africa, the work of Aelst and Holvoet (2016) in Tanzania show that widows and single women are generally more at risk when a climate shock occurs. They also point out that enterprising women resist better when a climate shock occurs. Cannon (2002) already pointed out that to limit the impact of climate shocks in a society, it is necessary to reduce gender inequalities through social transformations.

Based on this literature, the objective of this article is to analyze the effect of women's political empowerment on vulnerability to climate change in 169 countries. The contribution of this work can be assessed at three levels. First, an attempt is made to enrich the literature on "feminist political ecology" by providing empirical evidence of the importance of gender in adaptation to climate change. Second, the indicator of political empowerment of women proposed by Sundström et al. (2017) is used. This indicator is recognized for its completeness compared to the other indicators developed by Klasen (2006), Alkire et al. (2013), Liebowitz and Zwingel (2014) and Hanmer and Klugman (2016). The adopted indicator was obtained by a Bayesian estimate and was evaluated by 2,600 experts. Third, the framework of the study is not exclusively limited to analyzing the relationship between women's political empowerment and vulnerability to climate change because, channels through which the political empowerment of women can reduce vulnerability to climate change are also examined.

The analysis of the effect of women's empowerment on vulnerability to climate change within the framework of this study is carried out on 169 countries between 1995 and 2017. The indicator of vulnerability to climate change is taken from the work of Chen et al. (2015).

The panel data analysis leads to the following results. Women's political empowerment reduces vulnerability to climate change across the world. Specifically, women's freedoms, participation in civil society and political affairs significantly reduce vulnerability to climate change. These results were subjected to a set of sensitivity tests with respect to sample size, continental origin, income bracket, level of development and country size. These results are also robust to an alternative analysis using the generalized method of moments, Tobit and the dynamic panel fixed effects estimators. In addition, public spending on education, the effectiveness of governance and education are the real transmission channels through which vulnerability to climate change is affected by women's political empowerment.

The remainder of the article is organized as follows: section 2 covers a theoretical framework by analyzing transmission channels. Section 3 presents the basic data, methodology and results. Section 4 performs sensitivity and robustness tests and Section 5 concludes.

2. Theoretical underpinning and transmission channels

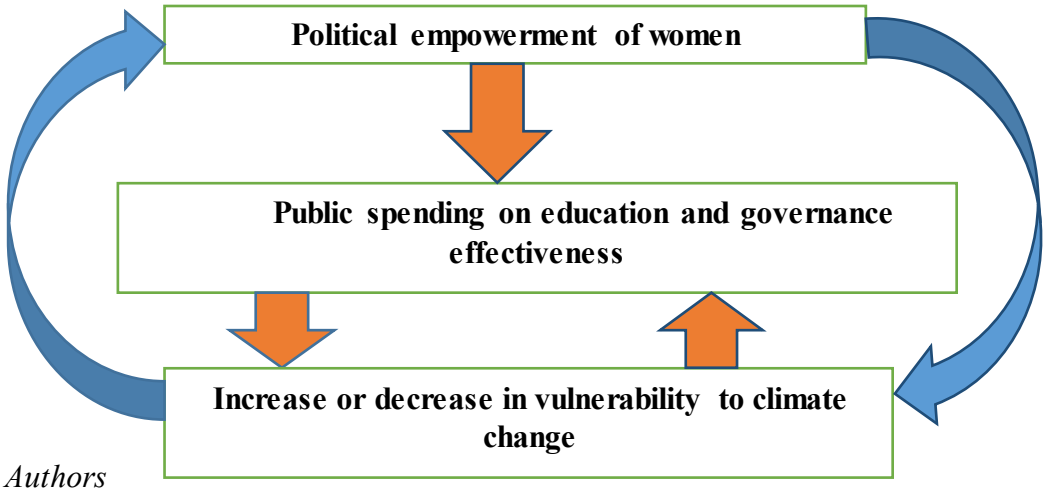
The relationship between women's political empowerment and vulnerability to climate change can be direct or indirect.

On the direct front, several studies show that there is a direct relationship between politically empowered woman and the quality of the environment. For example, Alber and Roehr (2006) argue that a high participation of women in decision-making spheres is favorable to efficient climate policy. For Gaard (2015), women are more attentive to climate issues than men. Other authors point out that more than 60% of members of organizations committed to the cause of climate change are women. They also state that women are more educated than men in terms of vulnerability to climate change and consider climate shocks to be consequences of an expansive nature in the future (Brú &Cabo, 2004; McCright, 2010; Ergas & York, 2012).

On the indirect front, the empirical work of Sarkodie and Strezov (2019) on 192 countries around the world shows that preparation for economic, social and governmental adaptation significantly reduces vulnerability to climate change. Asongu et al. (2021) in the case of African countries, state also that, the economic inclusion of women through industrial employment has a positive effect on non-resource-related taxes. Thus, the political empowerment of women affects vulnerability to climate change through improving economic adaptation, increasing efficiency in governance and contributing to adapting social conditions in the event of shocks. In other words, a politically empowered woman increases the capacity

for resilience in a country. Moreover, there is an abundant literature on the relationship between women's empowerment and education, health, the quality of governance and economic growth. Swamy et al. (2001) for example demonstrate that the strong presence of women in government negatively influences the level of corruption in public administration. Similarly, Clots-Figueras (2012) finds that administrative decisions by women tend to increase spending on education and health. Moreover, Branisa et al. (2013) as well as Sraboni et al. (2014) establish that the empowerment of women positively affects economic growth. Therefore, if women's empowerment promotes the readiness for governance as well as economic and social adaptation in the event of a shock, it is reasonable to assume that women's political empowerment reduces vulnerability to climate change through the channels of economic, social and government preparedness for adaptation to natural disasters caused by climate change.

Figure 1: relationship between political empowerment of women and vulnerability to climate change



Source: *Authors*

Women's political empowerment can reduce vulnerability to climate change through economic readiness. In developing countries for example, the work of Gaard (2015) demonstrates in a factual manner how women bear the burden of climate change in a difficult way. Starting from the fact that women are generally limited to household chores, and languish in poverty, the author points out that women are often neglected by their husbands. These women for reasons of unemployment, *inter alia*, often revert to immigration as a means of generating income for their families. Unfortunately, this is not always the case. Consequently, the occurrence of a climate shock condemns the women who sometimes assume the survival of the family alone. In Africa, for example, women are more exposed to

climate change because of their heavy occupation of jobs in the informal sector. It is therefore clear that endowing women with decision-making power over the management of resources can increase the preparedness of countries to in the event of a climate shock.

Moreover, statistics of victims caused by natural disasters show that the lack of empowerment of women exposes them to a high vulnerability to climate change and reduces the resilience capacity of developing countries. Empowering women politically therefore helps to better adapt to climate change. Women's participation in administrative decisions can improve the business climate because of their ability to reduce corruption. It can also promote adaptive governance with a company that presents guarantees on the growth of investments and profits. Women's empowerment can also improve social adaptation to climate change as it can ensure safe and efficient economic activities (Swamy et al., 2001; Clots-Figueras; 2012; Branisa et al., 2013; Sraboni et al., 2014).

3. Data and methodology

3.1 Data

The analysis of the effect of women's empowerment on vulnerability to climate change will be carried out in 169 countries. The study period runs from 1995 to 2017. This study period is justified by the availability of data and particularly, the expansive nature of the empowerment of women around the world over the chosen period. The list of countries included in the sample is provided in Appendix 1 while a description of the variables and corresponding sources is apparent in Appendix 4. The dataset constitutes a panel which avails the possibility of exploiting both temporal and spatial dimensions of the data.

The dependent variable is vulnerability to climate change; it measures the propensity or predisposition of human societies to suffer the negative effects in the event of climate shocks. The data for this variable come from the Notre Dame University database on the "Global Adaptation Index 2018" previously proposed by Chen et al. (2015). This variable varies between "0 and 100". Modality 0 reflects the absence of vulnerability, while modality "100" expresses high vulnerability to climate change.

The independent variable of interest is represented by the index of political empowerment of women and its sub-dimensions. These variables are taken from "Varieties Democracy database of 2017 (V-Dem)". They were compiled by Sundström et al. (2017) and vary between "0 and 1". The value "0" represents the absence of empowerment and the value "1" represents a strong empowerment of women. These indices in terms of reliability and

temporal coverage have the advantage of being theoretically better founded than the existing indices. The sub-dimensions of empowerment are represented by women's civil liberties, women's participation in civil society, and participation in political affairs.

Women's civil liberties refer to their ability to make decisions in important areas of their daily lives. The participation of women in civil society makes it possible to take into account their capacity to participate freely in public debates. Participation in political affairs is seen as the representation of women in political positions like parliament. The average of these three indicators forms the index of political empowerment of women. The low modality of these indices also reflects the fact that "men have a virtual monopoly on political questions". On the other hand, the strong modality reflects "the balance between men and women in terms of influence with decision makers".

Due to the complexity of climate change, the study uses a set of control variables to measure adaptive capacity. These variables have been tested empirically by Sarkodie and Strekov (2019). Overall, they reduce vulnerability to climate change. These are: Adaptive preparation of the social framework (*SOC*) which measures the level of social inequalities in a weighted manner, the quality of the infrastructure, the educational framework and the capacity to innovate. It reflects the social conditions of a country to ensure safe and efficient economic activities. Good quality social preparation reduces vulnerability to climate change. It integrates the social conditions favorable to the productivity of investments and enables an efficient and equitable use of the profits recorded. It also measures the resilience of the social framework to a climate shock.

Adaptive governance readiness (*Gov*); it combines the indicators of political stability, the control of corruption; the rule of law and the quality of regulation. It measures the capacity of a government to react when a climate shock occurs. We also have the preparation for an adaptation of the economic framework (Eco). This variable measures the various economic maneuvers favorable to the business climate necessary for the mobilization of capital in the private sector.

The composite index of these three previous control variables provides the indicator relating to an overall adaptation of the environment of a country in the face of a climate shock. All of these control variables are taken from the Notre Dame University “Global Adaptation Index (2018)” database.

The descriptive statistics is provided in Table 1 which provides characteristics such as the mean, the standard deviation, the total number of observations as well as the maximum and minimum values. According to this table, the climate change vulnerability index has an

average of 0.451 in our sample and its standard deviation is 0.098. The maximum value of the climate change vulnerability index observed in the sample is 0.709 and the minimum value 0.259. The aggregate index of women's empowerment has an average of 0.723 which is very close to that of women's civil liberties (0.677) and women's participation in civil society (0.696). Women's political participation averages roughly 0.808. Regarding the capacity for social adaptation, governance and the economy, we observe an average of 0.307, 0.484 and 0.384, respectively. The respective maximum and minimum values of the adaptation capacity are 0.802 and 0.001. However, we also notice that the empowerment index and its components have high standard deviations (0.191; 0.246; 0.206; 0.214). This reflects a strong dispersion and requires taking into account heterogeneity in the modeling exercise.

Table 1 *:descriptive statistics*

Variables	Obs	Mean	S.D	Min	Max
Vulnerability to climate change	3887	0.451	0.098	0.26	0.709
Political empowerment of women	3884	0.723	0.191	0.055	0.975
Civil liberties of women	3921	0.677	0.246	0.002	0.985
Participation in women's civil society	3921	0.696	0.206	0.016	0.975
Women's political participation	3884	0.808	0.214	0.066	1
Preparation for global adaptation	3933	0.388	0.155	0.001	0.802
Preparation for social adaptation	3818	0.307	0.16	0.08	0.814
Preparation for adaptation of governance	3864	0.484	0.184	0.001	0.906
Preparation for economic adaptation	3749	0.384	0.174	0	0.827
Dummy on regions	3933	2.93	1.639	1	7
Dummy on the income bracket	3933	2.696	1.066	1	4
Dummy on the level of development	3933	0.257	0.437	0	1
Dummy on the size of the country	3933	0.187	0.39	0	1
Dummy on the country's level of fragility	3933	0.175	0.38	0	1
Dummy on the islands	3933	0.123	0.328	0	1

Obs : Observations. S.D : Standard Deviation. Min : Minimum. Max : Maximum.
Source : Authors

These descriptive statistics can be deepened by examining the correlations between the different variables included in the empirical model. The table in Appendix 2 shows the correlation matrix of the variables. This matrix shows that the political empowerment of women, the civil liberties of women, the participation of women in civil society, the political participation of women, the preparation for social adaptation, governance and economic are negatively and significantly correlated with the index of vulnerability to climate change. In summary, one might conclude that there are negative relationships between vulnerability to climate change and the empowerment of women. However, this analysis on the basis of correlations cannot enable the study to establish robust conclusions because correlations are not causalities and hence, an in-depth econometric analysis is worthwhile in the next section.

3.2 Methodology

The empirical analysis of the effect of women's political empowerment on vulnerability to climate change is carried out using an econometric model motivated by the work of Sarkodie and Strekov (2019). Vulnerability to climate change from the underlying study is a function of the adaptive preparation of the environment to which we add the political empowerment of women in the relationship below.

$$\mathbf{Vulnerability} = \mathbf{f}(\mathbf{APF}, \mathbf{adaptataion})(\mathbf{1})$$

By disaggregating the effect of adaptation on vulnerability to climate change, we obtain Equation 2 as follows:

$$\mathbf{Vul_{i,t}} = \boldsymbol{\varphi_k}\mathbf{APF_{i,t}^{k}} + \boldsymbol{\alpha}\mathbf{Soc_{i,t}} + \boldsymbol{\beta}\mathbf{Gov_{i,t}} + \boldsymbol{\gamma}\mathbf{Eco_{i,t}} + \boldsymbol{\mu_i} + \boldsymbol{\tau_t} + \boldsymbol{\varepsilon_{i,t}}(\mathbf{2})$$

where $Vul_{i,t}$represents vulnerability to climate change in a country i for year t, with $i = 1, 2, \ldots 169$ and $t = 1995, 1996, \ldots, 2017$. The independent variable of interest is the political empowerment of the woman represented by APF. We use k (k = 1, 2, 3, 4) measures of the political empowerment of women, namely: women's civil liberties (LCF), women's participation in civil society (PFSC), women's participation in political debate (PPF) and the Global Index of Women's Political Empowerment (APF). The control variables are represented here by economic (Eco), social (Soc) and governance (Gov) adaptation. Sarkodie and Strekov (2019) show that these different adaptation variables reduce vulnerability to climate change by mitigating poverty, and improving education and institutions. They also promote better quality jobs, sustainable economic growth and the reduction of inequalities. In other words, preparedness for adaptation to climate shocks improves the resilience capacity of governments. μ_i is the country-specific effect while $\boldsymbol{\tau_t}$ represents the time-specific constant. They enable the control the unobservable characteristics that are invariant over time and specific to each country. $\varepsilon_{i,t}$ is the error term composed of the individual fixed effects and the time effect common to all countries. These effects are assumed not to be observed. φ_k , α, β and γ are the parameters to be estimated.

In order to estimate Equation 2, we adopt a sequential econometric approach depending on the difficulties encountered for each estimation technique. We start our series of ordinary least squats (OLS) estimates. These enable the study to use all the information available relating to the individual and temporal dimensions. Moreover, it also increases the possibility of obtaining unbiased and consistent estimators under the assumption of exogeneity of the rectifiers. On the other hand, given the fact that several economies in our

sample present heterogeneities, it is difficult to claim that there is no bias in the results. Thus, this motivates the choice of a fixed effects (FE) model. The underlying removes the fixed effects. It also produces unbiased estimators, but at the cost of a loss of information. An alternative to FE estimator is to use a random effects (RE) model which produces efficient estimators in the absence of bias related to the omitted variables. One limitation of the RE model is that it is based on overly restrictive assumptions. For example, it is assumed that the individual effect is rather random and not correlated with the explanatory variables. The choice between FE and RE models is based on the LM type and Hausman tests.

4. Empirical results and discussion

4.1 Baseline results

The baseline results are disclosed in two tables. Table 2 presents the effect of the global index of women's political empowerment on vulnerability to climate change in 6 columns. The first two columns (1 and 2) are obtained by OLS. The other 4 columns are split between the fixed effects and the random effects models. However, the Hausman test shows that the fixed effects model is better than the random effects model. Table 3 analyzes the effect of the components of empowerment on climate change vulnerability by performing exclusively fixed effects regressions.

Table 2: baseline model with the Global Index of Women's Empowerment

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: vulnerability to climate change						
	OLS	OLS	RE	RE	FE	FE
APF	**-0.284*** **	**-0.089*** **	**-0.069*** **	**-0.046*** **	**-0.068*** **	**-0.046*** **
	(0.006)	**(0.007)**	**(0.003)**	**(0.003)**	**(0.003)**	**(0.003)**
soc		-0.199***		-0.093***		-0.090***
		(0.008)		(0.003)		(0.003)
gov		-0.061***		0.014***		0.020***
		(0.010)		(0.005)		(0.005)
eco		-0.137***		-0.028***		-0.023***
		(0.010)		(0.004)		(0.004)
Constant	0.725***	0.697***	0.501***	0.513***	0.501***	0.508***
	(0.005)	(0.004)	(0.007)	(0.006)	(0.002)	(0.003)
Observations	3,838	3,586	3,838	3,586	3,838	3,586
Countries	169	158	169	158	169	158
R^2 (adjusted)	0.423	0.649				
R^2 (overall)			0.2787	0.5457		
R^2 (within)					0.1506	0.3352
Wald test			671.51***	1771.21***		
Hausman test			0.000	0.000		
F-statistics					1543***	993***
Region fixed effects	Yes	Yes	No	No	No	No

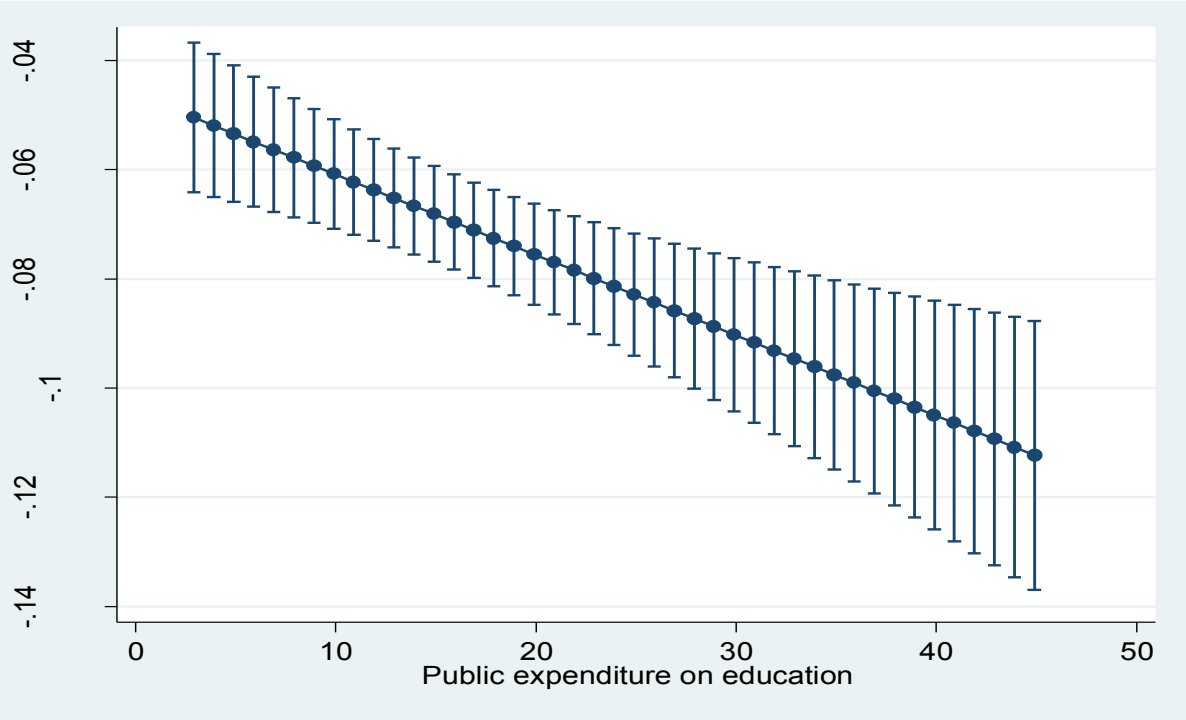
Notes: ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses OLS = ordinary least squares. RE = Random effects model. FE = Fixed effects model. APF = political empowerment of women; soc = social adaptation; gov = adaptation of governance; eco = economic adaptation

The main lesson from the results in Table 2 is that any increase in the overall index of women's political empowerment leads to a decrease in vulnerability to climate change around the world. Columns 1 and 2 obtained from OLS show a significant effect of the order of 1% of women's political empowerment on vulnerability to climate change in 169 countries. The corresponding coefficient of determination (i.e. R^2) of the first specification (or Column 1) is about 42%. The integration of the control variables in Column 2 or the second specification shows the same significant effect with an R^2 of around 64%. Interpretation of the fixed effects model shows that the overall index of women's political empowerment significantly reduces vulnerability to climate change around the world. This effect can be direct or indirect. On the direct front, part of the literature specifies that a large participation of women in decision-making spheres due to their sensitivity to natural disasters, favors efficient policies in relation to the fight against climate change (Alber & Roehr, 2006; Gaard, 2015).

On the indirect front, the effect of women's political empowerment is through economic, social and governmental preparation for adaptation to climate change. In other words, when women are involved in political and administrative decision-making processes, they reduce corruption (Swamy et al., 2001). The reduction of the underlying corruption in turn helps to guarantee investments and profits favorable to stable growth. The stability of this growth is therefore considered as a resilience capacity of the government in the event of a climate shock (Sarkodie & Strekov, 2019). The participation of women in political life also makes it possible to increase spending on health education while reducing social inequalities (Clots-Figueras, 2012). This helps promote a viable political, economic and social framework for safe and efficient economic activities. The promotion of a secure context for economic dynamics, according to Sarkodie and Strekov (2019), ensures a strong resilience capacity of a country in the event of a climate shock. The results of the marginal effects analysis confirm these different transmission channels.

The figures below illustrate the marginal effects of women's political empowerment on vulnerability to climate change, based on education score, governance effectiveness, and public spending on education. In each of these figures, there is a statistically significant negative association between the political empowerment of women and vulnerability to climate change for the different values of engaged transmission channels. In other words, for every gap in public spending on education, education and effective governance, women's political empowerment reduces vulnerability to climate change. More specifically, from Figure 2, the marginal effect of women's political empowerment on climate change vulnerability is negative for the range of public spending on education from 2.9 to 45.

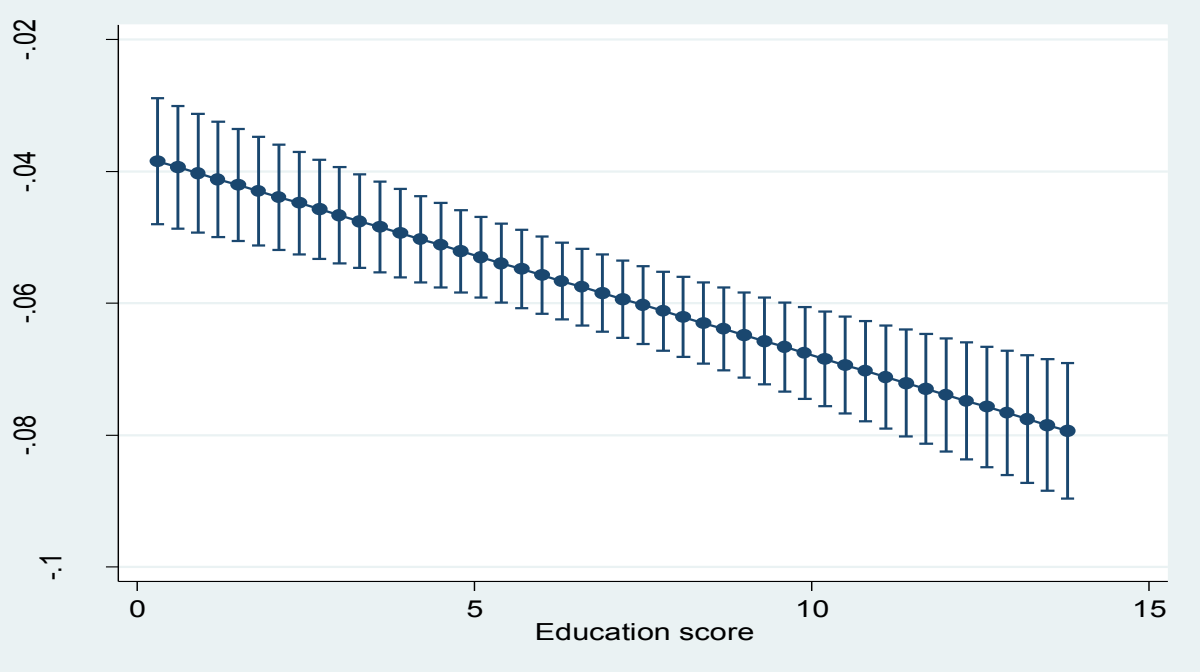
Figure 2: Marginal effects of women's political empowerment on vulnerability to climate change according to the score of public expenditure on education



Source : *Authors. Note : APF = political empowerment of women.*

In Figure 3, the marginal effect of women's political empowerment on vulnerability to climate change is negative for education values ranging from 0.3 to 14.

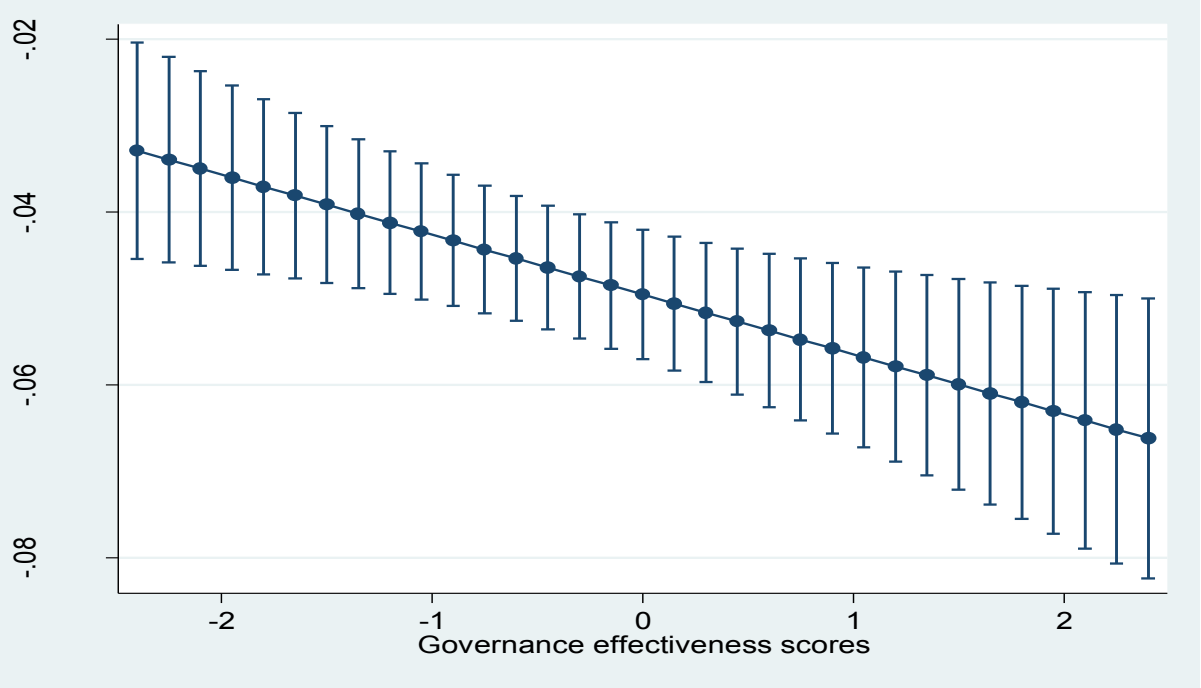
Figure 3 : Marginal effects of women's political empowerment on vulnerability to climate change by education score.



Source : *Authors. Note : APF = political empowerment of women.*

In Figure 4, it is apparent there is also a negative and significant marginal effect of women's political empowerment on climate change vulnerability for the range of values of -2.4 to 2.5 of the efficiency of the governance.

Figure 4: Marginal effects of women's political empowerment on vulnerability to climate change according to governance effectiveness scores.



Source : *Authors. Note : APF = political empowerment of women.*

The underlying marginal effects pertain to the first, second and third specifications of the table in Appendix 3 with confidence intervals of 95%. The decomposed effect of the Women's Political Empowerment Index on vulnerability to climate change is shown in Table 3 below.

Table 3 : baseline model with the components of women empowerment

	(1)	(2)	(3)	(4)
Dependent variable: vulnerability to climate change				
Estimation technique	FE	FE	FE	FE
APF	**-0.046*** **			
	(0.003)			
LCF		**-0.024*** **		
		(0.003)		
PFSC			**-0.048*** **	
			(0.003)	
PPF				**-0.021*** **
				(0.002)
soc	-0.093***	-0.107***	-0.098***	-0.093***
	(0.003)	(0.003)	(0.003)	(0.003)
gov	0.014***	0.016***	0.019***	0.010**
	(0.005)	(0.005)	(0.004)	(0.005)
eco	-0.028***	-0.025***	-0.024***	-0.020***
	(0.004)	(0.004)	(0.004)	(0.004)
Constant	0.513***	0.498***	0.511***	0.496***
	(0.006)	(0.003)	(0.003)	(0.003)
Observations	3,586	3,622	3,622	3,586
Countries	158	158	158	158
R^2 (adjusted)	0.3352	0.302	0.344	0.319
R^2 (within)		0.3019	0.3443	0.3187
R^2 (overall)		0.5330	0.5275	0.4997
F-statistics	993.91***	958***	1002.66***	987.66***

*Note: ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. FE = Fixed-effects model. APF = Political empowerment of women; LCF = civil liberties of women; PFSC = participation of women in civil society; PPF = participation in political debate by women; soc = social adaptation; gov = adaptation of governance; eco = economic adaptation.*

The analysis of Table 3 shows that all three components of women's political empowerment significantly reduce vulnerability to climate change. Indeed, women's civil liberties (columns 2), the participation of women in civil society (Column 3) and the presence of women in political institutions (Column 4) reduce vulnerability to climate change by about 1%. However, it is apparent that the effect of participation in civil society debates is more pronounced than that of the other two components (Column 4). This result confirms our hypothesis which postulates that the political empowerment of women helps reduce vulnerability to climate change.

4.2 Sensitivity tests

Four sensitivity tests are performed on our results. Indeed, starting from the statistics of the "World Development Indicator" proposed by the World Bank in 2018, we separate high-income countries from middle-income countries and low-income countries. We also distinguished countries according to their continental origin. The level of development, fragility and size of each country are also taken into account. These sensitivity tests are inspired by the work of Feindouno and Guillaumont (2019) and Guillaumont and Simonet (2011). According to these, the level of income, geographic position, level of fragility and size of a country influence its vulnerability to climate change. Ignoring these aspects in this work would lead to biased results. Table 4 presents the result by income bracket.

Table 4 : results by income bracket

	(1)	(2)	(3)	(4)
Income brackets	Low income countries	Lower middle-income countries	Upper middle-income countries	High income countries
Dependent variable: vulnerability to climate change				
APF	**-0.021*** **	**-0.013** **	**-0.042*** **	**-0.019*** **
	(0.006)	**(0.007)**	**(0.005)**	**(0.004)**
constant	0.627***	0.571***	0.483***	0.409***
	(0.005)	(0.006)	(0.004)	(0.005)
Countries	24	42	42	50
R^2 (adjusted)	0.205	0.541	0.542	0.357
R^2 (within)	0.2046	0.5414	0.5422	0.3575
F-statistics	707.67***	271.54***	592.72***	1224.98***
Control Variables	Yes	Yes	Yes	Yes

***Note** : ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. The estimates were made with the Fixed Effects Model. APF = Political Empowerment of Women*

The interpretation of findings in Table 4 shows that even by distinguishing countries in terms of income levels, the negative nexus between political empowerment of women and vulnerability to climate change is maintained. Moreover, the magnitude of the nexus is more apparent in upper middle income countries, following by low income countries, high income countries and lower income countries, in this order, in terms of decreasing magnitude. The corresponding findings are presented in Table 5 in terms of geographical location.

Table 5: results according to geographical distribution

	(1)	(2)	(3)	(4)	(5)	(6)
	SSA	EAP	ECA	LAC	MENA	SA
Dependent variable: vulnerability to climate change						
APF	**-0.055*** **	**-0.072*** **	**-0.044*** **	**-0.076*** **	**-0.034*** **	**-0.042*** **
	(0.005)	**(0.012)**	**(0.006)**	**(0.008)**	**(0.004)**	**(0.009)**
Constant	0.582***	0.535***	0.444***	0.538***	0.472***	0.600***
	(0.005)	(0.014)	(0.005)	(0.008)	(0.006)	(0.014)
Observations	989	414	1,015	552	409	184
R^2 (within)	0.112	0.376	0.412	0.606	0.417	0.775
F-statistics	499.2***	259.8***	493.1***	525.5***	823***	326.8***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Countries	43	18	45	24	19	8

***Note** : ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. The estimates were made with the Fixed Effects Model. APF = Political Empowerment of Women.* SSA= Sub-Saharan Africa; EAP= East Asia and the Pacific ; ECA=Europe and Central Asia; LAC= Latin America and the Caribbean; MENA= Middle East and North Africa. SA= South Asia.

Analysis of Table 5 above shows that in sub-Saharan Africa (i.e. Column 1), women's political empowerment is significantly reduced by approximately 1%. The same effect in terms of sign of estimated coefficient is observed in East Asia and the Pacific (Column 2); in Central Europe (Column 3); in Latin America and the Caribbean (Column 4); in the Middle East and North Africa (Column 5) and South Asia (Column 6). In other words, despite the disaggregation of the sample in terms of geographic area, the negative influence of women's political empowerment on vulnerability to climate change withstands empirical scrutiny. However, in Asian countries (Column 2) and Latin American and the Caribbean countries (Column 4), the effect of empowering women is higher. Moreover, even taking into account the level of development, fragility and size of countries in Table 6 below does not change the negative tendency of the result which further supports the validity of the tested hypothesis.

Table 6: result depending on the level of development, fragility and size of the country

	(1)	(2)	(3)	(4)	(5)	(6)
	Less developed countries	Advanced countries	Fragile countries	Non-fragile countries	Small countries	Large countries
Dependent variable: vulnerability to climate change						
AFP	**-0.013****	**-0.050*****	**-0.009****	**-0.063*****	**-0.075*****	**-0.048*****
	(0.006)	**(0.003)**	**(0.005)**	**(0.003)**	**(0.013)**	**(0.003)**
Constant	0.630***	0.477***	0.592***	0.501***	0.449***	0.511***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.014)	(0.003)
Observations	897	2,689	598	3,011	391	3,218
R^2 (within)	0.406	0.372	0.190	0.372	0.285	0.334
F-statistics	336.1***	637.3***	1728.5***	828.5***	425***	1001.1***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Countries	39	119	26	133	17	142

***Note** : ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. The estimates were made with the Fixed Effects Model. APF = Political Empowerment of Women.*

The analysis of the results in Table 6 shows that advanced countries; non-fragile and small countries are the best performers when it comes to mitigating vulnerability to climate change through the political empowerment of women.

4.3 Robustness tests

Three robust tests are presented in this part. These additional robustness tests are motivated by the fact that the results presented above have certain shortcomings, notably, the estimation approach does not take into account some specificities of the outcome variable such as its limited range. First, in terms of limited range, the fact that the outcome variable is defined within the specific range of between 0 and 100 implies it is censored and hence, a double censored estimation approach such as the Tobit model is approach (Asongu, Biekpe & Cassimon, 2020). Furthermore, our dependent variable is a continuous random variable over an interval and hence with this apparent censorship, OLS provide biased and non-convergent estimators due to the model law which is a mixture of a discrete law and a continuous law. The Tobit model is therefore appropriate to address this shortcoming. The choice of a model with limited dependent variable is justified by the fact that vulnerability to climate change cannot be negative.

The second robustness check pertains to employing a dynamic fixed effects estimator. This technique has the advantage of offering the possibility of addressing the long-term

determinants of vulnerability to climate change separately from short-term adjustments. This estimator imposes the identity of all the slope coefficients and the variances of the error terms and only tolerates differences in individual effects between countries. Applying the Tobit and the dynamic fixed effects estimator leads to the results in Table 7 below.

Table 7 : results of the Tobit and the dynamic panel

	(1)	(2)	(3)	(4)
Dependent variable: vulnerability to climate change				
	FE	Tobit	Marginal Effects	DFE
APF	**-0.046*** **	**-0.059*** **	**-0.059*** **	**-0.077*** **
	(0.003)	**(0.008)**	**(0.008)**	**(0.011)**
D.APF				0.004*
				(0.002)
EC (Ø) coefficient				-0.117***
				(0.007)
Constant	0.508***	0.650***		0.060***
	(0.003)	(0.004)		(0.004)
Observations	3,586	3,586	3,586	3,586
R^2 (adjusted)	0.335			
Countries	158			
Control variables	Yes	Yes	Yes	Yes

***Note** : ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. The estimates were made with the Fixed Effects Model. APF = Political Empowerment of Women.* FE=Fixed Effects. DFE= Dynamic Fixed Effects. EC = Error Correction.

It is apparent from the findings in Table 7 in the Tobit estimates that a percentage change of the order of 1% in the political empowerment of women leads to a marginal attenuation of vulnerability to climate change of 0.05 (Column 3). In the same vein, in Column 4 pertaining to the dynamic fixed effects estimator, the established negative effect is robust to the long run incidence of the political empowerment of women in reducing vulnerability to climate change. These results indicate that countries around the world that promote women's empowerment are indirectly improving their resilience to climate change. The estimated average coefficient associated with the error correction term is negative, significant and situated between an interval of 0 and -1 which shows the stability of the model. In summary, the attendant findings, confirms a long-term equilibrium relationship between vulnerability to climate change and the group of significant determinants.

The estimated coefficients established so far have been based on estimation approaches that address only some dimension of endogeneity such as variable omission bias and the unobserved heterogeneity. However, the concern of simultaneity or reverse causality can be taken on board with the employment of the generalized method of moments (GMM) that has been established to address such a concern (Tchamyou, 2019). As opposed to the one-step approach which only accounts for homoscedasticity, the two-step process which control for heteroscedasticity is used in the study in accordance with the corresponding literature (Blundell & Bond, 1998; Tchamyou, Erreygers & Cassimon, 2019). It is also important to note that the choice of this third robustness check is related to the stochastic nature of the outcome variable (i.e. past values significantly explain future values of vulnerability to climate change) implies that an estimation technique such the GMM (Tchamyou & Asongu, 2017) is worthwhile in order to take into account the persistent nature of the attendant outcome variable (Tchamyou, 2020). The persistence of the outcome is confirmed because the correlation between level and first lag series of the outcome variable exceed a documented threshold of 0.800 established in the contemporary GMM-centric literature (Tchamyou, 2019, 2020). The GMM results that are presented in Table 8 below confirm the baseline findings on the negative nexus between the political empowerment of women and vulnerability to climate change. The model is valid because it passes the post-estimation diagnostic criteria related to: (i) the absence of instrument proliferation (i.e. the number of countries are less than the corresponding number of instruments) and (ii) failure to reject the null hypotheses of the Hansen test as well as the second order autocorrelation test in difference (Vu & Asongu, 2020).

Table 8 : estimation by the generalized method of moments

	(1)
Dependent variable: vulnerability to climate change	
	GMM
L.vulnerability to climate change	0.979***
	(0.0121)
APF	**-0.023*** **
	(0.006)
Constant	0.016*
	(0.009)
Control variables	Yes
Observations	359
Countries	93
AR(1)	-2.06**
AR(2)	0.12
Fisher	13680.93***
Instruments	15
Hansen test	0.159

***Note** : ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. The estimates were made with the Fixed Effects Model. APF = Political Empowerment of Women.* GMM= Generalised Method of Moments.

5. Concluding implications and future research directions

This study has analyzed the effect of women's political empowerment on vulnerability to climate change around the world. To achieve the underlying objective, three dimensions of the political empowerment of women have been considered, notably: women's civil liberties, women's participation in civil society activities and women's participation in political debates. To the best of our knowledge, the empirical literature on the influence of women's political empowerment on climate change is sparse[1]. The empirical evidence in the present study is based on a panel of 169 developing countries for the period 1995-2017.

The findings show that the political empowerment of women significantly reduces vulnerability to climate change. When these findings are subjected to sensitivity tests, the negative nexus withstands scrutiny on premises of income brackets, geographic location, level of development, economic size and level of fragility of countries. The findings also further withstand empirical scrutiny when assessed within the remit of further robustness checks using, Tobit, dynamic fixed effects and GMM regressions. It is also apparent from the

[1]Accordingly, while the contemporary literature has substantially focused on the economic empowerment of women in developing countries (Asongu, Nnanna & Acha-Anyi, 2020; Morsy, 2020; Asongu, Adegboye & Nnanna, 2021), the role externalities of women empowerment remain spares in the literature.

findings that public spending on education, the effectiveness of governance and education are the real transmission channels through which vulnerability to climate change is affected by women's political empowerment. This implies that the engaged socio-economic and governmental channels should be consolidated in view of empowering women politically in order to ultimately mitigate vulnerability to climate change and attendant unfavorable economic development externalities.

The findings in this study obviously leave for future research especially as it pertains to engaging more country-specific empirical strategies in order to provide more country-specific policy implications. Accordingly, while these findings provide insights into how regional and global policy agenda focusing on developing countries can be envisaged in view of the fighting climate change and empowering the female gender, country-specific initial conditions would determine the magnitude of the proposed policy directions.

Appendix 1: Lists of countries by region

SSA		EAP	ECA		LAC	MENA	NA	SA
Angola	Mali	Australia	Albania	Latvia	Argentina	Algeria	Canada	Afghanistan
Benin	Mauritania	Myanmar	Armenia	Lithuania	Barbados	Bahrain	USA	Bangladesh
Botswana	Mauritius	Cambodia	Austria	Luxembourg	Bolivia	Djibouti		Bhutan
Burkina Faso	Mozambique	China	Azerbaijan	Macedonia	Brazil	Egypt		India
Burundi	Namibia	Fiji	Belarus	Moldova	Chile	Iran		Maldives
Cameroon	Niger	Indonesia	Belgium	Montenegro	Colombia	Iraq		Nepal
Central AfricanRepublic	Nigeria	Japan	Bosnia and Herzegovina	Netherlands	Costa Rica	Israel		Pakistan
Chad	Republic of the Congo	Laos	Bulgaria	Norway	Cuba	Jordan		Sri Lanka
Comoros	Rwanda	Malaysia	Croatia	Poland	DominicanRepublic	Kuwait		
Democratic Republic of the Congo	Sao Tome and Principe	Mongolia	Cyprus	Portugal	Ecuador	Lebanon		
Equatorial Guinea	Senegal	New Zealand	CzechRepublic	Romania	El Salvador	Libya		
Eritrea	Seychelles	Papua New Guinea	Denmark	Russia	Guatemala	Malta		
Ethiopia	Sierra Leone	Philippines	Estonia	Serbia	Guyana	Morocco		
Gabon	Somalia	Singapore	Finland	Slovakia	Haiti	Oman		
Ghana	South Africa	Solomon Islands	France	Slovenia	Honduras	Qatar		
Guinea	Sudan	South Korea	Georgia	Spain	Jamaica	SaudiArabia		
Guinea-Bissau	Swaziland	Thailand	Germany	Sweden	Mexico	Syria		
IvoryCoast	Tanzania	Timor-Leste	Greece	Switzerland	Nicaragua	Tunisia		
Kenya	The Gambia	Vanuatu	Hungary	Tajikistan	Panama	United ArabEmirates		
Lesotho	Togo	Vietnam	Iceland	Turkey	Paraguay	Yemen		
Liberia	Uganda		Ireland	Turkmenistan	Peru			
Madagascar	Zambia		Italy	Ukraine	Suriname			
Malawi	Zimbabwe		Kazakhstan	United Kingdom	Trinidad and Tobago			
			Kyrgyzstan	Uzbekistan	Uruguay			
					Venezuela			

Notes : SSA= Sub-Saharan Africa ; EAP= East Asia and the Pacific ; ECA=Europe and Central Asia; LAC= Latin America and the Caribbean; MENA= Middle East and North Africa. NA= North America , SA= South Asia.

Appendix 2 : Correlation matrix

	(1) vul	APF	LCF	PFSC	PPF	soc	gov	eco	adg
vul	1								
APF	-0.528	1							
	(0.000)								
LCF	-0.526	0.902	1						
	(0.000)	(0.000)							
PFSC	-0.504	0.919	0.845	1					
	(0.000)	(0.000)	(0.000)						
PPF	-0.328	0.808	0.536	0.614	1				
	(0.000)	(0.000)	(0.000)	(0.000)					
soc	-0.667	0.518	0.514	0.477	0.367	1			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
gov	-0.665	0.636	0.685	0.583	0.370	0.653	1		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
eco	-0.690	0.492	0.523	0.459	0.277	0.635	0.818	1	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
adg	-0.745	0.617	0.647	0.569	0.379	0.839	0.928	0.916	1
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
N	3933								

Vul = vulnerability to climate change. APF = political empowerment of women; LCF = civil liberties of women; PFSC = participation of women in civil society; PPF = participation in political debate by women soc = social adaptation; gov = adaptation of governance; eco = economic adaptation; adg = global adaptation.

Appendix 3 : Channels of transmission of the Global Women's Empowerment Index

	(1)	(2)	(4)
Dependent variable: vulnerability to climate change			
Estimation technique	FE	FE	FE
APF	**-0.046*** **	**-0.038*** **	**-0.050*** **
	(0.008)	(0.005)	(0.004)
Public expenditure on education	0.001***		
	(0.000)		
APFx Public expenditure on education	**-0.001*** **		
	(0.000)		
Education		0.002***	
		(0.000)	
APFxEducation		**-0.003*** **	
		(0.001)	
Government effectiviness			0.004*
			(0.002)
APFx Government effectiveness			**-0 .007*** **
			(0.003)
Global adaptation	-0.118***	-0.104***	-0.128***
	(0.008)	(0.006)	(0.008)
Constant	0.528***	0.511***	0.533***
	(0.006)	(0.004)	(0.004)
Observations	2,045	2,952	2,055
Countries	158	144	166
R^2 (adjusted)	0.263	0.256	0.246
R^2 (within)	0.514	0.557	0.557
R^2 (overall)	0.600	0.557	0.565
F-statistics	595.92***	959.24***	750.74***

***Note** : ***, ** and * respectively indicate the significance of the coefficients at the 1%, 5% and 10% levels. Robust standard errors are in parentheses. The estimates were made with the Fixed Effects Model. APF = Political Empowerment of Women*. FE : Fixed Effects.

Appendix 4 : description of variables

Variables	Description	Sources
Variable Dépendante		
Vulnerability to climate change	It is about the propensity or predisposition of human societies to suffer the negative effects in the event of climatic shocks. This variable varies between "0 and 100".	*Global Adaptation Index (2018)*
Variables Indépendantes		
Political empowerment of women	Women's Political Empowerment Index. It represents the average of the indices of civil liberty of women. participation in civil society of women and political participation of women.	V-Dem (2018)
Civil liberties of women	Percentage of women making decisions in important areas of their daily life.	V-Dem (2018)
Participation in women's civil society	Percentage of women participate freely in public debate.	V-Dem (2018)
Participation in women's civil society	Percentage of women freely participate in public debate.	V-Dem (2018)
Preparation for global adaptation	The composite index of social adjustment readiness. governance and economic.	*Global Adaptation Index (2018)*
Preparation for social adaptation	It is a question of social inequalities, in particular the quality of infrastructure, the educational framework and the ability to innovate.	*Global Adaptation Index (2018)*
Preparation for adaptation of governance	It combines the indicators of political stability. Control of corruption; the rule of law and the quality of regulation.	*Global Adaptation Index (2018)*
Preparation for economic adaptation	Measures the various economic maneuvers favorable to the business climate necessary for the mobilization of capital in the private sector.	*Global Adaptation Index (2018)*

References

Aelst, K. V., & Holvoet, N. (2016). Intersections of Gender and Marital Status in Accessing Climate Change Adaptation : Evidence from Rural Tanzania. *World Development*, *79*(July 2015), 40–50.

Aguilar, L. (2007). Women and climate change: Women as agents of change. International Union for Conservation of Nature (IUCN) (http://cmsdata.iucn.org/downloads/climate_change_gender.pdf).

Alaimo, S. (2009). Insurgent vulnerability and the carbon footprint of gender. Kvinder, Kon & ForskningWomen, Gender, &Research, 3,22–35

Alber, G., & Roehr, U. (2006). Climate protection: What's gender got to do with it? Women & Environments International Magazine, 70(71), 17–20.

Alexander, A. C., Bolzendahl, C., &Jalalzai, F. (2016). Defining Women's Global Political Empowerment: Theories and Evidence. *Sociology Compass*, *10*(6), 432–441. https://doi.org/10.1111/soc4.12375

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., &Vaz, A. (2013). The women's empowerment in agriculture index. *World Development*, 52, 71–91.Al Riyami, A., Afifi, M., and Mabry, R. M. (2004). Women's autonomy, education and employment in Oman and their influence on contraceptive use. *Reproductive Health Matters*, *12*(23), 144–154. https://doi.org/10/bqmhft

Asongu, S. A., Adegboye, A., & Nnanna, J., (2021). Promoting female economic inclusion for tax performance in Sub-Saharan Africa. *Economic Analysis & Policy*, 69 (March), 159-170.

Asongu, S. A., Biekpe, N., & Cassimon, D., (2020). Understanding the greater diffusion of mobile money innovations in Africa. *Telecommunications Policy*, 44(8), 102000.

Asongu, S. A., Nnanna, J., & Acha-Anyi, P. N., (2020). Inequality and gender economic inclusion: The moderating role of financial access in Sub-Saharan Africa. *Economic Analysis and Policy,* 65(March), 173-185.

Blundell, R., & Bond, S. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Branisa, B., Klasen, S., & Ziegler, M. (2013). Gender Inequality in Social Institutions and Gendered Development Outcomes. *World Development*, *45*(C), 252–268. https://doi.org/10/gf7968

BrúBistuer, J., & Cabo, M. A. (2004). A gendered politics of the environment. In Lynn A. Staeheli, Eleonore Kofman, & Linda J. Peake (Eds.), Mappingwomen, makingpolitics: Feministperspectives onpolitical geography (pp. 209–225). New York: Routledge. Clots-Figueras, I. (2012). Are Female Leaders Good for Education? Evidence from India. *American Economic Journal: Applied Economics*, *4*(1), 212–244. https://doi.org/10/fxqw3f

Cannon, T. (2002). Gender and climate hazards in Bangladesh. *Gender and Development* 10 (2): 45– 50.

CARE (2010). Adaptation, gender and women's empowerment(CARE International Climate Change Brief). Retrieved from http://www.care.org/sites/default/files/documents/CC-2010-CARE_Gender_Brief.pdf

Chen, C., Noble, I., Hellman, J. J., Coffee, J., Murillo, M.,& Chawla, N. (2015). Country Index Technical Report. University of Notre Dame – Global Adaptation Index. Available at: http://index.nd-gain.org:8080/documents/nd-gain_technical_document_2015.pdf.

Doepke, M., & Tertilt, M. (2018). Women's Empowerment, the Gender Gap in Desired Fertility, and Fertility Outcomes in Developing Countries (Working Paper No. 2018–001). Human Capital and Economic Opportunity Working Group. https://econpapers.repec.org/paper/hkawpaper/2018-001.htm

Dollar, D., Fisman, R., & Gatti, R. (2001). Are women really the "fairer" sex? Corruption and women in government. *Journal of Economic Behavior & Organization*, *46*(4), 423–429. https://doi.org/10/fs88kx

Ergas, C., & York, R. (2012). Women's status and carbon dioxide emissions: A quantitative cross-national analysis. Social Science Research, 41,965–976.

Feindouno, S., & Guillaumont, P. (2019). Measuring physical vulnerability to climate change: The PVCCI, an index to be used for international development policies. In *Ferdi Working Paper 97*.

Gaalya, M. S. (2015). Trade Liberalization and Tax Revenue Performance in Uganda. *Modern Economy*, 228–244.

Gaard, G. (2015). Women ' s Studies International Forum Ecofeminism and climate change. *Women's Studies International Forum*, *49*, 20–33. https://doi.org/10.1016/j.wsif.2015.02.004

Goebel, A. (2004). Women and sustainability: What kind of theory do we need? Canadian Woman Studies, 23(1), 77–84.

Goh, A.H.X. (2012). A Literature Review of the Gender-differentiated Impacts of Climate Change on Women's and Men's Assets and Well-being in Developing Countries. CAPRi Working Paper No. 106. International Food Policy Research Institute, Washington, D.C.. http://dx.doi.org/10.2499/CAPRiWP106

Guillaumont, P., & Simonet, C. (2011). Designing an Index of Physical Vulnerability to Climate Change. *Ferdi Working Paper*, (March).

Hanmer, L., & Klugman, J. (2016). Exploring Women's Agency and Empowerment in Developing Countries: Where do we stand? *Feminist Economics*, *22*(1), 237–263. https://doi.org/10/gf44pb

Hansen, G., & Stone, D. (2015). Assessing the observed impact of anthropogenic climate change. *Nature Climate Change*, (December). https://doi.org/10.1038/NCLIMATE2896

Israel, A.L., & Sachs, C. (2013). A climate for feminist intervention: feminist science studies and climate change. In: Alston, M., Whittenbury, K. (Eds.), Research, Action and Policy: Addressing the Gendered Impacts of Climate Change, pp. 33e52. Jain, S., 19

Liebowitz, D. J., & Zwingel, S. (2014). Gender equality oversimplified: Using CEDAW to counter the measurement obsession. International Studies Review, 16(3), 362–389.

Martin, G., & Saikawa, E. (2017). Effectiveness of state climate and energy policies in reducing power-sector CO2 emissions. *Nature Climate Change*, 1–10. https://doi.org/10.1038/s41558-017-0001-0

Klasen, S. (2006). UNDP's gender-related measures: Some conceptual problems and possible solutions. *Journal of Human Development*, 7(2), 243–274.

MacGregor, S. (2010). Gender and climate change :Fromimpacts to discourses. *Journal ofthe Indian Ocean Region*, 6(2), 223–238.

McCright, A. M. (2010). The effects ofgender on climate change knowledge and concern in theAmerican public. *Population and Environment*, 32,66–87.

Miller, D.A.W., Grant, E.H.C., Muths, E., Amburgey, S.M., Adams, M.J., Joseph, M.B., Waddle, J.H., Johnson, P.T.J., Ryan, M.E., Schmidt, B.R., Calhoun, D.L., Davis, C.L., Fisher, R.N., Green, D.M., Hossack, B.R., Rittenhouse, T.A.G., Walls, S.C., Bailey, L.L., Cruickshank, S.S., Fellers, G.M., Gorman, T.A., Haas, C.A., Hughson, W., Pilliod, D.S., Price, S.J., Ray, A.M., Sadinski, W., Saenz, D., Barichivich, W.J., Brand, A., Brehme, C.S., Dagit, R., Delaney, K.S., Glorioso, B.M., Kats, L.B., Kleeman, P.M., Pearl, C.A., Rochester, C.J., Riley, S.P.D., Roth, M., &Sigafus, B.H.(2018). Quantifying climate sensitivity and climate-driven change in North American amphibian communities. Nat. Commun. 9, 3926. https://doi.org/10.1038/s41467-018-06157-6.

Morsy, H., (2020). Access to finance – Mind the gender gap. The Quarterly Review of Economics and Finance, 78(November), pp. 12-21

Nellemann, C., Verma, R.,& Hislop, L.(2011). Women at the frontline of climate change: Gender risks and hopes. A Rapid Response Assessment. United Nations Environment Programme. GRID-Arendal. http://www.unep.org/pdf/rra_gender_ screen.pdf. (Accessed 8 December 2014).

Nwoke, E. A., & Ibe, S. N. O. (2015). Climate change impact on the health of African women and adaptation strategies. *International Journal of Public Health and Epidemiology*, *4*(6), 162–171.

Resurrección, B. P. (2013). Persistent women and environment linkages in climate change and sustainable development agendas. *Women's Studies International Forum*, 40,33–43.

Raftery, A.E., Zimmer, A., Frierson, D.M., Startz, R., &Liu, P. (2017). Less than 2 C warming by 2100 unlikely. *Nature Climate Change*. 7, 637.

Roodman, D. (2009). Practitioners' Corner: A note on the theme of too many Instruments. *Oxford Bulletin of Economics and Statistics*, *71*(1), 135–158. https://doi.org/10.1111/j.1468-0084.2008.00542.x

Sarkodie, S. A., & Strezov, V. (2019). Science of the Total Environment Economic , social and governance adaptation readiness for mitigation of climate change vulnerability : Evidence from 192 countries. *Science of the Total Environment*, *656*, 150–164. https://doi.org/10.1016/j.scitotenv.2018.11.349

Sraboni, E., Malapit, H. J., Quisumbing, A. R., & Ahmed, A. U. (2014). Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh? *World Development*, *61*, 11–52. https://doi.org/10/ggr94x

Sundström, A., Paxton, P., Wang, Y. T., & Lindberg, S. I. (2017). Women's Political Empowerment: A New Global Index, 1900–2012. *World Development*, *94*(C), 321–335.

https://doi.org/10/f97spmSwamy, A., Knack, S., & Lee, Y. (2001). Gender and corruption. *Journal of Development Economics*, *64*, 25–55.Svaleryd, H. (2002). Femal Representation—Is it Important for Policy Decisions? (Research Papers in Economics 2002:7). Stockholm University, Department of Economics. https://econpapers.repec.org/paper/hhssunrpe/2002_5f0007.htm

Tchamyou, V. S., (2019). The Role of Information Sharing in Modulating the Effect of Financial Access on Inequality. *Journal of African Business*, 20(3), 317-338.

Tchamyou, V. S., (2020). Education, Lifelong learning, Inequality and Financial access: Evidence from African countries.*Contemporary Social Science*, 15(1), 7-25.

Tchamyou, V. S., &Asongu, S. A., (2017). Information Sharing and Financial Sector Development in Africa. Journal of African Business, 18(7), 24-49.

Tchamyou, V.S., Erreygers, G., & Cassimon, D., (2019). Inequality, ICT and Financial Access in Africa. *Technological Forecasting and Social Change*, 139(February), 169-184.

Vu, K. M., & Asongu, S. A., (2020). Backwardness advantage and economic growth in the information age: A cross-country empirical study. *Technological Forecasting and Social Change*, 159(October), 120197.

Watson, J. E. M., Iwamura, T., & Butt, N. (2013). Mapping vulnerability and conservation adaptation strategies under climate change. *Nature Climate Change*, *3*(9), 1–6. https://doi.org/10.1038/nclimate2007

Yadav, S. S., & Lal, R. (2017). Vulnerability of women to climate change in arid and semi-arid regions : The case of India and South Asia. *Journal of Arid Environments*, 1–14. https://doi.org/10.1016/j.jaridenv.2017.08.001

Yavinsky, R.W. (2012). Women More Vulnerable than Men to Climate Change. http:// www.prb.org/Publications/Articles/2012/women-vulnerable-climate-change. aspx. (Accessed 25 November 2014).