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Original Article

Empirical Analysis of the Impact of Climate Change on Togo's Economy

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Abstract *- Climate change may add significant impact to the developmental issue of ensuring food self-sufficiency and reducing poverty. Togo, in its configuration, has agriculture that occupies 70% of the population and generates 40% of the total GDP, but this agriculture is heavily dependent on weather conditions. Climate change tends to make Togo's population and the economy more vulnerable.*

The present study aimed to analyze the impact of climate change on Togo's economy. The study used the dynamic model in Ordinary Least Squared, in Time series data of Togo from 1970 to 2018, the research used secondary data. The variables: Gross Domestic Product per capita (GDPPC) as a proxy of Economic growth, linear climatic variables temperature, precipitation as a proxy of climate Change Lag of Gross Domestic Product per capita(lagGDPPC), Degree of Trade Openness (DOP), Official Development Assistance (ODA) were used for the model. After the analyses using Eviews 7, the study found that the change in climatic conditions has a significant impact on Togo's economy. The results of the study showed that an increase of 1% in Precipitation will decrease Togo's economy by 0.14%. Similarly, an increase of 1% in temperature will decrease Togo's economy by 1.86% (ceteris paribus). The variables Lag of Gross Domestic Product per capita (lagGDPPC), Degree of Trade Openness (DOP), Official Development Assistance (ODA) were found significant and positively affected Togo's economy.

Keywords *- Climate change, Economy, Togo, OLS.*

I. INTRODUCTION

The threat of climate change is the center of concern in the international community. In order to understand this international interest, one should know the meaning of the term "climate change". The meaning of the term "climate change" is simple enough to understand and no longer a source of controversy. However, its causes, magnitude, and the impacts of these changes on the economy, human well-being, and the environment are much discussed.

To accelerate economic growth and reduce poverty, developing countries must develop their industrial development and improve their living conditions. In this case, greenhouse gas emissions increase, which in turn leads to major climate change.

Togo has counted 60 urban and rural floods between 1925 and 1992 which have caused material damage and loss of life. The years 2007 and 2008 were particularly marked by the disastrous floods, with social and economic consequences for the country.

The series of floods cause the loss of human lives and the massive destruction of roads, residential houses, and fields. These phenomena, formerly located primarily in the Maritime Regions (Prefectures: Gulf, Lakes, Zio) and Savannah (Kpendjal), have become widespread these few years throughout the country (MERF 2009). Maximum temperature extremes manifest themselves almost every year, reaching 40° C in some places. They are common in the Maritime Regions and Savannah. Three cycles of droughts that triggered a severe famine were experienced between 1942-1943; 1976 1977, and from 1982 to 1983. The famine occurs in the regions of Savannah, Kara, Maritime, and east of the Plateau region. The winds that occur frequently arrive with a speed from 100 to 115 Km/h and are common in Regions Savannah, Kara, and Plateau East. These winds that tear through everything in their way are the cause of soil degradation by wind erosion, loss of biodiversity, the lodging of crops, and famine (MERF 2009).

Togolese agriculture as the engine of the national economy rose to the forefront of the country's sources of growth. According to figures from the General Directorate of Statistics and National Accounting (DGSCN, 2011), in 2015 the agricultural sector employed 70% of the workforce. The balance of economic performance in 2011 as part of the Accelerated Growth Strategy and Employment Promotion (SCAPE) indicates that the primary sector accounts for 20% of exports and contributes on average 38.4% in training real GDP. This sector, in fact, plays an important role in the national strategy to fight against hunger and poverty. Notwithstanding its economic importance, Togo's agriculture is severely limited by traditionalism. This agriculture is heavily dependent on weather conditions, and any change in weather will surely affect the agriculture production in Togo, thus affecting the Togolese economy. Hence the purpose of this study is to

analyze the relationship between climate change and Togo's economy.

A. Evolution of temperature in Togo

The observed temperatures have risen by 1.1 ° C since 1960, with an average rate of 0.24 ° C per decade. The fastest warming was observed between April and June with 0.31 ° C per decade. The rate of increase was generally faster in the northern regions of the country than in the south. Daily temperature data proved that the frequency of "hot" nights and days has increased significantly in all seasons. The number of "hot" nights and days increased by 21.5% or 15.5% between 1960 and 2003. The increase was higher in the period from September to November.

However, the frequency of "cold" days and nights decreased significantly from 1960-2003and in most seasons. The number of "cold" days and nights per year decreased by 5.8% or 4.0% between 1960 and2003. The decrease was strongest in the period from June to August.

Change in temperature constitutes a revealing and informative element of the changes taking place in the environment

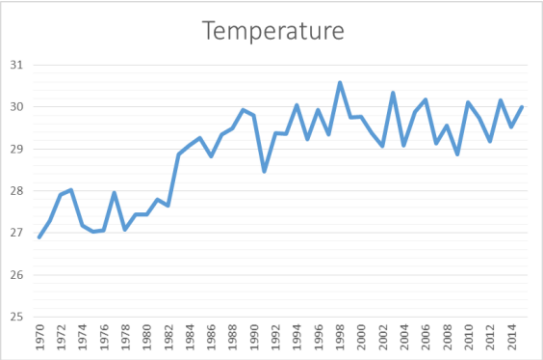

Fig. 1 Evolution of temperature in Togo from 1970-2015
Source: Author's Compilation

C. Togo's contribution of Greenhouse Gases (GHGs)

Emission is one of the major effects that can be seen through climate change and that has impacted many activities in Togo. These emissions are probably the causes of the cycle of drought and flood that a country has experienced.

Greenhouse Gases have mitigated a great deal in agricultural production with less fertile land and rainfall that has drastically decreased. This change is attributed, to the action of people with gas sources activities of greenhouse gases (GHGs).

In 2000, Togo has issued the equivalent of 13,250 gigatons of CO2 (CO2-eq). In 2000, Togo has issued greenhouse gas (GHG) (emissions from land-use change are not included) which correspond to 1.5 ton CO2-eq per capita per year. By comparison in 2000, the US has emitted 24.3 tons of CO2-eq per capita per year and the average global emissions amount to about 5.6 tons CO2eq per capita (WRI 2010).

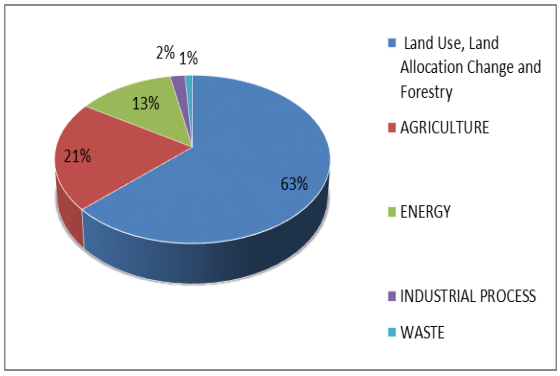

Fig. 2 Contribution of each sector to total GHG emissions in Togo in 2000.
Source: Author's Compilation

II. LITERATURE REVIEW

Various studies have been conducted to examine the relationship between climate change on economic growth using different methods.

Dell et Al (2012) analyzed the impact of temperature on countries' aggregate economic outcomes. The authors found that higher temperatures reduce economic growth in developing countries, with higher temperatures reducing developing countries' growth rate from 0.6 to 2.9 percentage points. Similarly, Tol et Al (2018) analyzed the economic impacts of climate change. The authors conclude that climate change will surely have an impact on the economy and human welfare in the twenty-first century. In the short run, climate change may have a positive impact on the economy. However, in the long run, the negative impacts are more than the positive ones. The authors also found that the poorer and lower-lying countries negative impacts will be greater. In order to see the impact climate change could have on Pakistan's economic growth precisely in the three sectors of the Pakistan economy, Gulzar et Al (2013) analyze the impact of climate change on the economic growth of Pakistan from the period of 1973-2010. Climate change was proxy by temperature. The authors found that temperature has affected the output and productivity negatively and significantly in the agriculture, manufacturing, and service sectors. However, the negative impact is much greater in agriculture in comparison with manufacturing and services. The authors also found that in the provinces of Balochistan and Khyber Pakhtunkhwa, growth is negatively impacted by climate change while the results have an insignificant

relationship with growth in Punjab and Sindh provinces.

Fabio et Al (2010) analyzed the impact of climate change on economic growth using dynamic multi-regional computable general equilibrium (CGE) on the world economy. The authors found that climate change had the most impact on developing countries.

Conor and Tol (2012) studied the relationship between civil war, climate change, and development by using a double Monte Carlo conducted for sub-Saharan Africa in order to account for both parameter and stochasticity. The authors concluded that climate change increased the probability of civil war and civil war reduced economic growth.

Thurlow et Al (2015) estimated the economy-wide impact of climate change taking advantage of a computable general equilibrium model. The author's study results stated that climate change negatively affected the national welfare, with poor and urban households and the northern Savannah zone.

Jonathan et Al (2017) studied the impact climate change could have on Nigerian output taking advantage of the ordinary least squares (OLS) estimation technique for the period of 1981-2014. Climate change was proxy by the variables with annual rainfall, carbon emission, forest depletion, government expenditure, domestic private investment, and the exchange rate used as control variables. The authors found that in the short run, carbon emissions affect output growth adversely while the impact is negative in the long run. In addition, forest depletion was found to negatively impact output growth in the short run.

III. METHODOLOGY

This study seeks to find the impact of climate change on economic growth in Togo from 1970 to 2018. The data used in this study were secondary in nature and were collected from the World Bank. The data were on an annual basis as contained in the World Bank.

A. Theoretical Background

The two most widely used types of approaches for analyzing the impacts of climate change on economic growth are the enumerative approach and the dynamic approach. In the enumerative approach, the economic impacts of climate change are analyzed separately sector by sector, such as the effects of climate change on agriculture, the ecosystem, or tourism. These effects are estimated jointly to obtain an estimate of the total change in social welfare caused by climate change (Nordhaus, 1991; Cline, 1994; Tol, 1995). In this approach, the effects of climate change are analyzed by focusing on only one period. Inter-temporal effects are ignored. These studies, however, have failed to provide information on how climate change may affect welfare in the long run. This approach also ignores the significant "horizontal inter linkages", such as the interaction of sectorial impacts. It mostly uses computable general equilibrium (CGE) models and simulation techniques.

In the dynamic approach, various specifications of growth models are used by adding the damage function. The Solow-Swan and Ramsey-Cass-Koopmans models are the most widely used growth models for analyzing the impacts of climate change on output growth. The Mankiw, Romer, and Weil (1992) model is also applied (Fankhauser and Tol; 2005), but to a weaker degree. In all three of these models, under the assumption of a constant savings rate, it has been found that if climate change has a negative impact on output, then the amount of investment will also be reduced. In the long run, capital stock and consumption per capita will reduce, which will result in shrinking aggregate demand and will oppositely impact the GDP.

B. Theoretical model

Dell et al (2008) added the climatic variables in the production function of their model, which was used as the baseline for the present study. The model provided the theoretical basis for including climate change into growth equations and the steps for decomposition of the impacts of changes in weather on economic growth.

Consider the production function.

$$Y_{it}=e^{\beta T_{it}} A_{it} L_{it} \qquad (1)$$

$$\Delta A_{it}/A_{it}=g_i+\beta T_{it} \qquad (2)$$

Where Y is GDP, L is labor force, A is a technology and can be referred to as labor productivity and T are the impacts of climate, g is the growth rate of GDP. Equation (1) captures the direct effects of climate change on economic growth, such as impacts on labor productivity. Equation (2) captures the indirect (dynamic) effect of climate, such as the impact of climate on other variables that indirectly influence GDP. Notably, equation (1) directly relates climate change to GDP whereas, in equation (2), climate changes affect labor productivity, which will, in turn, affect GDP growth. After adding the logarithm in the production function and difference the equation in respect to time, we obtained the dynamic growth equation:

$$log y_{it}=log(e^{\beta T} AL)$$

$$log y_{it}=\beta T+ C+ log L_{it}$$

$$\frac{dt(logy_{it})}{dt} = \frac{dt(log\beta T_{it})}{dt} + o + \frac{dt(logL_{it})}{dt}$$

$$g_{it} = g_i + (\beta+\gamma)\, T_{it} - \beta T_{it-1} \quad (3)$$

Where g_{it} is the growth rate of per-capita output the "level effects" of weather shocks on output, found in equation (1), can be seen through β? The "growth effects" of weather shocks, found in equation (2), can be seen through γ.

The empirical study is to explore the effect of climate change on poverty in Togo by adopting the ordinary least squared method to determine the relationship between poverty and climate change variables.

C. Model specification

$\log GDPPC_{it} = \beta o + \beta 1 \log lagGDPPC_{it} + \beta 2 \log TEMP_{it} + \beta 3 \log PRECIP_{it} + \beta 4 \log DOP_{it} + \beta 5 \log ODA_{it} + \mu_{it}$

Explained variable

GDPPC: Gross domestic product per capita

Explanatory variables

TEMP: Represents the average temperature at countries level in degrees Celsius

PRECIP: Represent the average level of rainfall at countries level (in mm).

LagGDPPC: lag of gross domestic product per capita

DOP: Represent the degree of trade openness which was obtained by calculating the sum of exports and imports of goods divided by GDP.

ODA: Official Development Assistance, also known as foreign aid

ε: error term

Log: Represent the natural logarithm

In the study, annual temperature and precipitation have been selected as indicators of climate change because changes in mean temperature have a direct relationship with GHG concentrations. However, it is relatively difficult to relate the other indicators directly to GHG concentrations.

D. Sensitivity Tests

1) Descriptive Properties of Data

The descriptive characteristics of the variables in the models are presented in Table I. The average of the GDPPC, LAGGDP, TEMP, PRECIP, DOP and ODA are respectively 361.4295, 353.0852, 29.08135, 114.3481 ,9.62E+08 and 1.5E+08 while the median are 338.3387, 335.3100, 29.34970, 113.3965, 6.54E+08 and 1.16E+08 respectively. The maximum values of the variables are for 620.1318, 620.1318, 30.58350, 174.3990, 2.95E+09, and 5.42E+08forGDPPC, LAGGDP, TEMP, PRECIP, DOP and ODA respectively. The minimum values are 131.0987 for GDPPC, 120.0539 for LAGGDP, 27.03130 for TEMP, 66.27210 PRECIP 1.14E+08 for DOP, and 19260000 ODA. The variables' standard deviation 118.8687, 121.4882, 1.055258, 27.57887, 7.57E+08, 1.17E+08 for GDPPC, LAGGDP, TEMP, PRECIP, LDAP and ODA respectively

1) Ramsey RESET Test

The Ramsey Reset Specification determines if non-linear combinations of the independent variables can explain the dependent variable. If the dependent variable is explained by the non-linear combinations of the independent variables, the model is not well specified. The p-values of the Ramsey Reset statistic for the model in Table II are insignificant at a 5% level of significance showing that the models were well specified.

Table 2. Ramsey RESET Test

Model	Value	df	p-value
t-statistic	0.784406	41	0.4373
F-statistic	0.615294	(1, 41)	0.4373

Source: Computer analysis using E-views 7.0

2) Serial Correlation LM Test

The presence of autocorrelation in the model would be detected by serial correlation LM test. It was used in addition to Durbin Watson to test for autocorrelation. The null hypothesis of the LM test is that there is no serial correlation up lag order 2. The p-values of the Breusch-Godfrey serial correlation test in Table III are insignificant at 5%, which envisages that variables are free from autocorrelation issues.

Table 3. Breusch-Godfrey Serial Correlation LM Test

Model	F-statistic	Prob.F (2,30)
Model	1.473340	0.2593

Source: Computer analysis using E-views 7.0

3) Heteroskedasticity Test

In classical linear assumption, a regression model should be devoid of the heteroskedasticity problem. As it appears in Table IV, the p-value of the Chq. statistic for the models is insignificant at a 5% level of significance, which shows evidence of the homoscedastic nature of the variables.

Table 4. Heteroskedasticity Test

Model	F-statistic	Prob.F (5,32)
Model	1.902492	0.1143

Source: Computer analysis using E-views 7.0

Table 5. Descriptive Properties of Data

	GDPPC	LAGGDPPC	TEMP	PRECIP	DOP	ODA
Mean	361.4295	353.0852	29.08135	114.3481	9.62E+08	1.5E+08
Median	338.3387	335.3100	29.34970	113.3965	6.54E+08	1.16E+08
Maximum	620.1318	620.1318	30.58350	174.3990	2.95E+09	5.42E+08
Minimum	131.0987	120.0539	27.03130	66.27210	1.14E+08	19260000
Std. Dev.	118.8687	121.4882	1.055258	27.57887	7.57E+08	1.17E+08
Skewness	0.341833	0.311787	-0.621067	0.241506	1.198100	1.480657
Kurtosis	2.393494	2.525886	2.226721	2.246828	3.387247	5.238564
Jarque-Bera	1.670498	1.227256	4.281713	1.601135	11.78348	27.56110
Probability	0.433766	0.541383	0.117554	0.449074	0.002762	0.000001
Sum	17348.62	16948.09	1395.905	5488.708	4.62E+10	7.31E+09
Sum Sq. Dev	664099.4	693690.5	52.33777	35747.93	2.69E+19	6.40E+17
Observation	48	48	48	48	48	48

Source: Computer analysis using E-views 7.0

4) ***Multicollinearity Test***

Multi-collinearity problem was not found to exist between the independent variables. The maximum correlation (0.88) between the independent variables was noticed for LLAGGDPPC and LDAP.

Table 6. Presents the correlation matrix of the variables.

	LLAGGDPPC	LTEMP	LPRECIP	LDOP	LODA
LLAGGDPPC	1.000000	0.528602	-0.465545	0.883180	0.774370
LTEMP	0.528602	1.000000	-0.623534	0.629051	0.568874
LPRECIP	-0.465545	-0.623534	1.000000	-0.588734	-0.387047
LDOP	0.883180	0.629051	-0.588734	1.000000	0.756197
LODA	0.774370	0.568874	-0.387047	0.756197	1.000000

Source: Computer analysis using E-views 7.0

IV. RESULTS AND ANALYSIS

After the series of tests, the regression was made by using the ordinary least squared method. It is important to note all the variables are stable, and significant at the 5%level. The variable lag GDP per capita (lagGDPPC), official development assistance (ODA), degree of openness (DOP) have a positive impact on GDP per Capita (GDPPC). The climate

variables temperature and precipitation have a negative impact on the economy. The lag GDPPC has a positive impact of 0.334% on the economy at a 1% significant level. In the same way, the degree of openness (DOP) and official development (ODA) have a positive impact of 0.203% and 0.116% respectively both at a 1% significant level. The variable temperature (Temp) has a negative effect of 1.867% on the GDP per capita at a 1% significant level at the same way the variable precipitation has a negative effect of 0.145 % on GDP per Capita at a 5% significant level.

V. INTERPRETATION OF THE RESULT

The model estimation emits applications to understand the effect that climate change can have on economic growth in Togo. The model shows that there is indeed a significant impact of climate variables on economic growth in Togo. For each climate change threshold, significant effects will be seen through the capacity of people to acquire food supplies in sufficient quantity. To this end, precipitation beyond a certain level will have a positive contribution to economic growth. This is understandable since precipitation contributes to the needs of crops (most of which are rainfed) and therefore agricultural production.

While excess precipitation is harmful to the crops planted, excess precipitation will lead to flooding. The temperature has an important and significant positive impact on economic growth. These results explain that Togo's economy is sensitive to some level rises in temperatures. This can be explained by rises in temperature, which will affect crop production, where more than 70% of Togo's population gets their income.

The results suggested by the model show that climatic variables significantly affect economic growth in Togo. At each level of change in Saving devices.

temperature and precipitation, significant negative impacts on the well-being of the Togolese will be observed through various channels. The climate is still in a process of change, the real challenge today is to find ways to reverse the trend to improve the level of well-being. To this end, it is essential that a real environmental program be implemented to limit the worst case of this climate change.

VI. CONCLUSION AND RECOMMENDATION

Climate change has become a major event today that involves all categories of the population. By its effects, it imposes heavy changes in the social, economic, and technological fields. In Togo, many cycles of drought and flooding have instilled a real weakness of environmental balance and socio-economic conditions of the country, particularly in rural areas. People's capacities and strategies to have access to adequate food have been modified with the climatic conditions which require people to either adapt or find themselves in relatively precarious conditions. This study analyzed the impact of climate change on Togo's economy using the ordinary least squared estimation technique and data for the period from 1970-to 2018. Temperature and rainfall were used as a proxy of climate change variables while lag of GDP per capita, degree of trade openness, and official development assistance were used as control variables. The results revealed that rises in temperature and rainfall affected Togo's economy negatively. These results imply that the Togolese government should implement rigorous environment protection policies. The government should evolve policies to encourage the use of environmentally-friendly equipment, machines, infrastructure, and technologies that generate minimal greenhouse gases, such as improved road and rail transport as well as the use of biofuels and energy

Table 6. OLS regression results

Independent variables	Dependent Variable
	Log of GDP per Capita
LLAGGDPPC	.334638*** (1.702427)
LTEMP	-1.867691*** (.485215)
LPRECIP	-.145691** (.068938)
LDOP	.203907*** (.038189)
LODA	.116907*** (.027202)
Constant	4.544197*** (1.702427)
R-squared	.948
F(4, 231)	153.6790
No. of observations	48

*** ** indicate significance at 1, and 5 percent respectively. Standard errors are given in parentheses.
Source: Computer analysis using E-views 7.0

REFERENCES

[1] Conor Devitt, R. S., Civil war, Climate change and development: A scenario study for sub-Saharan Africa. Journal of Peace Research, (2012) 129-145.

[2] DGSCN, D. G., Quatrième Recensement Général de la Population et de l'Habitat au Togo. Lome., (2011).

[3] Fabio Eboli, R. P., Climate change feedback on economic growth: explorations with dynamic general equilibrium model.,(2010).

[4] Gulzar, N. A., Climate change and economic growth: An empirical analysis of Pakistan. Pakistan Journal of Applied Economics, Applied Economics Research Centre, (2013) 31-54.

[5] Hulme, M., Doherty, R., Ngara, T., & New, M., Global warming and African climate change. Dans A. Low, Climate change and Africa (2005) (29-40). Cambridge: Cambridge University Press. Of current and future trends and impacts on agriculture and food security.

[6] Jonathan E. Ogbuabor, E. I., The Impact of Climate Change on the Nigerian Economy. International Journal of Energy Economics and Policy., (2017) 217-223.

[7] Laura Draucker, A. S., WRI 2010 Organizational Greenhouse Gas Inventory. Washington, DC 20002, USA: https://www.wri.org/publication/wri-2010-organizational-greenhouse-gas-inventory.FLEXChip Signal Processor (MC68175/D), Motorola, (1996) (2012).

[8] Laurent Da Silva., L'impact économique des changements climatiques sur l'agriculture canadienne, HEC MONTRÉAL, (2009) 88.

[9] Melissa Dell, B. F., Temperature Shocks and Economic Growth: Evidence from the Last Half Century. American Economic Journal: Macroeconomics, (2012) 66–95

[10] SCAPE, S. d., Employment policy, promotion of employment, and employment services. Lome-Togo., (2013).

[11] Shreekant Gupta, P. S., Impact of climate change on the Indian economy: Evidence from food grain yields. Climate Change Economics, (2014) 29.

[12] The United Nations Framework Convention on Climate Change and the Kyoto Protocol. See website at www.unfccc.org

[13] Thurlow, C. A., Implications of Climate Change for Ghana's Economy. Sustainability, (2015) 7214-7231

[14] Togo, MERF (Ministère de l'Environnement et des Ressources Forestière) ,2009 .Plan d'action national d'adaptation aux changements climatiques (PANA).Lomé.

[15] Tol, R. S., The Economic Impacts of Climate Change. Review of Environmental Economics and Policy, (2018) 4–25.

[16] WEIL, N. G., A Contribution to the empirics of economic growth. Quarterly Journal of Economics, (1992) 407-437.

[17] World Bank. World Development Indicators World Bank: Washington, DC, USA, (2014) (2015).