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Research Article

Does Flood Disaster Lessen GDP Growth? Evidence from the Gambia's Manufacturing and Agricultural Sectors

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ABSTRACT

Natural disaster such as floods has experienced extraordinary costs to animals, human, social and economic features, affecting not only the local but worldwide economy. Though the frequency of flood, time it takes for flood to last, the cause of floods, affected areas and economic damages are happening in the raining season in the Gambia. This paper studies the impacts of flood disaster on GDP growth, in the agricultural and manufacturing sectors in the Gambia for the period of 1969 to 2016 by applying the Autoregressive Distributed lags models with Dynamac (dynardl) for co-integration and error correction model (ECM) for short-run and long run relationship between the variables. Error correction (EC) specified in the model so as the dependent variable to be run in differences. The Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test inspects the stationarity of the variables in the level and first differences. Since the CUSUM test does not cross the upper and lower 5% line, the model is structurally stable. The findings of the study suggest that floods affect positively the agricultural growth in both the long run and short run. Floods also affects positively the growth of GDP in the short and long run while floods affect negatively the growth of manufacturing sector in the long and short run. The following variables negatively affect the growth of agriculture in the Gambia in the long run; frequency of floods, growth of GDP, growth of manufacturing sector, growth of inflation. The results of the study have important implications on growth of GDP, growth of agricultural sector and growth of manufacturing sectors.

Keywords: Human capital; Agricultural sector; manufacturing sector; GDP growth; Dynamac; co-integration testing

INTRODUCTION

Overview of the geographical background of the effects floods in the Gambia

The Gambia is the smallest smiling coast of Africa, has a land area of 11,000 km (NEA- National Environment Agency). Research from the UNEP state that, almost 1/3 of the Gambia surface area is covered by the river Gambia with marsh lands along banks of the river Gambia. The Gambian's river is originates from the Futa Djallon highlands in Guinea, crossing the country into a narrow strip of land, closely 400 km long and 30 km wide on both sides of Gambia. Gambia is surrounded both its sides, by the Senegal and on the west, by the Atlantic Ocean (GOTG, Government of The Gambia). Flooding has been the most common natural hazard and natural disaster, which affected the life of people throughout the world in general and the Gambia in particular. Every year in the World, 75million people are seriously affected by flood similar disasters [1]. In Gambia, the national management of disaster (2008-2011) revealed that between 2002 and 2006, there have different 65 flood events that occurred in the country. According to (NEA, National Environment Agency), human activities are the main causes that added to the vulnerability of flood disposed areas, especially in the north bank division, deforestation of forest and trees and poor ways of doing the farming tends to reduce the soils' ability to hold the waters, and this causes erosion floods. Floods is natural disaster that affecting the people of the Gambia for the last decade. It is causes of concern, because the Gambia is situated in the low lying coast and it can seriously be affected by flood. As the sea level rises combined with heavy rainfall, the Gambia's river reaches its flood stages, causes flooding and blizzard. The floods in general occurred several times in the Gambia since 1965. The flooding is due to heavy rainfall and especially in the in urban areas of Ebou Town and the surrounding town. Not only that but in the rural it has increasing damaging the most communities in the raining seasons and destroy crops and deteriorating the livestock of the farmers' and the communities. Increase poverty and causes mass movement of peoples. This increase poverty from

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perspective of food insecurity through the challenges faces by agriculture for heavy rain, which destroy crops and animals. Floods and high windstorms affected negatively nearly 34,000 peoples in the Gambia during the rainy season in the month of September and October 2012. The population of the Gambia in which 20% affected by floods that year.. According to news 13 people out of 34,000 were reported to have died from floods or some collapsed or drowning (UNICEF, United Nations International Children's Emergency Fund). As Gambia is part of most vulnerable countries that are seriously have high poverty level, and mostly vulnerable to flood, because of the negative of sea level rise and the country is too poor to remedy that situation. The per capita income is lower; the debt in the Gambia is too high to reduce poverty and hunger. The Government of the Gambia should deal more on agriculture to reduce poverty and hunger first before accumulated more that will prevent future generation to be financed the debt from the little resources they have. The Gambia's is part of the low-income per capita countries, that has negative impacts of sea level rises, and the country's could not solve it because of lack of sufficient resources UNFCCC (United Nations Climate Change Conference). The floods risk management and sea level rises have negative impacts on the livelihood of the Gambian's peoples. A study by University of Columbia in 2007 found out that approximately 62% of its resident, residing outside the 10 meter elevation of the coastal areas, are at high risk of coastal flooding, and they are to the effects from sea level rise the study concluded. The aim of the study is floods- growth nexus for the Gambia through the sectors of that component the economy.

The effects of floods in the agriculture in the Gambia cannot be over-emphasis. The lower rainfall has negative impacts on agriculture. The high rainfall causes floods and which also negatively affect the agriculture and land areas. These are studies done previously to analyses natural disasters- economic growth nexus [2]. There is a significant negative production of goods, followed by a fall in GDP growth after the flood events [3]. This is the main paper study this paper followed to study the effect of flood on the GDP of the Gambia in the sectors composed the economy. This situation forces every sector to increase prices of their readily available goods and services [3]. Furthermore, during and after floods, the recovery process increases government spending. However, the impacts of flood disasters depend on the level of economic [3]. In there study to investigate the effect of flood on the country GDP in the agriculture and manufacturing sector in Malaysia [3], the results found out that size of affected areas of floods affects agricultural growth negatively both the long run and short run by using ARDL framework and , total damage cost also appears to affect manufacturing growth in the short run and in the long run, the study concluded. In addition, the impacts of flood disaster are increased and may vary across different sectors. These events typically appear to affect mainly the agricultural sector, but other sectors are also affected, fisheries and forestry sectors for example through sea level rises and through erosion respectively. Furthermore, because of a decrease in activities due to reduction in production capacities and disruption to transportation especially the production of goods and services to-from the market, the manufacturing sector may be affected as well. By studied conducted of 28 cases of large natural disasters in the United Kingdom over two decades from 1970 to 1990, Albala-Bertrand [4] pointed out that disasters did not decrease the level of GDP. In fact, construction activities led to an increase in the gross fixed capital formation according to the research. Both trade- public deficits increased sharply, while the agricultural sector remained unaffected [4]. However, macroeconomic studies revealed an increase in poverty, a decline in a country's trade balance, and falling of fiscal balances which lead to an immediate reduction in economic output caused by natural disasters. According to Brown et al. [5] found that 1% increase in the area experiencing extreme rainfall can reduce GDP growth by 1.8%, according to the study. Investments in water security could help reduce this negative economic impact, say the researchers. Furthermore, conclusion that the major impacts of natural disasters on the especially on agricultural sector are negative. This is because environmental degradation occurs due to natural disasters leading to the vulnerability of agriculture, forestry and rangelands. Suggestion that although women are often more vulnerable to disasters than men and they also have more coping mechanism how to control natural disaster than men by Yande [6]. This study want to fill the gap in the existing introduction and literature of the periods study and is also limited to Gambian's cases to link the effects of flood in the economics growth of the Gambia by analysis the effects of agricultural sector, service and industrial or manufacturing sectors in the Gambia. This mean is flood affect agricultural sectors, did that sectors after floods affect economics growth? And so on. If floods affect economy sectors in the Gambia, Those economy sectors affect economics growth in the Gambia. These are the Gaps the study wants to fill by applying time series modeling.

MATERIALS AND METHODS

Theoretical model

The paper adopts the theoretical concept by following the work of Dell et al. [7] and Bond et al. [8] in which they incorporated climate change variables into the production function . This is why we added new innovations by incorporating foods into the growth theory. Hence the growth accounting equation offers direction for the breakdown of climate change impact on economic growth as derived below:

$$Y_{it} = e^{\alpha T_{it}} A_{it} L_{it} K_{it} \quad \text{Equation 1}$$

$$\frac{\Delta A_{it}}{A_{it}} = g_i + \beta T_{it} \quad \text{Equation 2}$$

Where Y is real GDP, L is labour force/population, A is technology and can also be referred to as labour productivity, K is human capital, T are the impacts of climate in which here is floods in the Gambia at time t and individual i, g is the growth rate of capital, t is time period and e is a constant or intercept term in the model. Equation 1 captures the direct effects of climate on economic growth e.g. effects on labour productivity and equation 2 captures the indirect (dynamic) effects of climate e.g. the effects of climate on other variables that indirectly impact GDP (proxy economic growth).

Introducing logarithm into equation 1 and deviating with respect to time period and individual i, we derived equation 3 below:

$$g_{it} = g_i + (\alpha + \beta) T_{it} - \alpha T_{it-1} \quad \text{Equation 3}$$

Where g_{it} is the growth rate of output, direct effects of climate change on economic growth are accounted for by □ and indirect effects are accounted for by □ and finally, g_i is the individual fixed effects. The study will observe both the direct and indirect effects of floods on socio-economic in The Gambia for the time periods observed given various shocks that will occur over time thus providing an insightful knowledge on sectors and other factors affects economic growth in The Gambia.

Methods

The data generated for this study was made by authors' from world development indicator (WDI). The periods covered from 1969 to 2016. The variables included are GDP , flood (frequency of flood and caused of flood), agriculture sector, manufacturing sector, Human capital, capital stock, labor growth rate, inflation (consumer price index as proxy). We consider the following model, GDP or Y is a function of human capita, flood variables (frequency and caused of flood), agriculture sector, manufacturing sector, labor growth rate, capita growth rate, inflation (consumer price index as proxy). Note, there is no data for labor growth or labor force for the Gambia in both Penn-world and World development indicator. The growth theory we developed was based on Romer [9] endogenous growth theory in which he incorporated human capital into growth model. We added or incorporated flood variables into growth theory to counts for the frequency and causes of floods in the Gambia. When Romer added human capital into production function is because of the following reasons; new invention such as research and development have positive significant impacts, increasing return to scale, investment in education, investment in any variables that are composed of sustainable development and economic growth and significant important determinant of growth theory developed by Romer [9]. To this extension, incorporating floods into the Cobb-Doulas production function will have short-coming as until we have total floods variables, sum them up and adds as one variables, otherwise we must add one after the others duration of the floods, caused of floods, frequency of floods, size of floods, cost of floods to individual and the nations and so on. This is the weak point of including floods into the model. The growth theory the paper followed was developed by Paul M. Romer [10] called "Endogenous Technological Change" in which he incorporated human capita into cobb-Douglas production function. We now incorporated floods into the growth theory model in which we have the following equations 4.1 -4.6.

$$Y = b^{\beta} K^{\tau} L^{\delta} Flo^{\varphi} e^{\varepsilon} A Z^{\alpha} \quad \text{Equation 4.1}$$

Where Y is the GDP, A is a given technology which is fixed over time, K is capita stock, flo is floods variables that included the frequency and caused of floods, L is labor, and Z contains agriculture sector, manufacturing sector, Human capital, and inflation (consumer price index as proxy). e is exponential, ε is the idiosyncratic error term, and τ, δ, φ are parameters which are proportions. We incorporate changes in floods variables either frequency or caused into the model to account for endogenous growth theory developed by Romer in which he incorporated human capita into production function.

We divide both side by population to account the series be in per capital terms. The assumption is the production function is constant return to scale i.e.

$$\tau + \delta + \varphi + \alpha = 1 \leftrightarrow \tau = 1 - \delta - \varphi - \alpha \quad \text{Equation 4.2}$$

$$\frac{Y}{L} = b^{\beta} A \left(\frac{K}{L}\right)^{\tau} \left(\frac{L}{L}\right)^{\delta} \left(\frac{Flo}{L}\right)^{\varphi} \left(\frac{Z}{L}\right)^{\alpha} e^{\varepsilon} \quad \text{Equation 4.3}$$

Taking the natural logarithm of both sides of the equation above we get:

$$\log Y = \log\left(b^{\beta} A\right) + \tau \log(K) + \alpha \log(Z) + \varphi \log(Flo) + \varepsilon \log(e)$$

Equation 4.4

Note: exponential and log cancelled each out and let's

$$\log\left(b^{\beta} A\right) = \beta_0$$

we have:

$$\log Y = \beta_0 + \tau \log(K) + \alpha \log(Z) + \varphi \log(Flo) + \varepsilon$$

Equation 4.5

Transforming the equation for the growth model at time t and individual I, we obtain the following model as follows:

$$g(Y)_{it} = \beta_0 + \tau_{i1} g(K)_{it1} + \alpha_{i2} g(Z)_{it2} + \varphi_{i3}\ \text{flo}_{it3} + a_i + \varepsilon_{it}$$

Equation 4.6

→ Y= F (Hc,frequency of flood,caused of flood,agriculture,manufacturing,labor,capita ,inflation)

To analysis the impacts of economic growth-floods and other exogenous variables nexus, the study adopts the model as follows in the equations 5-8:

$$\ln GDP = \beta_0 + \beta_1 \text{lnfr of flo} + \beta_2 \text{lnHC} + \beta_3 \text{lnAgr} + \beta_4 \text{lncause offlo} + \text{lnI}\beta_5 + \text{lncap}\beta_6 + \ln \text{M}\beta_7 + \varepsilon.....$$

Equation 5

$$\ln \text{flo} = \beta_0 + \beta_1 \text{lnHC} + \beta_2 \ln M + \beta_3 \ln \text{Ag} + \beta_4 \ln \text{GDP} + \beta_5 \text{Ln1} + \text{lncap}\beta_6 + \varepsilon...$$

Equation 6

$$\ln \text{Ag} = \beta_0 + \beta_1 \ln \mathit{fr} \text{ of flo} + \beta_2 \ln HC + \beta_3 \ln \text{cause of flo} + \beta_4 \ln \text{cap} + \beta_5 \text{lnI} + \beta_6 \ln \text{GDP} + \varepsilon...$$

Equation 7

$$\ln \text{M} = \beta_0 + \beta_1 \ln \text{fr of flo} + \beta_2 \ln \text{HC} + \beta_3 \ln \text{cause of flo} + \beta_4 \ln \text{cap} + \beta_5 \text{lnI} + \beta_6 \text{lnGDP} + \varepsilon...$$

Equation 8

Where:

lnfr of flo=growth rate offrequency of flood

Ln cause of flo=growth rate of cause of flood

lnI=growth rate of inflation measured by CPI

lncap=growth rate of capital stock

Y: GDP growth

lnY: GDP growth rate

Ag: Agricultural Growth

lnAg: Agricultural growth rate

M: Manufacturing growth

Model specification

The research on floods impact on economic growth is increasing most popular. However, little research has focus on particular developing country until the 21st century [11]. Mostly no-study has being done in the Gambia to incorporate floods either frequency or caused of floods into the growth theory. The paper adopts the Paul M. Romer model of growth theory in which we incorporated floods into production function so as to determine the impacts of flood disaster lessen gdp growth in the Gambia. Hence, the data used time series which applied unit roots and co-integration testing in order to estimate the long and short run relationship. For the unit root tests, we use Dickey Fuller test, KPSS, and phillip- perror test and for co-integration testing we use Error correction modeling (ECM) and Autoregressive Distribution lag model (ARDL) and stability test called CUSUM**.**

Unit root and stationary tests

A time series Y_t (t=1,2,3….) is said to be stationary (in the weakly sense) if its statistical properties do not vary with time (expectation, variance, autocorrelation). The white noise is an example of a stationary time series, with for example the case where Y_t follows a normal distribution N (μ, σ^2) independent of t. A non-stationary series can, for example, be stationary in first difference or so (also called integrated of order 1, 2 etc.): Y_t is not stationary, but the Y_t-Y_{t-1} as first difference is stationary. Stationarity tests allow verifying whether a series is stationary or not at levels or first differences or second differences called integration of order 2. There are two different approaches about this, 1) stationarity tests such as the KPSS test that consider as null hypothesis H_0 that the series is stationary and the alternative the series is not stationary and 2) unit root tests, such as the Dickey-Fuller test and its augmented version, the augmented Dickey-Fuller test (ADF), or the Phillips-Perron test (PP), for which the null hypothesis is on the contrary that the series has a unit root and hence is not stationary.

Stability test

Brown et al. [5] Cusum tests evaluate the stability of coefficients (β) in a multiple linear regression model of the form $y = X\beta + \varepsilon$. Inference is based on a sequence of sums, or sums of squares, of recursive residuals calculated iteratively from nested subsamples of the data. Under the null hypothesis of coefficient reliability, values of the sequence outside an expected range propose structural change in the model over time. *Cusum tests* offer useful diagnostics test for numerous model misspecifications, including gradual structural change, multiple structural changes, missing predictors and abandoned nonlinearities.

Ideally, blasting activities are to be avoided in inclement weather, when there are temperature inversions, very strong winds, and cyclonic storms. However, the remoteness of the quarry, lack of updated weather forecast for the mountainous areas and the unpredictable cloud movement/winds during blasting, coupled with the fact that the explosives magazine was about 95 km away from the quarry, made blasting cancellation difficult when already onsite. An exception though was during the ferocious cyclone Mekunu in May 2018, when the Royal Oman Police (ROP) cancelled all blasting activities within the Dhofar Governorate for a week.

ARDL bounds testing procedure for co-integration

We use autoregressive distributive lag model (ARDL) bounds testing method for co-integration to estimate the flood-GDP nexus in short and long run relationship. We used closely the ARDL bound testing approaches as developed by Pesaran et al. [12], which is unlikely the other methods, we can determined the effects of lack on the variables for longer periods of time. The ARDL bound testing approaches takes into the consideration the explanatory regression and brings un-biased estimates in the long-run and t-statistics that is valid value [13]. The ARDL bound testing approach for co-integration is a better analysis methods and produces improved and unbiased results for the model [14,15]. The ARDL equation of correlation between flooding- economic growth nexus equation can be formulated as:

ARDL model:

$$\Delta GDP = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta GDP_{t-1} + \sum_{i=0}^{q} \beta_{1i} \Delta \mathrm{fr\,offlo}_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta HC_{t-1} + \sum_{i=0}^{p} \beta_{3i} \Delta Agr_{t-1} + \sum_{i=0}^{p} \beta_{4i} \Delta M_{t-1} + \sum_{i=0}^{p} \beta_{5i} \Delta \mathit{cause\,of}\ \mathrm{flo}_{t\text{-}1} + \sum_{i=0}^{p} \beta_{6i} \Delta I_{t-1} + \sum_{i=0}^{p} \beta_{7i} \Delta cap_{t-1} + \lambda_1 \Delta M1_{t-1} + \lambda_2 \Delta \mathrm{fre\ offlo}_{t-1} + \lambda_3 \Delta HC_{t-1} + \lambda_4 \Delta Agr_{t-1} + \lambda_5 \Delta \mathrm{cause\ of\ per}_{t-1} + \lambda_6 \Delta I_{t-1} + \lambda_7 \Delta cap_{t-1} + \varepsilon..$$

Equation 9

$$\Delta flo = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta \mathrm{flo}_{t-1} + \sum_{i=0}^{q} \beta_{1i} \Delta HC_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta Agr_{t-1} + \sum_{i=0}^{p} \beta_{3i} \Delta cap_{t-1} + \sum_{i=0}^{p} \beta_{4i} \Delta GDP_{t-1} + \sum_{i=0}^{p} \beta_{5i} \Delta \mathrm{M}_{t\text{-}1} + \sum_{i=0}^{p} \beta_{6i} \Delta I_{t-1} + \lambda_1 \Delta flo_{t-1} + \lambda_2 \Delta HC_{t-1} + \lambda_3 \Delta Agr_{t-1} + \lambda_4 \Delta cap_{t-1} + \lambda_5 \Delta I_{t-1} + \lambda_6 \Delta M_{t-1} + \lambda_7 \Delta GDP_{t-1} + \varepsilon..$$

Equation 10

Where β_1, β_2, β_3, β_4 and β_5 the coefficients that measure the short run relationship while λ_1, λ_2, λ_3, λ_4, λ_5, and λ_6 are the coefficients that measure the long run relationship. Δ is the first difference of the variabless. To test for co-integration, we will use the bounded test that was proposed by Pesaran et al [12].

Error correction model

VECM (vector error correlation model) model: VECM or in short ECM is connected with the multiple time series models typically realistic for the data when the primary variables have long run stochastic trend that often called as co-integration. We implement the ECM test method in this study since it can treaty with both large and small sample sizes and therefore having a comparative advantage over the other traditional methods [16,17]. The ECM is thus determined by the following ARDL models:

$$\Delta GDP = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta GDP_{t-1} + \sum_{i=0}^{q} \beta_{1i} \Delta \mathrm{flo}_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta HC_{t-1} + \sum_{i=0}^{p} \beta_{3i} \Delta Agr_{t-1} + \sum_{i=0}^{p} \beta_{4i} \Delta M_{t-1} + + \sum_{i=0}^{p} \beta_{5i} \ln cap_{t-1} + \sum_{i=0}^{p} \beta_{6i} \ln \mathrm{I}_{t-1} + ECM_{t-1} + \varepsilon...$$

Equation 11

$$\Delta flo = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta \mathrm{flo}_{t-1} + \sum_{i=0}^{q} \beta_{1i} \Delta HC_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta Agr_{t-1} + \sum_{i=0}^{p} \beta_{3i} \Delta cap_{t-1} + \sum_{i=0}^{p} \beta_{4i} \Delta GDP_{t-1} + \sum_{i=0}^{p} \beta_{5i} \Delta \mathrm{M}_{t\text{-}1} + \sum_{i=0}^{p} \beta_{6i} \Delta I_{t-1} + ECM_{t-1} + \varepsilon$$

Equation 12

Where ECMt-1 represents lagged error- correction model term which is derived from co-integration equation of ARDL bound testing of co-integration. The ARDL bound testing method proposes that along with a long run relationship between the natural disasters and economic growth, there is necessity at least uni-directional Granger causality effects between them [18]. If we understand the Granger Causality test very well, the F-statistic significance value on the descriptive or explanatory variable determine the short-run causal effects and long-run causal effects can be assessed by the coefficient of the lagged Error correlation term in the model. Though we have included ECMs in both the equations 7 and 8. nonetheless a notable thing is that, simply the equation having disallowed or failed to reject the null hypothesis i.e. existence of a co-integration vector would be allowed to approximation with an ECM [19,20].

Data collection

This study inspected the effects of flood on GDP growth and the extent it damages the agricultural and manufacturing sectors. For this purpose, the annual data for GDP growth (percent), capital stock, human capital (secondary enrolment, percent), inflation (consumer price index) and flood variables: (1) frequency of floods (measured by temperature of floods), (2) cause of floods (measured by amount of rainfall), manufacturing valued added and agriculture valued added were used. All data were collected from the period between 1969 - 2016. The names of variable, the sources and the comments are indicated in Table 1.

RESULTS AND DISCUSSION

Table 2 presents the results of Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for all variables in levels and first differences using the time series annual data from 1969 to 2016. The results confirmed that the null hypothesis of unit root at the five percent and one percent critical value for all series can be rejected, except for growth rate of Inflation and growth rate of Human Capital and the null hypothesis was rejected at ten percent for growth rate of manufacturing industry. For growth rate of rainfall and growth rate of temperature were failed to reject the null hypothesis for KPSS test of unit root. Yet, the null hypothesis is rejected at different percentage levels of the critical value for the series in the first difference. The results in Table 2 show that there is a combination of I (0) and I (1) of the regressors in the models. Hence, it is appropriate to use the ARDL and ECM approaches for the analysis. The lag length selection test is given in Table 2 for the GDP, agricultural sector, floods, and manufacturing sectors. The lag length is selected using the minimum values of AIC criteria, which is 54.9232* in our model. This is confirmed in the study done by Shrestha et al. [21]. The optimal lag for the model is 2 (Table 3). In this study, the maximum order of lag in the ARDL is 2.

Floods is the most significant natural hazards in the Gambia in terms of its frequency, cause, and the population affected , plants and animals affected, land areas extent and socio-economics damages. In this study, the cause and frequency of floods are used as a measurements of floods disaster called total amounts of floods. According to the results from R-studio, the (Figure 1) below, there is sharp fall in the growth of agriculture in the Gambia both production and productivity. This falling could be due to climate change variability in the Gambia. The cause of flood, which is the growth rate of rainfall has showing a stationary trend around its mean and standard deviation. That is why farmers have low productivity and that impacts pessimistic to both the types of horticulture farmers in the Gambia and that in turn affects the households in term of food supply and food security. The frequency of flood is expected to increases in the Gambia because this may be due to high temperature which cause drought and low rainfall. High temperature reduces agriculture production and in turn have reduces the country growth. The GDP at certain point have decreasing trends due to agricultural sector, which is the backbone of the economic of the Gambia. Decline in agricultural production, reduces export and consumption and most of the government budget is assigned to imports and that have negative impacts on economy growth. The flood size, damages, duration, and frequency of its occurrence affected the economic growth of the Gambia seriously as indicated in the sharp falling the growth rate in the Gambia, measured by GDP. This is confirmed with the study done by Vikrant Panwar et al. [22]. Examining the economic impact of floods in selected Indian states, which they had indicated that floods have negative impact on growth in the short-term across

Table 1: Data sources.

Variables	Source	Comment
GDP Current(US$)	WDI	Current GDP
Human Capita (Proxy)	WDI	School Enrolment Secondary
Capital Stock	PENN World Table 9.1	Capital stock at current PPPs (in mil. 2011US$)
Temperature	WDI	Total Average Temperature Droughts, floods, extreme temperatures (% of population, average 1990-2009)e
Average Rainfall	WDI	Average precipitation in depth (mm per year)
Manufacturing	WDI	Manufacturing, value added (annual % growth)
Agriculture	WDI	Agr, value added (annual % growth)
Inflation	WDI	Consumer p i

Table 2: Unit root test.

Variables	ADF		PP		KPSS	
	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
lnGDP	0.134**	0.046**	0.152***	0.000***	0.662***	0.357***
lnAg	0.202**	0.013**	0.230***	0.000***	0.439***	0 .261***
lnM	0.785*	0.058*	0.848***	0.000***	0.907***	0.494***
lnT	0.000***	0.000***	0.000***	0.449***	0.095	0.0861
Inflo	0.030**	0.000***	0.022**	0.728**	0.121*	0.116
Inl	0.284	0.143	0.924***	0.000***	1.02***	0.523***
lnHc	0.266	0.136	0.316***	0.000***	-	-
InR	0.044**	0.000***	0.034**	0.741**	0.117	0.111

Note: *, ** and *** are statistically significant at 10 percent, five percent and one percent, respectively

Table3: Lag selection.

Varsoc GDP current US Agriculture forestry and fish Manufacturing value added of Floods

Selection-order criteria

Sample: 1973 - 2016

Number of obs - 44

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-1286.65				3.50E+20	58.6659	58.726	58.8281
1	• 1188.31	196.68	16	0.000	8.4e+18*	54.9232*	55.2239*	55.7342*
2	-1178.19	20.23	16	0.210	1.10E+19	SS.1907	SS.732	56.650S
3	1164.84	26.714	16	0.045	1.30E+19	SS.3108	56.0928	57.4194
4	-1149.83	30.013 •	16	0.018	1.50E+19	55.3559	56.3785	58.1133

Endogenous: GDP current US Agriculture forestry and fish
Manufacturing value added of Floods
Exogenous: cons

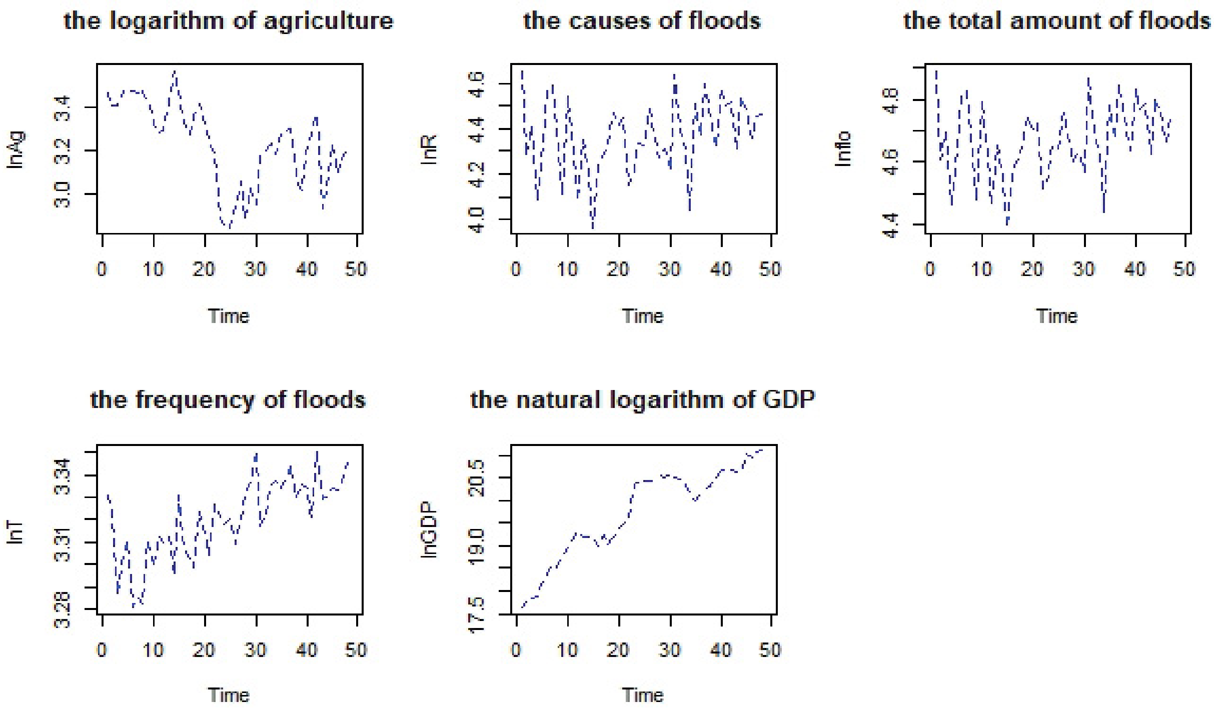

Figure 1: Time series trends of the variables.

economic sectors in India except for the agricultural sector, where the effects were observed to be positive. In most cases the floods in the Gambia have some negative impacts such as accessibility to market for days is very difficult, accessibility to schools is also becomes difficult, roads are filled with water and constraint in transportation, sometime water becomes polluted and that caused water born diseases or even malaria or health complication because of the externalities of pollution, houses collapsed, properties damages, poverty increases, sometimes animals and people died on floods in the upper parts of the Gambia but obviously very rarely in the Gambia. In terms of displacement of peoples due to floods, it makes those who left behind to suffer a lots in term of food security, climate problems and settlement problems in the new places. In the Gambia floods affect also those who built their building in the areas in which water passes.

Estimating ARDL models with Dynamac (dynardl)

Though, ARDL models are flexible, but their flexibility often results in variables of different lengths due to differencing and lagging of those variables. Dynamac (code dynardl in R) is ARDL code in R that helps to simulate these counterfactuals that occurred in ARDL. The ARDL and ECM model is joining as one for the code of Dynamac and the variables are cointegrated in the levels and first differences. Simply plotting the series reveals the following: The equations of both the agricultural growth , manufacturing growth, economic growth and growth in floods are describe in the tables below. In the long run inflation measured by consumer prices index have significant positive impact on the growth of the GDP. 1% increase in the growth of inflation, increases growth of GDP by 0.0018% in the Gambia. This is due to the fact that the economy of the Gambia is import based economy and youth are highly unemployed, underutilized. As increase in inflation discourages investors' to invest, thereby contribution to high unemployment rate and higher taxes rate, which substantially cause slow economic growth. This result is further supported by Sweidan, who found a significant positive relationship between the growth in inflation and growth in GDP in the long run. In the manufacturing growth have insignificant negative impacts on the growth of GDP, the study asserted. This is due to lack of innovation and sufficient technology that contribute to boost the economic growth. This could also because an increasing number of labour unemployed in the sector will decrease production capacity and lead to negative economic growth in the long run. Likewise ,most of the manufacturing industries in the Gambia are family business, as the owner died is very difficult for the business to passed to another generation due to conflict of interest, mismanagement of funds, nepotisms and so on. The growth of agricultural sector in the Gambia have significant negative effects on the growth of GDP. 1% increase in the growth of agriculture lead to deceases in the growth of GDP by 0.044%. This is due to the fact that lower productivity is due to lower rainfall and high temperatures. Most of the rainfall month in the Gambia are mostly September, this is due to climate change effects and that affects farmers to have low production and productivity and that in turn affects the growth of GDP through low consumption and low export of agricultural goods. This is due to the inadequate technologies used by Gambian farmers (Figure 2). The use of machines in agricultural sector production can generate growth especially the used of adaptation strategies (Table 4).

Own evaluation using R

The growth of GDP is insignificant negative impacts affected by floods disaster in the Gambia.1% increase in growth of GDP cause deceases in floods by 0.000056%. In the long run, the results indicates growth in GDP will have positive insignificant impacts on the growth of natural disaster. The reason is due to the purchasing of new machines and replacement of old technologies. The replacement makes production of goods more efficient, and hence, generates GDP growth in the long run. In the floods damages causes by floods (cause and frequency) is very high and cost economic losses the affected areas in terms of migration, food insecurity, households income loss, the houses and everything insides damages and loss of live. All of this could damages the growth of economic in the long run, because lack of human capital. The frequency of floods and causes of floods both negatively affected the growth of the GDP, if others variables remained constant, the study confirmed. Growth in agriculture positive affected floods (cause and frequency). This could be due to the fact that agriculture improvement through the plating more tree will substantially reduce floods in the Gambia. Inflation also positively affect floods, one percent increase in the growth of inflation, increase floods by 0.018%. In the short run, both growth in agriculture and growth in manufacturing sector are affected by frequency and cause of floods in the Gambia. The floods damages is even more severe in manufacturing sectors because of the negative impacts it cause to agricultural sector. This

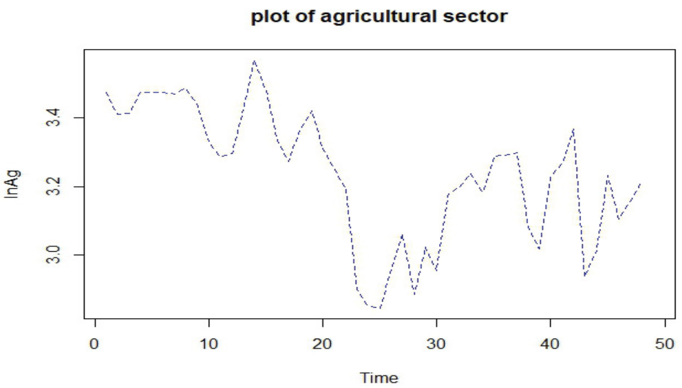

Figure 2: Agricultural sector *vs.* Time.

Table 4: ARDL Mode, the dept. variable growth of GDP.

Coefficients	Estimate	Std . Error	t value	Pr(> l t l)	
(Intercept)	7.37788	1.81187	4.072	0.000228	***
1.1.lnGDP	-0.32069	0.08887	-3.6081	0.000885	***
d.1.Inflo	0.06646	0.15102	0.44-0	0.662372	
d.1.lnAs	-0.22059	0.22282	-0.99	0.3284-56	
d.1.lnM	0.24741	0.16827	1.47	0.1497	
d.1.In1	-0.28715	0.34179	-0.84	0.406088	
1.1.1nAg	-0.44125	0.21205	-2.081	0.044238	*
l.1.lnM	-0 .06541	0.12187	-0.537	0.594605	
l.1.In1	0.18045	0.0584-8	3.086	0.003778	**

Signif . codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '1

Multiple R -squared: 0.3861, Adjusted R -squared: 0.2568 F-statistic: 2.987 on 8 nd 38 DF, p-value: 0.01066 Author own evalution using R studio

is confirmed in the following studied about the damages cause by floods, Urbanization has a negative impact on the risk of flooding by increasing impervious surfaces (roofs, roads, sidewalks, parking lots, etc.). Kundzewicz [23] Extensive asphalted or concrete surfaces contribute to the rapid runoff of rainwater and the drying the soil under these built-up areas, including reduction of groundwater reserves and climate change in cities (Table 5).

In the case of the agricultural sector, the results show a significant positive relationship between size of the affected area and total damage cost with GDP growth. The bigger the area affected and the larger the damage cost, the higher the fall will be in GDP growth. The results indicate that a one percent increase in the size of affected area decreases GDP growth by very small amount. This is because the loss of output in the agricultural sector could not be replaced immediately after flood due to low productivity in the agricultural sector. This low productivity in the agricultural sector is evident in Gambia because it is not as capital intensive as in the manufacturing sector (Tables 6-9). Hence, there are not many significant production assets to be repaired and no newer technologies to be replaced that can enhance production as in the case of the manufacturing sector (Figure 3).

In the long run frequency of flood negatively impact on the growth of GDP in the Gambia. 1% increases in floods, decease economic growth by 0.0678%. In the short run, floods affected positively the growth of GDP at an increasing rate of 0.0057%. This may due to the fact that in the Gambia households that are affected does have somewhere or friends or family to helps but this does not continue in a very long time. In the very long term those affected will either have some consequences of poverty, migration, and food insecurity and eventually affect the whole human capital that contributes to economic growth and development. Human capita positively affected the growth of GDP by 0.05% in the long run, if we increase human capital by 1%, the study noted. In the short run the growth of human capita negative affect the growth of GDP. This may be due to the fact that in the Gambia unskilled labor contributes less to economic growth. In the long run, the growth of manufacturing sector affected negatively the growth of GDP. 1% increase in the growth of manufacturing, reduces the growth of GDP by 0.001%. This si due to the fact that less technologically

Table 5: ARDL model: the dept. variable growth of floods.

Coefficients	Estimate	Std . Error	t va1ue	Pr (> |t|)	
(Intercept)	5.607258	1.610695	3.481	0.0013	**
1.1.Inflo	-1.	O.146429	-7.589 4.	4.72E-09	***
d.1.lnGDP	0.081085	0.109882	0.738	0.4652	
d.1.lnAg	0.208721	0.15024	1.389	0.1731	
d .1.lnM	-0.310267	0.123041	-2.522	0.0161	
d.1.Inl	0.180731	0.232756	0.776	0.4424	
l.1.lnGDP	-0.005609	0.069929	-0.080	0.9365	
l.1.lnAg	-0.067591	0.151686	-0.446	0.6585	
l.1.lnM	-0.181851	0.089264	-2.037	0.0488	*
1.1.Inl	0.062001	0.044966	1.379	0.1762	

Signif . codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '1
Multpile R -squared: 0.671, Adjusted R-squared: 0.591
F - statistic: 8.386 on 9 and 37 OF, p-va1ue : 1 .102E-06
Own eva1uation

Table 6: ARDL model: the dept. variable growth of agriculture.

Coefficients	Estimate	Std . Error	t va1ue	Pr (> |t|)	
(Intercept)	-1.62E-15	1.09E-15	-1 .484e+00	0.1463	
1.1.1nAg	0.000e+e0	9.154-e-17	0.00E+00	1	
d .1.1nAg	1.00E+00	9.63E-17	1.03Se+16	<2e-16	***
d.1.1nM	7.174-e-17	8.18E-17	8.77E-01	0.386	
d.1.InF1o	2.20E-16	1.04E-16	2.12E+00	0.0405	*
d.1.In1	-6.97E-17	1.47E-16	-4.73E-01	0.6388	
1.1.1nGDP	2.65E-17	3.83E-17	6.91E-01	0.4938	
1.1.Inf1o	2.25E-16	1.48E-16	1.52E+00	0.1367	
1.1.1n1	7.42E-17	5.97E-17	1.24E+00	2215	
1.1.Xn1	-2.35E-17	2.68E-17	-8.78E-01	3856	

Signif . codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '1
Author own evaluation

Table 7: ARDL model: the dept. variable growth of gdp

		Coefficients		
(Intercept)	L(lnGDP, 1)	L(lnGDP, 2)	lnT	L(lnT, 1)
22.6567906	0.3915013	0.1175285	-1.324549	-2.0063307
lnHc	L (lnHc, 1)	lnAg	L(lnAg, 1}	lnM
-0.1591143	0.4100661	-0.9772695	0.0858080	0.1578679
L(lnM, 1}	capital	L(capital, 1)	Inl	L(Inl, 1)
-0.2073959	-0.0001629	0.0001824	-0.8499332	0.9850212
		Long-term coefficients		
lnT	lnHc	lnAg	lnM	Capital
-6.784280949	0.511134334	-1.81571405	-0.100877827	0.00003961
Inl	~	~	~	~
0.27514498	~	~	~	~
		Short-term coefficients		
(Intercept)	L(d (lnGDP}}	d lnT}	d (lnHc}	d (lnAg}
-3.580909222	-0.128384362	0.565225371	-0.753427104	-1. 3511289142
d (lnM)	d(capital}	d Inl}	L(coint)	~
-0.064093476	-0.0001486	-0.7532500814	0.0834892485	~

Author own evaluation

advancement and low labor productivity and low supply of goods, make the manufacturing sectors contributes negatively in the growth of GDP. Agricultural sector impacts negatively on the growth of GDP. 1% increase in the growth of agriculture, decreases the growth of GDP by 0.018%. This is due to the fact that agricultural sectors is affected by many consequence such as low rainfall, lack

Table 8: Dep. variable growth of agriculture.

		Coefficients		
(intercept)	L(1nAg, 1)	L(1nAg, 2)	1nT	L(1nT, 1)
11.3140298	0.6976346	-0.2912972	-0.8248118	-1 .3112768
1nHc	L(1nHc , 1)	1nGDP	L (lnGOP , 1)	1nM
0.2927654	0.0036291	-0.295044-2	0.1492974	-0.1471428
L(1nM, 1)	capital	L(capital, 1)	In1	L(In1, 1)
-0.0016582	-0.0003325	0.0003492	-0.0341014	0.0242643
		Long-term coefficients		
lnT	lnHc	lnGDP	lnM	Caapital
-3.60E+00	4.99E-01	-2.46E-01	-2.51E-01	2.81E-05
In1	~	~	~	~
-1.66E-02	~	~	~	~
		Short-term coefficients		
(intercept)	L(d(1nAg))	d(1nT)	d(lnHc)	d(1nGDP)
-7.49E+00	2.08E-01	4.04E-01	1.66E-01	-2.03E-01
d(1nM)	d(capita1)	d(ICn1)	L(coint)	~
-2.10E-01	8.99E-05	-1.21E-01	3.96E-01	~

Table 9: Dept. variable growth of manufacturing.

		Coefficients		
(Intercept)	L(1nM, 1)	L(1nM, 2)	1nT	L(1nT, 1)
-26.7	2.198E-01	-0.3317	4.173E+00	3.016E+00
lnHc	L(1nHc, 1)	1nGOP	L(1nGOP, 1)	lnAg
1.703	-0.4617	0.08962	0.05836	-0.3651
L 1nAg , 1)	capita1	L(capita1., 1)	In1	L(In1, 1)
-0.01703	-0.0005649	4.113e-04	0.8397	-8.532e-01
		Long-term coefficients		
lnT	1nHc	lnGOP	lnAg	capital
6.465989715	1.116100569	0.133091082	-0.343661881	-0.000138155
In1	~	~	~	~
-0.012168286	~	~	- -	~
		Short-term coefficients		
(Intercept)	L(d(1nM))	d(1nT)	d(1nHc)	d(1nGOP)
7.030507	-0.09002305	1.377067	1.266521	-0.05942153
d(lnAg)	d(capital)	d(Inl)	L (coint)	~
-0.7917858	2.2735E-05	0.05336326	0.2943216	~

modern ways of farming such as adaptation method, lack subsidies from government that alter the farmers ambition to growth more, less percentage from total budget attached to agriculture, climate change, pest and diseases and so on.

In the long run, floods negative affect the growth of agriculture at the minimal amount. This is due to the fact that the frequency of floods is rarely seeing in the Gambia. The cause of floods is more common the Gambia at different place both urban settlement and rural settlement e.g. "Ebou town" floods," Basse" floods, "Kotu" floods, "North Bank" floods and even most part of the Gambia that cause temporary displacement and sometimes lost live and properties such as crops and animals. The following variables negatively affects the growth of agriculture in the Gambia in the long run; frequency of floods, growth of GDP, growth of manufacturing sector, growth of inflation. In the long run, only capital stock and the growth of human capital affect positively the growth of agriculture, the study asserted. Ceesay et al. [24] export in the Gambia does not cause growth and imprt cause growth in the Gambia, the researchers' confirmed in their finding.

In the manufacturing sector, frequency of floods, the growth of human capita, the growth of GDP all affects it positively but the growth of agriculture, capital stock and the growth of inflation affect negatively the growth of manufacturing sector the study acknowledge.

This paper examines the impacts of flood on economic growth (GDP growth,human capital, capita stocks, inflation, , agricultural sector and manufacturing sectors in the Gambia from 1969 to 2016. The paper explores the existence of the short run and long run relationships between GDP growth, growth in flood variables (frequency and cause of floods), and the other variables evidence from the Gambia. The paper used the ARDL dynamic approaches

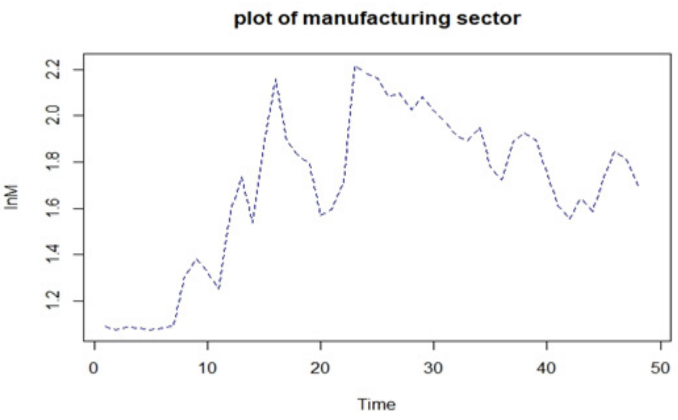

Figure 3: Manufacturing sector *vs.* Time.

for co-integration and error correction model (ECM) for the short run relationship. Error correction (EC) specified in the model so as the dependent variable to be run in differences. The ADF, PP and KPSS unit root tests examine stationarity of the series in the levels and first differences. In the case of the Gambia, flood psotively affects economic growth in the long run and as well as short run. The findings suggest that there are growth in floods and growth in GDP have negative impact in the growth of agricultural sector in the short run and long run. Floods affect positively the manufacturing sector in the Gambia, the study confirmed. In the long run, agriculture affect floods and negative and in the long run floods affect agriculture positively. This finding is reliable with the ndings of Benson et al., [25]. They established that the impacts of floods could be quite significant for agricultural growth in both the short run and long run. In the Gambia floods affect positive the agriculture in both the short run and long run. Meanwhile, total damage cost by frequency of floods positively affects the manufacturing growth in both the short run and long run and likewise human capital. This result is similar to the conclusion made by Das [26] who stated that natural disasters caused loss of potential production due to disturbed flow of goods and services, lost production capacities and increased costs of production. Such indirect impacts appear to progressively generate growth in the long run.

CONCLUSION

The results of the study have important implications for the agricultural, manufacturing sectors and growth of GDP. First, the agricultural sector should develop adaptation and mitigation strategies to overcome the negative impacts of flood in the long run such as allocating new areas which are out of flood prone areas so that the impacts of flood on the sector can be minimized in the long run and control temperature so as to minimized the effects of climate change on agriculture and the impacts of agriculture on climate change through machine and renewable energy supply to the farmers (industrial agriculture). Furthermore, new areas to keep agricultural portfolios should be assigned at free flood zones or no go areas for floods so that food production and productivity will not be disturbed in the short run. The manufacturing sector should make adequate inventories to circumvent disruptions in production in the short run. For growth in GDP those properties and health impacts or poverty it may cause should be minimized by providing immediately assistance to those in the needs in short time and so it will not cause human capita lost in the long run through migration and displacement.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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