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Effect of Climate Change on Philippine Agriculture

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Abstract: ***The vulnerability of Philippine agriculture to climate change has been acknowledged to be substantial. Government policies have been pushed through to be able to cope up with the demands of climate change. This paper seeks to determine the impact of climate change to the agriculture sector of the country. This study finds that lag of temperature change has an inverse relationship with the change in output. Based on the data - results show that gross production value of Philippine agriculture decreases by 19.21 when there is a 1ºC increase in temperature. The same is true with precipitation – gross production value in agriculture would decrease by .24 for every 1 mm increase in precipitation but more number of rain days would increase gross production value by 1.24. An increase in Diurnal range temperature as measured by the difference between the daily maximum and minimum temperature would decrease gross production value by 5.74. This paper also supports the idea that the agriculture sector of the Philippines as a tropical country, is rain-fed and that a drier season would decrease agricultural output.***

Keywords: climate change, Philippines agriculture, temperature, precipitation, diurnal temperature range

1. Introduction

The Philippines lies along the western rim of the Pacific Ring of Fire, a belt of active volcanoes and major earthquake faults, and the Pacific typhoon belt. It has a total discontinuous coastline of 2,400 kilometers, the longest in the world and is especially vulnerable to the adverse impacts of climate change. It is one of the world’s most natural disaster-prone countries due to a combination of high incidence typhoons, floods, landslides, droughts, volcanoes, earthquakes and the country’s considerable vulnerability to these hazards.

Climate change has been identified as one of the most daunting challenges facing the world in this millennium and it is particularly more serious in developing countries largely due to their geographic exposure, low incomes, greater reliance on climate-sensitive sectors and weak capacity to adapt to the changing climate (IPCC, 2007).

Climate change in the global perspective can be attributed mostly to the change in temperature, changes in precipitation, sea level rise and the melting of ice and snow in the Northern hemisphere (IPCC, 2009). The Climatic Research Unit on the other hand measures cloud cover, diurnal temperature range, frost day frequency, precipitation, daily mean temperature, monthly average daily maximum temperature, vapor pressure, potential evapo-transpiration and wet day frequency as variations of climate.

Over the past three decades, the country have been experiencing substantial rise in temperature – ranging from 1º C to 3º C, although the general circulation models (GCM) used in the Philippines’ Initial National Communication on Climate Change (PINCCC,1999) predict an average increase of 2 to 3°C in annual temperature in the country should a doubling of CO2 in the atmosphere occur. Major impact areas include eastern Mindanao, portions of Samar, Quezon, western Luzon, Metro Manila, and other highly urbanized areas.

However, the Climatic Research Unit of the World Wildlife Fund (CRU-WWF) expects the Philippines to warm more slowly than the global average mainly due to its location in a tropical ocean. They believe that its future warming will be uniform throughout the islands and throughout the year. They estimate that it will proceed at a rate of between 0.1°C per decade to 0.3°C per decade.

The GCMs mentioned above predicted rainfall to increase in many areas of the country under the same CO2 scenario. For instance, a 60 to 100 percent increase in annual rainfall is projected in the Central Visayas and Southern Tagalog provinces, including Metro Manila. Meanwhile, an increase of 50 percent or less is predicted in the other areas of Luzon, Samar, and the central and western parts of Mindanao. On the other hand, a decrease in annual rainfall is expected for other sections of the country such as northern and eastern Mindanao and parts of western Luzon.

Climate change’s impact on the Philippines is most often associated with extreme weather disturbances such as typhoons and floods, which, in turn, affect many other sectors of economic life. With 50.3 percent of its total area and 81.3 percent of the population vulnerable to natural disasters, the Philippines is considered a natural disaster hot-spot. About 85.2 percent of its US$86 billion annual GDP is endangered, as it is located in areas of risk (World Bank 2008). Since 2000, approximately 3 million people have been affected by various disasters annually. The vulnerability of the Philippine agriculture sector to climate change has been acknowledged to be substantial according to the ADB (2009) as it is the most vulnerable among Asian countries like Thailand, Indonesia and Vietnam when it comes to floods and storms.

However, there is limited empirical analysis on the damaging effects of climate change on the agriculture sector of the country. This paper aims at quantifying the implications of climate change on Philippine agriculture using annual data on mean temperature, average precipitation (rainfall), average rain days and diurnal temperature range. The diurnal temperature range is the difference between the daily maximum and minimum temperature. Changes in DTR have multiple possible causes (cloud cover, urban heat, land use change, aerosols, water vapor and greenhouse gases). Data were gathered from the

Food and Agriculture Organization (FAO) and the Climatic Research Unit, with 50 observations from 1961-2011.

2. Research Hypotheses

To ascertain the impact of climate change on Philippine agriculture, data were gathered from the Climatic Research Unit (CRU) at the University of Anglia in Norwich, UK for data sets on mean temperature, average precipitation (rainfall), diurnal temperature range and rain days; and the Food and Agriculture Organization (FAO) for data set on gross production value of Philippine agriculture.

The overall purpose of this research is to find out the impact of climate change on Philippine agriculture and aims to prove the following hypotheses:

a) Changes in temperature does not have an impact on productivity of Philippine agriculture
b) Changes in rainfall does not have an impact on productivity of Philippine agriculture
c) Changes in number of rain days does not have an impact on productivity of Philippine agriculture
d) Changes in diurnal temperature range does not have an impact on productivity of Philippine agriculture

To be able to prove the hypotheses stated above, gross production value (GPV) on agriculture will be used as dependent variable and mean temperatures, number of rain days, diurnal range temperature and precipitation (rainfall) will be used as a function of GPV agriculture.

3. Methodology

Data Gathering

This section describes the data used to run the model specified on the previous chapter and the descriptive analysis is presented in the next section. Data on mean temperature, precipitation, diurnal temperature range and number of rainfall for the Philippines was taken from the Climatic Research Unit. The CRU data set is composed of monthly, quarterly and annual .50 latitude/longitude gridded series of climatic parameters for the Philippines over the period 1901-2012, however the data used for this paper runs from 1961-2011. For the purpose of studying the impact of climate change on productivity of Philippine agriculture, data was secured from the Food and Agriculture Organization of the United Nations (FAO-UN) over the period 1961-2011.

4. Results and Discussion

This section represents the annual mean temperature, precipitation, number of rain days and diurnal temperature range of the Philippines from 1961 to 2011 and gross production value (in million $US). Philippine annual data from the Climatic Research Unit of the University of East Angliawas used as independent variables in the analysis of this paper. Gross production value (in million US dollars) of Philippine agriculture, are the annual data used in the analysis of this paper as the dependent variable.

A regression analysis of the relationship between productivity of Philippine agriculture and climate variables, produced the following results. Results show an estimated model:

Y(GPV) = -36.80807 - 5.74306(DTR) - 1.240485(RAIN_DAYS) + 19.21285(TEMP) + .236256(PRECIP)

t (-3.475041) (-5.607491) (-1.993306) (7.706825) (0.568079)

se (10.59212) (1.024174) (0.622325) (2.492966) (0.415885)

R^2= .788350 = 78.84%

F-stat = 42.83490

An R^2 of .788350 explains that 78.84% of the variation in the gross production value is explained by variations in diurnal temperature range, rain days, temperature and precipitation. Computed results show that gross production value of Philippine agriculture decreases by 19.21 when there is a 1 °C increase in temperature. The same is true with precipitation – gross production value in agriculture would decrease by .24 for every 1 mm increase in precipitation but more number of rain days would increase gross production value by 1.24. An increase in Diurnal range temperature as measured by the difference between the daily maximum and minimum temperature would decrease gross production value by 5.74. Results of climate change in different literature mentioned earlier also support findings of this paper.

Table 1

Dependent Variable: LOG(GPV)				
Method: Least Squares				
Sample: 1961 2011				
Included observations: 51				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-36.80807	10.59212	-3.475041	0.0011
LOG(DTR)	-5.743046	1.024174	-5.607491	0.0000
LOG(RAIN_DAYS)	-1.240485	0.622325	-1.993306	0.0522
LOG(TEMP)	19.21285	2.492966	7.706825	0.0000
LOG(PRECIP)	0.236256	0.415885	0.568079	0.5727
R-squared	0.788350	Mean dependent var		9.056919
Adjusted R-squared	0.769945	S.D. dependent var		0.422772
S.E. of regression	0.202779	Akaike info criterion		-0.260511
Sum squared resid	1.891480	Schwarz criterion		-0.071116
Log likelihood	11.64302	Hannan-Quinn criter.		-0.188137
F-statistic	42.83490	Durbin-Watson stat		1.008496
Prob(F-statistic)	0.000000			

Table 1 reveals that p-value for diurnal range temperature (DTR) and mean temperature (TEMP) is significant, therefore it rejects the hypotheses that DTR and TEMP does not affect gross production value of Philippine agriculture, which agrees to studies of Gornal (2010) and Lyman et al (2013) that temperature affects production in Agriculture. However, for the number of rain days, p-value is almost equal to .05 but still accepts the hypotheses that it does not affect gross production value; p-value for precipitation (rainfall) generated a value of .57, which accepts the hypotheses of having no impact on gross production value.

These hypotheses also are in cognizant that Philippine agriculture is mostly rain-fed.

5. Conclusion

The vulnerability of Philippine agriculture to climate change has been acknowledged to be substantial. Government policies have been pushed through to be able to cope up with the demands of climate change. This paper seeks to determine the impact of climate change to the agriculture sector of the country.

This study finds that lag of temperature change has an inverse relationship with the change in output. Based on the data - results show that gross production value of Philippine agriculture decreases by 19.21 when there is a 1 ^{o}C increase in temperature. The same is true with precipitation – gross production value in agriculture would decrease by .24 for every 1 mm increase in precipitation but more number of rain days would increase gross production value by 1.24. An increase in Diurnal range temperature as measured by the difference between the daily maximum and minimum temperature would decrease gross production value by 5.74. This paper also supports the idea that the agriculture sector of the Philippines as a tropical country, is rain-fed and that a drier season would decrease agricultural output.

Given the critical role of agriculture in the country's economic growth and development, heavy investment in research and development on the most appropriate adaptation interventions such as development of drought resistant crops and promoting the development of water resources management infrastructure would be vital in moving forward. To ensure a proactive engagement in addressing this challenge, climate change adaptation should be integrated into national development agenda and also reflected into budget implementation. The proximity effect exhibited by the findings raises the need for economies of scale in dealing with the effectof climate change. Sub-regional climate change mitigation and adaptationinitiatives may be more effective in the country.

Efforts to strengthen regional trade and integration may be an important strategy toindirectly ameliorate effects of climate change in the country.

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