SIMULATING CLIMATE-INDUCED IMPACTS ON PHILIPPINE AGRICULTURE USING COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

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(Received: July 21, 2013; Accepted: March 22, 2014)

ABSTRACT

This research employed a computable general equilibrium model to analyze the likely extent of climate-induced impacts on the Philippine economy and its agricultural subsectors. Using two simulation scenarios (*i.e.* decline in agricultural productivity, and combination of a decline in agricultural productivity and fishery policy response), the results reveal that the real gross domestic product (GDP) at factor cost, export quantity, import quantity and employment will decrease. However, if the government will employ fishery policy response that would target an increasing production in the fishery subsectors (i.e. ocean fishing, freshwater/coastal fishing, and aquaculture), then the reduction in percent deviation from the base for real GDP, export and import quantity, and employment will be lower. Overall, climate-induced impacts will result in a net loss to the Philippine economy and its key agricultural sectors in the short run. Therefore, it is imperative for Philippine farmers to adopt adaptation measures that will lessen the impacts of climate change such as use of organic, indigenous and/or diversified farming practices coupled with safety nets provided by the national and local government units for the affected farmers in the agricultural subsectors – banana, corn, sugarcane, rice and fiber products.

Key words: climate change, closure, modeling, shock, short-run

INTRODUCTION

The Philippines is a minor emitter of global greenhouse gases, but its location and geography make it highly vulnerable to the impacts of climate change specially by natural disasters and periodic El Niño and La Niña (Rincon and Virtucio, 2008). In 2007, the Philippines was ranked as the 43rd largest emitter of carbon dioxide in the world, accounting for 0.27% of the total global carbon dioxide emissions ($MtCO_2e$), excluding land use change (WRI, 2011). Indeed, climate change is a serious threat to the country's economy especially to agricultural sector. Since agricultural production relies heavily on the environment, increased uncertainties and risks from natural calamities and disasters greatly affect the production of agricultural goods.

Rainfall and temperature variability are the two main contributing factors affecting agricultural production in the country. Intergovernmental Panel on Climate Change (IPCC, 2007, p. 475) reported that since 1971, average temperatures in the Philippines have increased by 0.14 ºC per decade. This has led to increased annual mean rainfall (since the 1980s), increased number of rainy days (since the 1990s), and increased inter-annual variability of onset of rainfall. This situation is most likely to continue, since the Philippine Initial National Communication on Climate Change (PINCCC) (Republic of the Philippines, 1999) have projected a temperature increase of 2-3^{0}C in annual temperatures.

There are varying estimates of climate change impacts resulting in yield reduction of selected Philippine agricultural crops and production losses due to damages from onslaught of climate-induced events, such as typhoons, floods, drought/El Niño, La Niña, and pests and diseases. Increasing temperature due to climate change results in: (1) decreased crop yield due to heat stress; (2) increased livestock deaths due to heat stress; and (3) increased in outbreak of insect pests and diseases. Meanwhile, the variability in rainfall (including the El Niño Southern Oscillation) results in: (1) increased frequency of drought, floods, and tropical cyclones (associated with strong winds), causing damage to crops; (2) changes in rainfall patterns affecting current cropping pattern, crop growing season, and sowing period; and (3) increased runoff and soil erosion resulting in declining soil fertility and crop yields (IPCC, 2001).

Tables 1 and 2 show the varying estimates of climate change impacts resulting in yield reduction of selected Philippine agricultural crops (rice, corn, banana, cotton, sugarcane, tomato and coffee)[1] and production losses due to damages from the onslaught of climate-induced events, such as typhoons, floods, drought/El Niño, La Niña, and pests and diseases. For example, rice yields are expected to result in a 15% to 27% for a temperature increase of 2°C (Escaño and Buendia, 1994) because of heat stress, decrease in sink formation, shortening of growing period, and increased maintenance for respiration. SEARCA (2005) estimated the yield reduction coefficients[2] would range from 1% to 100% due to typhoon, flood, drought and pest and diseases for selected Philippine agricultural commodities. Typhoon/flood damages in rice fields are estimated to result in losses of about 2.6-62.54%. Losses due to droughts are estimated 1.5%, while losses due to pests and diseases are seen at about 10% (Rincon and Virtucio 2008; SEARCA 2005). Delos Santos *et al*. (2007) stressed the impacts of extreme climatic events on corn production in the Philippines.

Based on the reports of the farmers, up to 70% of corn crops can be damaged by typhoons, while flooding can wipe out the entire corn farms (Table 2). Meanwhile, drought and La Niña episodes can result in yield losses of 50%-70% and 16%, respectively. On the other hand, Global Circulation Models predicted that corn yields would decline by 12.64% for the first crop of PS 3228 variety and 19% for the first crop of sweet corn (Republic of the Philippines, 1999).

Such uncertainties and risks further stress the importance of assessing the impacts of climate change to Philippine agriculture and the overall economy. This assessment of climate-induced impacts will provide a useful vehicle for practical policy analyses and targeted climate-change adaptation and mitigation strategies and measures. To date, there is no study yet that uses the computable general equilibrium (CGE) model to estimate economy-wide implications of climate change in Philippine agriculture.

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[1] These crops were selected because they are the commodities with reported estimates of yield reduction due to climate change. Other agricultural commodities were not included in this paper due to unavailability of literature citing estimates of yield reduction due to climate change as of January 2012.

[2] Reduction coefficient (RC) is defined as: RC = (1-RT)*(1-RF)*(1-RD)*(1-RP&D), where RT, RF, RD and RP&D are reduction coefficients for typhoon, flood, drought, pests & diseases. RC is synonymous to the measure of risk due to climate induced events. Yield loss = Potential yield * Reduction Coefficient

Table 1. Reported yield reduction (%) and yield reduction coefficients (%) of selected agricultural crops in the Philippines.

Commodity	Yield Reduction (%)	Yield Reduction Coefficient (%)[a]			
		Typhoon	Flood	Drought	Pest & Diseases
Rice	15-27[b]	10	30-80	15	10
Corn	12-19[c]	80-100	85	90	25-90
Banana			85	90	1-30
Cotton			85	90	20-99
Sugarcane			85	90	5-80
Tomato			85	90	10-70
Coffee			85	90	5-60

Source: [a]SEARCA (2005), [b]given 2^0 C increases in temperature (Escaño and Buendia, 1994), [c]Republic of the Philippines (1999)

Table 2. Production losses (%) of selected agricultural crops in the Philippines.

Commodity	Losses (% Damages)			
	Typhoon/Flood	Drought/ El Niño	La Niña	Pest & Diseases
Rice	2.6[a], 62.5[b]	1.5[a]		10.0[b]
Corn	70.0[c], 75.0[b]	27.0-70.0[c] , 87.0[b]	16.0[c]	65.8[b]
Banana	5.5[b]	4.4[b]		9.4[b]
Cotton	76.7[b]	87.0[b]		72.7[b]
Sugarcane	18.3[b]	47.5[b]		30.0[b]
Tomato	43.9[b]	32.5[b]		27.0[b]
Coffee	44.2[b]	43.6[b]		25.7[b]

Source: [a]Rincon and Virtucio (2008), [b]SEARCA (2005), [c]Delos Santos *et al*. (2007)

The earliest CGE models of the Philippines were done by Clarete (1984) on trade policy and Habito (1984) on fiscal policy and income distribution. Since then, quite a number of models have been constructed that evaluated the impacts on welfare, poverty, outputs, prices, international trade, consumption, employment, pollution emissions, income distribution, food security, and agriculture, among others. For Philippine agriculture, CGE models were employed to assess the trade policies and impacts of avian influenza outbreak (Rodriguez *et al*., 2007); impacts of Philippines-USA free trade agreement (Rodriguez and Cabanilla, 2006); biofuel (Rodriguez and Cabanilla, 2008); agricultural policies (Habito, 1986; Clarete and Warr, 1992), poverty (Cororaton and Corong, 2006), and welfare (Coxhead and Warr, 1992).

This research is the first to assess the economy-wide estimates of climate-induced impacts on Philippine agriculture. Specifically, this research determined the extent of climate-induced impacts on the different subsectors of Philippine agriculture, and assessed the total macroeconomic impact of climate-induced changes in agricultural production.

METHODOLOGY

Overview of the Model

CGE model is a useful tool for analyzing the likely extent and induced distributional impacts of climate change on all the sectors of the economy and the different subsectors of Philippine agriculture. The tool used in the analysis was based on the ORANI-G, a generic single-country CGE model using the Philippine input-output (IO) data. This CGE model is named AGRIK.

The ORANI was designed for comparative-static simulations. The ORANI applied general equilibrium (AGE) model of the Australian economy is widely applied and adapted by economists and academicians in the government and private sectors for practical policy analysis, e.g. study of macroeconomic and sectoral shocks addressing competition and trade policies (Horridge, 2003). ORANI-G has been adapted to build models of South Africa, Pakistan, Sri Lanka, Fiji, South Korea, Denmark, Vietnam, Thailand, Indonesia, Philippines, and China. In particular, the Philippine's TARFCOM model is an adapted CGE model of Orani-G with Philippine data (Rodriguez and Cabalu, 2005).

The ORANI-G–based model was used in general equilibrium modeling because of the following advantages. First, the model allows for direct implementation of production and consumption shocks in the analysis. Second, it contains equations that explicitly link agriculture, manufacturing, and trade sectors to other industries in the economy. Finally, the model computes macroeconomic variables (e.g. gross national product (GNP), imports and exports, among others) that allow an overall assessment of the impacts. In particular, the theoretical structure of ORANI-G consists of equations describing producers' demands for produced inputs and primary factors, producers' supplies of commodities, demands for inputs to capital formation, household demands, export demands, government demands, relationship of basic values to production costs and to purchasers' prices, market-clearing conditions for commodities and primary factors, and numerous macroeconomic variables and price indices. Horridge (2003) presented a detailed guide of the ORANI-G model, its structure, assumptions and drawback, key relationships, closures, etc.

The AGRIK model includes 25 industries and 25 commodities, 15 of which are agricultural. Moreover, there are two sources (domestic and imported) and two occupation types (skilled and unskilled). Producers were assumed to be price takers operating in competitive markets for both their outputs and inputs. Furthermore, the model used the assumptions of constant returns to scale and marginal cost pricing to eliminate quantity variables from the industry zero pure profits condition. Each industry produces a mixture of all the commodities using domestic inputs and imported commodities, labor types, land and capital. This mixture varies according to the relative prices of commodities. In addition, commodities destined for export were distinguished from those which are for local use. There is no substitution between produced inputs, primary factors and other inputs or between inputs of different commodity categories. However, there is substitution between aggregate labor, capital and agricultural land, and between alternative sources (i.e. domestically produced goods and imports) of produced inputs of a given commodity category. The 25 industries are also the investors themselves. Capital was assumed to be produced with inputs domestically produced and imported commodities and no primary factors were used directly as inputs to capital formation. Furthermore, the model includes market-clearing equations for locally-consumed commodities, both domestic and imported.

The Database of the AGRIK Model

The data used in the AGRIK model was based on the 2004 Philippine input-output (IO) table from the Global Trade Assistance and Protection (GTAP) database (version 7), which has 57 GTAP commodities (Corong, 2008). The 2004 Philippine IO was an updated 2000 IO table of the country with 240 commodities. The IO table contains data on payments made by various agents on the commodities and factor services provided by the other agents. The 2004 IO table from GTAP database has 57x57 sectors, which was aggregated into 25x25 sectors in the AGRIK model, following the commodity definition of the 2000 Philippine IO. Other data used in the model were obtained from the National Statistics Coordination Board (NCSB), the Bureau of Agricultural Statistics, and the Food and Agriculture Organization of the United Nations Statistical Database.

Figure 1 shows the structure of the information contained in the IO table. Demanders identified in the column headings (i.e. the absorption matrix) include:

- domestic producers divided into *I* industries;
- investors divided into *I* industries;
- a single representative household;
- an aggregate foreign purchaser of exports;
- government demands; and
- changes in inventories.

V1BAS (*c*, *s*, *i*) represents the flow of commodity *c* in basic value from source *s* to industry *i* for intermediate use. *V2BAS* (*c*, *s*, *i*) represents the flow of commodity *c* in basic value from source *s* to industry *i* for investment. *V3BAS* (*c*, *s*) represents the flow of commodity *c* in basic value from source *s* for household consumption. *V4BAS* (*c*) represents the flow of export commodity *c* in basic value. *V5BAS*(*c, s*) represents the flow of commodity *c* in basic value from source *s* for government consumption. *V6BAS* (*c, s*) represents the inventories of basic flow of commodity *c* in basic value from source *s*. *V1MAR (c, s, m)* is the value of margin type *m* used to deliver commodity type *c* from sources *s* to producers (user 1). *V2MAR (c, s, m)* is the value of margin type *m* used to deliver commodity type *c* from sources *s* to investors (user 2). *V3MAR (c, s, m)* is the value of margin type *m* used to deliver commodity type *c* from sources *s* to households (user 3). *V4MAR (c, s, m)* is the value of margin type *m* used to deliver commodity type *c* from sources *s* for exports (user 4). *V5MAR (c, s, m)* is the value of margin type *m* used to deliver commodity type *c* from sources *s* to government (user 5). *V1TAX* (*c*, *s*, *i*) represents the sales tax imposed on commodity *c* from source *s* for intermediate use by industry *i*. *V2TAX* (*c*, *s*) represents the sales tax imposed on commodity *c* from source *s* for investment use by industry *i*. *V3TAX* (*c*, *s*) represents the sales tax imposed on commodity *c* from source *s* consumed by households. *V4TAX* (*c*) represents the sales tax imposed on export commodity *c*. *V5TAX* (*c*, *s*) represents the sales tax imposed on commodity *c* from source *s* for government consumption. *V1LAB (i*, *o*) represents the wage bill by industry *i* by occupation. *V1CAP (i*) represents the capital rentals by industry *i*. *V1LND (i*) represents the land rentals by industry *i*. *V1PTX* is an *ad valorem* production tax while *V1OCT (i*) represents the other costs incurred by industry *i*. The MAKE *(c*, *i*) represents the make matrix at the bottom of Figure 1 by commodity *c*, by industry *i*, i.e. the value of output of each commodity by each industry. *V0TAR* (*c*) represents the tariff revenue by commodity *c*.

Updating the 2004 Philippines Input-Output Table

The 2004 Philippine IO above may not be appropriate for policy analysis because it no longer reflects the present structure of the Philippine economy, which went through significant structural changes from 2004 to 2009.

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Household	Export	Government	Change in Inventories
	Size	← I →	← I →	← 1 →	← 1 →	← 1 →	← 1 →
Basic Flows	↑ C×S ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	↑ C×S×M ↓	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
Taxes	↑ C×S ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
Labor	↑ O ↓	V1LAB					
Capital	↑ 1 ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Production Tax	↑ 1 ↓	V1PTX					
Other Costs	↑ 1 ↓	V1OCT					

C = Number of Commodities
I = Number of Industries

S = 2: Domestic, Imported
O = Number of Occupation Types

M = Number of Commodities used as Margins

	Joint Production Matrix
Size	← I →
↑ C ↓	MAKE

	Import Duty
Size	← 1 →
↑ C ↓	V0TAR

Fig. 1. The database (Horridge, 2003).

Appendix Table 1 shows the percentage changes in real aggregates from 2004 to 2009 from the demand and supply sides of the economy. The expenditure side includes household and government final consumption expenditures, capital formation, exports and imports, while the supply side includes employment and population (or number of household). Gross value added of each major industry was used for the industry output. Since the employment data is more aggregated for the agriculture sector, it is assumed that the changes in productivity within this sector are the same. Therefore, following Buetre and Ahmadi-Esfahani (2000), the Philippine IO table was updated from 2004 to 2009.

The procedure outlined in Buetre and Ahmadi-Esfahani (2000) in updating the database followed the simulation technique based on Dixon and McDonald (1993), which employed the CGE model. This macroeconomic historical simulation requires the following variables to be included in the database:[3] real household consumption (x3tot), aggregate real investment expenditure (x2tot_i), export volume index (x4tot), import volume index (x0cif_c), and aggregate real government demands (x5tot) from 2004 to 2009 as shown in Appendix Table 1.

This inclusion requires the adoption of new closure[4]. In this regard, the following macroeconomic variables were endogenized:

- a1primgen - a general technological change or total factor productivity
- ff_accum - a general shifter for aggregate investment
- twist_src_bar - a general twister for import
- f4q_general - a general shifter for exports
- f5tot2 - a general shifter for aggregate 'other' demand.

Moreover, the following shocks were introduced:

- employment (employ_i) = 10.91. This is the percentage change in aggregate employment in the Philippines during the period.
- number of households (q) = 19.86. This allowed for the changes in consumption to be measured in terms of per household basis.
- consumer price index (p3tot) = 32.67. This allowed the actual change in aggregate consumer price to be imposed exogenously, leading to an updated database expressed in 2009 values.

Simulation Scenarios

Two simulation scenarios were implemented in the CGE application. The agricultural production scenario (1st) highlights the possible climate-induced impacts on the Philippine economy and on the selected agricultural subsectors. In the first simulation, production shocks were simultaneously employed for rice (-18%), corn (-16%), sugarcane (-32%), banana (-6%), and other crops (-15%). These assumptions were based on the information presented in Tables 1 and 2.

On the other hand, the fishery policy-response scenario (2nd) that would target an increasing production in the fishery sector (ocean fishing, freshwater/coastal fishing, and aquaculture) is viewed as a potential policy response given climate change impacts on the selected subsectors of Philippine agriculture, i.e. 1st simulation scenario. This second scenario is a possible policy response to climate change impacts since the Philippine fishery sector is less vulnerable to the impacts of climate change compared with those in 137 other economies (Allison *et al.*, 2009). Furthermore, the Philippine Government's increased provision of grants in the form of agri-fishery inputs, equipment and facilities, including farm-to-market road projects, are expected to further boost the development of the agricultural and fishery sector and increase the productivity of fisherfolks and small farmers to selected provinces and local government units in the country. In the fishery policy-response scenario, it was assumed that fishery production could be increased by 10%.

Given the two scenarios, CGE model was employed to estimate the changes on the following macroeconomic variables: real gross domestic product (GDP) at factor cost, consumer price index (CPI), export quantity, import quantity, employment, and average return to land (rent). Likewise,

[3] These variables are estimated from the respective changes in the expenditures on commodities in each of the five categories in the final demand, hence usually treated as endogenous in the model.
[4] A closure must be satisfied wherein the number of endogenous variables must equal the number of equations so that the CGE model will run and the equation system can be solved using GEMPACK.

changes in the sectoral activity-level or value added for the 25 sectors of the Philippine economy were estimated. Fifteen of the 25 sectors in the CGE model comprised the agriculture, fishery and forestry sectors.

Since the AGRIK model discussed above has more variables than equations, closure rules were imposed so that the number of equations is equal to the number of endogenous variables. In solving the CGE model, both the short-run or long-run closure rules can be employed. In the short-run closure, capital stocks are held fixed, implying that it is not affected easily by the short run shocks. Likewise, real wages are held fixed in the short run closure, accompanied by an endogenous level of aggregate employment. This assumes that firms do not substitute between labor of different types. A short-run closure rule assumes that a) unemployed resources exist and b) there will be a short period of time (1-3 years) needed for economic variables to adjust to new equilibrium (Horridge, 2003). In other words, short-run influence connotes "a short period of time (1-3 years) needed for economic variables to adjust to new equilibrium." On the other hand, the long-run closure rule allows the real wage rate to adjust to an exogenously determined level of aggregate employment. This long-run scenario assumes that the economy is operating under full employment.

Given high unemployment in the country (7.5% in April 2013), a long-run scenario was not adopted in the CGE application. While in terms of time period, the impacts of climate change on agriculture and economy is significant in the long-run; however, given the timescale of the simulations employed and employment condition of the country, a short-run closure was more appropriate to use. Hence, the most appropriate assumption, based on the given needs or timescale of the proposed simulations above, is the use of short-run closure. Hence, all the results below were treated as representatives of the simulated short-run influence of climate-induced impacts on the Philippine agriculture and economy.

Short-run closure was adapted in the implementation of the AGRIK model. The macro variables are *swapped* as follows:

- disconnecting government from household consumption by treating *x5tot* as exogenous variable instead of f5tot2;
- household consumption *x3tot* as exogenous variable rather than w3lux;
- inventory changes *delx6* as exogenous variable rather than fx6; and
- average *real wage* as exogenous variable rather than the overall wage shift, f1lab_io.

The AGRIK model was implemented using the General Equilibrium Modelling PACKage (GEMPACK) system. GEMPACK is a flexible system for solving CGE models and facilitates the automation process of translating the model specification into a model solution program.

RESULTS AND DISCUSSION

On the macro level, simulation results show that climate-induced impacts are likely to reduce aggregate output. This can be seen from the 1.83% projected decline in real GDP accompanying the production shock (simulation 1). Results from the combination of production shock and fishery policy response shock (simulation 2) indicated a possible 1.63% reduction in aggregate output (Table 3).

A decline in agricultural production is expected to raise the general price level (as measured by consumer price index) by 0.15%, while increasing the production of the fishery sector given climate induced impacts on agricultural production is seen to reduce aggregate prices by 1%. Climate-induced impacts would mostly affect the country's quantity of export and import, as well as employment, though the country would be benefiting slightly from the fishery policy response of increasing production. The decline in agricultural production due to climate change was reflected in the reduction of quantity exported by 6.54% and quantity imported by 1.93%. Likewise, the country's employment will decrease by 4.91% with the assumed reduction in selected agricultural production.

Table 3. Simulated macroeconomic effects, in percent deviation from the base.

Variables	Simulation 1 Agricultural production	Simulation 2 Agricultural production + fishery policy response
Real GDP at factor cost	-1.83	-1.63
Consumer's price index	0.15	-1.00
Export quantity	-6.54	-5.72
Import quantity	-1.93	-1.89
Employment	-4.91	-4.36
Average return to land	73.26	75.27

Given reduction in agricultural production due to climate change and targeted fishery policy response, the percent deviation from the base in export quantity is lower at 5.72% decline, a decrease of 1.89% in import quantity, and a decrease of 4.36% in employment. In addition, land rent is expected to increase by 75.27%, which might trigger improvement in production efficiency and further input intensifications (Table 3). Simulation 2 results indicated that the fishery policy response could increase real GDP, employment, export and import in the fisheries subsectors.

Detailed disaggregation of the results shows a similar pattern. The reduction in activity level or value-added was most significant in corn, banana, sugarcane, manufacturing, and rice sectors (Table 4). Value-added for forestry rose slightly by 0.12%. In simulation 1, 23 of the 25 sectors will have a decrease activity level. On the other hand, simulation 2 caused the value-added of 18 sectors to decline. The fisheries sectors (ocean fishing, freshwater/coastal fishing, and aquaculture) are the only sectors that gained positively from simulation 2. Moreover, there were slight increase in the value-added for forestry (0.29%), mining and quarrying (0.02%) and construction (0.01%) sectors.

Given the structure of the Philippine economy, the simulation results show that the decrease rate of most of the sectors in simulation 2 is lower than that in simulation 1. The model implies that with fishery policy response, the value-added created in the three subsectors of the fishery will have multiplier effects in the economy and the associated subsectors of the country. For example, Table 4 shows that given simulation 2, transport subsectors will benefit slightly from fishery policy response since without it, the reduction in value added will be higher at 0.44% compared with 0.13% with the fishery policy response.

CONCLUSION AND RECOMMENDATIONS

Overall, climate-induced impacts will result in a net loss to the Philippine economy and its key agricultural sectors in the short run. Since production would be greatly affected and would have ripple and multiplier effects in the economy, it is imperative for Philippine farmers to employ adaptation measures to lessen the impacts of climate change.

Therefore, boosting the fisheries subsectors may lessen the impact of climate change on the Philippine economy. In 2009, commercial fisheries contributed PhP 58M of the total fish (27%) production, municipal fisheries contributed PhP 75M (35%), and aquaculture contributed about PhP 81M (38%) (BFAR, 2009). Since climate change would have an impact on the greater number of municipal fishing operators, an increase in the capacity of commercial fishing and aquaculture operators may be encouraged. In the country, climate change shortens fishing season[5] as heavy rains and strong waves now begin as early as late March or early April.

The use of organic farming practices is one of the strategies being advocated by the Department of Agriculture in response to climate change. Some government subsidies may be needed to promote indigenous and diversified farming practices in the countryside. Furthermore, going local and buying local produce may benefit the domestic economy in the short run. Finally, government should establish safety nets for those stakeholders affected by declining employment and reduced food crop production. Priorities should be on the most affected subsectors - banana, corn, sugarcane, rice, and fiber products.

Table 4. Simulated sectoral activity level/value-added effects, in percent deviation from the base.

Sectors	Simulation 1 Agricultural production	Simulation 2 Agricultural production + fishery policy response
Rice	-4.83	-4.48
Corn	-7.32	-7.09
Vegetable and oil seeds	-2.49	-2.22
Fruits and nuts	-2.49	-2.22
Sugarcane	-6.05	-5.76
Abaca	-3.72	-3.44
Cotton and other fiber crops	-3.72	-3.44
Banana	-7.55	-7.25
Other crops	-2.49	-2.20
Livestock	-3.11	-2.83
Other livestock products	-3.64	-3.40
Forestry	0.12	0.29
Ocean fishing	-0.17	9.86
Freshwater/coastal fishing	-0.17	9.86
Aquaculture	-0.17	9.86
Mining and quarrying	-0.05	0.02
Manufacturing	-5.54	-5.18
Electricity, gas and water	-1.83	-1.70
Construction	-0.03	0.01
Trade	-2.01	-1.86
Transportation, communication and storage	-0.44	-0.13
Finance	-0.39	-0.28
Private services	-0.45	-0.08
Government services	-0.03	-0.01
Dwellings	0.00	0.00
No. of sectors with lower activity-level/value added	23	18

[5] Heavy rains and strong waves in the Philippines coincide with the rainy/typhoon season which commonly start in June.

ACKNOWLEDGEMENTS

This research was supported by funds from the Economy and Environment Program for Southeast Asia (EEPSEA) through the Center for Economics and Development Studies (CEDS), Faculty of Economics - Padjadjaran University. The author is grateful to its CGE instructors, primarily Dr. Arief Yusuf and Dr. Ian Bateman. Thanks are due also to Kim Narvaez for his assistance in this research. Any errors are sole responsibility of the author.

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Appendix Table 1. The Philippines macroeconomic data for historical simulations.

Variable	2004	2009	% Change
Household final consumption expenditure	903,814	1,152,6580	27.5
Government final consumption expenditure	75,455	101,163	34.1
Capital formation	234,065	243,052	3.8
Exports	539,950	574,284	6.4
Imports	628,911	621,543	(1.2)
Employment (1,000 persons)	31,613	35,061	10.9
Population	76,946,500	92,226,600	19.9
Gross national expenditure	1,252,331	1,654,936	32.2
CPI (1994 = 100)	121	160	32.7

Sources: Philippine Statistical Yearbook (2004, 2010)
Note: Expenditures are in million Pesos, constant 1985 prices.