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Climate Change and Threats to Sustainability in South East Asia: Dynamic Modelling Approach for Malaysia

Gamini Herath and Akram Hasanov

1 Introduction

Climate change is a significant challenge for policy makers in all countries in the world. Each year human activities release around 30 billion tons of CO₂ into the atmosphere, mainly by burning fossil fuels in energy generation, transport, industry, and household activities. Forest clearing in South East Asian (SEA) countries is a major contributor of GHGs and destroyed considerable biodiversity and ecosystem services (Singh 2013). Asia contributed 31.0 % of global emissions in 2006 which is expected to rise to 42.1 % of global emissions in 2030 (Shui and Harriss 2006). Globalization since the 1980s and rapid industrialization has accelerated emission of GHGs exacerbating climate change. The change in the composition of industrial activity, increase in income and consumption, and technology were driving globalization creating natural resource scarcity.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) estimates that each of the last three decades has been successively warmer than any preceding decade since 1850. The Earth's climate is getting warmer by 6C over the past 1000 years with two main periods of warming, between 1910 and 1945 and from 1976 onwards and is greater than at any other time during the last 1000 years. Warming in Malaysia since the 1970s has been three times as rapid as the preceding 100 years. The 1990s saw the warmest decade in the 142 years since temperature records began. Over the next 30 to 50 years, estimated temperature can rise by about 2.6 °C in Malaysia. Increase in sea level ranges from 0.18 m to 0.59 m (Intergovernmental Panel on Climate Change 1995).

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These changed weather conditions will have serious impacts on food availability, accessibility, utilization, and food system stability (Gu et al. 2010). The most significant impact of CC in Asia would be on food security and the increased incidence of natural disasters. CC impacts if not mitigated can largely nullify years of unprecedented development in Asia achieved over the last 30 years. It is important for Asia to better manage impacts of CC by focusing on natural disasters and food security both of which are closely interlinked. CC can affect even many decades later creating intergenerational equity. In Asia, income inequality widened with growth with adverse consequences to SEA affecting resource availability reduced human development and growth.

Varying policies have been adopted in South East Asian countries to mitigate climate change but they failed, and food security and natural disasters remain an ever present threat to sustainable development (SD). In developing countries in Asia, the capacity for governance may be limited. Adaptation and mitigation strategies require better understanding of the inter-linkages between climate change and socioeconomic vulnerabilities of the population. Developing countries must focus on developing integrated responses to CC by improving institutional capacity.

SEA countries must specially focus on promoting awareness, capacity building, and encouraging the organizations and the public to take affirmative action to respond to climate change. Policy information should guide national agencies and the community on how to address climate change adaptation. A multidisciplinary synthesis of the knowledge of CC impacts on major food crops of the world is needed.

The aim of this chapter is to study impacts of CC in SEA in order to identify the future challenges for Asia. The study is supplemented by a case study of Malaysia. The specific aims are to:

- a. review trends in climate change in SEA countries
- b. examine the impacts of CC on food security and natural disasters
- c. examine the impact of CC on rice production in Malaysia, using dynamic modelling
- d. identify policies to mitigate CC challenges in SEA

The methodology involves review of extant literature and synthesis of a narrative that reflect CC responses to date. The review covers up-to-date literature to provide insight on recent developments with special focus on natural disasters and food security in SEA. The last section of the chapter will provide a discussion of the impact of CC on the rice industry in Malaysia.

2 Causes of Climate Change in SEA

2.1 Deforestation in SEA

Deforestation in SEA is a major factor causing climate change. Deforestation is responsible for 20 % of the global GHG emissions. SEA lost an average of 78,500 ha, of its forests, annually during the 1990s. Deforestation in Malaysia is faster than

many other tropical countries. Malaysia's annual deforestation rate increased by 86 % between the 1990–2000 and 2000–2005 (FAO 2008). Between 1990 and 2010, Malaysia lost an average of 96,000 ha or 0.43 % per year or 8.6 % of its forest cover, or around 1,920,000 ha. Oil palm in Malaysia has caused forest loss of about five million hectares (20 % reduction of forest land (Wicke et al. 2008).

Over the periods of 1990–2000 and 2000–2005, deforestation rates in Indonesia increased from 2.3 % to 2.7 % per year for its primary (undisturbed) forests. As a result, sustainable forest management alternatives have emerged to reduce deforestation and ensure that biodiversity and ecosystem values are protected (Stringer 2006).

Thai villagers migrated into forest reserves for shifting cultivation, especially in the watershed areas in the north. During the period 1961–1985, the forest area decreased at an average rate of 0.5 million hectares annually. Deforestation influences flood occurrence through the reduction of water conservation effect, resulting in the increase of peak flood discharge.

2.2 Globalization and Rapid Economic Growth in Asia

The unprecedented economic growth rates experienced in Asia over the last three decades is a major cause of pollution and global warming (see Table 1). Singapore achieved impressive economic growth with a booming building sector. The building sector contributes a significant proportion of CO₂ contributing to global warming. Singapore needs to balance long-term economic growth and environmental pollution.

Environmental policies are weak in developing countries, and hence specialization in “dirty” activities will occur (Copeland and Taylor 1995). Studies show that the South exports relatively dirty products and the North exports relatively clean products. The pollution intensity of trade between Indonesia and Japan measured by a human toxicity index of effluents is a case in point (Lee and Roland-Holst 1994). Japan's aggregate output has an index of 0.86, while Indonesia's index is 2.45 showing specialization in dirtier activities. Exports from

Table 1 Rates of economic growth (in percent) in selected South East Asian countries

Country	2011	2012	2013	2014
Cambodia	7.1	7.3	7.5	7.1
Indonesia	6.2	6.0	5.6	5.0
Malaysia	5.3	5.5	4.7	6.0
Myanmar	–	–	8.2	8.5
Philippines	3.7	6.7	7.1	6.1
Singapore	6.2	3.4	4.4	2.9
Thailand	0.8	7.3	2.8	0.9
Vietnam	6.2	5.2	5.4	6.6

Source: The World Bank, Annual Data Bank, Washington DC 2014

Indonesia to Japan have an index of 10.64 while Japanese exports to Indonesia have an index equal to 1.62.

Between 1990 and 1993, over 5.4 million tons of hazardous waste were shipped to Bangladesh, China, Hong Kong, India, Indonesia, Malaysia, Pakistan, the Philippines, Singapore, South Korea, Sri Lanka, Taiwan, and Thailand. Worldwide, over 103 countries have banned hazardous waste importation; only one of these, the Philippines, is an Asian country. E-waste from high-tech electronics can have significant social and environmental costs affecting SD (Pellow 2007).

3 Climate Change, Food Security, and Natural Disasters

Climate change is a principal source of fluctuations in food production in developing countries (Oseni and Masarirambi 2011). Various critical direct and indirect consequences of CC on crop production can be seen due to unpredictable rainfall disturbing the food security aspects of the globe (Poudel and Kotani 2013). Climate-related natural hazards such as droughts and floods can affect Asian food security, in the major rice-growing regions of Asia.

3.1 Food Security

The World Food Summit (1996) defined food security as a multidimensional concept that includes food access, availability, food use, and stability. Food security is at the heart of the basic livelihoods of populations in some countries in SEA where many people are vulnerable and lack coping strategies (Chambers and Conway 1992). Food security cannot simply be represented as starvation and crop failure but should accommodate sociopolitical imperatives. Climate, natural disasters, and food security are inextricably linked. The ethical and human rights dimension of food security have been enshrined in the constitution of many countries. Hence, the desirability of highlighting the social construction of vulnerability and the sociopolitical processes by which people are made vulnerable is most relevant for mitigation strategies (Cutter 1996).

It has been estimated that yield decreases 7 % for every 1 °C rise in temperature above current mean temperature at existing atmospheric carbon dioxide concentration. Roslina and Abu Kasim (2009) studied the impact of global warming on Malaysian agriculture by using time series data of 28 years (1980–2007). The study indicates that agricultural activity comprising harvesting area (ha), yield (kg/ha), and quantity of production (ton) were estimated to decrease by between 0.94–2.06, 0.43–0.61, and 1.2–5.5 %, respectively, due to global warming. Table 2 indicates the potential consequences of CC on food security.

Sea level rise can affect food security for people located in coastal areas due to rise in average temperatures (Raman 2009). Fisheries which is a main source of

Table 2 Impact of climate change on food security

Food security dimension	Consequences of climate change
Availability (<i>sufficient quantity of food for consumption</i>)	<ul style="list-style-type: none"> • Reduced agricultural production in some areas locally (especially at tropical latitudes) could affect dietary diversity • Changes in the suitability of land for crop production • Changes in precipitation patterns could affect the sustainability of rain-fed agriculture in some areas • Increases in temperature could lead to longer growing seasons in temperature regions and reduced frost damage • CO₂ fertilization could increase yields for those crops with the physiology to benefit from CO₂ enrichment
Access (<i>ability to obtain food regularly through own production or purchase</i>)	<ul style="list-style-type: none"> • Lower yields in some areas could result in higher food prices • Loss of income due to the potential increase in damage to agricultural production
Stability (<i>risk of losing access to resources required to consume food</i>)	<ul style="list-style-type: none"> • Instability of food supplies due to an increase in extreme events • Instability of income from agriculture
Utilization (<i>quality and safety of food, including nutrition aspects</i>)	<ul style="list-style-type: none"> • Food security and health impacts include increased malnutrition • Ability to utilize food might decrease where changes in climate • Impact on food safety due to changes in pests and water pollution

Source: Krishnamoorthy et al. (2013)

sustenance for poor fisher communities and a source of employment and money will be seriously affected (FAO 2008).

CC can affect food security by damaging agricultural systems reducing yields of crops such as rice, wheat, and maize (Lewis 2009). Data from the International Rice Research Institute (IRRI) revealed that rice yields drop as much as 10 % for every 1 % rise in temperature. Malaysia's temperature will rise by 1.5 °C and agriculture will be seriously affected (Siwar et al. 2009). Malaysia has nearly 5.5 % of arable land under rice, fruits, and vegetables. About 9 % of the land in Malaysia is flood prone (Al-Amin et al. 2011). Some studies of the economic effects of climate change on agricultural production (Vaghefi et al. 2011; Challinor et al. 2014; Auffhammer et al. 2011) reveal that crop agriculture in developing countries is highly susceptible to climate change.

An analysis of climate risks for crops in 12 food-insecure regions based on statistical crop models and climate projections for 2030 indicate South Asia and Southern Africa as two regions that, without sufficient adaptation measures, will likely increase food insecurity (Lobell et al. 2008). Rice is the most widely grown crop under irrigation, accounting for almost 40 % of the developed freshwater resources in Asia, where almost 90 % of rice is consumed by 45 % (2.7 billion people) of the world's population. The water-intensive nature of rice production is of great significance for rice production under irrigated conditions increasingly competing for water from industrial and urban sectors, the quantity of water

available for rice production is expected to decline. Changes in temperature and rainfall patterns could lead to food price rises between 3 and 84 % by 2050.

Coastal flooding and land loss is most significant in east, south-east, and south Asia. Extreme precipitation, inland and coastal flooding, as well as drought and water scarcity pose risks to food security. Fish catches in some areas have fallen and in the tropics are projected to fall by between 40 and 60 %.

There is relatively little research on SEA investigating how CC will affect humanity to feed itself in the future. Feeding the world's burgeoning population, especially the poor who rely on small-scale and subsistence farming and fisheries is a serious dilemma for policy makers.

3.2 Climate Change, Natural Disasters, and Food Security

Climate change has increased the intensity and frequency of precipitation, extreme rainfall, droughts, river and inland flooding, and environmental health, and food security in Asia. During 1968–2004, Malaysia has experienced 19 natural disasters resulting in 1460 fatalities. The winter monsoon of 2006/2007 and 2007/2008 brought in heavy rainfall and caused severe floods in Malaysia. The Johor flood in Malaysia in 2006 displaced 110,000 people (Siwar et al. 2009).

Floods are frequent in Thailand and the lower Chao Phraya river basin suffered from repeated flood events. The 2011 flood affected 77 provinces and a third of the country was under water. Thailand encountered the worst floods in 2011 due to heavy rain in most areas of the country. The floods affected the northern, central, and northeastern regions of Thailand. There were 813 deaths, and over 13.5 million people affected. The floods inundated about six million hectares of land, of which over 300,000 hectares is farmland (Khunrattanasiri 2012). UNIDO estimated the damages of the floods to be up to 42.8 billion baht (1.43 billion USD).

In the Philippines, the frequency of floods has increased and in 2008 42 flood events were reported. The annual flood damage amounted to US\$ 1829 billion (Herath 2012). In the Philippines, for example, the government has made strong efforts to improve resilience and emergency preparedness, and its experience with post-disaster assessments is helping Haiyan recovery efforts.

A recent World Bank report finds that over the last 30 years natural disasters caused close to \$4 trillion in economic losses, owing mostly to extreme weather events. Losses rose from an annual average of about US\$50 billion in the 1980s to close to US\$200 billion over the last decade. We know that by 2050 global economic costs from flooding in cities alone could rise to US\$1 trillion a year. The average damage to land due to floods have been estimated at RM100 million a year in Malaysia (Al-Amin et al. 2011).

The poor households who lack coping strategies are most vulnerable to environmental risks (UNDP 2004). According to the UNDP while 11 % of those exposed to droughts floods etc. are from the developing countries, 53 % of them lose their lives (Schipper and Pelliong 2006). Most Asian countries were

preoccupied with poverty alleviation and paid less attention to development of natural hazard risk mitigation capacity and strategies.

Natural disasters increase undernutrition due to disruption to incomes and food distribution systems (IPCC 2001). The cumulative effect of undernutrition may only be apparent in the long term.

4 Case Study of Malaysia

4.1 The Rice Economy of Malaysia

It is widely recognized that irrigated agriculture has reached the point of diminishing returns. From a policy-maker's perspective such developments will necessitate reduction in water consumption and/or increasing agricultural productivity which enhances their total livelihood system of farmers.

The rice industry in Malaysia provides the main livelihood to about 296,000 farmers, nearly 40 % of whom are exclusively rice farmers. Sustainable production of rice is critical for rural livelihoods and food security.

Rice in Malaysia is mainly grown by small holders with an average farm size of about 1.06 hectares and the poorest group in rural areas. Rice accounts for about 86 % of the country's food grain production. Production has been sufficient to meet about 65 % of the requirements. Malaysia is a cereal importing country. The population today is 28 million and will be 40 million in 2050.

In Malaysia, climate impacts on rice depend on the geographical location (Alam et al. 2011) and will affect rice output and productivity (Roslina and Abu Kasim 2009; Challinor et al. 2014; Herman et al 2015).

Chamhuri reviewed that production and yield changes may be due to reduction in the water available for irrigation. The crop productivity will be altering due to changes in climate and weather events (Chamhuri and Abul Quasem 2009). Policies and programs in the agriculture sector focus on the enhancement of income of agricultural producers to reduce the poverty incidence and to minimize inter-sectoral disparity and inequity between the agriculture and non-agriculture sectors of society.

4.2 The Data and Methodology

In this study, we employ annual data on rice output, prices, yield, temperature, and rainfall data to estimate the impact of CC over the period from 1961 to 2015 (see Fig. 1). Malaysian data on rice output, price, and yield are retrieved from International Rice Research Institute database while temperature and rainfall data are obtained from the Malaysian Meteorological Department. The temperature and

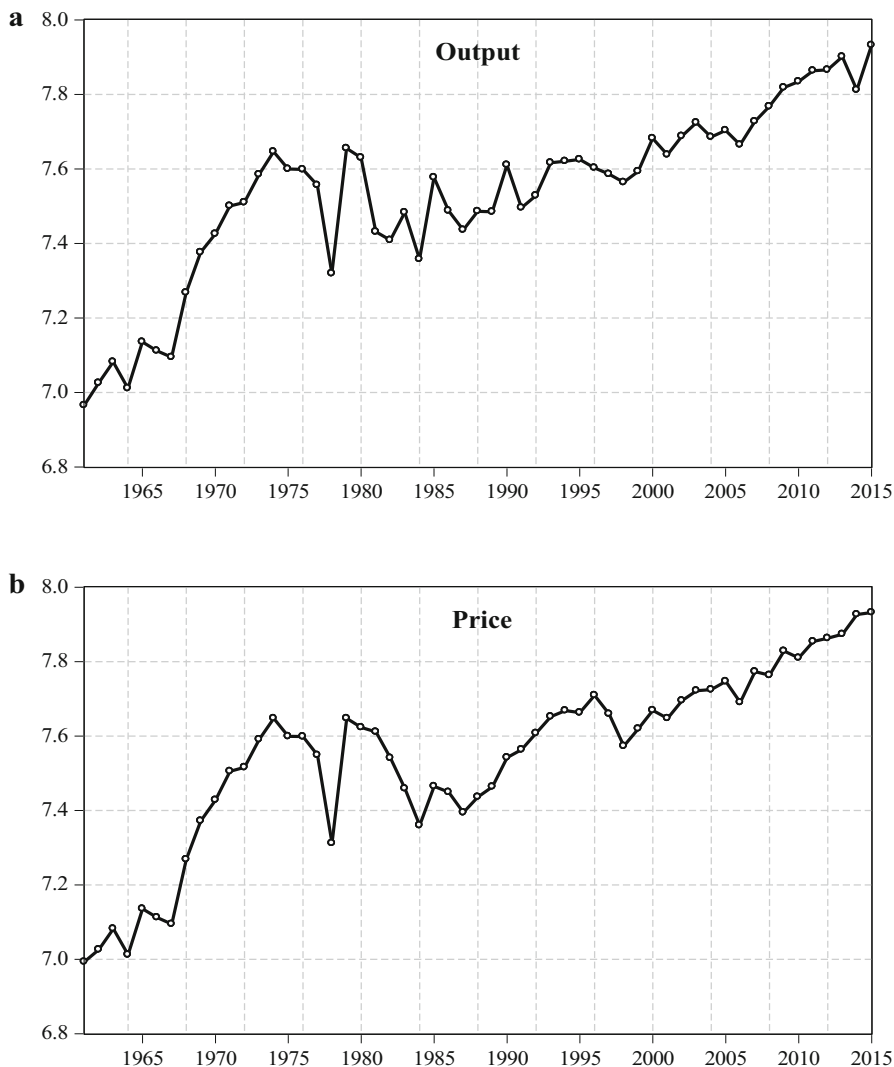


Fig. 1 Variables in log form for the sample period. (a) Total rice output in Malaysia; (b) change in price/ton in Malaysian Ringgit; (c) amount of annual average rainfall amount in milliliters; (d) records of annualized 24 h temperature; (e) change in rice yield/ha in Malaysia

rainfall data were obtained for four stations (Alor Setar, Chuting, Ipoh, and Kuching) which are closest to the major rice-growing areas in Malaysia namely Perak, Kedah, Perlis, and Sarawak for the period 1951–2015 (65 years). These were averaged to get an average annual figure for rainfall and temperature.

We use the following dynamic model with an autoregressive distributed lag process in the estimations:

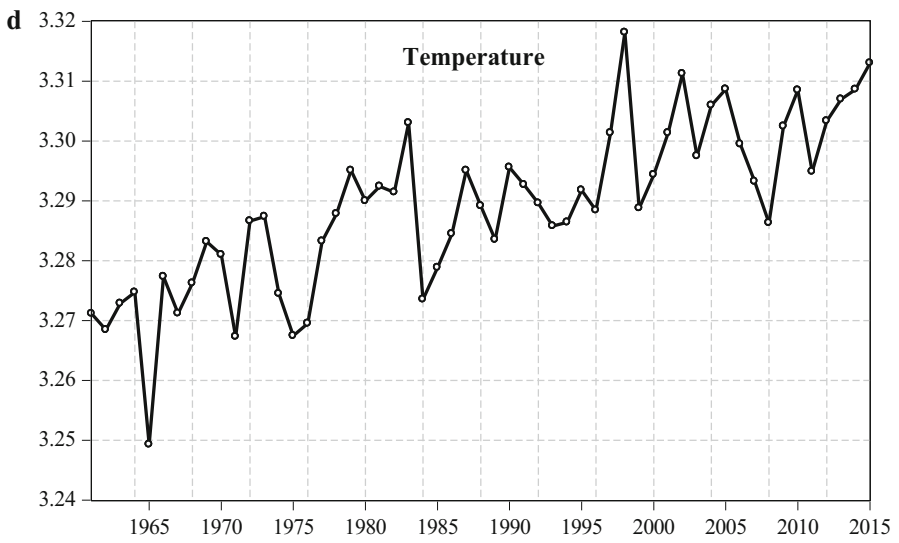
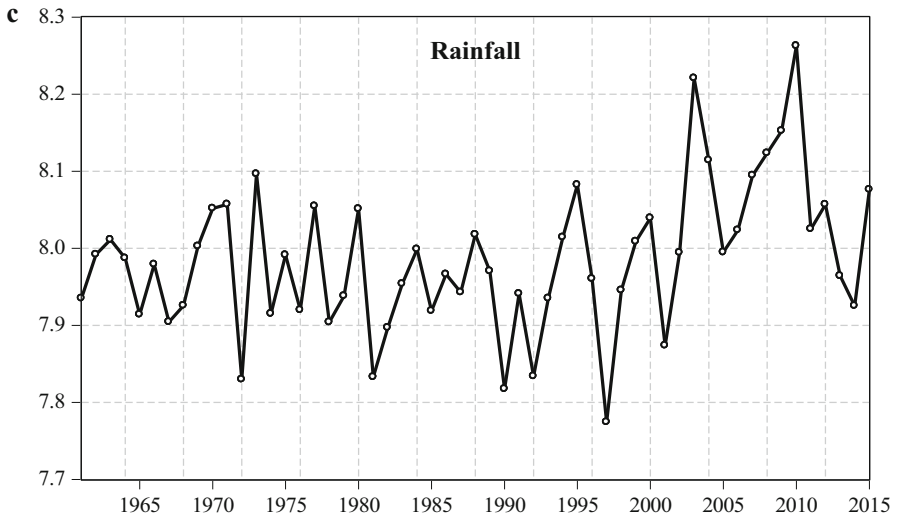


Fig. 1 (continued)

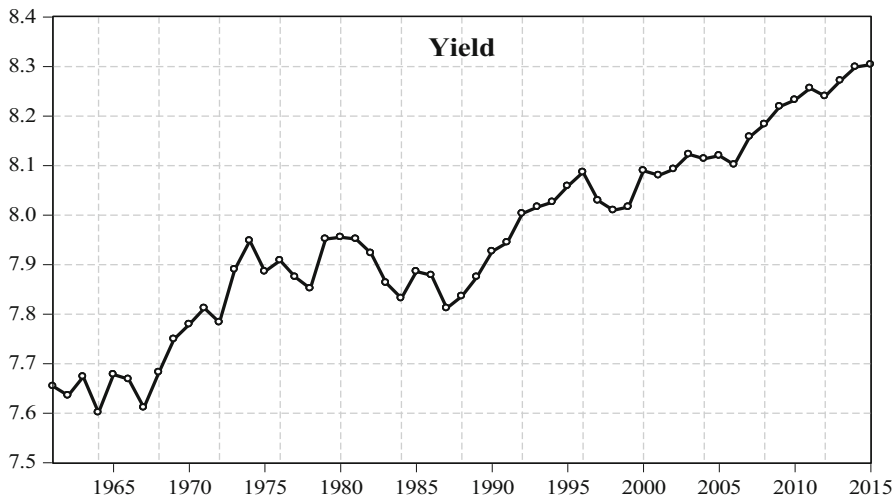


Fig. 1 (continued)

$$\begin{aligned} \Delta \ln \text{OUT}_t = & \alpha_0 + \sum_{i=1}^m \xi_i \Delta \ln \text{OUT}_{t-i} + \sum_{i=0}^n \tau_i \Delta \ln \text{PR}_{t-i} \\ & + \sum_{i=0}^p \delta_i \ln \text{Rain}_{t-i} + \sum_{i=0}^q \theta_i \ln \text{TEM}_{t-i} + \sum_{i=0}^r \gamma_i \Delta \ln \text{Yield}_{t-i} + \varepsilon_t, \end{aligned} \quad (1)$$

where OUT_t is the output volume, PR_t is the price, Rain_t is the average rainfall, TEM_t is the average annual temperature, and Yield_t is the yield. The maximum lag length for each variable in Eq. (1) is set to be 3 to ensure sufficient degrees of freedom and a combination of lags that minimizes the Akaike information criterion (AIC).

We begin the analysis by first discussing the stationary test and error diagnostics results and then estimated parameters. We test for stationarity by applying two different unit root tests to all series under study: the augmented Dickey and Fuller (1979) (ADF) and the Phillips and Perron (1988) (PP) tests. As shown in Table 3, these tests do not reject the stationarity hypothesis for output, price, and yield series and therefore these series follow a non-stationary process, regardless of whether a trend variable or intercept term is incorporated in the unit root equation. On the other hand, null of non-stationarity is rejected for rainfall and temperature series. Therefore, in the analysis that follows we treat output, price, and yield series as I(1) processes while rainfall and temperature series as I(0) process in our model. Hence, the output, price, and yield variables are taken as differenced form in the model while temperature and rainfall variables are incorporated in a level form to avoid spurious regression issue. The Ljung-Box serial correlation test statistics proposed by Ljung and Box (1978) suggest that the null hypothesis of no serial correlation up to the 5th lag order is not rejected for the residuals. In Table 4, we also conduct the ARCH heteroskedasticity test of Engle (1982) to further analyze

Table 3 Unit root test results for the series in level

	Variables	ADF	PP
Intercept	Output	-1.7320	-1.9511
	Price	-1.8662	-1.8173
	Rainfall	-5.4287**	-5.4148**
	Temperature	-3.0789*	-3.0789*
	Yield	-0.5239	-0.9048
Int. and trend	Output	-3.4072	-3.2935
	Price	-2.8431	-2.7448
	Rainfall	-5.9017**	-5.9025**
	Temperature	-6.3244**	-6.2469**
	Yield	-2.6854	-2.6731

Notes: ** and * denote significance at 1 % and 5 % levels, respectively. Lag lengths are identified via Schwartz Information Criterion. The number of lags used in each case ensures no residual autocorrelation

Table 4 Estimation results

$$\Delta \ln \text{OUT}_t = \alpha_0 + \xi_1 \Delta \ln \text{OUT}_{t-1} + \xi_2 \Delta \ln \text{OUT}_{t-2} + \tau_0 \Delta \ln \text{PR}_t + \tau_1 \Delta \ln \text{PR}_{t-1} + \tau_3 \Delta \ln \text{PR}_{t-3} + \delta_0 \ln \text{Rain}_t + \delta_2 \ln \text{Rain}_{t-2} + \delta_3 \ln \text{Rain}_{t-3} + \theta_1 \ln \text{TEM}_{t-1} + \theta_3 \ln \text{TEM}_{t-3} + \gamma_0 \Delta \ln \text{Yield}_t + \gamma_3 \Delta \ln \text{Yield}_{t-3} + \varepsilon_t$$

Parameters	Coefficient estimates	p-Value
α_0	1.2417	[0.507]
$\Delta \ln \text{OUT}_{t-1}$	-0.6078	[0.000]
$\Delta \ln \text{OUT}_{t-2}$	-0.2951	[0.000]
$\Delta \ln \text{PR}_t$	1.0189	[0.000]
$\Delta \ln \text{PR}_{t-1}$	0.3081	[0.052]
$\Delta \ln \text{PR}_{t-3}$	0.0935	[0.535]
$\ln \text{Rain}_t$	0.2043	[0.009]
$\ln \text{Rain}_{t-2}$	-0.1459	[0.077]
$\ln \text{Rain}_{t-3}$	0.1145	[0.144]
$\ln \text{TEM}_{t-1}$	-1.5585	[0.017]
$\ln \text{TEM}_{t-3}$	0.7659	[0.237]
$\Delta \ln \text{Yield}_t$	-0.2091	[0.418]
$\Delta \ln \text{Yield}_{t-3}$	-0.3986	[0.117]
Ljung-Box Q(5)	3.5195	[0.620]
ARCH(5)	0.0398	[0.998]
R-squared	0.83	
Adjusted R-squared	0.77	
AIC	-3.174	

Figures in square brackets denote p-values; AIC denotes Akaike information criterion; the Ljung-Box Q(5) and ARCH(5) are serial correlation and heteroscedasticity statistics, respectively, for the residuals up to lag 5.

the distributional features of residuals. This test provides an obvious indication of no heteroskedasticity in the residuals of estimated model. In sum, these diagnostic tests support the modelling approach adopted in the current study. In addition, the coefficients of determination, R^2 and adjusted R^2 , are summary measures that show the sample regression line fits the data very well (see Table 4).

4.3 Results of Analysis

As seen from Table 4, the estimated parameters of $\Delta \ln \text{OUT}_{t-1}$, $\Delta \ln \text{OUT}_{t-2}$, $\Delta \ln \text{PR}_t$, $\Delta \ln \text{PR}_{t-1}$, $\ln \text{Rain}_t$, $\ln \text{Rain}_{t-2}$, and $\ln \text{TEM}_{t-1}$ are statistically significant at conventional levels. These results reveal that the output growth has been directly affected by its own lags, price changes, lagged price changes, rainfall, lagged rainfall, and lagged temperature. The appealing aspect of the results is that the parameter of $\ln \text{TEM}_{t-1}$ has negative sign. It indicates that climate change has an adverse impact on rice output growth. However, contemporaneous temperature ($\ln \text{TEM}_t$) does not seem to have any significant effect on output growth. Therefore, it was omitted from the model. Interestingly, the yield log changes do not appear to have any effect on output growth. Several studies focus on the qualitative and quantitative estimates of climate change effects on crop yields obtained from various crop simulation models (Tripathi et al. 2016). These simulations consider the changes in precipitation, higher temperatures, and higher atmospheric CO_2 concentrations to assess the climate impacts on wide range of crops (Reidsma et al. 2010). Literature generally suggests that rice is found to be more vulnerable to a rise in temperature as compared to decline in temperature. In other words, there is continuous reduction in the yield for a positive change in temperature (Endo et al. 2009). Albeit in a different setting, our results corroborate the findings in the literature in the sense that it supports the existence of adverse impact of climate change on rice production. Lastly, it is worth noting here that future research that focuses on examining the impact of climate change on production of agricultural commodities should attempt to use more sophisticated econometric tools that accounts for integration and co-integration properties of the data.

5 Conclusions and Policy Implications

This chapter has reviewed evidence along with an empirical study of damages to food security in Malaysia to show that CC can increase natural disasters and impact on food security in Asia. The impacts of these disasters and resulting food security problems are manifestations of unresolved problems of development. Most natural disasters preparedness and food security policies do not conceptualize the centrality of rural poverty in mitigating disaster risk and food security. The mutual integration of all development efforts would enhance the socioeconomic benefits for the poor

and achieve better environmental outcomes. Policy must address the causes of climate change and the resulting risk of floods and droughts. This will require political will and allocation of resources to investments for reduced longer term vulnerability and disaster.

Policy makers have a growing menu of options for managing disaster risks: at national, regional, and international levels. Mitigating climate change also involves a wide range of regulatory processes and global environmental (GEG) arrangements.

CC mitigation clearly needs participation of all countries. Industrialized countries must reduce their own GHG emissions and provide leadership through international development assistance. The Kyoto Protocol created an arena for new governance experiments, for state and non-state actors in 2002 (Christoff 2008) but political powerplay reduced its effectiveness. The APP is another alternative with seven partner countries—Australia, Canada, China, India, Japan, the Republic of Korea, and the United States. The initial six partner countries, other than Canada, account for 50 % of GHG emissions and 48 % of global energy use, and they produce about 65 % of the world's coal, 48 % of the world's steel, 37 % of the world's aluminium, and 61 % of the world's cement. The APP may be useful policy for SEA due to their specific resource endowments. The APP has flexibility to accommodate divergent national and sectoral considerations (Fujiwara 2007) and recognizes poverty alleviation as important for developing countries in Asia (Asselt 2007). However, the rampant inequalities and power block in SEA and inadequate political will can stall progress in climate policy in Asia.

Improvements in national meteorological and hydrological services to provide early warnings for extreme weather events could save an average of 23,000 lives a year, prevent displacement of populations, and provide up to US\$30 billion annually in economic benefits globally.

In SEA, climate change can undermine the viability of small-scale farmers' and fisherfolk livelihoods in spite of the vast resources, such as forests, seas, rivers, lands, and ecosystems. The Malaysian study supports the conclusion that rainfall and temperature can affect rice yield and they have a lagged effect.

Due to diversity of agriculture in many countries, customized adaptive strategies must be the focus. The strategies may include land use, local climate, and research to improve agricultural and water management strategies including traditional wisdom (Tripathi and Singh 2013). The increased investments in agriculture to protect agricultural lands, water, and other assets of the poor in all disaster-prone areas of a country is imperatives.

Adaptation and mitigation requires crops resistant to drought and water logging, proper selection of technique to cope with uncertainty and build adaptive capacity among farmers. Given the right technologies and financial support, shifting cropping area and cropping pattern may be useful and is already practiced by many farmers in India. Livelihood diversification and the mobilization of community-based support networks provide support during natural disasters and food security issues and adaptations (Abdelhak et al. 2012).

In Sabah, Sarawak and Johor in Malaysia, images, topographical maps, and land use maps provide information on the flood extent and flood depth maps to show the extent of damage to the environment, lives, and property which helps advanced planning. Such early warning systems are very useful to minimize damages due to natural disasters.

The provision of short-term measures such as food and safety nets with immediate benefits for the poor is important. Minimum food security quotas can prepare a nation for natural and social disasters. Malaysia, Sri Lanka, China, and India have adopted such measures. To enhance food security, allocation of scarce resources to productivity enhancement for the poor is essential. Public sector may be under pressure and appropriate institutional arrangements with the private sector is required.

National, regional, and global initiatives are still weak because political will and collective commitment are lacking. Unilateral decisions except in the case of local adaptation and mitigation cannot make a significant dent on natural disasters and food security in Asia. The GEG initiatives, such as the KP, were divisive and controversial and reconciling national and international priorities remains problematic and challenging. Another issue is that climate change is guided by global cooperation but disaster related to risk is taken at national and subnational levels. National disaster risk management institutions can undertake adaptation measures for climate change. Recent experience also shows that reduction of GHG will not automatically follow international accords. More serious initiatives Post-Kyoto must be initiated with greater global cooperation if climate change is to be addressed successfully.

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