

### Key Points

- The impacts of extreme events due to climate change, such as droughts, floods, and typhoons, along with the temperature rise due to global warming, are especially important for food security.
- Increasing socioeconomic factors, such as population and income, as well as the decline of the agriculture sector, relate to climate change and accelerate the food crisis.
- The challenges and impacts of climate change on agriculture can be categorized into (i) the inundation of agricultural land and saline intrusion due to sea level rise, (ii) desertification due to drought, (iii) flood damage and soil erosion, (iv) typhoon damage to food crops, cattle, and agricultural facilities, (v) reduced plant and livestock growth due to cold, and (vi) reduced yields due to pests and diseases.
- During past Asian food crises, the government's role has been to expand the cultivated area, develop and disseminate high-yielding seeds, and subsidize agriculture-related costs, such as those for fertilizer. The most important solution is using intergovernmental food aid organizations to establish international governance.

# How Do We Prevent a Food Crisis in the Midst of Climate Change?

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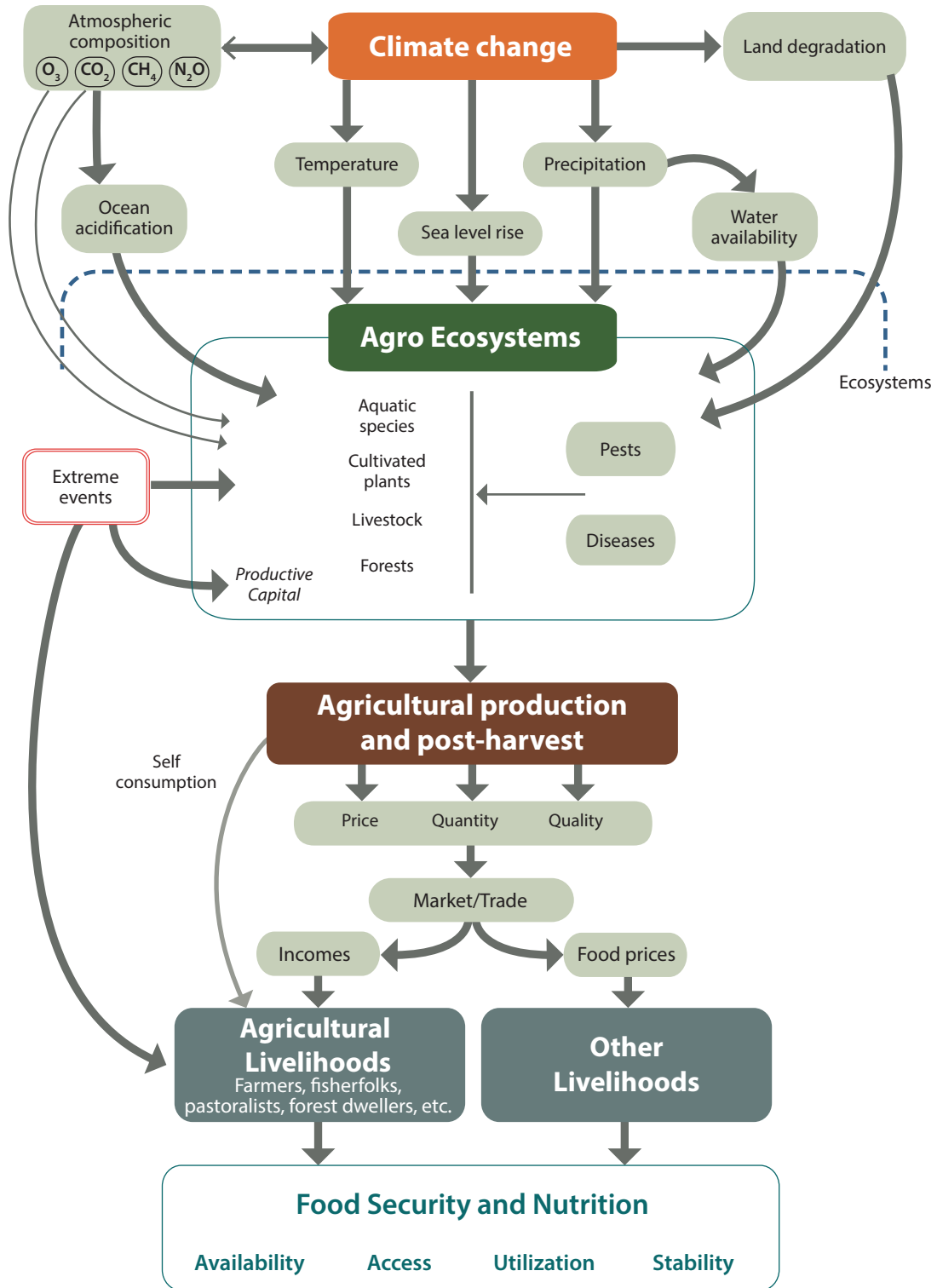
The current global warming trends are extremely likely to be the result of human social and economic activity since the middle of the 20th century (NASA 2018). Evidence of rapid climate change varies and includes global average temperature increases, seawater temperature increases, ice sheet loss, glacier retreats, snowfall reduction, rising sea levels, the retreat of Arctic sea ice, and extreme events. In particular, the impacts of extreme events due to climate change, such as droughts, floods, and typhoons, along with the average temperature rise due to global warming, are especially important for considerations surrounding food security. Indeed, climate change will have far-reaching influences on crop, livestock, and fisheries production and will change the prevalence of crop pests (Campbell et al. 2016). As a consequence of the vast impact of increasing climate change on food production systems, food security might be threatened (Islam and Wong 2017). The World Bank (2017) reported that food shortages due to drought are severe enough to affect 80 million people per day. Currently, 400 extreme weather events occur on average each year, and global climate change continuously increases climate hazards. These effects are more severe in poor countries and result in problems including housing shortages, poverty, and famine (Oxfam 2018). Climate change, in particular, could give rise to food crises, which would intensify poverty (Figure 1).

## Climate Change and Food Crises in Asia

These changes in climate are associated with a surge in demand for resources. In Asia, resource consumption is expected to increase in the future as a result of rising populations, economic development, increased food consumption, and changes in consumption patterns due to rising incomes. Indeed, income levels in major Asian countries have increased sharply, and the rate of income growth in Southeast Asia as well as that of the People's Republic of China (PRC) has been steep (Figure 2). Meanwhile, the population of Asia has been steadily expanding since 1950 (Figure 3). This increase in population and income means a need for more resources. This enlarged resource consumption leads to various



Figure 1. Cascading Effects of Climate Change Impact on Food Security



Source: Singh (2017: 3).

forms of environmental degradation, such as through the extraction of more resources, the depletion of resources, increasing resource prices, decreasing species diversity, greenhouse gas emissions, land degradation, water pollution, air pollution, and so on. These factors contribute to and exacerbate climate change.

In most Asian countries (excluding the Democratic People's Republic of Korea and Singapore), annual carbon dioxide emissions have increased. The emissions growth rate appears steep for Bangladesh, Cambodia, Indonesia, the PRC, Thailand, and Viet Nam (Figure 4).

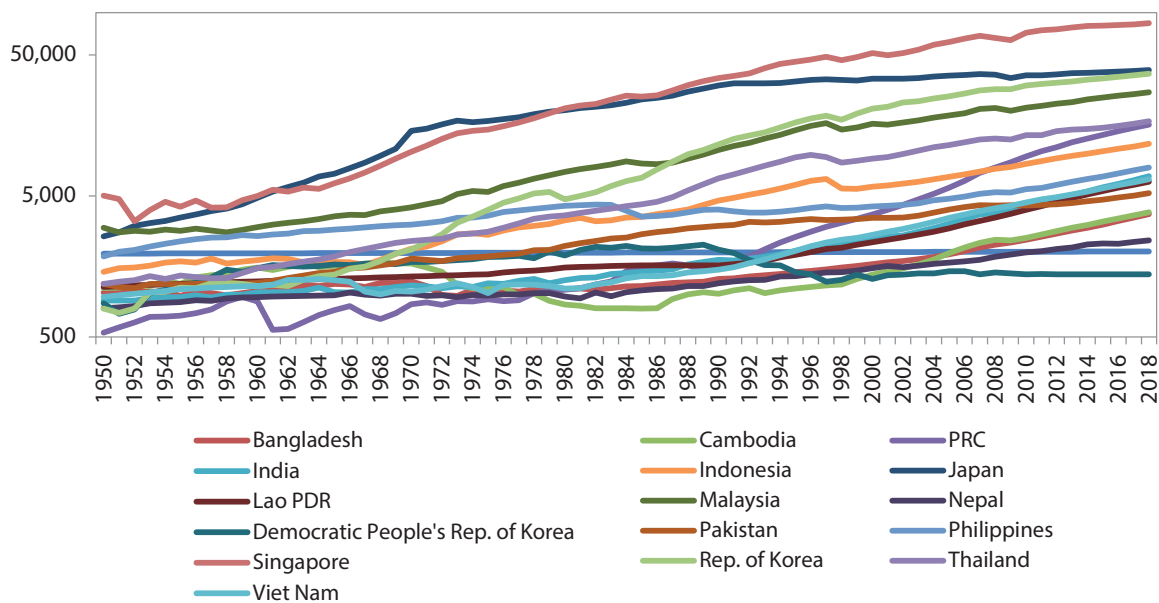
While these trends in Asia can accelerate food crises brought about by climate change, the share of agriculture in gross domestic product in Asian countries is shrinking (Figure 5). The Food and Agriculture Organization of the United Nations (2016) states that the effects of climate change on our ecosystems are already severe and widespread and that ensuring food security in the face of climate change is very challenging. Kim and Ryu (2018) present the impacts and challenges of climate change on agriculture in six categories:<sup>1</sup>

1. Inundation of agricultural land and saline intrusion due to sea level rise
2. Desertification due to drought
3. Damage and soil erosion of crops and livestock caused by floods
4. Damage to food crops and cattle caused by typhoons and damage to agricultural facilities
5. Reduced growth of plants and livestock due to cold
6. Reduced yields of crops and livestock due to pests and diseases

As a result, food shortages due to climate change and reduced investment in a country's agriculture sector can accelerate a food crisis, emphasizing the importance of national and international responses.

The number of undernourished people in the subregions of Asia tended to decline from 2011 to 2016, except in West Asia. For instance, East Asia had the strongest decrease by more than 15 million people from 2011–2013 to 2014–2016, followed by South Asia (5.4 million), Southeast Asia (600,000), and Central Asia (300,000). In contrast, the

**Figure 2: GDP per Capita Trends of Asian Countries (log scale)**

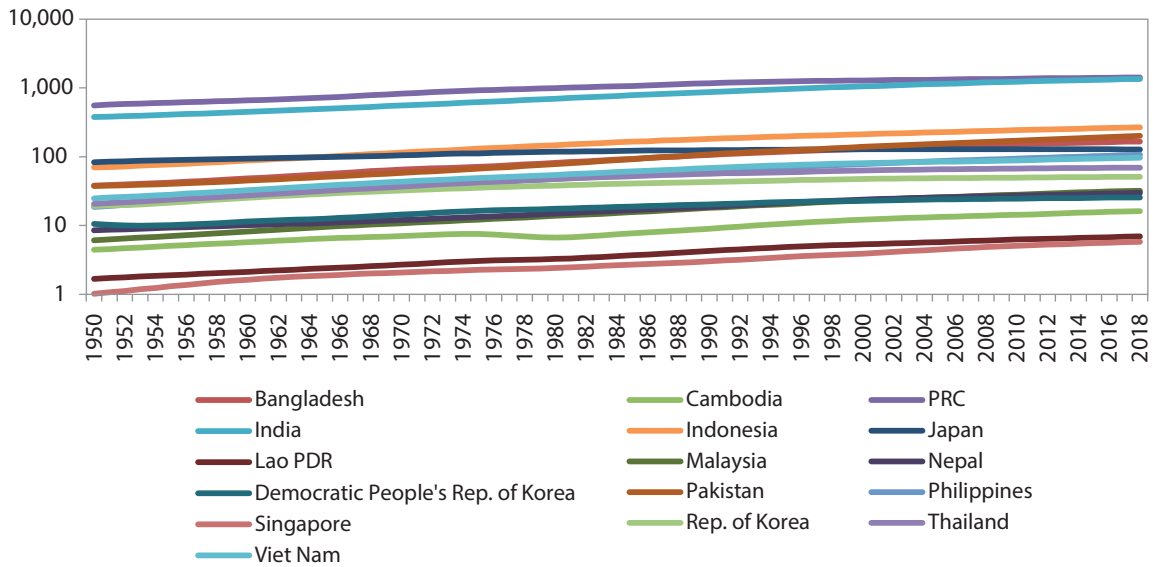


GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PPP = purchasing power parity, PRC = People's Republic of China.

Source: Graph drawn by Gapminder. <https://www.gapminder.org>

<sup>1</sup> Modified from Kim and Ryu (2018). They present three more challenges that affect agricultural production: qualification of farmers, lack of investment capital to build infrastructure and support the training of farmers, and lack of policy mechanisms (legal, politics, budgeting, etc.).

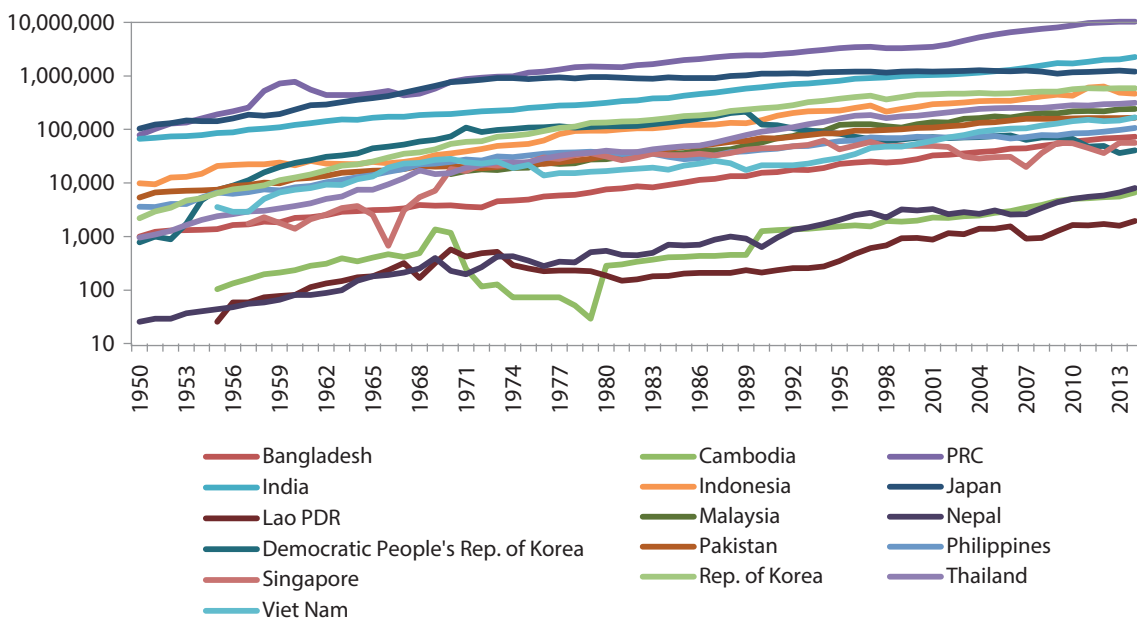
Figure 3: Population Trends of Asian Countries (log scale)



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Source: Graph drawn by Gapminder. <https://www.gapminder.org>

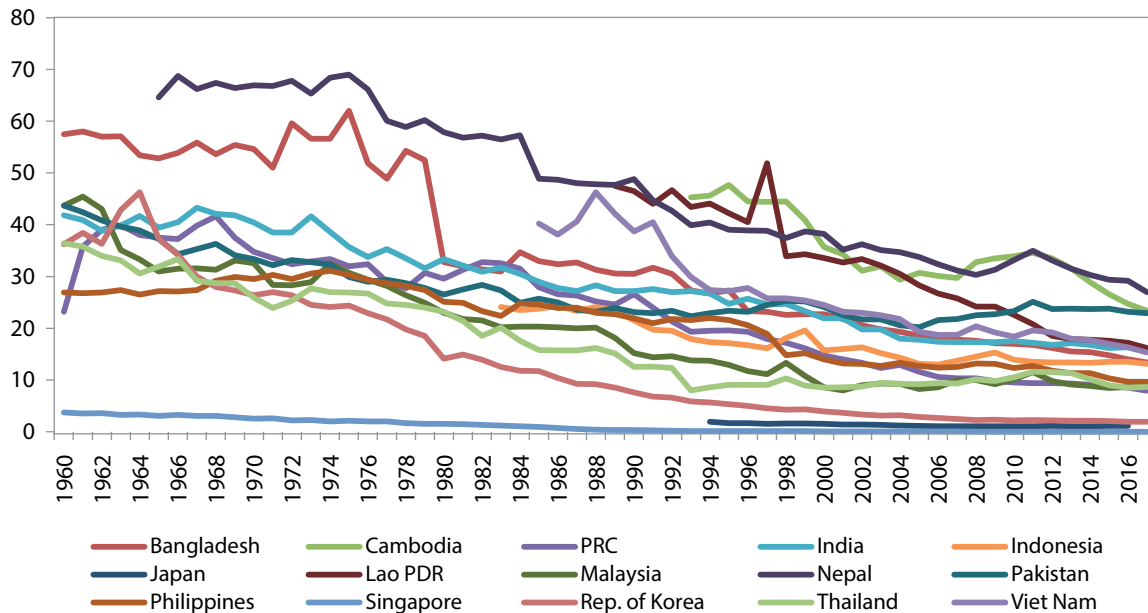
Figure 4: Annual CO<sub>2</sub> Emissions of Asian Countries (log scale)



CO<sub>2</sub> = carbon dioxide, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

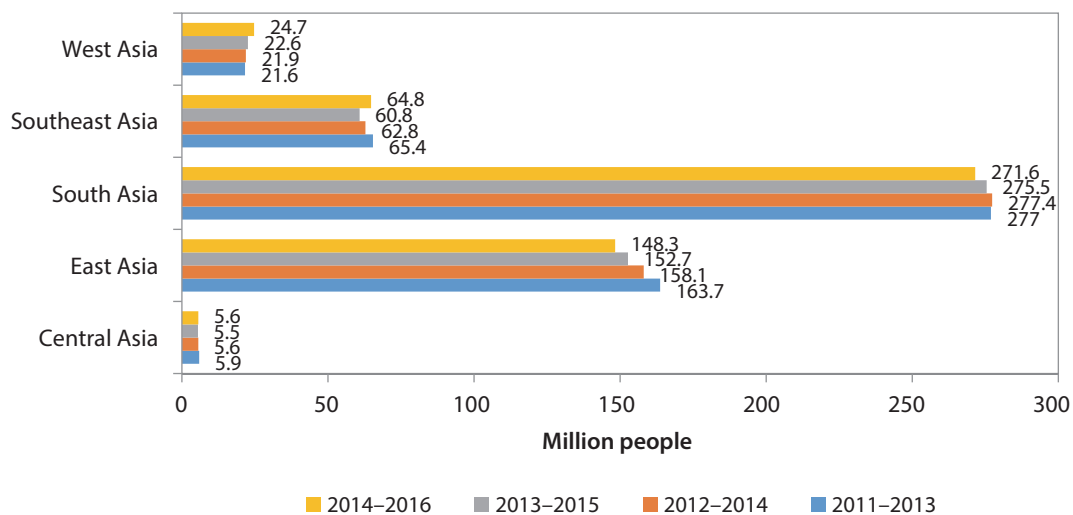
Source: Graph drawn by Gapminder. <https://www.gapminder.org>

Figure 5: Proportion of Agriculture in GDP of Asian Countries (%)



GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.  
 Source: Graph drawn by Gapminder. <https://www.gapminder.org>

Figure 6: Number of People Undernourished in Asia (3-year average)



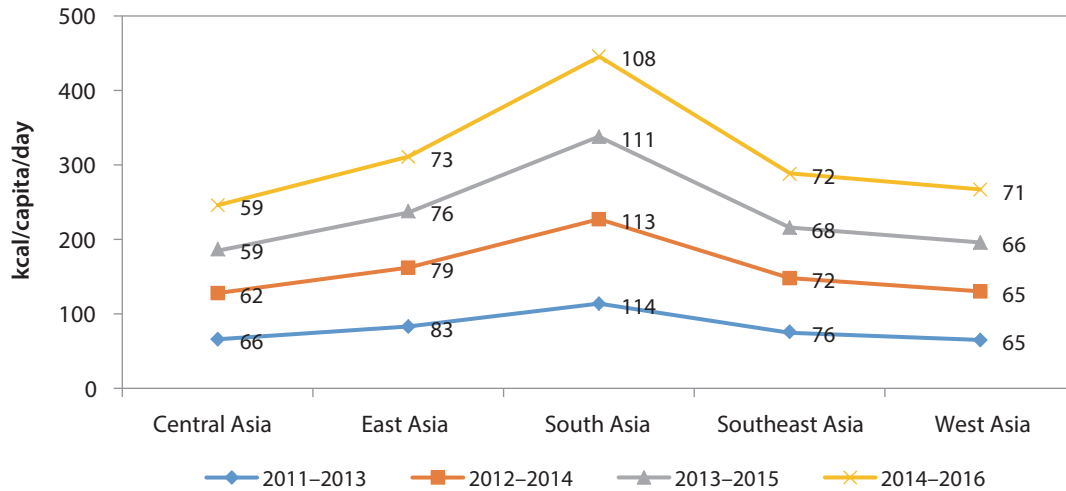
Source: FAO (2018).

number of undernourished people in West Asia increased by more than 3 million in the same period (Figure 6).

Similar to the undernutrition trend, the food deficit in the subregions of Asia tended to decrease from 2011

to 2016, except in West Asia. Specifically, the average food deficit of East Asia had the strongest decline by 10 kilocalories per capita per day (kcal/capita/day), followed by Central Asia (7 kcal/capita/day), South Asia (6 kcal/capita/day), and Southeast Asia (4 kcal/capita/day).

Figure 7: Average Food Deficit in Asia (3-year average)



kcal = kilocalorie.  
Source: FAO (2018).

day). However, the food deficit of West Asia increased by 6 kcal/capita/day in the same period (Figure 7).

## Experiences of Countries' Food Crisis Responses

The value added of agriculture, forestry, and fishery (VAAFF) increased among regions during 1997–2016, especially in East Asia and the Pacific. For example, by 2016, the VAAFF of East Asia and the Pacific rose significantly by nearly \$983 billion relative to that in 1997. In the same period, the VAAFF of South Asia increased dramatically by nearly \$349 billion and that of the Middle East and North Africa by about \$100 billion (Figure 8).

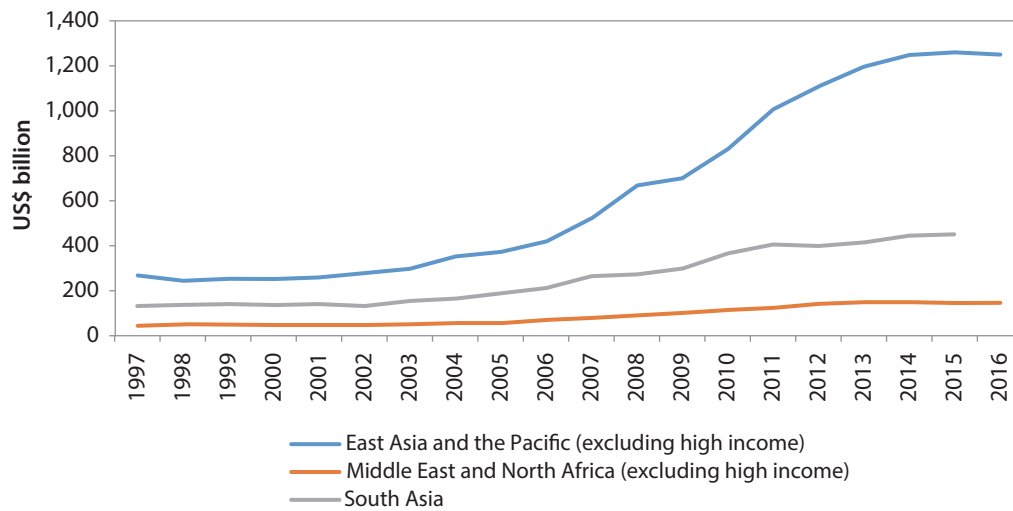
As shown in Figure 9, the food production indices of regions tended to grow during 1997–2014. By 2014, the food production index of East Asia and the Pacific had increased by 1.8 times compared to 1997, followed by South Asia (1.7 times) and the Middle East and North Africa (1.6 times). These increases imply that the food production of regions in the world progressed.

What will be important for policy in Asian countries when food security crises related to climate change arise in the near future is the valuable experience of responding to the 2007–2008 food crisis in the region. The crisis was brought about by the steep rise in food prices in 2007–2008; each country tried to escape the crisis in

its own way. As a result, the Association of Southeast Asian Nations (ASEAN) established the ASEAN Plus Three Emergency Rice Reserve (APTERR), an international food crisis response organization providing food aid. Managing food security and its sustainable development is a tremendous challenge globally. About 1.7 billion poor people live in countries in South Asia and sub-Saharan Africa (Chen and Ravallion 2007), of which 860 million people are covered by food security (Misra 2014). We will look at the food policy of individual countries at the time of the food crisis and try to derive implications for future food crises related to climate change.

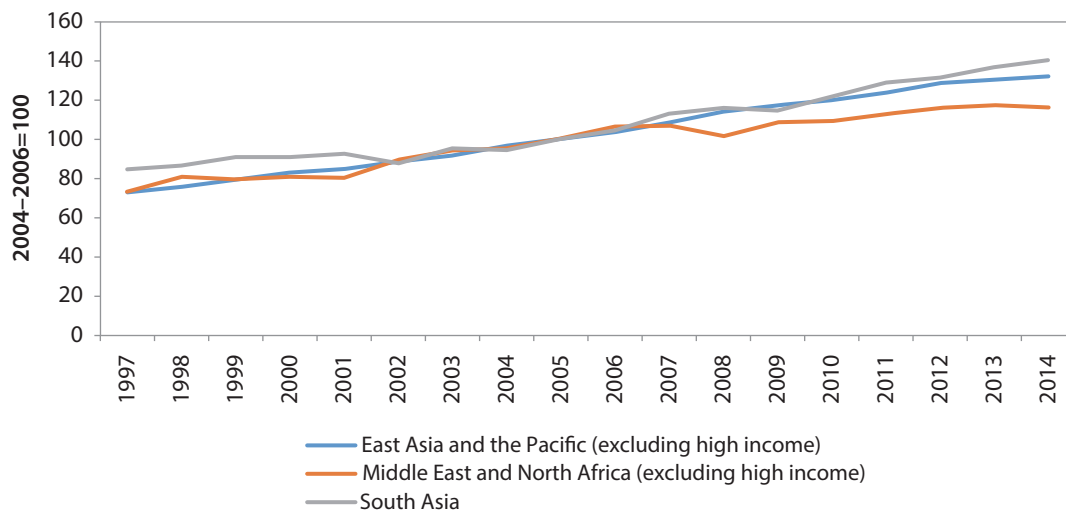
Each ASEAN member state has its own strategy in responding to a food crisis. Thailand and Viet Nam are major rice exporters, while Indonesia and the Philippines are rice importers. Myanmar is working to obtain a level of agricultural competitiveness that will enable the country to export rice, which it had previously done in the 1950s. Brunei Darussalam and Singapore only import the best-quality rice. Although the approaches among the countries differ, all expect to achieve their targets in terms of food security (Astriana, Arif, and Fadhillah 2015). Malaysia has developed short- and long-term policy measures under the National Food Security Policy for enhancing paddy and rice production, especially in Sabah and Sarawak. However, there has been widespread discontent and disequilibrium in the local plowland and rice market due to irrational extensive interventions in the Miller Subsidy and Beras Nasional programs (Tey 2010).

**Figure 8: Value Added of Agriculture, Forestry, and Fishery of Regions in the World**



Source: World Bank (2018a).

**Figure 9: Food Production Indices of Regions in the World**



Source: World Bank (2018b).

In 2007, the rise in food prices in Viet Nam was the most important cause of high inflation. It similarly had a severe impact on the poor and low-income population. As a result, the government made efforts to promote food production, investing in irrigation facilities, setting up the National Seed Program, stabilizing oil prices, and reducing or exempting irrigation fees. There are also plans to increase the yield of the third crop (autumn-winter), apply restrictions on agricultural land, and increase investment in agricultural technology.

Risk and uncertainty are increasing in South Asia because of the greater frequency of extreme events due to climate change as well as the increased possibility of temperature-influenced diseases and pests due to global warming (Shah and Lele 2011). Food and water security in the region have given rise to the highest prevalence of both child and adult undernutrition. Therefore, land and water resource management in this region is more urgently required than anywhere in the world (Shah and Lele 2011).



Bangladesh has tried to address the shortage of rice, but the surge in food prices has been crucial (World Bank 2010: 90). In 2007, three cyclones (respectively in July, September, and November) caused significant damage to the *aman* (main monsoon season, June to October) and *aus* (short season, April to May) rice crops. Due to these crop losses, the price of rice began to soar and caused panic in the rice market in the last quarter of 2007. Export restrictions in rice-exporting countries led to soaring world market prices and aggravated market instability. To make matters worse, India raised its minimum rice export price from \$425 per metric ton (October 2007) to \$1,000 per metric ton (March 2008). To counter this, the government and the private sector imported 1.7 million metric tons of rice and implemented a policy to stabilize rice prices. Efforts were made to raise food prices by adjusting rice purchase prices, supplying seeds, subsidizing chemical fertilizers, and increasing food storage to prepare for emergencies. However, the domestic price of rice had risen by more than 50%, leading to general price increases. Furthermore, efforts to supply high-quality seeds to increase domestic food production were also hampered. As a result, income growth stagnated due to deepening poverty in the country. In response to this food crisis, the Bangladesh government aimed to increase public food storage to 1.5 million metric tons.

In Nepal, in view of the 2007–2008 food crisis, as well as the country's low average per capita income level (\$320 in 2006) and high poverty rate (31%), the share of food purchases in household consumption is relatively high (World Bank 2010: 109). Further exacerbating the situation is the lack of a social safety net for food, the limited area of agricultural land, and low agricultural productivity. When the food crisis broke out, people in the mountainous areas of Nepal suffered the most. As such, there is a difference in the severity of the food crisis interregionally in that it has had a more severe impact on poor households. Considering the relatively long border between India and Nepal, there is active rice trade between the two countries. Thus, the price of rice in the two countries is highly correlated, and Nepal assumes the role of price taker. As a result, India's export restrictions on rice since October 2007 put an upward pressure on Nepal (World Bank 2010: 109).

In terms of ensuring food security, Nepal has prioritized improving its irrigation facilities to raise grain productivity, increase trade in diverse seeds with high yields in terms of inputs to increase food production, and expand the share of agriculture in gross domestic

product. Taking into consideration the serious food problems in mountainous areas, efforts are being made to increase accessibility in the northwestern region.

India was the least affected by the food crisis in 2007–2008. Domestic rice prices in India are less volatile than international prices, and the government is deeply involved in agriculture so that domestic food prices are relatively stable. By 2007, food prices in the international market had increased by 160%, while Indian wholesale prices rose by only 7.9%. This limited the impact of international market price increases on domestic consumers in India. However, India's agricultural growth rate is gradually decreasing, and countermeasures are needed. Like other South Asian countries, the average productivity of agriculture in India is quite low (Kumar, Mittal, and Hossain 2008). Milesi et al. (2010) asserted that the main reason for India's poor productivity in agriculture is "perverse agricultural policies and subsidy regimes" rather than climate change.

Investments in irrigation facilities and water management are essential, and efforts are needed to strengthen information and knowledge on climate change and its effects. In addition, there should be emphasis on strengthening research and development related to rice and wheat.

## Suggestions for Ensuring Food Security

Based on the above discussion, we plan to find ways to respond to a future food crisis. It is important to note that such a food crisis in the future is likely to be due to climate change. Increasing socioeconomic factors, such as population and income, as well as the decline of the agriculture sector also relate to climate change and can accelerate the food crisis. Climate change can trigger the occurrence of extreme meteorological events, such as average temperature rises, rising sea levels, floods, typhoons, and droughts. The result is a decrease in cultivated land, a decline in crop growth, and a shift in the main crop growth environment and crop yields. In particular, the low predictability of extreme events makes it difficult to prepare for a food crisis. In addition, past experience, particularly in 2007–2008, shows that food crises occur not only at the national level but also at the international level and that, furthermore, the impact is greater the lower the socioeconomic level.

Of foremost importance is governance. There need to be systems of governance to work on resolving food



crises among Asian countries or between the public and the private sectors within countries. The basis of the government’s role in the past food crisis was to expand the cultivated area, develop and disseminate high yielding seeds, and subsidize agriculture-related costs, such as oil and fertilizer. In addition, intergovernmental food aid organizations, such as APTERR, have been established to ensure international governance at all times. While the food price hike between 2007 and 2008 led to a food crisis in Asian countries, it also established an interstate system of countermeasures and compelled each country to establish policies and response measures. One resulting evaluation could be that the role of the countries that have suffered a food crisis and the manner of cooperation between the countries are structured in a formal way.

The solution for future food crises must be different from the existing solution. Instead of resolving the problem after a food crisis occurs, solving a climate change-related food crisis will require advance measures. In the following, the solutions to a food crisis are largely examined in terms of domestic, foreign, and technological aspects (Table 1).

As a preliminary countermeasure at the domestic level, one suggestion may be to expand investments in agriculture and irrigation projects. There is also a need to diversify the impact in the event of a shortage of specific crops through the diversification of food demand. Furthermore, various subsidies exist to prevent farmers from falling into poverty when a food crisis occurs, in addition to the free distribution of state stockpiles.

Proactive countermeasures at the international level include the institutionalization of the stockpiling of grain for free grants among countries. In Asia, APTERR is being implemented. Post-response measures could be to grant

aid between countries and mutual assistance in the export and import of grain or trade.

From a technical point of view, the development of agricultural technology (breeding improvement, fertilizer and pest-related technology, etc.), water management, and smart farming are suggested for improving crop yields. In addition, efforts to advance climate change research and forecasting techniques should be included. Following a food crisis, it is important to identify the problem by analyzing the size and variation of the impact of the food crisis. A further requirement is to share information and resources using a platform through which governments and the private sector can cooperate.

Finally, there needs to be general agreement in terms of food security as countries will be required to produce more food on a declining land farming area, with reduced water and labor resources and in the face of more variable weather and increased consumer demand for safe food. Hence, exploring new sources of food production and reducing the large amounts of food loss and waste are feasible solutions in order to enhance food production. In addition, food trade is crucial for ensuring the availability of food in all regions of the world (Teng and Oliveros 2015).

Climate change is a global phenomenon, but the impacts of related food crises are expected to be greater in Asia, particularly in the context of the region’s industrial structure, population structure, and food culture. In the long term, it will be necessary to actively and proactively respond to future food crises at the national and international levels. It is necessary to address food security in its broadest sense and integrate it in the development of agriculture worldwide. “Climate-smart agriculture” can be built up by improving technology and management systems to achieve global food security (Wheeler and Braun 2013).

**Table 1: Dimensions of Food Crisis Countermeasures**

Dimension	Proactive Measures	Post-response Measures
Domestic	Diversification of food, expansion of cultivation area, and increase in investments in agriculture and irrigation business	Agricultural subsidies, food purchases, and gratuitous distribution
International	Stockpiling of cereals through international organizations	Grant aid among countries and export and import of grain
Technology	Development of agricultural technology to improve crop yield (cultivar improvement, fertilizer and pest control, etc.), water management, smart farming, and research and technology to predict for climate change	Analysis of food crisis situation (influence, regional deviation, etc.), and platform for cooperation between government and private sector

Source: Compiled by the authors.

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