Chapter 9

Improving the Resilience of Regional Food Value Chains Against Climate Change and Natural Disasters

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January 2020

This chapter should be cited as

Anbumozhi, V. (2020), 'Improving the Resilience of Regional Food Value Chains Against Climate Change and Natural Disasters', in Breiling, M. and V. Anbumozhi (eds.), *Vulnerability of Agricultural Production Networks and Global Food Value Chains Due to Natural Disasters.* Jakarta, Indonesia: Economic Research Institute for ASEAN and East Asia, pp. 153-167.

CHAPTER 9

IMPROVING THE RESILIENCE OF REGIONAL FOOD VALUE CHAINS AGAINST CLIMATE CHANGE AND NATURAL DISASTERS

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Introduction

The general consensus amongst those in the research community is that agriculture is highly vulnerable to increased frequency, severity, and unpredictability of extreme weather-related events caused by climate change. On a global scale, various models predict the impact of climate change on different time scales. Although positive opportunities may arise for increased production in temperate countries due to carbon fertilisation effects, past and current research indicate that in the tropical Association of Southeast Asia Nations (ASEAN) countries, the net effect will be negative (ADB, 2009a; FAO, 2002; IPCC, 2007; USDA, 2012; Parry et al., 2004). For Asia, biophysical crop model results show yield reductions under climate change scenario compared to no climate change scenario. By 2050, the expected reduction of irrigated paddies is in the range of 14%–20%; irrigated wheat, 32%–44%; irrigated corn, 2%–5%; and irrigated soybean, 9%–18% (ADB, 2010). Within ASEAN, the differences may occur locally. It is very difficult to make exact predictions as available data at sub-national level and on other food and cash crops are scarce.

On the other hand, ASEAN is a highly disaster-prone region that experiences frequent climate-induced disasters such as floodings, typhoons, earthquakes, and tsunamis. In 1990–2011, the region experienced nearly 40% of the total of world natural disasters. In the same period, Asia's share of the total death toll from these climate-induced disasters was nearly 80%. Also, nearly 58% of natural disasters in Asia occur in the East Asia region. In particular, the Asian countries prone to natural disasters are Bangladesh (312 disasters), China (681), Hong Kong (103), India (604), Indonesia (412), Iran (193), Japan (291), Pakistan (166), the Philippines (529), Sri Lanka (81), Thailand (119), and Viet Nam (177). The average number of people exposed to yearly flooding more than doubled in

1970–2010, from 30 million to 64 million (Anbumozhi et al., 2011). Half a billion people live in rural areas. When disaster strikes, the impacts on them is devastating, affecting food production systems and value chains.

Vulnerabilities to climate change and other natural disasters constitute a set of interactions between society and food value chains. Research on vulnerability to disasters and adaptations to climate change is a major component of assessments conducted by Intergovernmental Panel on Climate Change, United Nations Framework Convention on Climate Change, United Nations Environment Program, International Geosphere-Biosphere Program, and many national and regional disaster risk reduction programmes. Southeast Asian economies are particularly vulnerable to current disasters and future climate change projections due to their physical geography and manifold economic and institutional challenges (Anbumozhi, 2015).

This paper is focused on the disaster risks and vulnerability in ASEAN. The next section of the paper provides ample evidence on vulnerability and assessment based on disaster and climate change scenarios. Section 3 provides analysis of climate change, disasters, and food value chain linkages, and discuss key uncertainties. Section 4 examines food security challenges in ASEAN and proposes a set of policy measures that can bring long-term stability to resilience to food value chain. Particular attention is given to the interplay between the technical and institutional changes needed. Section 5 examines how multi-dimensional integrated strategies can help reduce the vulnerability of food production network in a long-term sustainable way. The concluding section discusses some challenges and limitations in the proposed assessment frameworks.

Effects of Climate Change and Disasters to Fisheries and Aquaculture Production System

Many inland fisheries in ASEAN will be threatened by alterations to water regimes, reduced precipitation and greater evaporation, and indirect effects when more water is used for irrigation to offset reduced precipitation. Threats to aquaculture arise from increase in temperature, pH values, biochemical oxygen demand, increased frequency of diseases, sea level rise and salt water intrusions, and uncertain future supply of fishmeal and oils from capture fisheries (FAO, 2007). Table 1 projects changes in agriculture and decline in aquaculture production. However, Indonesia (11.1%), the Philippines (13.4%), Thailand (9.0%), and Viet Nam (10.0%) have projections for growth in aquaculture, which will be influenced by climate change. For these countries, in recent years, net export of fish generated more foreign exchange earnings than other agricultural products such as rice, coffee, and sugar. At the policy level, there is a need for increased cooperation and

flexibility in fishing agreements to cope with declining fishing stocks, as well as integration of fisheries into other national policies on climate change, food security, and trade.

This regional assessment of vulnerability of agricultural production to climate-induced disasters such as drought or flooding relies primarily on the global scenarios. It focuses on the physical aspects of risk such as land degradation and changes in productivity, and on impacts of availability of water resources to meet future needs. On the other hand, a considerable amount of economic research on global and regional environmental change suggests that the institutional aspects of vulnerability to hazards along the value chain represent another critical dimension of understanding vulnerability of food production and distribution system, and that this perspective shifts the focus proximate cause to reducing the causes of vulnerability. Such factors as economic choices, institutional capacity, and trade on agricultural commodities can be equally important as bio-physical impacts in identifying and defining the effects of disasters and the differentiated abilities of farmers and other population groups to adapt to changes. This emphasis on socio-economic dimensions of vulnerability along the value chain is particularly prominent in large-scale land use change assessments that define a vulnerability framework as a combination of exposure, sensitivity, and resilience components of physical-economical-human system.

Table 1: Effects of Climate Change on Agricultural Production in ASEAN

Mean Global Temperature Increase (°C)	Agriculture Production	Number
1.0	0.82	-0.12
1.3	0.0	-0.28
1.8	-0.82	-1.39
2.8	-1.58	-1.17
4.0	-2.62	-1.83
4.2	-2.78	-2.04
5.2	-4.78	-3.15

ASEAN = Association of Southeast Asian Nations

Source: Darwin, 2001.

Despite some methodological divergence between different approaches, the assessment of vulnerability along the value chain requires blending of top-down analysis motivated by climate change scenarios with location-specific risk analysis of vulnerabilities and options for resilience, in which both physical and socio-economic factors contribute to the spectrums of possible resilience choices. Monitoring changes in the physical environment is a necessary pre-condition for an assessment of effects of natural disasters, stressors, vulnerabilities, and adaptive capacities at most geographic scales. It is not sufficient, however, as sensitivity to stressor and the adaptation spectrum is strongly modulated by

economic and social factors. The case of regional food value chain is one example of this complex dynamic interactivity between bio-physical, economic, and social systems.

Climate Change, Disasters, and Regional Food Value Chains

Climate change and disasters have direct impact on intra-regional trade and food value chain. The total food supply of any country depends on production capacity, imports, and exports that generate income and foreign exchange to buy food. In this context, changes in food availability (due to climate change and other factors) in China and India (with markets of 2.8 billion people) will affect world prices, generating more or less capacity for any ASEAN country to obtain food on the global markets. When bio-physical impacts of climate change discussed in section 1 are integrated into the International Model for Policy Analysis on Agricultural commodities and Trade model, food prices increase sharply for key crops. Rice prices are projected to be 29%–37% higher in 2050 compared to a no-climate change; wheat prices, 81%–102%; corn 58%–97%; and soybean, 14%–49% (ADB, 2009b).

Table 2: ASEAN Rice Balance Sheet in 2015 (tonnes)

Country	Initial Stocks	Production	Domestic Utilisation	Imports	Exports
Brunei Darussalam	15,505	869	33,797	32,294	0
Cambodia	128,000	4,590,000	2,927,000	0	1,471,000
Indonesia	1,172,435	40,346,922	38,433,251	186,438	2,897
Lao PDR	30,169	1,820,750	1,764,642	n.a.	n.a.
Malaysia	275,899	1,585,708	2,531,159	1,094,419	n.a.
Myanmar	4,345,208	20,196,456	19,157,000	0	667,000
Philippines	2,638,287	10,737,201	13,163,706	1,638,314	159
Singapore	55,000	n.a.	262,000	280,000	33,000
Thailand	6,251,800	20,899,417	11,267,000	0	8,500,000
Viet Nam	5,680,101	25,282,075	18,327,996	0	5,950,000
ASEAN	20,592,404	125,449,397	107,867,551	3,231,465	16,624,056

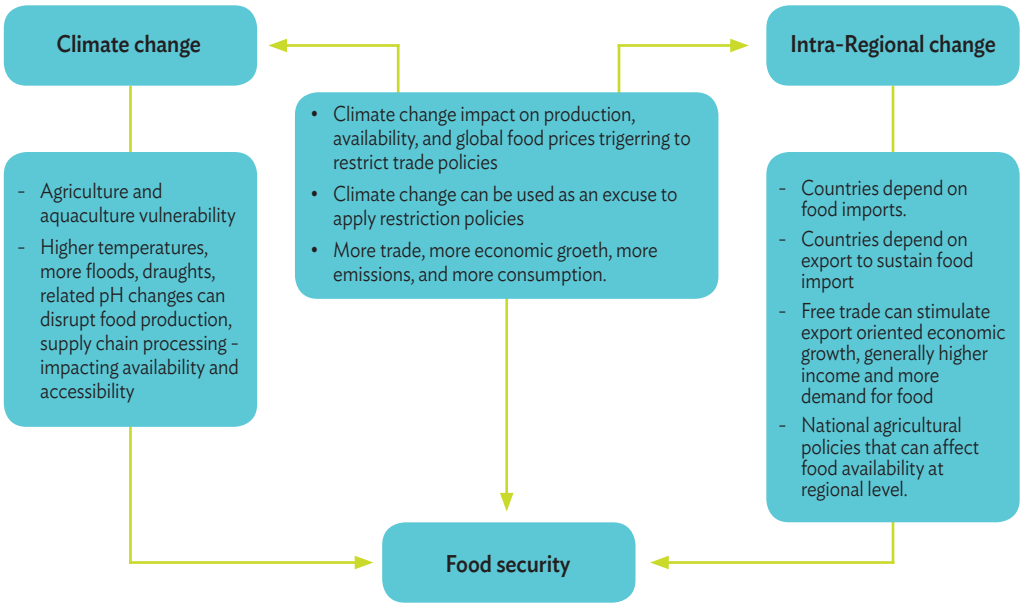
ASEAN = Association of Southeast Asian Nations, Lao PDR = Lao People's Democratic Republic.

Source: ASEAN Food Security Information System, 2016

Table 2 shows the rice balance sheet of ASEAN. The regional group houses the world's major rice-exporting countries (Thailand and Viet Nam), the major rice importers (Singapore, Indonesia, the Philippines), and the still agrarian countries (Lao PDR, Myanmar, and Cambodia). In the event of sharp increase in world prices, large exporting countries like Thailand and Viet Nam can impose export ban to bring stability and security

to the domestic market. Indeed, they invoked the agreement on agriculture within the World Trade Organization framework when the food crisis erupted in 2008. Nevertheless, it remains unclear how free trade restrictive measures can be reasonably implemented if the needs of neighbouring ASEAN countries that rely heavily on trade to ensure food stability under varying climate conditions are taken into consideration. These linkages are illustrated in Figure 1.

Figure 1: Climate Change, Trade, and Food Security Linkages



Source: Author.

In analysing the vulnerability of the regional food value chain, the identification of main areas of vulnerability and the most important transmission mechanisms need to be considered. In particular, three main macro areas of influence can be identified.

The first, impact to farmers, includes the economic costs and benefits and disruptions generated to the agricultural production system that produces the basic and intermediate food products. The second, impact to infrastructure, includes all the disruptions affecting the traders and infrastructure used for transport. The third, impact to consumers, includes all the direct and indirect costs and benefits generated on final consumers. Disaster and climate change events affecting one or more entities along the supply chain could generate impacts on other parts of the agricultural production network. For this reason, the main vulnerabilities of each of the components need to be analysed. However, since a multitude of different supply chain systems exist, the magnitude of damage and transmission mechanisms can be different based on value chain characteristics. In particular, some

of the most important factors determining disaster and climate change vulnerability of ASEAN food value chain can be identified as (i) complexity and dimension of stages and networks: when the food value chain is constituted by a large number of suppliers, the possibility of suffering negative impacts generated by disruptions is larger than in the case of small and local supply production system; (ii) concentration of supplier: the possibility of having different suppliers of the same commodity, e.g. rice, is an important element to increase the flexibility of the supply chain and to reduce the costs and the time of recovery after a disaster; and (iii) the magnitude of the impact, which is dependent on how and how much the agricultural commodity is susceptible to the effects of disasters and climate change. Resilience and adaptability or substitution between resources are important elements to determine the magnitude of impacts. Further, how resilient the supplying area is in coping with unexpected disaster events is also important. This is based on elements such as recovery, risk management, and governance.

Table 3 illustrates the policy response of ASEAN countries during the 2008 financial crisis. The cascading effects of domestic policy interventions affected the market conditions and changed the food value chain structure.

Food availability and access are mainly influenced not only by productivity variation but price changes as well. When combined with external shocks, climate change-induced disasters affect food manufacturing and trade. A limited number of analyses have specifically quantified the economic impacts related to food affordability, purchasing power, or prices during the disasters.

Table 3: Policy Responses of Selected ASEAN Countries to the 2008 Global Food Crisis

Policy Response	Cambodia	Indonesia	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Reduce import duties		X						
Increase supplies using reserves	X	X					X	
Build up reserves/ stockpiles	X		X		X	X	X	X
Increase imports/relax restrictions		X			X		X	X
Increase export duties								
Impose export restrictions	X							X
Price control/consumer subsidies	X	X	X		X		X	
Minimum support prices					X			X
Minimum export prices								
Subsidies to farmers					X			

Policy Response	Cambodia	Indonesia	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Promote self-sufficiency			X	X	X			
Cash transfers						X		
Food rationing		X			X			

ASEAN = Association of Southeast Asian Nations

Note: Cambodia, Thailand, and Viet Nam are considered to be net exporting countries, whereas Indonesia, Malaysia, Myanmar, the Philippines, and Singapore are net importing countries.

Source: Author.

Implications of ASEAN Food Value Chains Under Climate Change and Disaster Conditions

Climate change is already affecting food production and livelihoods of vulnerable, small-scale producers in ASEAN, and providing indication of challenges that lie ahead (ADB, 2009b). Although the relationship between trade along the value chain and food security is complex to understand, the available adaptation options (Table 3) are easy to grasp.

Table 4: Examples of Climate Change Adaptation Measures and Policy Options

Adaptation Measure	Policy Option
Near-term Actions (5-10 years)	
Crop insurance for risk coverage	Improved access to information, risk management, revised pricing incentives
Crop/livestock diversification to increase productivity and protect against diseases	Availability of extension services, financial support, etc.
Time adjustment of farm operations to reduce risks of crop damage	Extension services, pricing policies, etc.
Changes in cropping pattern, tillage practices	Extension services to support activities, policy adjustments
Modernisation of irrigation structures	Promotion of water saving technologies
Efficient water use	Water pricing reforms, clearly defined property rights
Risk diversification to withstand climate shocks	Employment opportunities in non-farm sectors
Food buffers for temporary relief	Food policy reforms
Redefining land use and tenure rights for investments	Legal reforms and enforcements
Medium-term Targets (2030)	
Development of crop and livestock technology adapted to climate stress: drought and heat tolerance, etc.	Agriculture research (cultivar, fish, and live stock trait development
Development of market efficiency	Investment in rural infrastructure, removal of market barriers, property rights, etc.
Irrigation and water resources consolidation	Investment by public and private sector
Promoting regional trade in stable commodities	Pricing and exchange rate policies
Improving early warning/forecasting mechanisms	Information and policy coordination across the sectors
Capacity building and institutional strengthening	Targeted reforms on existing institutions on agriculture and skills development

Source: Adopted from ADBI, 2012.

However, the above policy options should be seen from the fact that trade and climate change factors will continue to have implications for food security at the national and regional levels for ASEAN countries. Thus, policymakers need to increase their awareness of these issues (UNCTAD, 2011). Specific policy recommendations for ASEAN should include:

- A more precise assessment of local food production vulnerabilities to climate change is made for major agricultural trading crops and inland fish species. ASEAN economic integration or free trade efforts should be enhanced with the recognition that food security and climate change are interlinked cross-cutting issues. Buyers in importing countries should build longer-term and more stable relationships with suppliers in food-exporting countries to create the means to mitigate production volatility.
- National planning efforts should incorporate food security early warning systems, taking into consideration factors such as weather-related events at ASEAN level and potential external shocks coming from their major trading partners (ASEAN+5 countries).
- Long-term innovative financing plans should be developed to support adaptation actions at national level.

Developing 'no regret' adaptation measures and 'win-win' strategies in ASEAN requires careful balancing of long-term and short-term, proactive and reactive, planned and spontaneous adaptation options. In the context of the fragile agricultural eco-systems of Southeast Asia, already affected by human-induced land and water degradation, any short-term, unplanned, and reactive adaptation may provide an immediate solution for a limited group of population at risk but are likely to exacerbate the problem over longer term. Unfortunately, the history of natural resource management in ASEAN is replete with examples of short-term adaptation to disaster and climate vulnerability. For example, a study conducted in Indonesia showed that 49% of the respondents indicated that they wanted to leave their farmland because of severe drought in 2010 (ADBI, 2015). It is estimated that the number of displaced people due to flooding was more than 100,000 in Thailand in 2013 (Anbumozhi, 2015). The recent drought in Viet Nam that started in 2007 doubled the net emigration from over 3,000 to over 6,000 persons. The prospect for the long-term resolution of drought-related disasters remain doubtful in ASEAN as precipitation levels vary widely and trans-boundary water disputes preclude the upstream release of more water for downstream uses. Temporary labour migration from countries like Cambodia, Lao PDR, and Myanmar to Thailand is also very common, with about 10% of working-age agricultural population leaving home for industrial work every year (ILO, 2016). These migrants are usually individuals with skills, opportunity, and psychological aptitude in managing climate and disaster risks. The concern arises that the population left behind might have lower capacity, skills, and potential to respond effectively to disasters. To cope with multiple stresses in the context of increasing risks caused by

disasters, climate change, land use, and socio-economic changes of the past decades, ASEAN needs to develop and implement sustainable adaptive strategies.

Table 5: Triple Bottom Line Considerations for Assessing Adaptation for Building Resilient Food Supply Chains

Vulnerability Area	Agriculture and Food Security	Water Resources	Human Health
Adaptation sector			
Risks	Yield reduction due to drought	Higher evaporation; higher water consumption	Higher risk of malaria in irrigated areas caused by the longer transmission season
Adaptation measure	Changing the planting dates, and cultivar and irrigation method	Rehabilitation of existing irrigation systems	Use of pesticides
Triple Bottom Line criteria			
Environmental appropriateness	Minor or no environmental impact	Reduction of water loss; water pollution by pesticides	Negative impact on watershed ecosystems and health
Economic cost effectiveness	Cost effective, does not require additional investments	Increased water efficiency; significant investments are required	Relatively cost-effective; additional investments are required
Social acceptability	Acceptable	Reduction of water-related conflicts	May have adverse impact on health

Source: Author.

Successful adaptation to climate change, and disaster risk reduction in the context of continuous economic integration would require consideration of many environmental, economic, and social criteria. To be plausible, the resilience strategies along the value chain should be appropriate from a climate change perspective, cost-effective from economic perspective, and acceptable from socio-cultural perspective. In other words, adaptive strategies need to meet the triple bottom line criteria that place equal importance on environmental, social and, economic considerations. Table 4 illustrates how these criteria can help assist the assessment of potential adaptations. In this example, three sector-specific adaptation measures provide examples of how the triple bottom line criteria can be used to assess the suitability of each adaptive strategy.

It is obvious that development of almost any adaptation strategy along the value chain involves inevitable trade-offs. In fact, the potential trade-offs between the TBL criteria represent an objective limitation of sustainability of any adaptation option. As several impact assessment studies suggest, the risk of win–lose scenario caused by trade-offs can be reduced by incorporating minimum acceptability thresholds for each criterion into the TBL model and requiring that any adaptation initiative at least meets its minimum threshholds. At the regional scale, multi-objective multi-criteria evaluation algorithms based on geographic information system, such as ordered weighted averaging and

weighted linear combination, can be particularly useful for assessing potential risks and trade-offs involved in the TBL assessment of adaptation strategies and policy choices.

Supply Chain Logistics and Associated Disaster Risk Management Strategies

Adaptation at the farm level is necessary but not sufficient to tackle the wide array of problems that arise along the (global) food supply chains. Technical expertise, market power, and actionable knowledge of downstream actors such as processors, wholesalers, and retailers will play seminal role in facilitating the long-term co-investment needed to thwart climate change impacts on food security. It may be feasible to scale up local level adaptation to global supply chain assuming that other chains actors bring their capacities to the adaptation process. But this will require structural changes, in which adaptive measures are applied at critical spots of food value chains. Bringing about such changes requires a collective approach to assessing climate change impacts and adaptation options.

Because ASEAN food supply chains are complex and often informal, it is difficult for decision makers and it discourages them from taking part in collective targeted interventions (Anbumozhi et al., 2011). This also underlines the importance of more case study research analyses on specific food chains (rice, corn, shrimp, etc) to provide actionable recommendations for collective adaptation. The key factors for any food supply chains in ASEAN countries include crop impacts, the vulnerability of small producers (income, housing, road, education), supply chain characteristics (logistics–technology and finance), and behaviours along with institutions (economic operators).

To help farmers/producers build their adaptive capacity and deliver more resilient supply chains, the private sector should:

- Raise awareness and understanding of adaptation among suppliers/producers/retailers, drawing upon their market knowledge and technical capacity;
- Continuously ask producers/suppliers about current climate trends and impacts; and
- Work through existing institutions, including governments, to spread the risks to more sites by diversifying procurement.

Governments should:

- Provide a research support platform to share knowledge about crop and site-specific impacts and adaptation strategies;
- Improve physical infrastructure for irrigation, transportation, and marketing; and

- Offer business operators and farmers easier and more equitable access to financial instruments such as start-up investments and micro-financing to implement collective adaptation measures.

Adaptation measures and resilience strategies that are likely to be successful should target multiple aspects vulnerability and remain useful regardless of existing uncertainties about climate change projects and occurrence of high-impact low-frequency disasters. For example, diversifying agriculture and growing drought-tolerant legume crops and climate-resilient fruits and vegetables along with applying conservation tillage practices could increase food security while improving soiling through nitrogen fixation, decreasing water use, and reducing net carbon flux to the atmosphere. Replacing the existing network of open irrigation canals by more efficient irrigation system could significantly reduce evaporative loss while simultaneously improving crop productivity, reducing soil salinisation, and decreasing the risk of water contamination and transmission of vector-borne and water-borne diseases. However, such extensive rehabilitation of rural infrastructure would be expensive and would necessitate the large-scale introduction at farm level of technologically advanced management techniques. To be truly integrated, the interactions amongst the three bottom lines of impact assessment must be considered, since both positive and negative synergies may occur.

Developing early warning systems such as forecasts on droughts, floodings, pests, and diseases, and water quality monitoring systems should also be considered as an important strategy for improving resilience along the value chain. Such early warning systems should integrate surveillance systems and provide forecasts at sub-national scale to capture heterogeneity of risks and climate hazards across ASEAN.

Economic and social equity have been an enduring challenge along the food value chain in many parts of ASEAN. Economic inequalities amongst the regions and individual groups of farmers increase immediately after disasters. After disasters, several urban centres have shown positive increase in the quality of life, whereas in rural areas, the quality of life and food security and the level of health are profoundly poor and continue to deteriorate. Reduction of socio-economic vulnerability to disasters and climate change along the value chain can be only achieved through income distribution, effective business continuity plans formulation, and building resilient infrastructure.

Public education and communication of disaster risks to all groups of stakeholders, farmers, middlemen, business intermediaries, traders, and consumers are important components of long-term adaptive strategies. Education and public awareness, supplier technical assistance programmes, and climate advocacy can play an important role in the

recognition of existing links amongst economic and social components of vulnerability and the need for such integrated approach at ASEAN or national policies.

Enhancing Local-level Climate Change Adaptation and Disaster Resilience in ASEAN

A broad range of national needs and priorities exist across ASEAN member states. Generally, climate change and disaster risk are mainstreamed at the national level but the trickle down to the local level is very limited. Stakeholder consultations in many countries have highlighted the need for area-based pilots focusing on selected priorities. Amongst the aspects highlighted include the following:

- Not only agricultural and aquaculture but forest value chains in ASEAN are expected to be impacted by climate change and disasters, such as landslides. Hence, the aspect of carbon stock is of importance as carbon sinks. Disaster-coping strategies and adaptation practices for addressing climate change impacts on forests should be investigated by drawing on TBL method or modelling studies.
- There is much discussion on the issue of carbon credit mechanisms amongst some Southeast Asian countries. It has been identified as priority area for supply chain resilience, but local experts are limited. Building capacity in this area is needed, particularly on the aspects of securing income or incentives out of carbon credits that shall be used for building resilience along the value chain.
- Health is identified as a priority issue, particularly health problems in the aftermath of extreme events such as floods and droughts. For example, water-borne diseases, dengue fever, and malaria are common and have been projected to become worse according to the National Adaptation Program of Action. The capacity to model health impacts need to be enhanced in ASEAN.
- There was emphasis on the need to differentiate vulnerability to current climate and disaster risks and vulnerability to long-term climate risks, where both approaches are equally important. Methods are available for both approaches. Inherent vulnerability index may be suitable for short-term adaptation of agricultural development projects to current climate, i.e. water resource development, ecosystem-based adaptation approaches, etc. However, for long-term resilience, the use of vulnerability-index-based climate change scenario is more relevant.
- To effectively tackle the impact of disasters and climate change, the participation of local governments in supply chain resilience and climate change adaptation is important and necessary as they are the ultimate implementers. However, coordination at the national level is critical to make this happen. There are many changes in local

development planning, including mainstreaming of adaptation, allocation of resources, provision of local mandate, etc.

Variations in local conditions exist within a national boundary and this is where the problems need to tackled. In this regard, the need should be to select a specific area of high priority, e.g. a landscape or an ecosystem with a cluster of villages or a sub-basin within a watershed that may have a small landscape with communities, aquaculture farms, crops lands, plantations, water resources, etc. Within this specific area, both aspects of adaptation and mitigation of risks can be considered. Short-term risks can be handled via immediate adaptation programmes and policies that could integrate disaster risk reduction, where climate modelling outputs are optional. There is a need to identify climate extremes and hotspots that constitute pockets of highly vulnerable communities in various landscapes such as coastal areas, forests, watersheds, etc., so that adequate adaptation measures can be given priority. Long-term planning and long-term resilience programmes will require modelling. This can be handled using the same context- and area-specific approach. The benefits of the projects in facilitating learning and capacity building need to be emphasised in local communities. Establishing platform comprising academia and researchers to exchange information on good international practices and communicating with local leaders on continuous basis will be helpful. This could serve as the starting point for mobilising expertise from within ASEAN on a consortium basis to address regional needs and priories. This network, when linked with Asian Europe Network on Climate Science and Technology, will facilitate exchange of information amongst universities and other affiliated organisations in the region.

Conclusion

This paper has attempted to provide insights into how climate change is affecting agricultural production networks and value chain in ASEAN. Governments and the private sector can strengthen the adaptive capacity of producers and in doing so make their food value chain resilient. ASEAN is projected to become more vulnerable in the coming decades due to climate-induced disasters and integrated economic activities. These events are one of the most important elements influencing the efficiency of the present value chain and production networks. The increasing rate of unexpected and extensive disasters taking place along the food value chain make climate change a serious factor of concern in terms of food security, economic stability, and social welfare.

During the last decades, an increasing number of studies have investigated the main elements of disaster risks and vulnerability in the ASEAN region. The largest part of the studies focused on the main direct impacts generated in a specific sector or in a specific

geographical area. This paper analysed the overall vulnerability of the supply chain and its impact on socio-economic systems. A good understanding of the most vulnerable entities is in fact a fundamental step to avoid, reduce, and mitigate the potential costs of disasters. A combination of climate modelling, date, and intra-regional and intra-sectoral analysis are the fundamental elements needed for the assessment of risks. However, lack of database on adaptation options and assessment of trade-offs make it difficult to determine cascading effects resulting from the disruption of regional food value chain. In general terms, a wide data gap exists in ASEAN countries where climate change and disaster-related events are expected to generate the biggest catastrophic impacts. In addition, the lack of updated and detailed information covering the trade links between economic sectors and geographical areas is one of main limits for the quantification of benefits of recommended adaptation measures along the value chain. Much more research is needed on how countries and companies can best invest in building adaptive capacity along the entire value chain of food-importing countries of ASEAN. They are often one step removed from primary production and thus from focus of policy research. Furthermore, many small-scale producers do not form part of global supply chain. Subsistence farmers have small surpluses to sell in the local markets. It is thus the primary role of individual governments to bring them at the core of addressing climate change and food security issue, while ASEAN as a community must ensure that they have appropriate knowledge, technology, and financial resources to increase their productivity, and stay connected to global markets. Governments and the private sector should take key steps to support them in their value chain rather than leaving them bear disproportionately the cost of climate change.

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