FOOD SECURITY IN ASEAN AND CLIMATE CHANGE

AN ASSESSMENT OF VULNERABILITIES OF STAPLE FOOD CROPS IN ASEAN MEMBER STATES

-DRAFT-

Authors:
-CCROM - Center for climate risk and opportunity management
in SE Asia and Pacific
-ABL - Alexander Ballard Ltd.
-GAP-CC - ASEAN-German Programme on Response to Climate Change

Draft 5.6.2013

Contents

1 Introduction

Food security has long been an important agenda of ASEAN. In response to the high fluctuation in international food prices experienced in 2007 and 2008 coupled by the financial crisis in 2008, ASEAN needed to take a strategic and comprehensive approach towards long-term food security in the region. To ensure long-term food security and to improve the livelihoods of farmers in the ASEAN region, ASEAN Leaders adopted the ASEAN Integrated Food Security (AIFS) Framework in order to provide scope and joint pragmatic approaches for cooperation among ASEAN Member States.

Southeast Asia is one of the world's most vulnerable regions to climate change, due to its long coastlines, high concentration of population and economic activity in coastal areas, and heavy reliance on agriculture, fisheries, forestry and other natural resources. Due to its geological and geographical factors, the region is also one of the world's vulnerable regions to suffer from a range of climatic and natural hazards such as earthquakes, typhoons, sea level rise, volcanic eruptions, droughts, heat waves and tsunamis which are becoming more frequent and severe. The threat of climate change to environment and economic development has is a priority to ASEAN as the agriculture and forestry sectors are highly vulnerable to climate change. To address the issues of climate change to food security, the region has developed the ASEAN Multi-Sectoral Framework on Climate Change (AFCC): Agriculture and Forestry towards Food Security to address the impact of climate change to the agriculture and forestry sector.

The objective of the AFCC is to contribute to food security through sustainable, efficient and effective use of land, forest, water and aquatic resources by minimizing the risks and impacts of and the contributions to climate change. To achieve the overall goal of the framework, the following objectives are considered: (1) coordination on the development of adaptation and mitigation strategies; and (2) cooperation on the implementation of integrated adaptation and mitigation measures. To achieve these objectives, ASEAN established a close partnership and cooperation arrangement with international organisations, such as by commissioning the ASEAN-German Programme on Response to Climate Change (GAP-CC).

GAP-CC supports ASEAN in advancing the formulation and implementation of regionally coordinated strategies and policies for food security and climate change within its Member States. It aims to channel lessons and experience from individual country action into the work of the regional organisation and vice-versa. One focus area of GAP-CC is to support Senior Officials Meeting of the ASEAN Ministers of Agriculture and Forestry (SOM-AMAF) to agree on (i) priority value chains and (ii) countries and regions which are particularly vulnerable to climate change and where adaptation is of high priority, and on key elements of support strategies and their financing. This scoping study was therefore conducted to enable ASEAN to prioritize the sectors (commodities)/regions most vulnerable to the impacts of climate change. Once prioritization has been made, GAP-CC within the context of the AFCC and together with relevant ASEAN and Member State support, will do a more detailed assessment of the selected food sectors and countries, in order to identify capacity needs, adaptation options and their financing.

The objective of this study is to provide ASEAN with a framework and methodology to identify commodities integral to current and future food security. The study looks at vulnerabilities to assess which factors including climate change contribute to the vulnerability of the major food staples in the ASEAN member states. This complex issue should be well understood to ensure sound policies are developed and decisions taken at a regional aligned with policies and institutional frameworks in place to effectively address and adapt to the climate change impact on food security system within ASEAN. This study aims to support ASEAN decision makers in prioritizing food products integral to food security in the region and assessing their vulnerability to factors including climate change. Furthermore, it highlights what common problems are faced by the member states, the capacity needs in addressing climate change and food security problems and challenges.

Hence the aim of the study is to

(1) Provide ASEAN with a framework to identify commodities integral to current and future food security. This framework is a model that can be used across sectors / countries or within a sector / country.
(2) Assess the vulnerability of each ASEAN country and identify what factors contribute to the vulnerability
(3) Provide recommendation on possible area of intervention for ASEAN at both regional and national level and to effectively prioritize adaptation programs and policies

The scoping study aims to serve the ASEAN working groups and sectoral bodies as a supporting document to make an informed choice prioritizing food products and countries which are integral to food security and particularly vulnerable to climate change. Furthermore, the study defines key recommendation for SOM-AMAF on possible areas of intervention that can be taken by ASEAN - both at regional and national level.

2 Methodology

The actual definition of food security according to FAO is the following: "Availability and accessibility of food by people at all time to meet their dietary needs and food preferences for an active and healthy life". Among all traditional influencing factors, climate change has been considered an additional important factor affecting food security. This study provides an assessment of the vulnerability of food systems of the ASEAN countries and the additional influence of climate change. For this purpose an ASEAN food security index is built, looking at available data[1] on ASEAN level and assessing the relative food security of the ASEAN states compared to each other[2]. It consists of a production index, a consumption index and a distribution index, each one composed of selected indicators. This ASEAN food security index provides a regional overview using regionally comparable data of individual member states, to allow ASEAN to make an informed decision on prioritization of sectors integral to food security and impacts of climate change of the ASEAN region as a whole and provides recommendations of intervention and support areas. A detailed look into this manifold data, for example through country specific spider diagrams, can give valuable advice on possible interventions on national and regional level. The study consists of the following phases.

2.1 Phase 1 - Initial Prioritization Process and Identification of Vulnerable Value Chains

The indicators used to define the three components and building the index are presented in the following Table 2-1. Indicators of the three components are transformed into three indices on production, consumption and distribution using the following formula. Higher weight is given to indicators with higher and direct impact on the components:

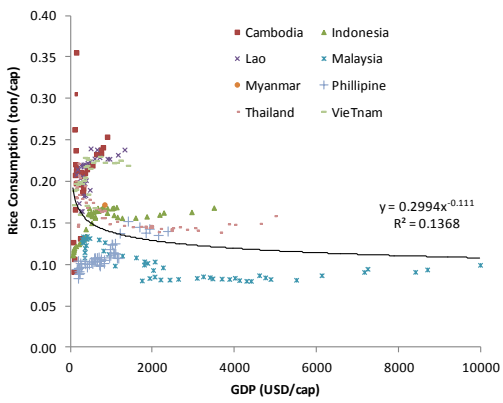
$F = \sum w_i * I_i$ (where w_i is the weight of indicator-i^{th} of the component and I_i is value of the indicator-i^{th}.)

The projection until 2030 without considering climate change entails a rapid increase in population which will lead to increasing food consumption, which will again threaten food security if it is not balanced by increased production. Countries that have better capacity to increase their production, to minimize and diversify their food consumption and to develop a good distribution system will be less vulnerable to food insecurity.

The future projection is based on two different scenarios (see Annex 1 for details on assumptions):

-Scenario A '*optimistic scenario*' basically follows a business as usual approach, most indicators of production are projected based on projection factor from various studies and based on historic development and indicators of consumption changes following the changes of country's GDP. Most of consumption indicators have significant relationship with the GDP (see Box 1).

Box 1. Relationship between rice consumption/cap and GDP in ASEAN Countries



Rice consumption per capita in ASEAN countries such as Philippines, Indonesia, Myammar, tend to increase when the GDP is still below 4,000 USD/cap. In some countries such as Indonesia and Philippines, rapid increase in rice consumption occurred when GDP per capita was still below 2,000 USD/cap.

Scenario B a more '*realistic scenario*' can be considered more realistic as a number of indicators such as irrigated area, harvested area and growth of yield are adjusted to more realistic conditions due to limitations (e.g. increase of irrigation area is very limited due to water scarcity for supply).

[1] Data source for production and consumption indicators are mainly FAO (faostat.fao.org), Mundi Index (www.indexmundi.com), Word Bank Metadata (http://data.worldbank.org/country) and ADBI (2012), distribution indicators are from CIA Database (www.cia.gov).

[2] Singapore and Brunei were excluded as they both are importing countries of agricultural products and their GDP is also significantly different from other ASEAN countries. So even not much production in the country, it has a very high capacity to import.

The distribution indicators are kept constant in both scenarios as the distribution index is only used to indicate relative condition of distribution systems across the countries at present.

Table 2-1: Indicators used for representing the production, consumption and distribution component of the food system

Components/Indicators	**Description, what does it represent?**
Production Component: *all indicators reflect capacity of the countries in producing the staples. Countries that have high value for all the indicators with exception 'yield loss after harvesting', will have a more productive production system (the higher the better).*	
P1: Ratio of harvested area to arable land	Actual planting intensity of the staples ***
P2: Ratio of irrigated area to arable land	Actual irrigation capacity and potential for increasing planting intensity***
P3: Ratio of forested area to the total land	Condition to ensure sustainability of water supply for agriculture***
P4: Growth of harvested area	Historical and thus potential future capacity to improve planting intensity*
P5: Ratio of yield gap to potential yield	Level of actual yield*
P6: Yield	Level of crop productivity***
P7: Growth of yield	Historical and thus potential future capacity to improve productivity*
P8: Yield loss after harvesting (% of yield)	Yield loss after harvesting adapted from various studies as % of yield*** [3]
P9: Per capita GDP	Capacity to import staple if production doesn't match consumption level **
Consumption Component: *Indicators represent the level of countries' consumption. Thus countries that have high value for all the indicators will have more vulnerable consumption system (the lower the better).*	
C1: Ratio of consumption to food crops	Level of food diversity, reliance on this specific staple** [4]
C2: Ratio of population to arable land	Availability of land to meet the food demand*
C3: Per capita consumption	Level of staple consumption***
C4: Prevalence of undernourishment	Capacity to meet food demand*
C5: Ratio of poverty to total population	Purchasing power of people to access food***
C6: Ratio of wheat consumption to three commodities in the analysis (to explain the dependency to imported crops i.e. wheat)	Dependency on imported food and importance of imported commodity to meet carbohydrate diets **
C7: Ratio of consumption to production	Reflects the self-sufficiency of country to the respective staple food***
Distribution Component: *Indicators on data about transportation and communication infrastructure (the higher the better). If adequate amount of food from production and import are not distributed well, food security will still be threatened.*	
D1: Ratio of number of airports to total land	Condition of transportation system is needed to ensure safe and timely distribution of food***
D2: Ratio of railways length to total land	
D3: Ratio of paved ways length to total land	
D4: Ratio of unpaved ways length to total land**	
D5: Ratio of waterways to total land	
D6: Telephone lines per 100 population	Condition of communication system is needed to ensure timely information on food situation*
D7: Mobile cellular subscription per 100 population	
D8: Internet user per 100 population	
D9: Secure internet servers per 1 million population	

Note: *** Indicators with higher and direct impact on the components, **medium and * with lowest and indirect impact on the components. All the indicator values were normalized based on the distribution of the data across ASEAN countries. The normalized data will have value between 0 and 1. Indicators that have higher and direct impact will have higher weights. The weights may be changed depending on the view of the analyst in assessing relative importance of the indicators in influencing the systems. Ideally the weights can be defined through stakeholder process and consultation with related experts.

[3] Note: In the analysis, this value is converted to (100-% yield loss), thus it has the same impact as other indicators to the production system, i.e. the higher the better.

[4] Note: For rice, the lower the better but for maize and cassava, the higher the better as they indicates food diversity improvement. Thus, for maize and cassava, this value is converted to (1-ratio) to make them have the same impact as other indicators to the consumption system, i.e. the lower the better

Assessment of main factors in each component causing vulnerability of a country is based on the web diagrams (See Figure 2-1 for the example of web diagram).

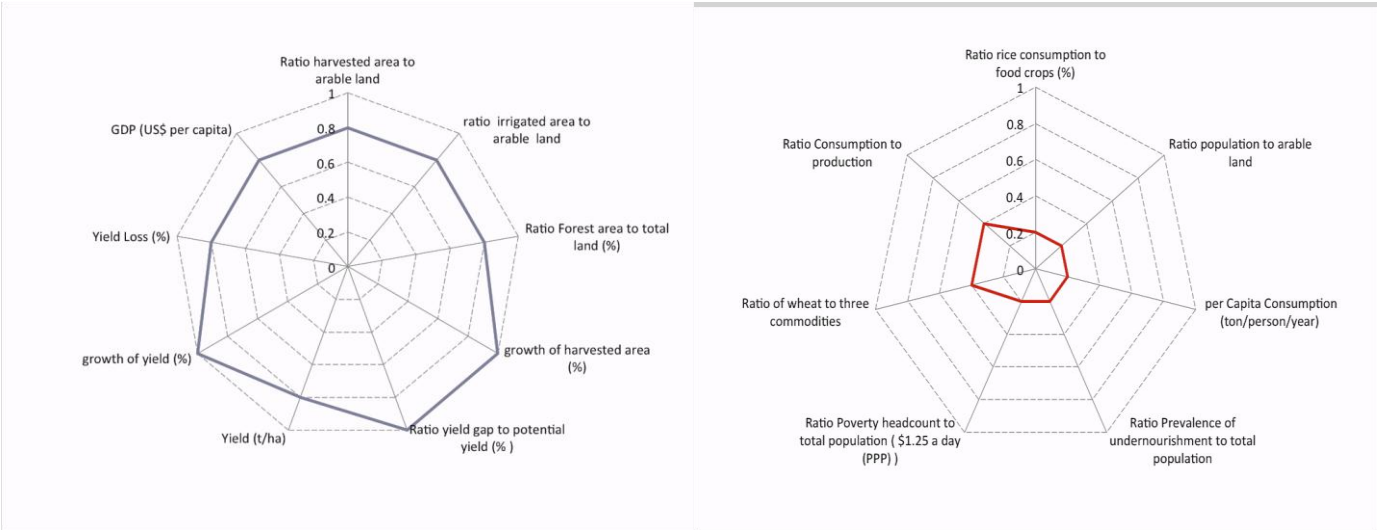


Figure 2-1: Idealized spider diagram showing the condition of indicators representing the production (left) and consumption indices (right). The larger the production spider is, the more food secure a country is, whereas for the consumption spider, this is the reverse.

The relative position of the countries in term of their vulnerability to food insecurity is presented in quadrant system, with production on the x-axis and consumption on the y-axis and distribution index as additional info (B - below, M – medium, G - good) indicating the distribution index compared with ASEAN average.

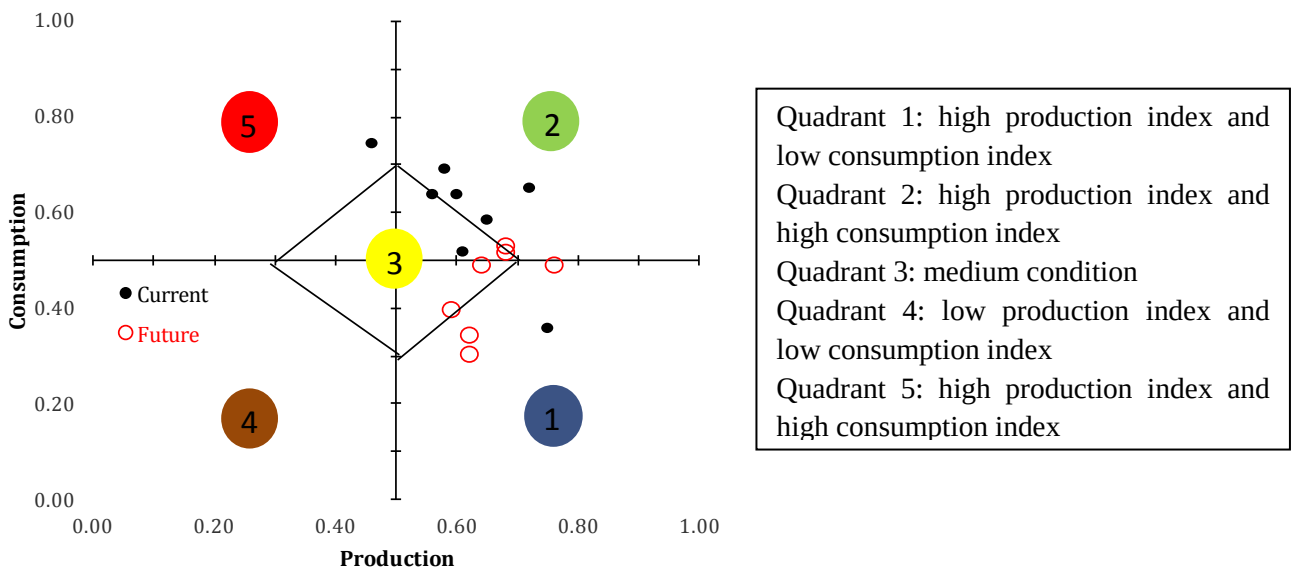


Figure 2-2: Quadrant system to present the relative position of countries in the context of production and consumption.

Lastly an important aspect to consider in the context of food security and climate change is the gender dimension which significantly affects the processes of production, consumption and distribution. Women actually play a pivotal role in all three components of food security, especially at micro (household) level (UNDP, 2012; AFA, 2009; FAO, 2002; Quisumbing, 1999).

FAO (2002) reported that women are involved in every stage of food production. However, the major shares are in sowing, weeding, fertilizing and harvesting. In the development of agriculture sector, women are also leading the crop domestication. Although the contributions vary by region, age, ethnicity and social status but women farmers generally have valuable knowledge in seed selection, vegetative propagation and the reproduction of plants (UNDP,

2012). In the rural areas of developing countries household usually produce most of the food for their own consumption and here the crop domestication by women is started. For example in the highland areas of Philippines where usually are known as vegetable production centers, Lu (2010) highlighted the role of women, which is not merely complementary to the work of men but have a large share of labor ranging from the land clearing, pesticide and fertilizer application up to harvesting and trading. Other studies like Garcia (2004) added that about 50% of rural women in the Philippines are classified as economically active with significant role in cash crop production and small livestock rearing. Other study reported that women in Indonesia devote 30-50% of their workday undertaking the productive work (AFA, 2009). Home garden by women in Indonesia is also dominant. It contributes to the 40% of domestic food supply and 20% increase of household income.

Further, the role of women is not limited to micro (household) level agriculture but also in the commercialized agriculture. FAO (2002) indicates world's average data that 20% of farms is headed by a woman. However, in Asia the percentage of farm holding headed by women is only about 6%, rather lower than other regions like Africa or Latin America. Unfortunately the "head of holding" is not necessarily defined as the "head of household". In 103 countries out of 141 countries worldwide, there are legal differences between men and women (UNDP, 2012). This may hinder women's economic opportunities such as access to credit. Men are more legally recognized even women are responsible for the day-to-day works and decisions of running the farms. If both men and women were given the same access to resources such as finance/credits, women's agriculture yield could increase by 20-30%, national agriculture production could rise by 2.5 – 4% and the number of malnourished population could be reduced by 12-17% (FAO, 2011).

In the context of consumption, a growing number of studies on gender and agriculture reported that improvements of household welfare depend not only on the level of household income but also on who earns the income. Quisumbing (1999) reported that women's income are more strongly associated with improvements in nutritional status and food consumption in the family than are men's income. This indicates a positive relation of women's income on food security, even in general women's incomes are lower that men's e.g a study in Indonesia classified households into four categories and the proportion of women headed households is the highest among the poorest category of household (FAO, 2002). Women are assigned as the "family keeper" by social and cultural norms. This inflicts their responsibility to ensure that household members, especially children receive adequate amount of food.

In addition to the major roles in production and consumption, women are also in favor of food access and distribution. Women's role in distribution mainly refers to acquiring appropriate food or nutritious diet for the family and also selling the agricultural products to the market (CGIAR, 2012).
Limitations:
Despite the concerted efforts to learn about gender dimension in food security, there were limited conclusions to be drawn. We understand different roles of men and women in production, harvesting, storage, processing, distribution and consumption of the food supply chains and that these may differ within and between countries. However so far we do not have sufficient comparable data to be able to integrate this issue in the quantitative analysis.

2.2 Phase 2 -Assessing Future Vulnerability considering Climate Variability and Climate Change

Additional to the two scenarios with 2030 prediction, in a second step the influence of climate variability and climate change is integrated, as it will affect future food security directly and indirectly. Direct impacts are mainly on crop production and distribution systems. While they are considered for the production component as depicted in Table 2.2, impacts on the distribution component (e.g. damage in road infrastructure and communication system due to extreme weather events) could not be integrated due to lack of data.

Indirect impacts are mainly on the production component and include for example change on severity of pest and diseases, damage of irrigation infrastructure etc. Indirect impacts on food consumption are also included in the sense

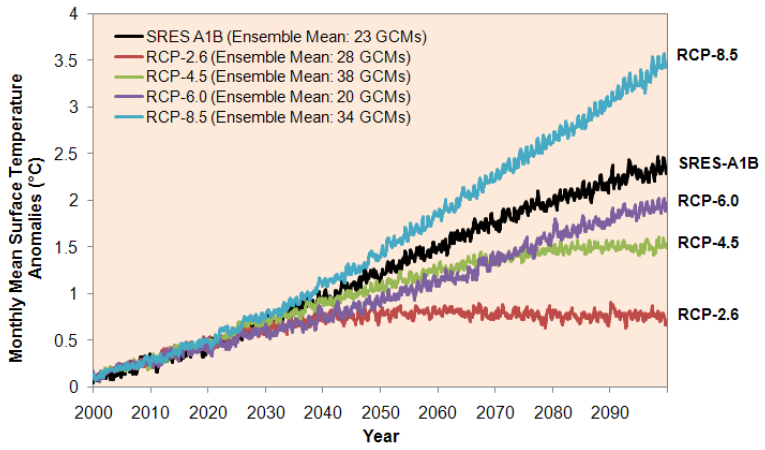
that climate change (climate hazards) will reduce GDP, which also eventually influence the calorie intake and consumption behavior (see Box 1).

Table 2.2: Direct impacts: Continuous, discontinuous and permanent impact of climate change

Continuous impacts are mainly on crop yield due to changes in temperature, length of seasons, salt intrusion and increasing concentration of CO_2 in the atmosphere.	**Discontinuous impact** resulted from the increasing of extreme weather events, which lead to the increasing of crop failures.	**Permanent impact** is the irreversible conditions caused by climate change, e.g. the loss of arable land in the coastal areas due to sea level rise.
Included but only part of continuous impact of climate change, i.e. direct impact on yield due to change in average temperature and rainfall. Impact on the change of season that would directly affect the planting intensity was not included due to limited number of studies in this area for regionally comparable data, and also indirect impact of this on the change of pest and diseases severity. Current experience in the ASEAN region shows how volatile the climate is in ranging above and below the average both within seasons and between seasons. Changes in average, even if small, are expected to also increase the volatility either side of the average. This volatility cannot yet be captured by the data and so is not factored into these findings. It is also worth noting that the averages for each country do not yet reflect the wide variation of conditions and vulnerability within the ASEAN Member States. This study use two climate change scenarios, namely SRES A2 (high emission scenario) and SRES B1 (low emission scenario).	Basically included but without changes in frequency nor intensity as there are no studies with regional comparable data that can be used as basis for making projection of present observation of main disasters (flood, drought, storm, landslide, and forest fire) into the future. However a number of studies suggested that impact of global warming on the change in intensity and frequency of extreme climate would be significant in the long term (year 2100). Thus, within the period of 2010-2030, the global warming might not drastically change the intensity and frequency of extreme climate events. However, slight change in frequency (e.g. an event with return period 30 year could change into 20 year return period) and intensity in extreme events within the timeframe '2030' may have significant impact on agriculture. However, basis and data for including these factors are still lacking. Therefore these changes were not taken into account in the quantitative analysis	Not included, due to lack of regionally comparable data. The increase of sea level within the timeframe 2010-2030 would not significantly result in permanent inundation of agriculture land in ASEAN countries, However this may worsen the salinity problem ('*continuous impact*') which results in yield reduction. In addition, low increase in SLR within the timeframe of the study may increase the probability of the coastal areas to be exposed to damaging storm surge ('*discontinuous impact*'). These potential impacts were also excluded due to limited information available for the across all ASEAN countries.
Masutomi *et al.* (2009) for rice, Rosenzweig and Iglesias and Zhu and Syhimete (*2010*) for maize and cassava respectively.	Present climate hazards were adapted from Gupta *et al.* (2010)	
Data For Long Term Decisions The assumptions being used for these 2030 forecasts make clear that the climate in 2030 will be different from that in 2100. Many of the longer term decisions that need to be made during the period to 2030 e.g. major infrastructure impacting on food security will need to consider the impact of climate over the life of those decisions (from current to future climate change impacts).		

Continuous impacts: Studies on the continuous impact of climate change on crop production are multiple. The studies range from global to local level. Continous impacts are mainly through the changes in temperature, rainfall intensity, the onset and length of seasons, salt intrusion and increasing concentration of CO_2 in the atmosphere. For allowing fair comparison across ASEAN countries in assessing continuous impact of climate change, this study use global studies from Masutomi *et al.* (2009), Rosenzweig and Iglesias who applied the same methodology across countries. Both studies assessed the impact of changes in average temperature and fertilization from increasing CO_2 concentration in the atmosphere on crop yield. Within the timeframe of 2010-2030, Masutomi *et al.* (2009) found that the impact of climate change under high (SRES A2) and low emission scenarios (SRES B1) on rice yield were not so significant. Impact of different emission scenarios will be significant in the long term.

Box 2. Projection of mean temperature over Indonesia



Projection of mean monthly air temperature over Indonesia (11 °LS – 6 °LU, 95 °BT – 141 °BT) based on projection of AR4 (scenario SRES-A1B) and that of AR5 (scenarios RCP-2.6, RCP-4.5, RCP-6.0 dan RCP-8.5) (Analyzed from CMIP3 and CMIP5 by Faqih, 2013).

Masutomi *et al.* (2009) found that the change in rice yield across ASEAN countries due to continuous impact of climate change ranges from +1.5% to -2.3%. This estimate is not much different from some other studies for example Mathauda *et al.* (2000). With slight temperature increase of about 0.5°C, the rice yield decrease is about 3.2%. Within the time frame of this study (2010-2030), the temperature increase from 2010 would be about 0.5°C (see Box 2). Furthermore, Easterling *et al*. (2007) estimated that the continuous impact of climate change on rice yield in tropical countries due to temperature increase of less than 1°C is only about -2%. FAO (2011) also predict the rice yield decrease in Vietnam (Mekong river delta) in 2020 would be between -0.25% and -3.71%. In 2050, rice yield decrease due to global warming is expected to increase to between -1.71% and -12.48%. It is clear that in the long term the effect can really be much worse than what we look at until 2030.

Other important continuous impact of climate change on agriculture is the change of the monsoon onset and length of rainy season. This will hinder the opportunity to improve planting intensity in the future. For example, Naylor *et al.* (2007) projected that global warming would increase probability of monsoon delay and changes in the annual cycle of rainfall in Java-Bali main rice growing area of Indonesia. They found there would be a significant increase in probability of a 30-day delay in monsoon onset in 2050 for these islands. A 30-day delay in monsoon onset would reduce planting area for the rainy season and this could potentially reduce rice production in Java and Bali up to 14%. The impact of the global warming on season length could be opposite to what would happen in Java and Bali. Taking this impact into the analysis will required detail information on how the change of the season would be and where this change would take place whether in agriculture production centre or not. In this study, this impact was also excluded. **Thus the continuous impact of climate change on rice yield used in this study might be underestimated. Adjustment is required in the further study as the data becomes available.** Likewise, we have not been able to factor in the fact that local experts in adaptation are reporting that extreme weather events are occurring in places where historically they did not. These extremes and shifts in weather patterns have significant implications for developing the human capacity to address them. Human capacity to be able addresses the extremes of climate wherever they occur is crucial. Human capacity development is dealt with separately in Chapter 3.2. of this report Indications from regional experts in the field are also reporting that farming practices are already changing in response to changes in climate patterns (e.g. cropping calendars are already being adapted to accommodate these changes).

In addition, the increase in temperature and the changes in rainfall pattern and length of seasons may also trigger the development of crop pests and diseases. For example, in Indonesia BPH (Brown Plant Hopper) population normally increases when rainfall in the transitional season increases compared to normal (MoE, 2007). The changes in cropping patterns as part of adaptation efforts to climate change may also alter crop pests and diseases problems in the regions. Invasion of new varieties of pests and diseases may likely occur in a changing climate. In addition, change in temperature and rainfall may also change the domination of certain crop pest and diseases (Wiyono, 2007). Field observations in a number of districts of Java-Indonesia such as Indramayu, Magelang, Semarang, Boyolali, Kulonprogo, and Ciamis provide the evidence of this phenomena (Nastari Bogor and Klinik Tanaman IPB, 2007). **This indirect impact of climate change was not taken into account in this analysis.**

Discontinous impacts: All of ASEAN countries at present are already exposed to climate related disaster, particuarly storms, floods, drought, forest fires and landslides. The most prevalent climate disasters vary across ASEAN countries. Storms is the main climate hazard in Phillipines and Vietnam, while floods are common in all countries (Figure 3.5). Based on 40 years disaster data (1970-2009), Gupta (2010) estimated mean annual economic losses due to these five climate hazards in all ASEAN countries vary from 23 to 543 million USD which are equivalent to GDP loss of between 0.02% to 0.50% (Figure 2.3). The loss mainly came from crop failures and damages of infrastructure. A number of other studies suggested that most of the losses came from the agriculture sector. Based on historical data from Indonesia (1989-2010) and Laoss (1991-2011), the mean annual area affected by storm/flood and drought reached 293,772 ha and 42,636 ha respectively. While in Malaysia, it was reported that the mean annual economic loss due to flood on reached about 100 million RM (Loi, 1996). Using the current price of rice (241 USD/ton) and mean rice yield in Malaysia (4.07 ton/ha), we can estimated the total area affected by the flood based on the economic loss data, i.e. about 35,342 ha. Using this approach we used Gupta's study to estimate affected area by the five climate hazards in all ASEAN countries as depicted in Table 3.1. A comparison with reported data shows that the approach performs reasonably well (Table 3.1).

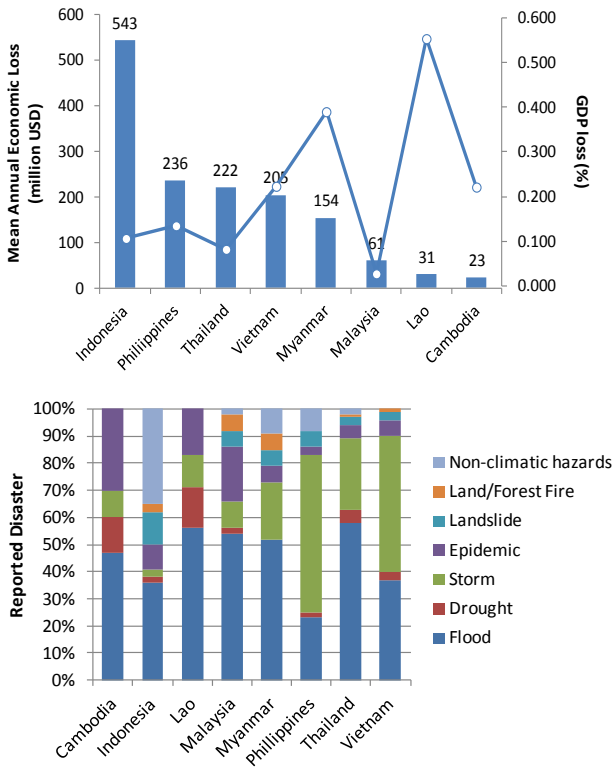


Figure 2.3. Natural disaster (left) and mean annual economic and GDP loss due to five climate related hazards (storm, flood, land slide, drought and fire) in eight ASEAN countries

Table 3.1. Comparison between estimated mean annual damaged rice area and observed data

Country	Mean estimated damaged area (ha/year)[1]	Reported data storm/flood and drought (ha/year)	Difference (%)
Cambodia	35,878	N.A	N.A
Indonesia	337,790	293,772	14.98
Laos'PDR	42,546	42,636	0.21
Malaysia	44,545	35,242[2]	26.40
Myanmar	272,746	N.A	N.A
Philippine	103,532	N.A	N.A
Thailand	159,988	N.A	N.A
Vietnam	90,186	N.A	N.A

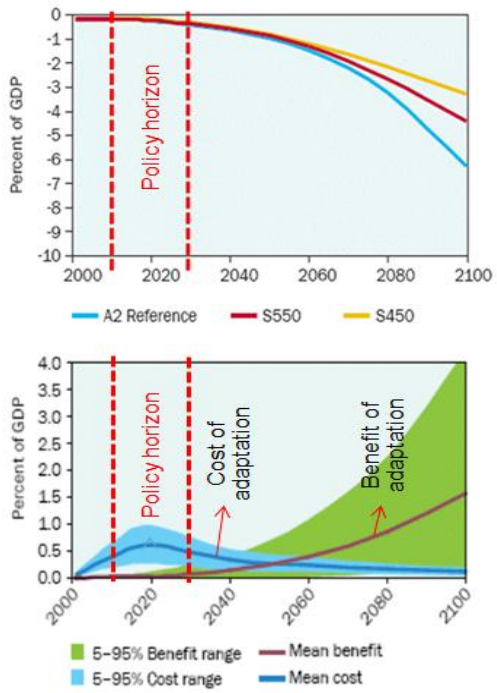
[1]This includes damages due to storms, flood, drought, land slide and fire. [2]Drought is excluded. In all ASEAN countries, major climate hazards causing most of the economic lost is storm and flood.

Many studies estimated that global warming may increase the frequency and intensity of extreme weather events. Knutson *et al.* (2010) predicted that greenhouse warming would cause the globally averaged intensity of tropical cyclones to shift towards stronger storms, with intensity increases of 2–11% by 2100. However, many modelling studies consistently project decreases in the globally averaged frequency of tropical cyclones, by 6–34%. Thus, global warming would substantially increase the frequency of the most intense cyclones. It was predicted that the precipitation rate within 100 km of the storm centre would increase in the order of 20% from the current. The change in the intensity of the tropical cyclones would have severe impact on Philippines, Vietnam, Laos, Myanmar and Thailand. Philippines will be the most affected country. **Projection of increasing intensity and frequency of disasters due to climate change is however in the long term (i.e. 2100), while the time frame of our analysis is only 2010-2030 and these effects could not be considered quantitatively**. The magnitude change of global temperature within this time frame may not cause a drastic change in the tropical cyclone.

Extreme weather events associated ENSO (El Nino Southern Oscillation) has also been predicted to increase due to the global warming. This has also been observed by Timmerman *et al.* (1999) from Max Planck Institute who notes that greenhouse forcing and the warmer conditions that are linked to it will result in "more frequent El Nino-like conditions and stronger cold events (La Nina)", or by Hansen *et al.* (2006) who found that over recent years, the El Niño events have become more frequent because the global temperature anomalies associated with each El Niño continue to increase. In some of ASEAN countries, extreme drought years are usually associated with the ocurrence of El Nino while wet years is associated with La-Nina. Even most of ASEAN countries are affected by the ENSO events, however, Indonesia has been found to be the country that would be the most severely affected by the increasing intesity of the ENSO. However, how the future of ENSO will look like is still uncertain, as climate models have disagreed on this. Some suggest the cycle will get more intense, some say less, and some project little change.

BOX 3. LONG-TERM IMPACT OF CLIMATE CHANGE AND THE NEED FOR EARLY ACTIONS (ADB, 2009)

Look at climate impact in the near-term view, it may not yet be seen as a very urgent and high priority issue, but this will put us at risk of getting significant loss later (see figures below) and may lead to mal-adaptation. Early actions would give benefit at later stage. The annual benefit in terms of avoided climate change is likely to exceed the annual cost of adaptation after 2050. The cost of adaptation for agriculture and coastal zones is about $ 5 billion per year by 2020.



Detail studies in ASEAN on how global warming will change the extreme climate events in the future are still limited. Some studies are available, but most of studies are long-term basis (up to 2100). As the driver of the climate change is warming the atmosphere, the increase in global temperature within the timeframe of this study (2010-2030) may not be high enough to cause drastic changes in extreme climate. Thus in this study, the occurrence of future extreme climate events within the timeframe of 2010-2030 is assumed to be the same as the current. However, it should be noted that a number of studies showed evidence of shortening of return periods for extreme rainfall events connected with the global warming (e.g. Urich et al., 2011; ADB, 2010). The shortening of return periods for extreme rainfall events would have significant implications for planning and decision making of durable infrastructure along with emergency services planning, land use regulation and building codes. There is a possibility that within the timeframe of this study, the extreme events with a longer return period may happen. In the case of ASEAN, based on Gupta's study, if an extreme event with return period of 40 years occurs once within the timeframe of this study, the economic loss would increase by 5.4% (equivalent to about 10 million USD). Specific studies on assessing the impact of global warming on extreme climate events within the short timeframe for ASEAN region is needed for the refinement of the study.

Permanent impacts: Sea level rise on the inundation of agriculture area was not included in this study as study on this in ASEAN is also limited. A number of studies use sea level rise of 100 cm, which is expected to occur in 2100 (Jevrejeva *et al.* 2010; Rahmstorf 2007; Forster *et al.*, 2011). Forster *et al.*, (2011) predicted that the area of agriculture land in Indonesia that would be permanently inundated due to sea level rise of 1 m was about 120,446 ha. This is equivalent to rice production loss of about 885,430 ton (1.5% of national production) However, the increase of sea level within the timeframe of 2010-2030 is predicted to be between 11 and 28 cm (SRESB1; FAO, 2011).

Projection from the existing studies indicates less risk to be envisaged within the time frame of our study. However in the longer term, the impact is much more severe and the adaptation will be costly if action is taken too late.
It is important to note that the quantitative analysis in this report **looks at climate change up to 2030**. Many decisions made during that time which affect food security will last much longer than this period and be affected by wholly different climate change scenarios e.g. major infrastructure projects such as irrigation, weirs and dams, roads, processing and storage facilities. Many of these will be expected to be functional far beyond 2030; some to the end of the century and beyond. Climate change assessments relevant to those later periods will be those relevant to making this sort of long term decision. This means that for good long term decisions, people making them will need the capacity to consider climate change far beyond the period to 2030.
This indicates an urgent need to think beyond the 2030 policy time horizon, which typically is related with shorter timeframe compare to the impact of climate change on their decisions (See Box 3). Most of the direct impact of climate change is mainly related with the crop productivity and planting index which are expected to significantly change beyond 2030 as illustrated in table 2.2 (i.e. temperature, rainfall [levels & intensity] and CO_2 fertilization impact on yield, changes in the length and onset of seasons and loss of arable land impacts on the harvested area). In the longer term sea level rise will further affect the availability of land. In addition, the environmental degradation also threatens forested area. This will affect the availability of water catchment areas and water supply for agriculture. **These amplifies the importance of research on the development of high yielding varieties, intensification of agriculture production, and paying serious attention to develop a resilient agriculture system by taking the right long term decisions considering the long term climate change impacts now and preventing maladaptation (investments in the wrong infrastructure).**

In the context of climate change, gender analysis reveals that men and women often have different capacity to adapt to climate change. The most direct impact of climate change on food security is through the production component. Although in many aspects it amplifies the same consequences but changes in production cause different issues to men and women (CGIAR, 2012). For example with less production men tend to focus on having less fodder for animals, while women are more likely to worry on the nutritional status of the family members. Other example is the increasing frequency of extreme weather events, which lead to crop failures. Men will likely to travel farther from home to find an alternative of incomes while women have less flexibility and have to stay closer to home because they have to take care of other family members. **Therefore dealing with the impacts of climate change on agriculture and food security needs to be gender specific. However there is not sufficient comparable data available to be able to integrate this issue in this quantitative analysis. We recommend that efforts to learn more about this important issue be maintained within further investigations into capacity development options in the region. A deeper understanding of such issues will be critical to designing targeted interventions that support human capacity development across the value chains.**

2.3 Phase 3 & 4: Identification of Current Gaps, Limitation and Capacities & Key recommendations

To identify current gaps, limitation and capacity of the ASEAN countries in addressing climate change and food security issues a series of interviews with key stakeholders were conducted in a qualitative assessment of vulnerabilities to food security within member states posed by climate change. In doing so the exercise assessed capacity needs of member states and the role that ASEAN can play in order to contribute to the ASEAN Climate Change Initiative (ACCI) under the ASEAN. Additionally a literature review from existing literature mainly from the countries' National Communication to UNFCCC, NAPA and other climate change strategies documents was conducted.

This two stage approach with a quantitative and qualitative part shall lead to ***prioritised focus points for more in-depth analysis of climate change impacts on food security in ASEAN Region, leading to a programme to strengthen value chains through the GIZ/ASEAN partnership within GAP-CC.***

BOX 4

RESPONSE LEVELS FOR ASSESSING AN ORGANISATION'S CAPACITY TO ADAPT TO CLIMATE CHANGE

„Core Business": Focusing on core activities. Does not see climate change as relevant to it

„Stakeholder Responsive": Responds to the expectations of stakeholders. It is aware that climate change is relevant to it but takes its lead from others about what to do.

„Efficient Management": Makes its own judgment about adapting to climate change and does so by using more efficient versions of its normal processes. It sees climate change as a significant issue to address.

„Breakthrough Projects": It finds that simply being more efficient does not achieve the adaptation required to address climate change. It is therefore investing in greater understanding of the issues and piloting different approaches for successfully adapting to them.

Three broad themes for grouping prospective focus points include

1. Response to climate change in general
2. Value chains
3. Capacity development

The series of 20 semi structured interviews [not all yet completed] were conducted in a qualitative assessment of vulnerabilities to food security within member states posed by climate change. In doing so the exercise assessed capacity needs of member states and the role that ASEAN can play in order to contribute to the ASEAN Climate Change Initiative (ACCI) under the ASEAN SCC as well as:

- The AFCC under the AIFS and the Economic Community (EC),
- ASEAN Climate Change Initiative (ACCI) under the ASEAN Socio Cultural Community (SSC) as well as
- The ASEAN SCC Blueprint activities on climate change, D.10. Responding to climate change and addressing its impacts:
    - Enhance collaboration among ASEAN Member States and relevant partners to address climate related hazards, and scenarios for climate change;
    - Encourage the participation of local government, private sector, non-governmental organisations, and community to address the impacts of climate change; and
    - Promote strategies to ensure that climate change initiatives lead to economically vibrant and environment friendly ASEAN Community taking into account win-win synergy between climate change and the economic development

Capacity was assessed using a framework of questions on current activity to build food security resilience to climate change. This approach scored capacity on a scale of 1-5, where 1 represents very low capacity and 5 represents very high capacity.

Interviewees were also invited to consider what the barriers and enablers to building food security resilience to climate change in ASEAN are. How people see opportunities and constraints helps assess their capacity to progress. It also helps identify potential project activities that optimise the likelihood of accelerated progress.
The capacity to respond to the challenges posed by climate change consists of multiple capabilities, skills and behaviours. This project therefore applied an assessment of capacity that recognises 9 different components of capacity. Each of the nine capacity components are called "Pathways" as each evolves in predictable ways as they develop along an itemized journey from low capacity to high capacity (i.e. from 1 to 5).

The 9 pathways, along with the 5 levels of capacity assessed in the interviews are taken from the PACT framework (a 9 by 5 matrix) designed for assessing and developing climate change adaptation capacity. The PACT framework also identifies effective interventions to build capacity at any 1 of the 5 levels. The value of applying this approach in this project is to provide valuable insight into: where the capacity to respond to information about climate change is weak in the region, and where it is strong, and identifying potential areas where meaningful interventions can support the development of the human, organisational and systemic capacity needed in the short-, medium- and long-term that builds resilience to climate change.
In future phases of this project, once commodities and countries have been selected, it is suggested that a thorough capacity assessment exercise be conducted using the PACT framework.

The Value Chain Approach

The interview process explored vulnerability at different stages in the food security system, from seed variety development to consumption. This is the "value chain" approach. The approach was used to identify the specific points at which climate change impacts on food security, and the capacity implications for addressing it.

3 Results

3.1 Current and Future Vulnerability of the Staples (Phase 1 and 2)

Assessing the availability and accessibility of staples at all time to meet dietary needs is very crucial for food security. Staples are the main sources of the carbohydrate and the share of the carbohydrate to meet the energy need is between 50% and 80%. The share of carbohydrate as source of energy decreases as economies develop (Beddington et al., 2012). Main sources of carbohydrate are mostly cereal and tuber/roots, with rice being the main source of carbohydrate in ASEAN. The energy intake from rice ranges between 25% to 70% (Figure 3.1). Among the eight ASEAN countries analyzed in this study, the lowest share of rice to total energy intake is in Malaysia which has the highest GDP. The other potential carbohydrate sources such as maize, roots and tubers remain low, even though the level of production of these crops, particularly cassava in some ASEAN countries is quite significant (Figure 3.1). Increasing share of these crops to energy intake will enhance food security in ASEAN countries as it will increase food diversity and reduce the reliance on rice. The greater commercial value of these alternative crops will also build resilience by building cash income and its capacity for recovery from extreme events. Thus, this study focused its assessment on rice, maize and cassava.

In term of food diversity, the more developed ASEAN countries such as Malaysia, Thailand, Indonesia, Phillipines, and Vietnam, the level of maize and wheat consumption increased quite significantly with the increase in GDP, however not for cassava (see Box 4). At present, Malaysia has been found to be the highest wheat consumption and followed by Phillipines, Indonesia, Thailand and Vietnam. Future consumption of wheat in these countries would increase further with the increase in GDP. For food security, the reliance of ASEAN countries on imported food or food which could not be produced in the region should be decreased in order to ensure regional food security. The use of the national budget for importing this food could be used for support food diversity programs. Cassava is one such potential food prodcut that should receive more attention.With exception of Malaysia and Phillipine, the ratio of cassava consumption to production is less than 0.5. For Thailand and Vietnam the ratios were less than 0.1

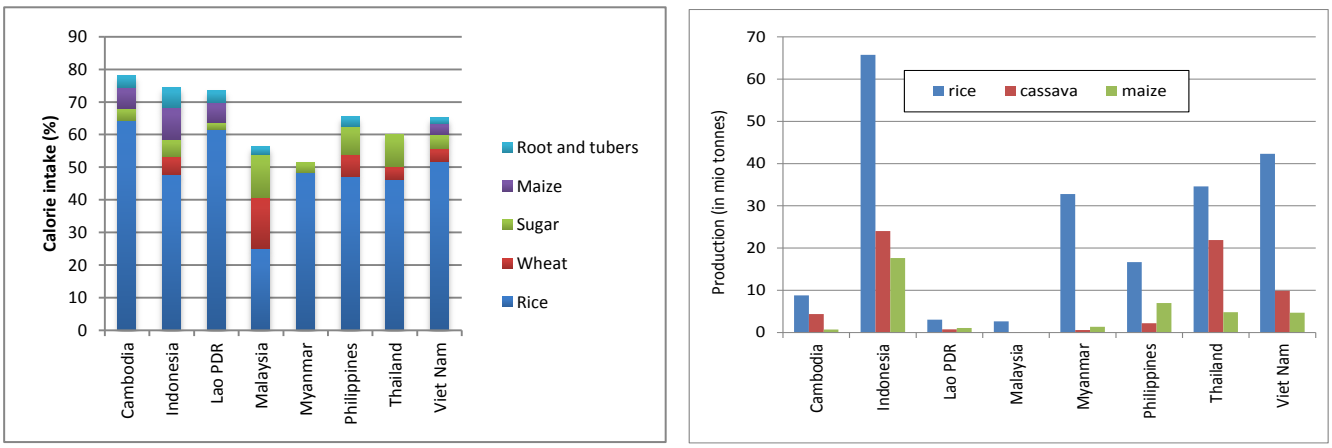


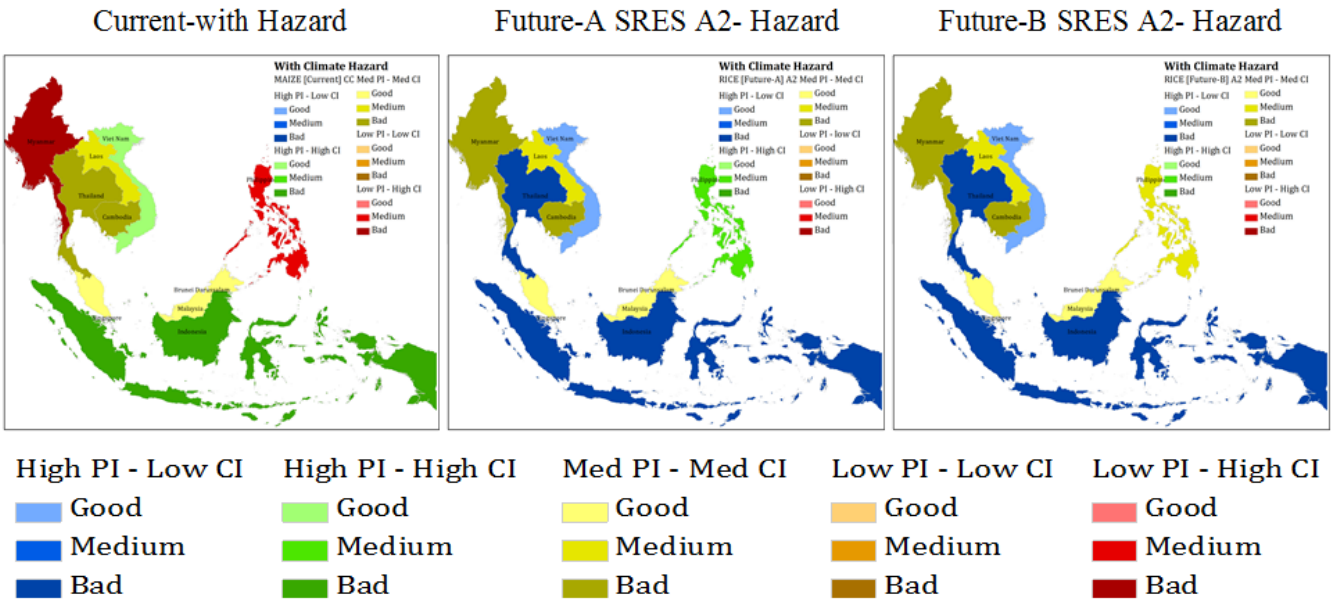
Figure 3-1. Profile of calorie intake (left) and production of main commodities in ASEAN region (right). Source: FAO Outlook

Looking at 2030 and beyond, FAO (2006) indicates that world cereals per capita consumption is expected to decline from the average of 165 kg in 1999/2001 to 162 kg in 2050. However, net trade in most of the countries is projected to remain negatives. Meaning that the declining per capita consumption is not followed by a significant increase in production to result in a positive balance between the supply and demand in the country. The study also highlighted that world average of self-sufficiency rate (SSR) is declining from 101% in 1999/2001 to 100% in 2050, while specifically for developing countries it is projected to decline from 91% in 1999/2001 to only 86% in 2050. SSR is representing the ratio between production and domestic demand. Given that Southeast Asia is the production center of major agricultural products, growth of its production will affect the world supply. It is necessary to sustain the surplus of agricultural production in ASEAN countries to at least maintain the self-sufficiency within the region.

Competing claims on agricultural production for food consumption and increasing demand for biofuel is also another issue to be addressed. There is no doubting that binding commitment to reduce GHG emissions marked a major turning point for a number of industrialized countries to spell the start of biofuels use. We need to ensure an effective management of agriculture in a way that puts food security first above the biofuel use. The developments of 2nd and 3rd generation of biofuel that cause less detriment to the food supply need to be accelerated.

3.1.1 Rice

Key message: *Without considering climate impact,* ***Myamar has been found to be the most vulnerable*** *to food insecurity at present and in 2030 with the lowest production index and the highest consumption index and the condition will get worse if climate impact is included. However, Myanmar can move to a group of countries with less vulnerability if the development of rice production system follows the more "optimistic" scenario A* ***The other vulnerable countries are Cambodia, Laos and Philippines****, however in the future these three countries are becoming less vulnerable. Thailand and Vietnam will remain as rice exporting countries and Cambodia will becoming exporting country as well in 2030.* ***The surplus for these three countries can meet the deficit of other countries if optimistic sscenario (A) is followed, but not if realistic scenario (B) is followed.*** *Indonesia, Myanmar and Laos could reach rice self sufficiency by increasing its rice productivity, planting intensity through improvement or development of irrigated facilities. For Indonesia, the improvement of rice yield may be difficult as in 2030 the yield is already close to its potential yield. Similarly for Vietnam, Thailand (two main rice exporting countries in ASEAN) and Philippines.* ***Finding new varieties with higher productivity with more resistance to environmental stresses is urgently needed for ASEAN to ensure future food security as the loss of production due to climate impact is quite significant****. At present the mean rice production loss due to climate impact reached 2 million tons annualy and in 2030 it may go up to about 3 million tons annualy. Higher loss is expected as this study only accommodate some of continuous impacts and discontinuous of climate change (permanent impact is excluded and current extreme weather continues to 2030 without changing the frequency and intensity). On the other hand, increasing productivity through expansion of agriculture land and irrigated area may be limited due to land availability and water scarcity.*



Maps of the food security concerning rice according to food security index of the ASEAN countires: present (left), scenario A 2030 (middle) and scenario B 2030 (right).

Without Climate Impact

Based on consumption and production indices, Myanmar is found to be a country with high consumption index though low production index (Quadrant 5), while Thailand has low consumption index with high production index (Quadrant 1). Referring to the C7 indicator, rice consumption to production ratio (see Table 2-1), Myanmar has the ratio of 1.2 (deficit) while Thailand is 0.6 (surplus). In addition, the distribution index of Myanmar and Thailand are below the ASEAN average (B). Other countries, such as Indonesia, Laos, Phillipines and Vietnam are found mostly in Quadrant 2, high production index and also high consumption index. The consumption and production ratio in these countries are all more than 1 (deficit). Cambodia and Malaysia are situated Quadrant 3 (medium), but the consumption and production ratio in Cambodia is 0.98 (surplus) while in Malaysia is 1.84 (deficit), the highest among the ASEAN countries. This large deficit condition does not put Malaysia in the Quadrant 5 as Malaysia has high capacity to import the commodity (as it has the highest GDP of the selected countries).

In the future, the position of Thailand remains in Quadrant 1 even though there is decrease in its production consumption index. Cambodia and Malaysia also remain in Quadrant 3 (Figure 3.2). However, the position of other ASEAN countries improve with the exception for Laos (both the projection scenarios A and B) and Phillipines (only for the projection scenario B). Indonesia and Vietnam remain in Quadrant 2 (high production index-high consumption index), Myanmar move from Quadrant 5 (low production index-high consumption index) to Quadrant 3 (medium production and consumption index), while Laos moves from Quadrant 2 to 3.

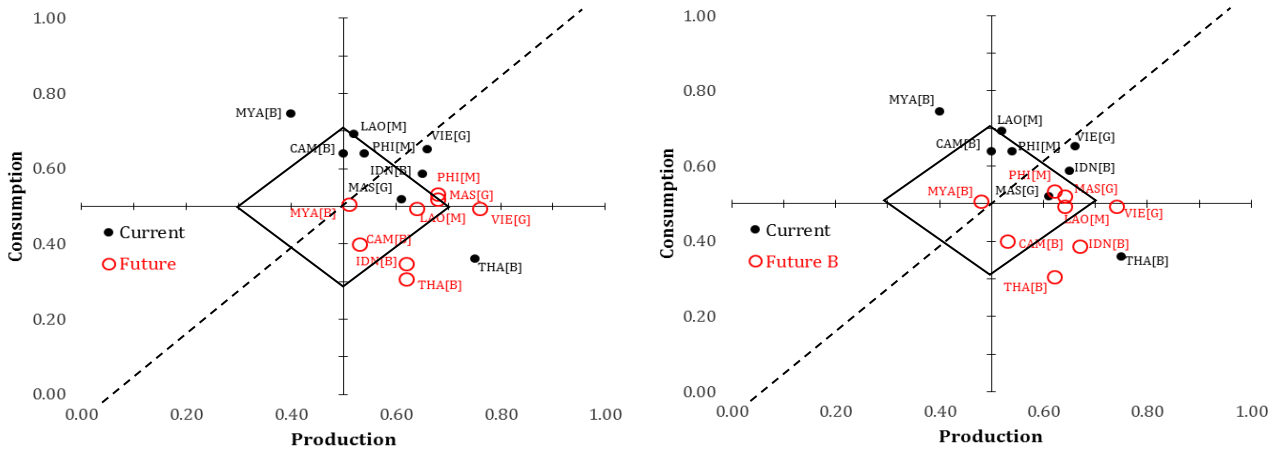


Figure 3.2. Relative condition of ASEAN countries in term of production, consumption and distribution index at present and future conditions (left Scenario A and right Scenario B)

Looking at the ratio of consumption and production, Thailand and Vietnam will remain as main rice exporter countriy, while Cambodia will also follow even though not as much as the two countries (Figure 3.3). Indonesia may reach rice self sufficiency by increasing planting intensity (increased irrigated area, see P1 and P2) slightly from the current scenario A (see Annex 1), and reduce rice consumption by diversifying food. In Indonesia by 2030, yield level almost reach potential yield (P5, yield gap already small), and difficult to increase further (see Figure 3.4) unless new varieties with higher yield are developed in the near future. This is also the case for Vietnam and Thailand the two main rice exporting countries in ASEAN. Laos and Myanmar could reach rice self sufficiency by accelerating the yield improvement, increasing planting intensity (P1) slighly from the current Scenario A (see Figure 3.4). Rice consumption may not change significantly (indicator C1 and C3) as the GDP in these two countries in 2030 are still less than 4,000 USD/cap (see Box 3).

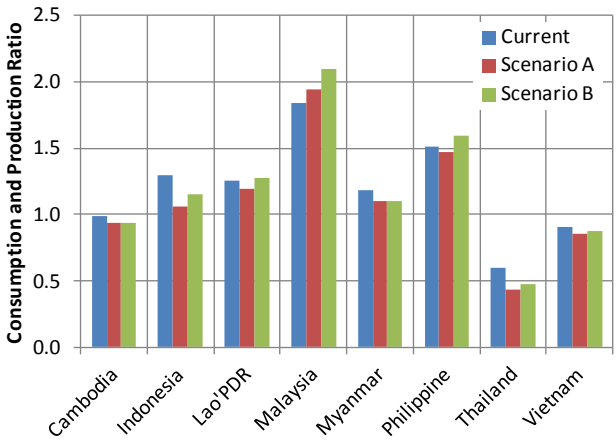


Figure 3.3. Consumption and production ratio under current and future (2030). Below the red line means self sufficiency.

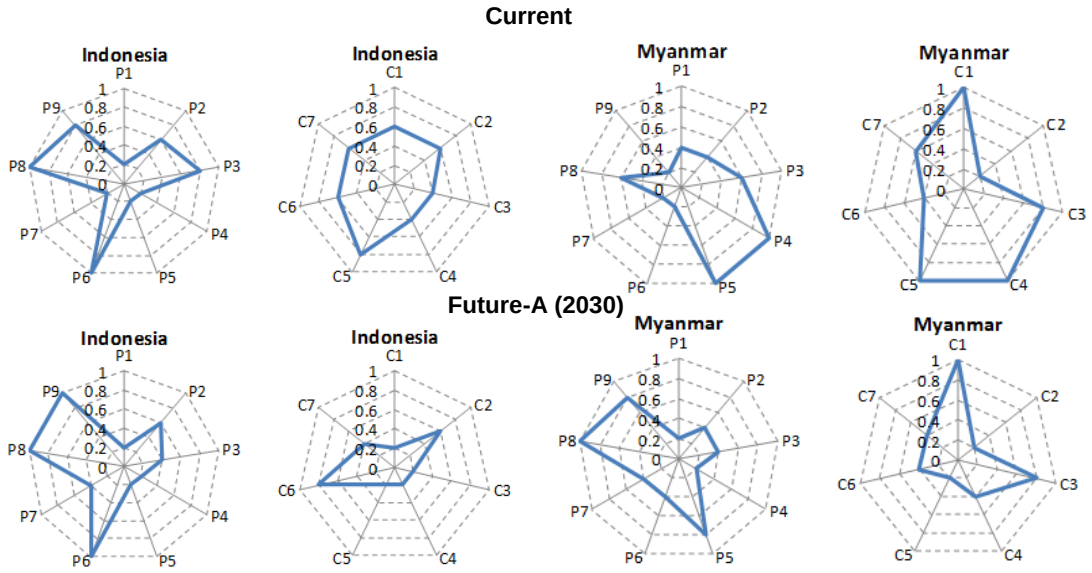
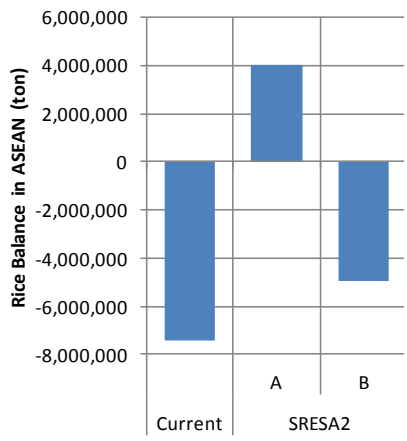


Figure 3.4. Production and consumption indicators of Indonesia and Myanmar at Present and Future (Scenario A). (Detailed spider diagram for each country are available in the full report for further analysis)

With Climate Impact

This study assessed the impact of extreme weather events and continuous impact of climate change on the vulnerablity of current (2010) and future (2030) rice food security. The result of the analysis suggested that the inclusion of climate hazard and continuous impact of climate change does not change the position of the countries in term of their vulnerability even though there is a change in their production and consumption indices. Under current condition, the inclusion of climate hazards worsens the consumption to production ratio slighly (Table 3.2), i.e. between 1% and 7% with average of about 3.1%. At present the total loss of rice production in the eigth countries due to climate impact at present reached 2 million ton per year and in the future this would increase to almost 3 million ton per year. This estimate may be less than the actual as this study only accounts for some of continuous and discontinuous impact of climate change (see Table 2.2). There is a possibility that extreme climate events with longer return period might occur within the timeframe of the study due to global warming as indicated by a number of studies (e.g. Urich et al., 2011; ADB, 2010). Over the last decades, all ASEAN countries has been exposed to more frequent and higher intensity of extreme climate events (ADB, 2010). There is also evidence of shortening of return periods for extreme rainfall events. However, the impacts of extreme climate events is always large indicating a low capacity of the ASEAN countries to manage climate risk (see Figure 2.3). Therefore, it is quite urgent for ASEAN to asssist its member in enhancing their capacity in managing climate risk and improving regional early warning system particularly for storm, flood and drought to allow for better anticipatory actions.

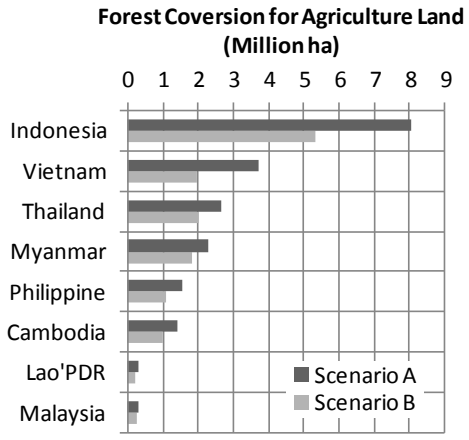
Box 5. Balance between production and consumption of rice in ASEAN (excluding Brunei and Singapore)



Research collaboration among member states that can assist policy makers to better understand the implications of climate change on livelihood, and all components of food security system (including long term investment for agriculture infrastructure) should be enhanced as this would enable greater climate resilience.

In the future, the ratio of consumption to production in all ASEAN countries with exception for Malaysia, will decrease (meaning improved concerning food security) compared to the present. Thailand and Vietnam would remain as main rice exporter countries in the region and Cambodia would follow (Table 3.2). The production surplus in these three countries could meet the rice demand of other ASEAN countries if future if projections follows the "optimistic" scenario (A; see Box 5) with a surplus of rice production by about 4 million ton. As Singapore and Brunei would be the main rice importing countries, thus the surplus would be used by these countries.
The "realistic" scenario B however shows a deficit of about 5 million ton.

Box 6. Forest conversion needed for the expansion of crop land in ASEAN country under scenario A and B



Nevertheless, the effectiveness of increasing irrigated area under scenario A in increasing planting intensity will increase the harvested area and the production level may be limited due to water scarcity during dry season as a result of decreasing forest cover, particularly in rainfall catchment area. In this study, the implementation of scenario A and B will result in reduction in forest cover (see Box 6) which in return may worsen the impact of extreme climate events in the country as forest plays very important role in buffering the extreme rainfall. This may also contribute to the shortening of return period of severe flood and drought events in the country. Thus the investment being made for the development of irrigation infrastructure may be lost if comprehensive adaptation strategies and sustainable policies are not integrated. Therefore, it is very important for ASEAN member countries to have comprehensive land use policies in place taking into consideration climate change. Incentives for using non-productive land for agricultural expansion rather than using forested land should be put in place as well as policy incentive for environmental services (water and carbon). A regional initiative in ASEAN to create regional carbon market particularly for land-forest based carbon projects may be effective to encaurage protection of forested land and the avoid the use of forested land for agriculture expansion and move to unproductive lands.

In the period of between 1990 and 2010, most of ASEAN countries have increased their agriculture lands but followed by the decrease of forested land, except for Vietnam where both agriculture and forested lands increased and for Thailand where both agriculture and forested lands decreased (see Box 7). This condition indicates that unlike other ASEAN countries, Vietnam has been succesfull in increasing its agriculture land without converting much forested lands. However, this condition may not persist if agriculture land is continues to increase, as availability of land is limited.
While in Thailand, the conversion of forested land were not for the expansion of agriculture lands.
Classification of the vulnerability of ASEAN countries based on production and consumption index can roughly be done by drawing a diagonal line as shown in Figure 3.6. Countries fallig above this line have higher consumption index thanproduction index. At present, countries situated above the diagonal line are Myanmar, Laos, Cambodia and Philippines, and in the future only Myanmar remain above the diagonal line, while others will move below the diagonal

Box 7. Trend of agriculture and forested lands in ASEAN countries (1990-2010; + increase and – decrease).

	Agriculture Land[1]	Forested Land[2]
Cambodia	+0.02%	-1.27%
Indonesia	+1.37%	-1.18%
Laos PDR	+0.03%	-0.47%
Malaysia	+0.20%	-0.46%
Myanmar	+0.90%	-1.07%
Philippines	+0.30%	+0.76%
Thailand	-0.60%	-0.15%
Vietnam	+2.57%	+1.90%

[1]Agricultural land refers to the share of land area that is arable, under permanent crops (perennial crops such as cocoa, coffee, rubber, fruit trees but exclude trees for wood or timber), and under permanent pastures (land used for five or more years for forage, including natural and cultivated crops). Arable land are land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. [2]Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (FAO).

line (Figure 3.6) i.e. increase their food security concerning rice. Without climate change Myanmar will move below the diagonal line if the "optimistic" scenario (A) is followed, but it will remain above diagonal line if the "realistic" scenario (B) is followed (see Figure 3.2).

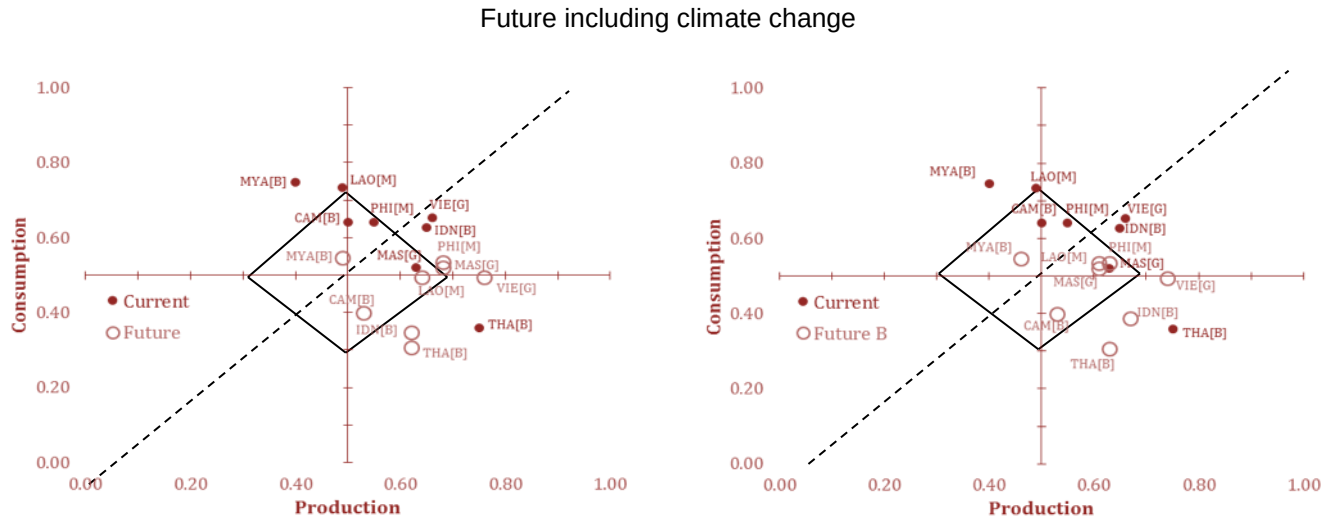


Figure 3.6. Relative condition of ASEAN countries in term of production, consumption and distribution index at present and future under SRES A2 with the inclusion of current climate hazards and continuous impact-Rice (Scenario A and Right Scenario B). Note: The result of another emission scenario (SRES B1) is not significantly different.

Table 3.2. Ratio of rice consumption to rice production under current and future with and without climate hazard and continuous impact of climate change

	Current Without Hazard	Current with Hazard	SRESA2	
			Future with Hazard and Continued Impact-A	Future with Hazard and Continued Impact-B
Cambodia	0.98	1.00	0.95	0.96
Indonesia	1.29	1.33	1.09	1.10
Lao'PDR	1.25	1.32	1.24	1.25
Malaysia	1.84	1.97	2.07	2.09
Myanmar	1.19	1.23	1.16	1.16
Philippine	1.51	1.55	1.51	1.52
Thailand	0.60	0.61	0.44	0.45
Vietnam	0.91	0.92	0.86	0.86

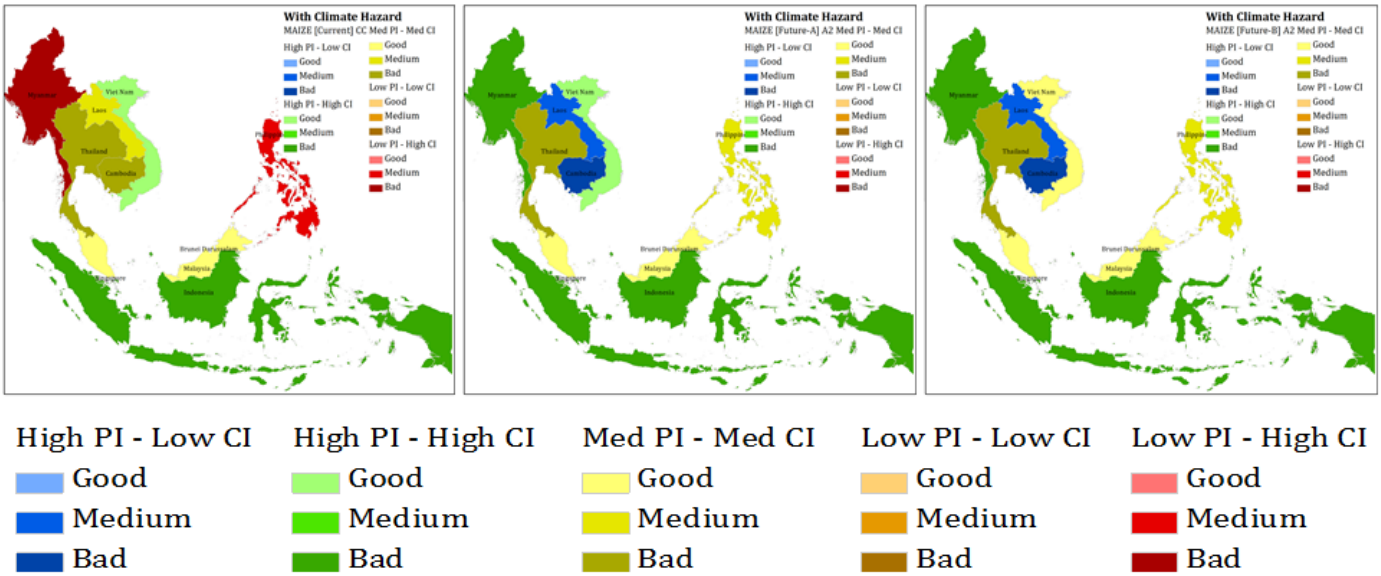
Considering that most ASEAN countries are at present net importers and it is most likely only Thailand and Vietnam and later Cambodia export (Table 3.2), trade becomes a very important issue. Especially if the ASEAN country will not follow the Scenario A, the surplus in the two countries would not be able to meet the increasing demand of other ASEAN countries (Box 5). The deficit is likely to be even larger if all climate change impacts (see Table 2.2) would be included in the analysis. Without increasing capacity to manage climate risk or to do anticipatory actions for addressing extreme climate events, frequent significant loss of crop production in ASEAN countries may become more frequent. This may trigger the increase in food prices and with limited capacity for importing food particularly for lower income member state countries, and food insecurity in these countries would become more serious. It is necessary for ASEAN to develop common policies in addressing this potential issue.

Collaboration across sectors in assisting main production regions in the country to enhance their resilience to climate change and support emerging production regions to develop in a climate change resilient way should be improved.

Developing agencies can assist in providing financial and technical assistance but a strong lead by ASEAN to support climate resilient development and climate proofed strategies and infrastructure is needed to support the main production regions. For instance it is crucial that the further development of the Irrawaddy delta in Myanmar considers the future changing climate and that development strategies integrate the latest information on climate change and adaptation options. ASEAN can also play a role in supporting the countries in developing protection system for farmers from affected years such as index insurance. Climate shocks like drought and flood often lead to food insecurity. Many farmers are being trapped by debt due to these extreme climate events and this can push them into persistent poverty. However even in relatively "good" years, the threat of climate variability makes people and institutions risk-averse, and they are unable or unwilling to make investments or to take out loans to do so, because a drought or flood could render their investments worthless. This causes farmers unable to reap the full benefits of good years and optimize their production output. Index insurance is a promising tool for facilitating adaptation to climate risk. By protecting farmers from the risks of the worst years, insurance can enhance productivity the rest of the time, providing the foundation for economic growth.

3.1.2 Maize

Key message: At present, Myanmar and Philippine are the most vulnerable concerning maize (as an alternative to rice) and also Indonesia and Vietnam though less compared to the two countries. In 2030 Indonesia remains as the most vulnerable, while Myanmar and Philippine become less vulnerable. Cambodia and Laos would become main exporting countries in ASEAN however the demand for maize of other countries is much higher than the surplus of these two countries. The present deficit reached 10 million tons per year and in 2030 it would go up to 25 million tons. The inclusion of climate impact would reduce the capacity of all ASEAN countries to increase their production. The total loss due to climate impact at present reached 2.5 million tons per year and in 2030 it would be close to 5 million ton.



Maps of the food security concerning maize according to food security index of the ASEAN countries: present (left), scenario A 2030 (middle) and scenario B 2030 (right).

Without Climate Impact

As for rice, Myanmar is currently situated in Quadrant 5, i.e. a country with high consumption index but low production index. Also the Philippines are in the same quadrant, while Laos is in the opposite position (Quadrant 1). Indonesia and Vietnam in Qudrant 2 (High production and consumption index) and the remaining in Quadrant 3 (Figure 3.7). In the future (2030), Cambodia which at present in Quadrant 3 will move to Quadrant 1 together with Laos. This indicates in 2030 Cambodia will become one of the main maize producer country. The consumption and production ratio of Cambodia in 2030, if scenario A is followed, will decrease from 0.960 to 0.770 (surplus). However if scenario B is followed the ratio will increase to 0.974. For Laos, its position in the Quadrant 1 will remain until 2030, however, there will be much improvement in its production index (See Figure 3.7). This suggest that Laos will also become main maize producing country. At present the ratio between consumption and production of Laos is 1.04, but in 2030 it will decrease to 0.91 (surplus). As Laos currently is in deficit of rice (Table 3.2), there would be potential diversification of food staples to maize in this country.

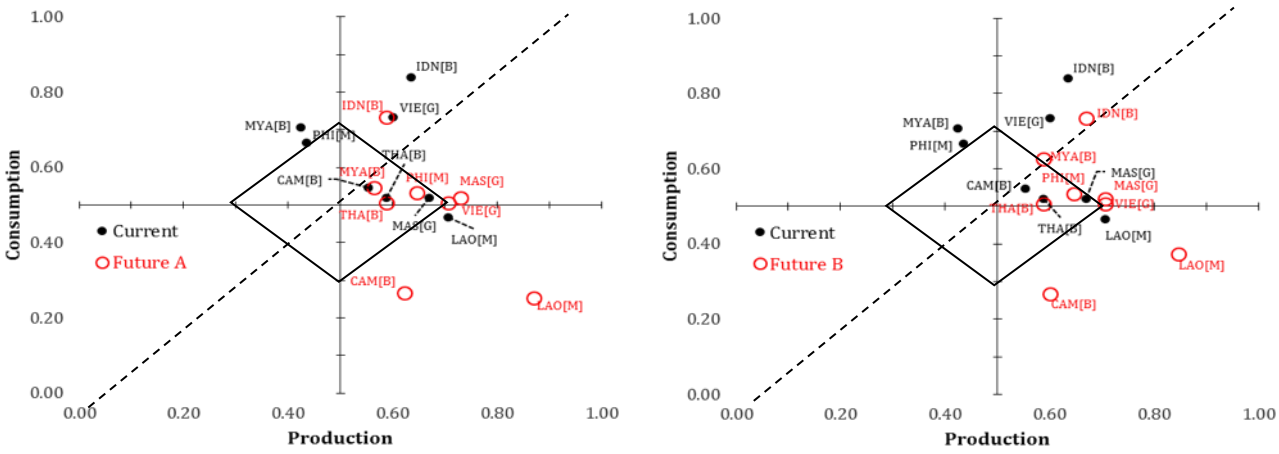


Figure 3.7. Relative condition of ASEAN countries in term of production, consumption and distribution index at present and future conditions for maize (left Scenario A and right Scenario B)

It is interesting to evaluate what factor cause the improvement of food security in Cambodia. From the spider diagram (Fugure 3.8), it is clear that there will be an increase in yield level (P6), while the yield loss (p8) would reduce. On the other hand, consumption levels would decrease in 2030. If demand for maize increase as a result of increasing need for food diversification, the surplus of maize may be used domestically.

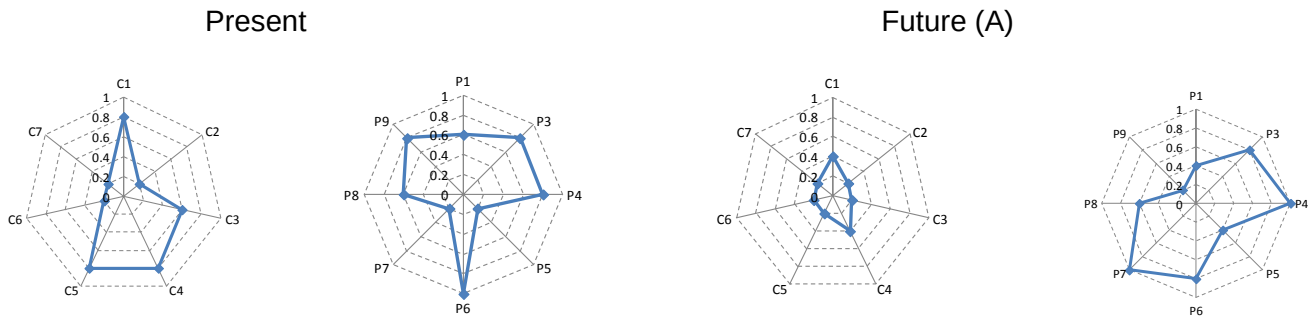


Figure 3.8. Production and consumption indicators of Cambodia at Present and Future 2030 (Scenario A)

With Climate Impact

Based on work of Rosenzweig and Iglesias, continuous impact of climate change on maize in ASEAN countries quite varies across country but is in general negative. The yield change range between 0.5% and -7.2% for scenario SRES

A2 and between -1.4% and -6.9% for scenario SRES B1. The highest decrease would be in Myanmar and the lowest in Thailand. This estimate is consistent with other global study from Easterling *et al* (2007). In tropical countries the increase of temperature by about 1 ^{o}C would reduce the mean yield of maize by about -5%. However if it is compared with country specific study in Thailand conducted by Felkner (2008), maize yield in Thailand would decrease by about -13%. Climate hazards on average could reduce yield between -0.68% and -24% with average of about -4%. The inclusion of climate hazard and continuous impact of climate change shifts the relative position of countries in the quadrants. Laos which currently is in Quadrant 1 moves to Quadrant 3 (Figure 3.9) and becomes more food secure. However, Laos and Cambodia is still projected to be the main maize exporting countries in ASEAN in 2030 irrespective of climate change (Figure 3.9).

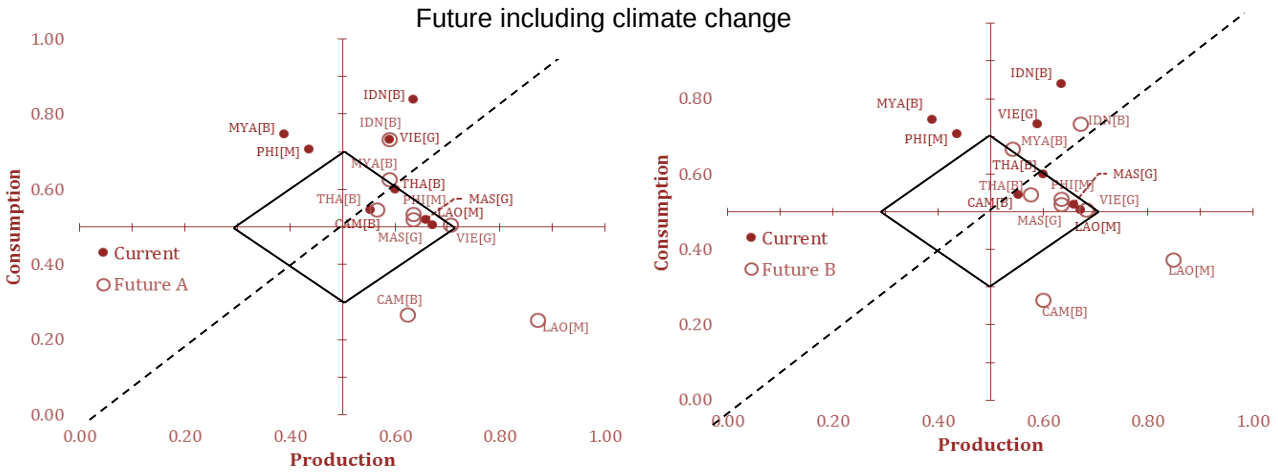
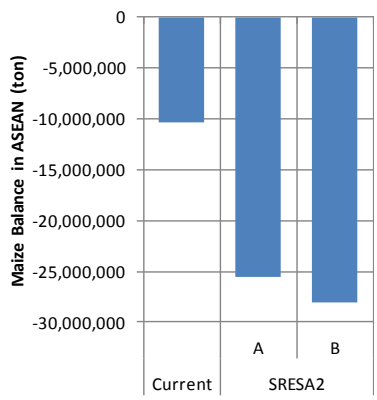


Figure 3.9. Relative condition of ASEAN countries in term of production, consumption and distribution index at present and future with the inclusion of current climate hazards and continuous impact of climate change under SRESA2-Maize (left Scenario A and right Scenario B). Note: The result of other SRES B1 is not significantly different from that of SRES A2.

Table 3.3 suggested that the role of Cambodia and Laos as maize exporting countries could be achieved if the countries follow the optimistic scenario A (see Annex 1) but not it they follow realistic scenario (B). The other countries would remain as countries consuming more maize than producing irrespective of the projection scenario. Climate impact would increase the need for importing maize in these countries as indicated by the increase of the consumption and production ratio. Maize production level in most of these countries can only meet between 50% to 75% of their consumption. The worst condition is in Malaysia, in which the consumption level is much higher than production. In 2030, its production can only meet 1-2% of its consumption. The surplus of maize in Laos and Cambodia may not be able to meet the need of other ASEAN countries. The deficit at present would be over 10 million tons and in 2030 would be more than 25 million tons (see Box 7). Contribution of climate impact on this deficit at present is about 2.5 million tons and in 2030 it close to 5 million tons (almost doubled). It is expected that the loss may be higher if the permanent impact can be included and the prediction of increasing intensity and frequency of extreme weather events occurs.

Box 7. Balance between production and consumption of Maize in ASEAN (excluding Brunei and Singapore)



Refering to Figure 3.9, countries situated above the diagonal line at present include Myanmar, Indonesia, Vietnam and Philippines and in 2030 only two countries remain namely Indonesia and Myanmar. As defined above countries falling above the diagonal line relatively would have high consumption index but low production index. In Malaysia even thought the ratio of consumption and production is far above other countries, however its position is below diagonal line. This is because the GDP of this country is far above of other ASEAN countries in 2030, thus its capacity to import

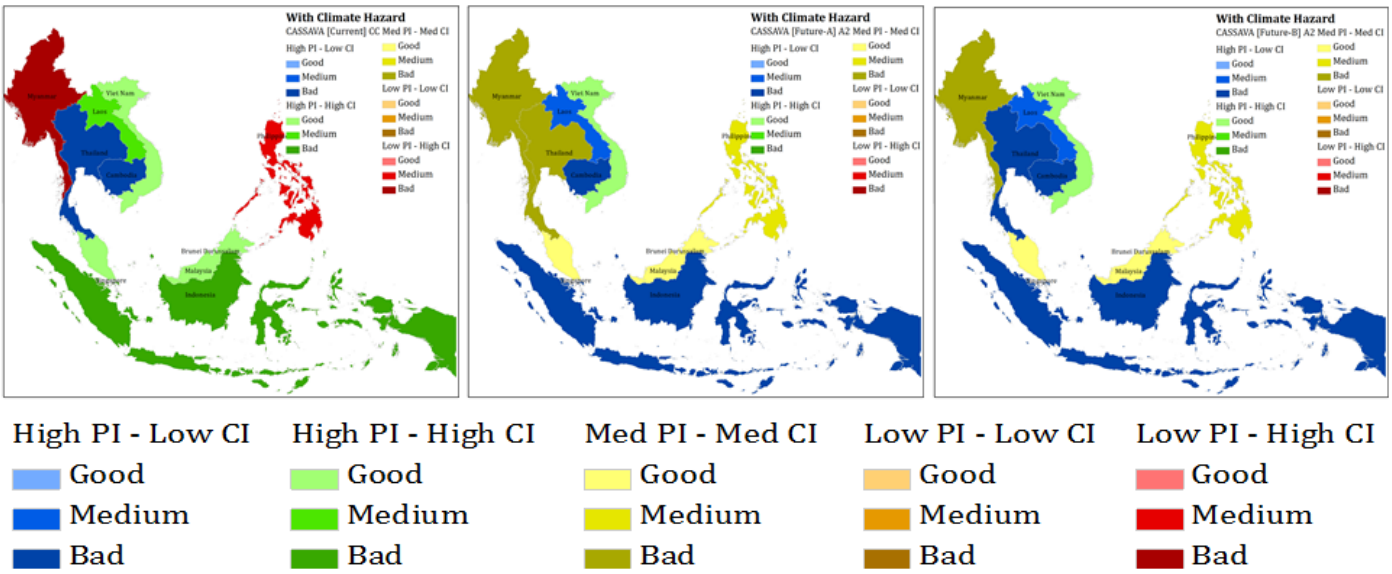
is much higher than other countries. In 2030, the GDP of Malaysia almost reach 25,000 USD/cap, while other countries still below 15,000 USD/cap.

Table 3.3. Ratio of maize consumption to maize production under current and future with and without climate hazard and continuous impact of climate change

	Current Without Hazard	Current with Hazard	SRESA2	
			Future with Hazard and Continued Impact-A	Future with Hazard and Continued Impact-B
Cambodia	0.96	0.99	0.77	1.00
Indonesia	1.62	1.82	2.60	2.53
Lao'PDR	1.04	1.16	0.92	1.41
Malaysia	35.28	65.22	96.27	115.03
Myanmar	0.99	1.08	1.21	1.53
Philippine	1.17	1.32	1.95	1.95
Thailand	1.15	1.27	1.57	1.63
Vietnam	1.49	1.72	1.73	2.14

3.1.3 Cassava

Key message: Myanmar and Philippines are the most insecure countries concerning cassava. Until 2030 the situation in these countries is expected to improve. If climate change is included, Myanmar, in particular, is expected to improve (however not as much) and it will remain food insecure concerning cassava. All ASEAN countries except Philippines and Malaysia are and would remain as cassava surplus countries. The demand for cassava in these two countries can be met by other ASEAN countries and there remains a large surplus, of more than 20 million tons per year, up to 2030. Cassava could be a potential alternative for meeting food demand in ASEAN countries and also to reduce the reliance of imported food such as wheat.



Maps of the food security concerning cassava according to food security index of the ASEAN countires: present (left), scenario A 2030 (middle) and scenario B 2030 (right).

Without climate impact

The production and consumption indices indicate that Myanmar and Philippines are having the lowest production and highest consumption of cassava (Quadrant 5) among other ASEAN countries (Figure 3.10). However both countries are projected to increase their production and respectively Myanmar shifts to Quadrant 2 (High consumption index – high production index) and Philippines shift to Quadrant 3 (medium) under both scenario A and B.

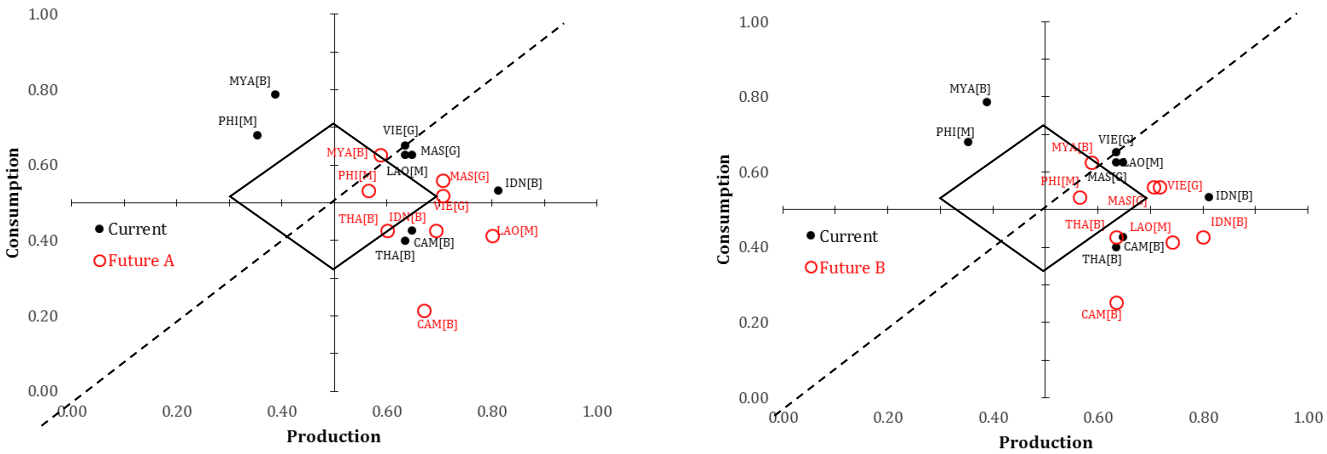


Figure 3.10 Relative condition of ASEAN countries in term of production, consumption and distribution index at present and projection of future 2030 conditions (left Scenario A and right Scenario B)

Figure 3.11 below suggests that gap between current yield of cassava and its potential yield in the Philippines is still high (P5).This indicates the opportunity to improve the production via technological intervention and yield increase. Planting intensity (P1 and P4) are currently also still relatively low and appear to be the window for improvement in the future. Current planting intensity in Myanmar is below the average of ASEAN countries (P1), however its growth is relatively high (P4). It is expected to increase in the future. In the context of consumption, poverty is found to be prevalent in both countries (C4-C5).

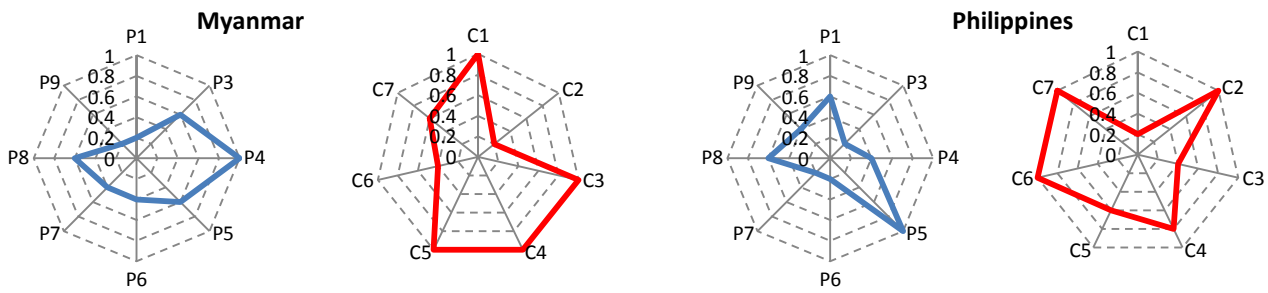


Figure 3.11 Production and consumption indices of Myanmar and Philippines in current condition

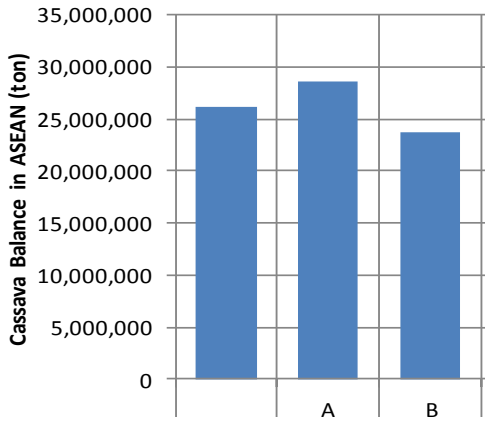
Unlike rice and maize where the ratio of consumption and production varies among countries, all ASEAN countries have a surplus of cassava except Malaysia and Philippines (Box 8). The ratio varies between 0.09 – 0.52 for other ASEAN countries, 1.15 for the Philippines and extremely high 12.98 for Malaysia. This information suggests the opportunity for ASEAN countries as cassava exporters and prospect of cassava as an alternative source of carbohydrate to reduce the dependency on rice.

With climate impact

For cassava, the assessment is only available in Vietnam (Zhu and Syhimete, 2010). The study suggested that the yield change due to climate change varied from +4.3% to -19.8%. For estimating the yield decrease for cassava in other ASEAN countries, we assumed the pattern of cassava yield changes following the pattern of rice yield change as cassava is C3 plant , the same as rice. For the discontinued impact, the analysis suggested that the yield would reduce between 0.3% and 4.4% with average of about 2.5%.

By including the climate impact, it was found that Figure 3.12 Myanmar and Philippines are the two countries located in Quadrant 1 and in 2030 they both are projected to move to Quadrant 3. In term of ratio between consumption and production, all countries are surplus except for Malaysia and Philippines. The deficit will increase in 2030 in these two countries (Table 3.3). However the demand for cassava in these two countries can be meet by other ASEAN countries and there remains a large surplus of more than 20 million tons. This crop could be a potential as alternative for meeting food demand in ASEAN countries. The reliance of wheat may be reduced in 2030, and the investment for food processing for cassava would strongly recommended and make cassava to be attractive as alternative food for ASEAN people.

Box 8. Balance between production and consumption of cassava in ASEAN (excluding Brunei and Singapore)



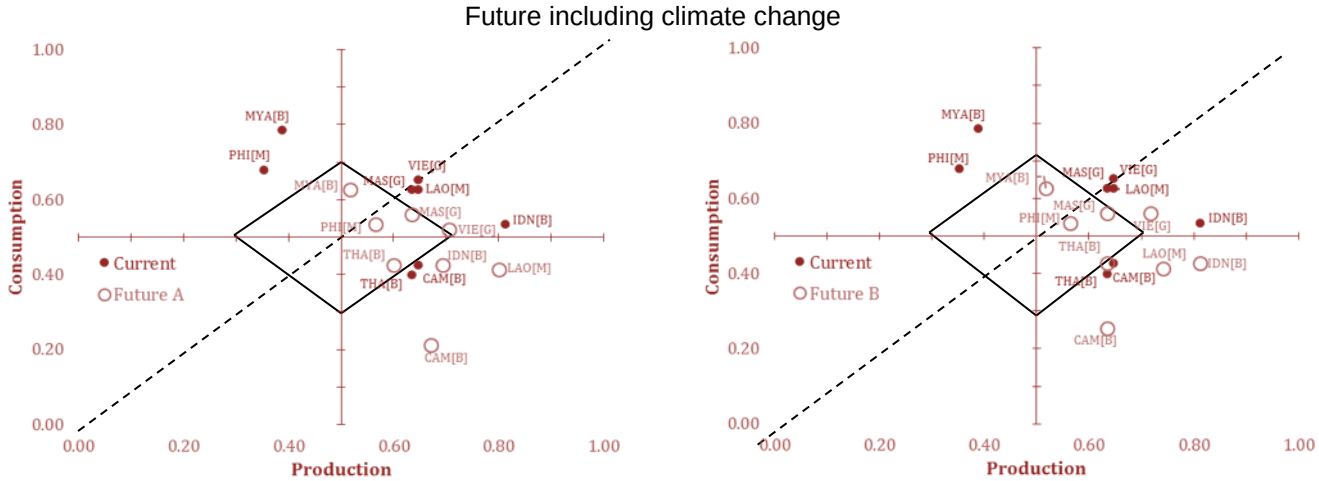


Figure 3.12. Relative condition of ASEAN countries in term of production, consumption and distribution index at present and future with the inclusion of current climate hazards and continuous impact-Cassava (Scenario A and Right Scenario B). Note: Current condition with climate hazard used as reference.

Table 3.3. Ratio of cassava consumption to production under current and future 2030 with and without climate hazard and continuous impact of climate change

	Current Without Hazard	Current with Hazard	SRESA2	
			Future with Hazard and Continued Impact-A	Future with Hazard and Continued Impact-B
Cambodia	0.11	0.11	0.10	0.12
Indonesia	0.52	0.53	0.69	0.76
Lao'PDR	0.20	0.21	0.13	0.18
Malaysia	12.98	13.30	25.61	23.14
Myanmar	0.41	0.41	0.54	0.59
Philippine	1.15	1.18	2.00	2.00
Thailand	0.09	0.09	0.11	0.11
Vietnam	0.09	0.09	0.10	0.12

Results of this study reflect general conditions among countries in term of vulnerability of their food security system to climate change. It does not capture the regional variation in the country as it only provides average condition. Countries which are considered to not be vulnerable may have a few regions that are very vulnerable and they could be more vulnerable than regions in a non-vulnerable country or vice versa. It is necessary to apply this framework model to see and understand regional differences within each country.

3.2 Current gaps, Limitation and Capacity in Addressing Climate Change and Food Security (Phase 3)

The scientific literature review on agriculture and food security in ASEAN countries indicated that research is mainly focusing on the impact of climate change on production, specifically yield. Most analysis was done on the commodity rice. Few studies included climate change impact assessment on consumption, and even less on distribution component. Studies on the impact on yield also mostly focused on continued impact of climate change and are very rare on the discontinued impact. Many studies suggested that extreme climate events may be more intense in the future and this aspect should get more attention in the future. Capacity development in ASEAN countries to use climate information and capabilities to manage extreme climate events and include it in developing policies/measures should be an important focus for ASEAN and member countries..

Based on the review of national documents e.g. National Communications, prioritization of climate change adaptation policy and program is based on insufficient scientific basis. The national documents commonly review a limited number of impact assessment studies. However the outputs are hardly incorporated as the basis for identification and prioritization of adaptation. Some of the factors contributing to this condition among others are limited spatial coverage and thus lack of quantitative outputs, hence it is difficult to identify appropriate, localized adaptation strategies, and there remains high uncertainty. Despite increasing studies of climate change impacts on agriculture and food security, only few are adopted by the policy makers in developing national strategies of adaptation to climate change.

From the interviews it was revealed that the main factor of not integrating scientific data and analysis into development plans is due to the limited capacity in framing evidence of climate change and its impact on food security in a way for decision makers and other actors to incorporate the consequences and recommendations. Capacity to identify these evidence gaps and the expertise that can effectively generate and interpret the evidence in a way that is useful to decision makers is one of the main crucial aspect that should be developed. In this regards, identification of expertise that compliments ASEAN capacity to deliver the intentions of the decision makers working with the evidence may be an urgent step that should be done. This will require expertise and the appropriate institutional frameworks (institutions as “rules of the game” as well as organisations) to contribute their expertise.

From the review process, it is also quite clear that national documents are still limitedly focusing on government policy and programs. Implementation of policies and programs are multi-stakeholders processes but national documents rarely identify the potential and/or existing involvement of non-governmental actors such as private sector, civil society organisations and the scientific community. Effective adaptation to climate change will require engagement of others as necessary changes are not completely under the control of one body. Indeed no single body can act alone as consequences are cross-sectoral. The capacity to work together is therefore crucial to the most effective adaptation. ASEAN is an ideal forum for identifying such issues and facilitating engagement. This could be between members or on behalf of members with other countries or regions. Interviewees have recognised this. They have also recognised that it is common in such situations for Member States to feel conflicted between self-interest and common interest. The skill with which ASEAN can help to engage with Members to achieve mutually beneficial food security outcomes will be fundamental to the outcome.

3.2.1 The Value Chain Approach

The interview process explored vulnerability at different stages in the food security system, from seed variety development to consumption. The value chain approach was used to identify the specific points at which climate change impacts on food security, and the capacity implications for addressing it.

3.2.1.1 Findings

Resilience through Diversity

One of the key messages from interviewees about building resilience to climate change to food security is the need to absorb a huge range of climate related events both within and between growing seasons. Resilience at farm level for instance will therefore require the capacity to be productive in a wide range of conditions e.g. unprecedented cold and heat. It is also likely that there will be increased extreme events too severe for most member states to afford complete protection. Resilience to such events requires being able to mitigate the impact of them (planned preparedness and avoidance measures), as well as having the capacity to recover quickly and return to efficient production. This inevitably requires significant investment across all links in the value chain from farm to national level. Success at these levels needs research, finance, engineers, planners, agronomists, hydrologists, architects, amongst many other skills, expertise and capabilities to work together in order to continue to build resilience and adapt. Numerous interviewees point to the cost of change which makes the poorest and most vulnerable even more exposed to climate change. There is good practice in understanding these issues throughout ASEAN e.g. research for development initiatives developments towards understanding the implications of climate change along with the technical, livelihood and policy responses that would enable greater resilience. However, the understanding generated by this good practice is rarely made available to decision makers in the region. A significant development intervention could therefore be to link decision makers more effectively with the pockets of better practice that exist in the Region.

Value Chain Vulnerability

This section considers the vulnerability of points along the value chain and capacity to build resilience at those points.

Variety Development

Interviewees focussed mainly on the rice value chain but acknowledge importance of other foods in both traditional and emerging diets as preferences change with economic development and urbanisation. To capture the importance of other foods the two highest production staple crops after rice, maize and cassava are also being considered in qualitative assessment.

There is intense activity in development of **new rice varieties** for a changing climate. This includes developing resilience to: temperature rise, drought, flood and salinity. There are also efforts to produce a C4[5] variety of rice through genetic modification which will be more productive, including under climate changed conditions, than its natural C3 characteristics. Methodologies have been developed by IRRI for rapid adaptation of vulnerable traits of varieties so that the qualities that make a variety well suited to a site are retained and only the vulnerable characteristics are changed. This process can be completed in 5 years from inception and development (3 years) to scaling up for large scale production (2 years with well developed capacity and infrastructure). Significant resources are wired for both variety development and scaling-up. The returns on investment can be significant though, especially developing varieties for "abiotic" factors such as these. The range of specific climate change challenges that can be helped by variety development would make it useful to prioritise focus areas in terms of impact and urgency (the time at which it is likely to be needed). If this prioritisation can be done on an ASEAN-wide scale or beyond through ASEAN collaboration with other affected partners, research resources can be used more efficiently and with greater impact.

Interviewees differed on their view of the role of variety development for different producers. With every 1°C rise in temperature, highly efficient farmers can experience a 5-10% decline in rice yield. Less efficient producers may not experience such losses. Neither would they experience the gains of new varieties. For these the most important step

[5] By creating rice with C4 characteristics rice will increase its yield with the same amount of sunlight.

for resilience would be increasing the efficiency of production; either to fulfil the potential of the current system in changed climate, or if new varieties are available and affordable, to a point where the benefits of productivity gains using adapted varieties are available. This helps regional food security through building farm level surplus. It also builds the capacity at farm level to sell surplus and raise resources for recovery to crop failures and other shocks.

Production Phase

During the crop production phase climate change adaptation largely follows the story of **water**. Increased temperatures and possibly longer dry seasons are likely to limit water availability. Changing **patterns of wet and dry season** are likely to make water available at different times. A valuable response seems to be to revise cropping calendars e.g. rice varieties can manage drought at some times and not others e.g. drought at flowering time is more damaging than others. Also **irrigation** for weed control may be done with shorter periods of flooding. It is noted that these **calendars** will need regular revision with changing climates. Revising cropping calendars depends upon **local level climate change forecasting** capacity. Ensuring that these adaptive practices are taken up depends largely on **extension** and other communication work. Capacity for this varies greatly in the Region. Examples of good practice include Climate Field Schools in Indonesia

Flooding resulting from expected higher **peaks in rainfall** as well as from the sea in extreme events and the impact of **sea level rise** is considered a significant risk both to production and infrastructure.

BOX 9. The Threat and Opportunity Of Climate Impacts On Infrastructure

Old irrigation infrastructure in Vietnam is regularly damaged by flooding as extreme events continue and in some cases become more frequent, especially in the South of the country. These events are recognised in the country's climate change adaptation plans as opportunities to upgrade the infrastructure and make it more resilient to future climate.

In periodic flooding the impact of a sudden loss of a crop in a single year affects food availability locally. It also impacts on those dependent on trade through lower volumes and higher price. Rice varieties resistant to submersion for 24 days are making production more resilient to flooding. As already mentioned the rate at which producers have the capacity to recover affects whether or not the impact is prolonged. The capacity to take opportunities to raise the threshold at which extreme events are disruptive will be a significant factor in building food security resilience e.g. **upgrading infrastructure** specifications during repairs, at maintenance points or where infrastructure is being upgraded or **newly built**. To do that well, **local climate forecasting** is once again important. In the case of infrastructure, the forecast needs to be far enough into the future for decision makers to understand what changes are likely within the **life time of their decision**. Without that facility, avoidable maladaptation is a likely outcome. This capacity is often related to the resources available for change. The same goes for **distribution**. In Philippines with hard topped roads recovery can be quick. In Vietnam with earth roads and lower resources, disruption can be greater and for longer, so prolonging pressure along the value chain on availability and price.

Available Land

Loss of agricultural land to changed land use is a major challenge to ASEAN food security. Climate change adds further pressure to the availability of productive land through sea level rise and drought.

Sea level rise threatens permanent loss of productive land in ASEAN coastal areas within the next 20 years. The most vulnerable of these are delta areas. 60% of Vietnam's production comes from the Mekong and Red River Deltas. It's climate change projection show 30% of productive area in these deltas being lost to sea level rise without adaptive action. The Irrawaddy Delta has high production potential but is also vulnerable to sea level rise if not developed using adaptive approaches. Sea level rise is also likely to disrupt access to food through displacement e.g. Metro Manila alone expects 200,000 people to be displaced by sea level rise and 2 million hectares becoming unusable. With 60% of ASEAN's population living in coastal areas this is likely to have a significant impact on productive land.

Drought in some areas also threatens to make productive land unviable, at least to current production systems e.g. in Northern Thailand.

Pests and Diseases

Climate change is also expected to increase **pests and diseases**. The level of threat depends on the ability of responses to be able to contain outbreaks e.g. recent pest outbreaks in cassava. Questions were raised by interviewees whether ASEAN's work on cross border phyto-sanitation was sufficiently factoring increased risk of climate change. Since these arrangements take a long time to agree, including them in current discussion would make the region more resilient for longer.

Processing and Storage

Interviewees identified **processing and storage** as particularly vulnerable parts of the value chain; in Asia post-harvest losses are estimated at around 30% or 5 billions of USD a year[6]. Climate change is likely to significantly increase losses through degradation in storage (at processing sites as well as storage of food reserves) from pests and diseases. Sea level rise and flooding is also likely to degrade the facilities, sometimes making them unviable. Where crop production is moved to other areas because of changing climate, physical structures like these may prove too expensive to relocate to new areas of production, making them more expensive and possibly unviable to run.. With storage in particular interviewees reflected that strategic storage practice is politically sensitive and hard to change, which makes the issue more vulnerable to climate change.

The wealthiest ASEAN members Philippines, Indonesia and Malaysia, as well as Singapore and Brunei are dependent on **imports** for rice security making trade an important issue. A number of members of ranging wealth have policies to build self-sufficiency or even export levels of production. The loss of agricultural land to climate change means that policies which aim to bolster rice security will be under significant pressure from climate change. One country that has been successful in this has been India which has recently become a net rice exporter. The impact of climate change on emerging rice trading partners will therefore need to be added to assessments of climate change impacts on rice security for Member States. Within ASEAN, Myanmar has the potential to develop significant rice production in the Irrawaddy Delta, offering further opportunity if developed in a climate change resilient way. This is a prime opportunity to ensure that decision-making capacity delivers resilient outcomes. The implications of maladaptation for Myanmar and ASEAN would be significant to all.

The Cost of Adaptation

The cost of slow recovery from **disruptive events** has been mentioned. The ADB puts the additional cost of adaptive design for infrastructure at 6-22%. The returns on this investment compared to losses that would otherwise occur will vary and some form of cost benefit analysis will be needed to prioritise points for intervention over time. This will require:

- a clear understanding of the length over which the decision will last,
- the likely climate changes that will impact upon it over that time,
- the points (both physical and moments in time) at which a climate event will diminish or strengthen the value of the investment
- the implications of those impacts on the investment return assumptions

Few Governments faced with the choice of either borrowing more to build resilience or commission "business as usual specifications" are choosing climate change adaptive specifications. On the few occasions where the additional costs are covered by grants then adaptive specifications are adopted. The maladaptation arising from these decisions has significant implications for ASEAN food security.

[6]http://www.asean.org/news/asean-secretariat-news/item/unido-asean-secretariat-to-strengthen-supply-capacity-of-main-food-commodities-to-address-post-harvest-losses-phl-in-asean-countries-at-a-two-day-workshop-in-jakarta

At a number of points in the value chain climate change adds to existing threats e.g. agricultural land use loss, currently from land use change, in future to sea level rise, drought and recurrent flooding.

Capacity

Through the qualitative analysis the capacity of six groups of actors affecting ASEAN food security in a changing climate were considered. These include:

- ASEAN Member States
- ASEAN Secretariat
- ASEAN Sectoral Ministerial Bodies, ASEAN working groups and expert groups etc.
- Other value chain actors e.g. producers, traders, processors and the variety of capacities within each group of actors requiring tailored interventions
- Donors
- Experts, technical advisors and researchers

BOX 10. Case Example Of Reaching Towards High Capacity

The Government of Vietnam is one of the ASEAN Member States working with businesses and other prospective investors to create an attractive regulatory framework and capacity amongst its agricultural producers and to build investor confidence that the regulations will be implemented and capacity delivered to encourage climate smart agriculture to enable climate resilient economic growth.

Member State Capacity

Interviews with Member State Officials suggest a range of adaptation capacity from examples of very low levels (PACT Response Level 1: i.e. it is not addressed as a policy issue) found in PDR Lao to examples of very high capacity found in Vietnam (PACT Response Level 4: i.e. moving beyond efficiency gains in a "business as usual" model, and piloting and experimenting with a range of different approaches to find a more resilient mode of working (see Text Box 10)).

This range is supported by the comments of experts and donors. Areas of medium level capacity (e.g. PACT Response Level 3: i.e. using familiar approaches with greater efficiency) as well as some Response Level 4 (experimenting with radically new ways of working) were reported in Indonesia and Philippines. These are provisional assessments. A more in depth PACT review would be required to confirm these impressions from interviews. This is proposed for the next phase of this initiative.

3.2.2 ASEAN

Internal Collaboration

A number of experienced interviewees report that different parts of ASEAN remain very focused on their task and are less strong at collaboration between each other. They feel that greater collaboration between parts of ASEAN and its Member States will be essential to build food security resilience. This is being addressed with the recent AFCC Ad-Hoc Steering Committee, which is a multi sectoral body addressing climate change and food security within the ASEAN context. It is the aim of this study to support the AFCC in the prioritisation and understanding of climate change impacts on food security.

Prospective participants include (whether involved in most work or in specific cases):

- ASEAN Senior Officials on Agriculture and Forestry
  - AFCC Ad-Hoc Steering Committee
  - ASEAN Work Group on Crops
  - ASEAN Work Group on Fisheries
  - ASEAN Work Group on Livestock
  - ASEAN Work Group on Forestry
  - ASEAN Regional Knowledge Network on Forestry and Climate Change
  - ASEAN Social Forestry Network

- ASEAN Senior Officials on Rural Development and Poverty Eradication
- ASEAN Senior Officials on Environment (ASOEN)
  - ASEAN Working Group on Climate Change (AWGCC)
- ASEAN Secretariat: Socio Cultural Community
  - Environment Division
  - Disaster Management & Humanitarian Assistance Division
  - Social Welfare, Women, Labour & Migrant Workers Division
- ASEAN Secretariat: Economic Community
  - Agriculture Industries and Natural Resources Division
  - Infrastructure Division
  - Trade & Facilitation Division
- ASEAN Working groups on Environment, Health, and Energy sectors
- ASEAN Food Security Reserve Board

Collaboration may also include external bodies such as:

- FAO
- NGOs
- Development agencies
- Donor agencies
- Finance/Insurance companies
- Private sector

For sound decisions to be made, all would need a sufficient level of capacity in resilient food security in a changing climate. It is also likely that a range of existing initiatives would have useful contributions to play. ASCC has already been mentioned. Others include:

- Strategic plan of action on ASEAN cooperation in food, agriculture and forestry
- ASEAN integrated food security (AIFS) framework and strategic plan of action on food security in the ASEAN region (SPA-FS) 2009-2013
- ASEAN multi-sectoral framework on climate change: agriculture and forestry towards food security (AFCC)

ASEAN Capacity

Impressions from observers are that capacity ranges from Capacity Level 1 (inactive) to 2 (reactive, but only in response to pressure from others; in this case Member States). This would be expected since some parts of ASEAN may not yet be feeling directly affected by climate change and as a Secretariat rather than a decision making body, ASEAN can only do what its Member States ask. This appears to create a challenge for ASEAN and its Members. ASEAN initiatives such as AFCC and the ACCI reflect an ambitious programme for addressing climate change. ASEAN Member States have also asked ASEAN to take leadership on some key climate change issues and developed the respective frameworks (please see Text Box below as well as joint statements). Yet the willingness, resources and capacity of Member States to act at a regional level (i.e. internal community building or in its external relations) are not yet sufficient to fulfil those functions. The following table shows the capacity "pathways" that Member States have granted ASEAN. It also shows the complete range of capacity pathways required to fully develop adaptive capacity and which the respective Member States have the authority to develop themselves. Table below provides a brief definition of each term.

ASEAN Capacities Mandated By Member States	Leadership	Working Together	Learning	Awareness

Capacities Required By Member States	Aware-ness	Agency	Leadership	Agents of Change	Working Together	Learning	Managing Operations	Programme Scope and Coherence	Expertise and Evidence

Capacity Pathways	**Definition**
Awareness	Awareness develops as people learn more about climate change. Without a grasp of the issue, serious action is impossible. As awareness rises, organisations consider their own contribution to climate change, and how they will be affected
Agency	Agency is the capacity that an organisation develops to spot, prioritise and make the most of opportunities for action in response to information on climate change. Agency has a strong relationship with what many organisations call "the business case".
Leadership	The role of an organisation's formal leadership— for example, a Government's Ministers or Senior Officials and — is crucial. Good leadership is needed to develop a strategic vision and govern its implementation.
Agents of change	An organisation needs people who understand climate change and have the skills and motivation needed to bring about change. It is crucial that they are recognised by the wider organisation and given the support they need.
Working together	This refers to an organisation's capacity to work collaboratively with other groups – communicating, sharing expertise, and building capacity as a network. This includes but goes beyond what is commonly called 'stakeholder engagement.'
Learning	The extent to which the organisation can support and promote learning from experience and use what is learned to improve procedures, strategies and mission is fundamental to the pace at which it adapts and the capacity it can achieve. This learning is relevant at individual, organisational, and inter-organisational level.
Managing Operations	Managing operations covers how effectively an organisation is translating its ideas into substantial progress towards its goals.
Programme Scope and Coherence	The extent to which climate change is integrated within and between an organisation's activities and objectives. This includes the organisation's ability to regularly update these in light of new learning.
Expertise and Evidence	Utilising the appropriate skills, understanding, expertise and evidence maximises a programme's effectiveness and helps avoid costly errors.

The capacities that have been granted to ASEAN are particularly important for adaptation though. Commonly, building resilience for one organisation requires adaptation by others outside their control. This can be hard to achieve. The ASEAN capacities of "working together" e.g. common position, funding opportunities etc. increasing funds available – reference to green climate fund – stronger position of ASEAN as a region to apply as well as "awareness raising" and "learning" are therefore particularly valuable for Member States. Interviewees reflected on the value of greater internal collaboration within ASEAN. Mention has also been made of collaboration between ASEAN and others relevant to its food security, for example the Mekong River Commission. Thailand, Cambodia, Laos and Vietnam are already Commission Members. Other ASEAN Member States, especially those dependent on imports also have interest in ensuring production along the Mekong remains resilient. ASEAN can represent their interests. Climate change leadership is a newer capacity that has been granted to ASEAN. How to develop this would be a useful focus for the future.

For ASEAN's role to be effective in enabling regional capacity development with its limited number of "pathways" for doing so will depend on the Member States making the other pathways available quickly. Currently these other pathways can only be originated in the Member States. It would be useful for ASEAN and its Member States to consider how they wish to bring those capacities together.

BOX 11. ASEAN Leadership On Climate Change

"The ASEAN Leaders have expressed their concern and commitment for ASEAN to play a proactive role in addressing climate change through their declarations to the 2007 Bali and 2009 Copenhagen UN Conferences on Climate Change. They view the protection of the environment and the sustainable use and management of natural resources as essential to the long-term economic growth and social development of countries in the region. The ASEAN Vision 2020 calls for "a clean and green ASEAN" with fully established mechanisms to ensure the protection of the environment, sustainability of natural resources, and high quality of life of people in the region. Climate change related issues are part of the ASEAN Socio-Cultural Community (ASCC) Blueprint, which is overseen by the ASEAN Environment Ministers. The ASEAN Climate Change Initiative was endorsed as the overall framework to address issues of climate change coordination in the ASEAN context.

However, climate change impacts as we know affect multitude of sectors and regions, in particular the agriculture and forestry sectors are highly vulnerable. hence Initiatives are also included in the ASEAN Economic Community, namely addressing climate change and food security under the ASEAN Ministers on Agriculture and Forestry (AMAF)"

It is clear from interviewee statements that the necessary "pathway" capacities exist in the region. Usefully they are present at a range of levels; amongst Member States, ASEAN and value chain partners. Having a range of capacities across ASEAN Member States as well as within the ASEAN Structures and the Secretariat provides an extremely valuable opportunity to accelerate progress across the region if the lessons and those that can best benefit from them can be linked together. It is not enough to try and learn solely from the cutting edge e.g. a low capacity organisation may learn more effectively from a medium capacity organisation whose logic it understands and with operational capacity that it recognises than a high capacity organisation whose rationale it does not yet understand and ways of working seem out of reach e.g. a country that has recently upgraded some of its infrastructure for the rice value chain may be able to share experience more easily with a partner that is just starting to think about building resilience than a country that is not only developing its infrastructure but also developing complex new policy and capacity amongst farmers to attract significant private inward investment for climate smart agriculture.

Box 12. Agents Of Change

CIAT have a wealth of experience of working in the field to develop climate resilient agriculture and value chain interventions.

Often they find themselves disconnected from others that can:

1. Strengthen their work
2. Implement it

The capacities they have had for a long time are: Expertise & Evidence, Learning, Awareness and Agency at field level.

They know that they do not have the: Programme Scope & Coherence, Leadership or capacity to Manage Operations of those that need to implement their findings if these are to have any impact.

Yet those we all depend upon for implementation lack many of CIAT's capacities. CIAT is now building capacity to Work Together, the missing link.

They are now building communities of practice with other researchers, Government staff and development organisations to; share what they have learned, learn from the experience of others, try new things out, and generate large scale implementation of what works.

Communities of Agents of Change like this are common features of effective adaptation amongst medium and high capacity organisations. They not only provide useful information. The experience of being part of a common initiative to address a common challenge appears to be important too.

On the other hand, with the experience the medium capacity organisation has gained it may now understand the rationale of the higher capacity organisation and even find it feasible to develop comparable ways of working, although the details of how to do that may need to be worked out because of difference between the countries that make a blueprint approach inappropriate. That helps to identify the next steps it needs to take to greater resilience. It

is clear then that a range of capacities such as those within ASEAN and its Member States can help match Members to the right partner in developing their capacity[7].

Since ASEAN is dependent on its Members for consensus decision making for any activity, ASEAN can only be as good as the collective decisions of its Members. Building individual Member State capacity to work through ASEAN would therefore develop collective capacity. This is more straight-forward with higher capacity Members who are more likely to welcome opportunities to strengthen their activity. Lower capacity Members may be harder to engage, especially those that do not feel they need to address this agenda. In this case, identifying "pathways" that might attract the attention of decision makers to the issue e.g. Agents of Change and using ASEAN's capacities to support them by introducing other capacity "pathways" such as their own 'learning' and 'awareness', as well as providing a network of similar change agents and access to evidence and expertise may be useful in attracting more attention from "leadership". Interviewees in this position also felt that more effective engagement of their national leaders on climate would help advocates of climate change resilience to be "heard" by their leaders and enable them to develop an adaptation programme. The most effective use of champions to drive change is through the promotion of an "eco-system" of champions within and between Member States.

Other Capacities

There are a wide range of capacities from PACT Response Level 1 to PACT Response Level 5 across the Region. There are some very high capacity advisors e.g. CIAT and IRRI and some at lower capacity. It is also clear that not all well-resourced advisors are high capacity and not all low resourced advisors are low capacity. In fact capacity and resource did not feel significantly correlated amongst advisors. A key challenge to all is that applicable data (whatever the level required for decision making whether that be sub-national, national, groups of nations or eco-zone) and capacity to interpret it is not sufficient for effective decision making at delivery level, even though the macro-level data makes a compelling case for food security jeopardising climate change in the ASEAN Region. This makes policy development and investment analysis for investment at national level hard to do with confidence. Many countries are building their own models, some using the Colombia University 30-40 year models. Even then localised data can be unclear. Given this situation, a common position proposed by interviewees is as follows; the Region already has climatic conditions placing stresses on food security for which much of ASEAN is not yet resilient e.g. with varying seasonal patterns, more frequent and widespread typhoons. A strategy of building resilience to this and "keeping an eye on the future" is one that advisors feel confident to support. There is a strong logic behind this and is a solid level 3 response (knowing that climate change is important and using more efficient versions of current practice to address it). It does leave the risk of making a long term decision now without considering climate change e.g. on infrastructure or storage that will lock in an outcome which makes it under-effective during its normal lifetime. It would be possible to build a strongly resilient food security value chain from this position though.

[7] This assumes one capacity building partnership option (though not the only one) is to provide mutual support between Member States and actors within them, or experience developed by one Member made available for learning by others. Member State relations may be a balance of common and self-interest, so such support might not be taken for granted.

4 Key Recommendations (Phase 4)

4.1 Framework

The framework and the food security index as a quantitative vulnerability assessment tool, developed in this study, can be very useful to ASEAN in identifying and understanding drivers causing the vulnerability of the food security of certain agricultural products in the period to 2030. It can help in the prioritization of food products (value chains) integral to food security, for intervention towards more climate resilience as well as localizing the most vulnerable ASEAN countries concerning food security and climate change in particular. The tool can also be used for evaluating the effectiveness of interventions reducing the vulnerability of the food security system to the impact of climate change with a lifetime within 2030. The impact of this information depends upon the capacity of ASEAN and its Member States to use it.

The findings of the qualitative part of this study make it clear that information does not necessarily lead to raised awareness, and that even when awareness is raised, this does not necessarily lead to meaningful action. For meaningful responses to develop, a number of other components of capacity (not just information and awareness) are required. The findings of this study show that this capacity varies widely throughout the Region. Developing capacity within ASEAN and the Members States will strengthen the impact of the vulnerability assessment tool within and beyond the period over which the tool is designed; i.e. to 2030. Decisions that are taken within this period but last beyond that timeframe e.g. irrigation, water and flood management, distribution & transportation infrastructures, processing or storage infrastructure will need to look at climate change data relevant to the full life of the investment e.g. many of these longer term decisions will last late into the century during which time very different climate impacts are expected, some of which are mentioned in Table 2.2. Capacity development can also build more effective decision making in these cases. It is therefore important to focus interventions designed to develop adaptive capacity at the points of decision-making and decision-taking. Many different actors tend to be involved within a single decision (e.g. a decision about a dam would involve local planners, local landowners and tenants, hydrologists, engineers, financial institutions, risk managers, environmental impact assessors, donors, etc). The capacity of these actors to collectively include climate change risks within decisions is key to developing climate resilience. In general, the capacity to recognize which decisions need to include climate change is rare. The capacity to take these decisions better even if recognized is even rarer. Annex 4 gives an overview of the key decisions concerning climate change and vulnerability which were being recognized by the regional experts that were interviewed during this study.

Results of the quantitative analysis in this study reflect the average food security condition among ASEAN countries in terms of vulnerability of their food security system at present and in two scenarios until 2030. Food security is looked at in general and the vulnerability to climate change in particular (under the conditions and limitations mentioned in Table 2.2). Part of the capacity development associated with this tool will involve coping with increased climate variability which is not reflected in the average consideration done in the quantitative part of the study. It is recommended that ASEAN could facilitate its member state countries to apply the framework, results and recommendations of this study and invest in the needed capacity development.

These results can give indication on what adaptation interventions in what geographical areas should be prioritized and potential partners for collaboration. Particular focus should be given to production (storage, processing and distribution) centers that are vulnerable to impacts of climate change.

Application of this framework for different sectors or different level of analysis needs to consider the data availability and selection of indicators to represent each production, consumption and distribution component. The availability of comparable data might be less challenging for the analysis at national/country level as usually within the same country use a set of nomenclature and/or same type of data. The selection of indicators needs to carefully consider its closeness in representing the country's/region's characteristics in term of production, consumption and distribution. Lastly, weighting process is also important. Weights can be based on expert judgment or more thoroughly via the Analytical Hierarchical Process (AHP).

4.2 Rice

According to our ASEAN food security index **Myanmar has been found to be the most vulnerable** ASEAN country to rice food insecurity at present and under the assumptions of the future Scenarios (A and B) until 2030. Currently, the other vulnerable countries are **Cambodia, Lao and Philippines,** however in the future Scenarios these three countries become less vulnerable. Therefore fully supporting policies need to be developed for the strategically important areas for ASEAN food security such as Mekong and Red river which currently are already important. A sustainable and integrated development of the Irrawaddy, which has the potential to become an important production area in ASEAN, is crucial. If climate change aspects are anticipated and integrated properly in the development of the Irrawaddy (climate proofing of policies, infrastructure, etc.) Myanmar's future food security can be seen much more positive than in the Scenarios of this study. Looking at the ratio of consumption to production Indonesia, **Myanmar and Lao could reach rice self-sufficiency by increasing its rice productivity, planting intensity through improvement or development of irrigated facilities**. For Indonesia, the improvement of rice yield may be difficult, as in 2030 the yield is already close to its potential yield. Thus, also given its population size, Indonesia will not reach self-sufficiency in the future. Hence **Indonesia needs to focus on other options such as strengthening capacity to reduce post-harvest losses. This also applies to Vietnam, Thailand and the Philippines**.

Thailand and Vietnam, and in the future according to the ASEAN food security index, Cambodia, are the main exporting countries in ASEAN for rice. The other ASEAN countries remain as net importing countries. Under "optimistic" Scenario (A) ASEAN can be self-sufficient for rice however not under the "realistic" Scenario (B). The deficit may even be larger as, due to limited data availability, not all climate change impacts have been integrated (see Table 2-2)..

Finding new, more resistant, varieties with higher productivity is needed for ASEAN to ensure future food security given that rice production loss due to climate impact will increase until 2030. Observing that impact of extreme weather events is always huge, indicates a low capacity of the ASEAN countries in managing the climate risks. The possible increase in frequency and intensity of such events (which could not be considered in the quantitative study) increases the urgent need for ASEAN to assist its members to enhance their capacity in managing climate risks (particularly for storm, flood and drought) and providing climate information for farmers to better adapt to changing conditions.

Increasing productivity through expansion of agricultural land and irrigated area may be limited due to land availability and water scarcity. Further expansion results in reduction of forest area and this increases the vulnerability to climate change as forests play an important role in buffering extreme rainfall as well as other environmental services. It is very important for ASEAN member countries to have comprehensive land use policies in place taking into consideration climate change impacts and risks. Incentives for using non-productive land for agricultural expansion rather than using forested land should be in place as well as policy incentives for supporting environmental services (water, soil, carbon sequestration etc.). A regional initiative in ASEAN to create a regional carbon market particularly for land-forest based carbon projects may be effective to encourage the protection of forested land and to avoid the use of forested land for agricultural expansion.

Research collaboration among member states that can assist policy makers to better understand the implications of climate change at the local level on livelihood, and all components of food security system (including long term investment for agriculture infrastructure) should be enhanced as this would enable greater climate resilience. Also it is strongly recommended that ASEAN develops common policies to address potential trade and food price issues which also can increase food security in the region.

4.3 Maize

According to the ASEAN food security index **Myanmar, Philippines, Indonesia and Vietnam** are categorized as vulnerable concerning maize food security. Under the assumptions of the future Scenarios (A and B) only Indonesia remains vulnerable until 2030, while conditions in Myanmar, Vietnam and Philippines improve. Cambodia and Lao become the main exporting countries in ASEAN however are unable to meet the ASEAN demand which lead to

deficit of about 10 million tons and reaches up to 25 million tons per year by 2030. Climate change impacts are likely to increase these deficits. As maize plays an important role in the food industry and also for animal feed, it is very important for ASEAN to focus on **designing climate resilience maize production systems** and support the member state countries in this area.

4.4 Cassava

According to the ASEAN food security index **Myanmar and Philippines** are the most insecure countries concerning cassava food security. **Myanmar will remain food insecure in cassava in 2030** under the assumptions of the future Scenarios (A and B). However, all ASEAN countries except Philippines and Malaysia will remain as cassava surplus countries. The demand for cassava in these two countries can be met by other countries and there remains a large surplus of more than 20 million tons per year in the ASEAN region. ASEAN could play important role in supporting countries in improving their food diversification by promoting the consumption of cassava as this can help to reduce the reliance of ASEAN countries to imported food such as wheat. Furthermore, cassava is one of the most drought tolerant crops, and is an alternative staple for food diversification in more marginal, food insecure regions. Also the role of cassava as a "backup" staple if other food staples should fail, cannot be neglected. The impression prevails, that despite significant production and consumption in ASEAN, the role of cassava in food security is underestimated, in particular in respect due an adaptation to coming climate change challenges.

4.5 Recommendations from qualitative analysis

Recommended activities from the qualitative analysis (Phase 3 of Methodology) which included stakeholder interviews can be grouped into three categories. The following table highlights recommendations seen as most urgent and feasible. Please refer to Annex 7 for the full list of recommendations. The following recommendations have been linked to the capacity pathways under ASEAN in which the following recommendations either promote certain capacity pathways, such as learning and sharing experiences across member states

FRAMEWORK: **CONNECTIONS BETWEEN ORGANISATIONS, LEADERS, RELEVANT ACTORS AND ENVIRONMENT/CLIMATE THAT DICTATE ADAPTATION OPTIONS FOR ASEAN FOOD SECURITY**	
	Adaptation through agricultural research Identify what adaptation is required through crop variety development for each part of the ASEAN region and when they are likely to be required. Also assess whether variety development to build resistance for climate change driven pest and disease threats is getting enough research attention. This will enable researchers to prioritise their support to ASEAN and help make new varieties available when required. This in turn will help donors to prioritise funding. *Capacity Pathway: Learning, Leadership and Working Together*
	Cross border issues Investigate the capacity in Member States to plan and design resilient transport infrastructure, especially where there are cross-border and strategic food security implications Assess whether ASEAN initiatives to strengthen trans-border issues such as pests and diseases, water management, food hygiene controls are factoring the impact of changing climate e.g. temperature and humidity. *Capacity Pathway: Leadership and Working Together*
	Safety nets An ASEAN initiative to understand, facilitate and support adaptation through emerging micro-credit schemes

	and also index insurance, would be a powerful contribution to adaptive capacity, especially to vulnerable small farmers. *Capacity Pathway: Learning and Working Together*
	Cooperation with other organisations Assess where there are actors in the ASEAN area with a strategic impact on regional food security with which ASEAN could usefully collaborate more closely in its leadership role e.g. The Mekong River Commission due to its impact on a major exporting area as well as individual Member State interests and on economic corridors. *Capacity Pathway: Leadership and Working Together*
	Investments and costing A collective approach could help share lessons, identify best practice and develop guidelines. It could also help develop a collective negotiation capacity to improve terms and attract investment to the region. Identify the criteria that lenders, donors and private sector investors require to make their investments in building food security resilience and support Member States to meet those criteria[8]. Understand the costs of building climate resilient food security in ASEAN and build a strategy for accessing funds. The ADB calculate that adding resilience to the design of food security related investments increases costs by 6-22%. *Capacity Pathway: Learning, Leadership and Working Together*
CAPACITY DEVELOPMENT **WHAT HAPPENS IN THE FRAMEWORK'S CONNECTIONS**	
	Showcasing Pinpoint examples of good practice and develop a strategy for effective sharing amongst ASEAN and Member States reflecting the different learning capacity and preferences amongst them. *Capacity Pathway: Learning*
	Cross country learning and regional frameworks Assess current capacity in ASEAN Member States, researchers, development organisations and other actors; • to communicate information on useful adaptation to each other and to farmers and • engage with to share experience, identify effective practice, the conditions for delivering it and supporting Member States to adopt what is relevant in terms of their capacity and needs. Factors included in this assessment would include: • developing common frameworks for organising information e.g. for doing the vulnerability assessment to maximise outcome and to control the prolification of CC Impact assessment that may lead to conflicting results, stardardising key indicators Developing "generative" communities of learning and practice *Capacity Pathway: Learning, Leadership and Working Together*
	Community of practice Make ASEAN a 'community of practice' for decision makers to share experience and ideas e.g ASEAN initiate stock-taking study on these. Then facilite and promote sharing among AMS. This function is found to be helpful for decision makers trying to address climate change. This could relate to: - ASEAN community (regional approach) or lessons learnt, cross country learning, peer consultations and review, development of standards, guidelines and

[8] For example, Vietnam has identified its climate change resilience programme, developed projects to deliver it and costed it at $3.5 billion. It only has $100 million and is being required by potential investors to demonstrate its seriousness and effectiveness in delivering its "side of the bargain" before funds are committed.

	- ASEAN community towards external relations – i.e. joint proposals for donors, support at regional level, development of join positions and proposals - ASEAN Member States – activities within Bring together relevant experts (climate, irrigation, rice, agri extension, etc.) into dialogue around the decisions being taken with regards to these intervention points *Capacity Pathway: Learning and Working Together*
	ASEAN capacity building Conduct in-depth PACT capacity assessments on participating parts of ASEAN and Member States in building ASEAN food security resilience. Use this to build a common understanding of capacity available and a plan for connecting the most complimentary capacities - to build a strong programme with current capacity - and consider where and how it is most useful to develop capacity further Work with Member States and their representative Ministries to develop their role in supporting capacity development internally and within ASEAN and to identify and prioritise climate change adaptation intervention points for food security. *Capacity Pathway: Working Together*
DATA: **INFORMATION GAPS**	
	Adaptation of climate models to ASEAN regional needs Review localised climate models for ASEAN Member States and review their implications for food security; both individually and collectively, factoring in cross border implications e.g. trade and water use, localised climate change scenarios: • At a provincial or other sub-national level • At river basin/catchment level • Where data is only confident at a larger scale, national level or eco-zone covering more than one country; whatever is the smallest are that can be considered with confidence. Promote the development of local climate change models where they have not been developed by Member States Where data is too weak for national level models but is useful at eco-zone covering more than one country e.g. typhoon vulnerability, assess the value of collective development of such models. *Capacity Pathway: Learning, Leadership and Working Together*
	Regional production hubs and vulnerable areas Build an ASEAN wide view of which geographical areas are likely to be most threatened by climate change and to what extent this will impact on individual Member State and collective food security e.g. threats to existing highly productive river deltas such as the Mekong and Red River; and the potential of under developed deltas with resilient infrastructure design such as the Irrawaddy. *Capacity Pathway: Learning, Leadership and Working Together*

Suggested focus area countries for more focused attention in the next phase:

1. Vietnam; high vulnerability and strategically important exporting country with signs of high capacity adaptation
2. A province of a net importing country which is domestically strategic as a significant net internal food exporter and vulnerable to climate change and with signs of medium to high adaptation capacity e.g. North Philippines or West Java, Indonesia

Myanmar: a low capacity country with high production growth potential that is vulnerable to climate change.

4.6 Other recommendations

Discontinuous impacts from increased extreme weather events due to climate change are likely to increase the vulnerability significantly. A strong lead by ASEAN to **support climate resilient infrastructure investments and developments** is needed to support the ASEAN member countries and its main production regions. For instance it is crucial that the further development of the Irrawaddy delta in Myanmar considers the future changing climate and the development strategy integrates the latest information on climate change and includes adaptation options.

Scientific studies on the implications of global warming on food security, including extreme weather events, are needed within the region, in particular, regional studies with high resolution, forecasting local developments for areas with particular importance to food security. This information is needed to integrate climate change in policies and measures such as market regulation, strategic reserves, storage, infrastructure planning, regional climate index insurance and other long term decisions vulnerable to climate change. **It is strongly recommended that ASEAN plays a role in supporting its members to develop their capacity to use climate information and downscale climate models to local levels.** ASEAN may also play role in **supporting the countries in developing protection systems** to support farmers to cope with bad years (e.g. index insurance). By protecting farmers from the risks of the worst years, insurances can enhance productivity the rest of the time, providing the foundation for economic growth.

In the next 20 years until 2030 (policy time horizon) ASEAN is facing big challenges in food security and self-sufficiency. In the complex food security system with its manifold urgent challenges, there is the risk that climate change is only looked at in a short term view and thus might be judged as not being a very urgent and high priority issue. The quantitative results of this study with a minor influence of climate change until 2030 can be misinterpreted to support this view. However, one has to be aware that many types of climate change impacts (e.g. shorter intervals of extreme weather events, outbreak of pests and diseases due to increasing temperature, changes of rainfall variability are not included due to unavailability of the data on an ASEAN level. **ASEAN has to be very cautious not to make this mistake and start acting and integrating long term climate challenges in their planning now**, as was also stressed by many interviewed stakeholders. Many converging research findings indicate that in the mid-term and longer-term, the impacts of climate change become much more severe and the adaptation will be costly if action is taken too late. **Therefore there is an urgent need to think beyond the policy time horizon which typically is related with shorter timeframe compared to the impact of climate change. Applicable climate information, research** to develop high yielding varieties, **sustainable intensification** of agriculture production, the **prevention of maladaptation** and the development of a **resilient agriculture system preventing** are needed now.

References

ADBI (Asian Development Bank Institute). 2012. Draft Highlights: ASEAN 2030 toward a Borderless Economic Community. Tokyo, Japan.

Baldwin K., Childs N., Dyck J., Hansen J. 2012. Southeast Asia's rice surplus. *A report from the economic research service.* United States Department of Agriculture

CGIAR. 2013. Reducing rice postharvest losses. International Research Institute (IRRI)

Easterling, W.E., P.K. Aggarwal, P. Batima, K.M. Brander, L. Erda, S.M. Howden, A. Kirilenko, J. Morton, J.-F. Soussana, J. Schmidhuber, and F.N. Tubiello. 2007. Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.). Cambridge University Press, Cambridge, UK, 273-313.

FAO. 2011. Strengthening Capacities to Enhance Coordinated and Integrated Disaster Risk Reduction Actions and Adaptation to Climate Change in Agriculture in the Northern Mountain Regions of Viet Nam. Food and Agriculture Organisation, Hanoi.

Faures J.M., Hoogeveen J., Bruinsma J. No year. The FAO irrigated area forecast for 2030. ftp://ftp.fao.org/agl/aglw/docs/fauresetalagadir.pdf. Accessed on April 18th 2013.

Forster, H., Sterzel, T., Pape, C.A., Moneo-Lain, M., Niemeyer, I., Boer, R and Kropp, J.P. 2011. Sea-level rise in Indonesia: on adaptation priorities in the agricultural sector. Regional Environmental Change 11:893-904.

Gupta, S. 2010. Synthesis Report on Ten ASEAN Countries Disaster Risks Assessment. ASEAN Disaster Risk Management Initiatives. UNISDR and the World Bank.

Hertel, T.W., Burke, M.B., and Lobell, D.B., 2010. The Poverty Implications of Climate-Induced Crop Yield Changes by 2030. GTAP Working Paper No. 59

Jevrejeva S, Moore JC, Grinsted A (2010) How will sea level respond to changes in natural and anthropogenic forcings by 2100?. Geophysical Research Letter 37:1–5

Jones, G.W. 2013. The population of Southeast Asia. Working Paper Series No. 196, Asia Research Institute, National University of Singapore.

Lobell D.B., Cassman K.G., Field C.B. 2009. Crop yield gaps: their importance, magnitudes, and causes. *NCESR Publications and Research.* Paper 3.

Loi, H.K. 1996. Flood mitigation and flood risk management in Malaysia. Proceeding of International Workshop on Floodplain Risk Management, pp: 205-216

Masutomi, Y., Takahashi, K. Harasawa, H., Matsuoka, Y. 2009. Impact assessment of climate change on rice production in Asia in comprehensive consideration of process/parameter uncertainty in general circulation models. *Agriculture, Ecosystems, and Environment 131:281-291*

Rahmstorf, S. 2007. A semi-empirical approach to projecting future sea-level rise. Science 315:368-370

Rosenzweig, C and Iglesias, A. Potential Impacts of Climate Change on World Food Supply data Sets from a Major Crop Modeling Study. http://sedac.ciesin.columbia.edu/giss_crop_study/CCMmethod.html

Sarma J.S., Kunchai D. 1991. Trends and Prospects for Cassava in The Developing World. International Food Policy Research Institute, Washington

Zhu, T., and Sihymete. *2010.* Climate Change Impacts on Agriculture in Vietnam. *International Food Policy Research Institute, 2033 K Street, NW, Washington, DC, USA*

Gummert, M. 2013. Reducing Rice Postharvest Losses. International Rice Research Institute (IRRI). Los Banos.

Mejía, D. 2003. MAIZE: Post-Harvest Operation. Food and Agriculture Organisation of the United Nations (FAO), Rome.

Bala, B.K., Haque, M.A., Hossain, M.A. and Majumdar, S. 2010. Post Harvest Loss and Technical Efficiency of Rice, Wheat and Maize Production System: Assessment and Measures for Strengthening Food Security. National Food Policy Capacity Strengthening Programme, FAO, Rome.

de Padua, D.B. Postharvest handling in asia: 1. Rice. International Rice Research Institute, Los Banos.

Annexes

Annex 1: Assumptions for the quantitative analysis

Annex 2. Detailed results of the quantitative analysis (spider diagrams)

Annex 3. Vulnerability mappings

Annex 4: Key Climate Change Vulnerable Decisions in ASEAN Food Value Chain

Annex 5: Literature review

Annex 6: Interviews

Annex 7: Additional recommendations from qualitative interviews