

STRIKING A BALANCE

MANAGING EL NIÑO AND LA NIÑA IN VIETNAM'S AGRICULTURE

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Mark Rosegrant, James Thurlow,
and Leocardio Sebastian*



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Abbreviations

AFS	Agriculture food system
ASEAN	Association of Southeast Asian Nations
AWD	Alternate wet and dry
CBDRM	Community-based disaster risk management
CCAFS SEA	CGIAR Research Program on Climate Change, Agriculture and Food Security in Southeast Asia
CGE	Computable general equilibrium
CRP CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CS MAP	Climate-smart maps and adaptation plans
CSCNDPC	Central Steering Committee for Natural Disaster Prevention and Control
DARD	Department of Agriculture and Rural Development
DCP	Department of Crop Production
DSSAT	Decision Support System for Agrotechnology Transfer
ECHO	European Civil Protection and Humanitarian Aid Operations
EMMA	Emergency Market Mapping Analysis
ENSO	El Niño–Southern Oscillation
ERP	Vietnam Emergency Response Plan
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
GDP	Gross domestic product
ha	Hectare
IFPRI	International Food Policy Research Institute
INGO	International nongovernment organizations
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
NCERSR	National Committee for Emergency Response, Search and Rescue
NCHMF	National Center for Hydro-Meteorological Forecasting
NGO	Nongovernment organization
ONI	Oceanic Niño Index
PACCOM	People’s Aid Coordination Committee
SAM	Social Accounting Matrix
SEA DRIF	South East Asia Flood Monitoring and Risk Assessment

SST	Sea surface temperature
UN	United Nations
UN-ESCAP	United Nations Economic and Social Commission for Asia and Pacific
UN-FAO	United Nations Food and Agriculture Organization
US\$	United States dollar
WMO	World Meteorological Organization

Foreword

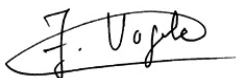
In a world of climate change and headline grabbing cyclones, El Niño is one of the most unspoken climate risks in East Asia and the Pacific. It is a cyclical event that consistently ravages the region's economies and agricultural sectors with droughts and water scarcity. In turn, La Niña, the cool phase which typically occurs the year after an El Niño event, often brings extensive damage from floods and heavy rainfall. El Niño has occurred eight times since 1980, with the most recent event, from 2014 to 2016, being the most severe, causing billions of dollars in damage to the region. Experts forecast another El Niño event, predicted to affect East Asia and the Pacific in the winter of 2018–2019.

Given the cyclical nature of the El Niño–Southern Oscillation (ENSO) events, it is critical that governments have plans in place to face the threat. The research presented here is the first to carry out in-depth economic modeling to calculate changes in agricultural production, gross domestic product, household welfare, and poverty levels from both El Niño and La Niña in East Asia and the Pacific. It also estimates how certain policy interventions could mitigate these impacts. As such, the *Striking a Balance* reports could be important tools for policy makers in Cambodia, Lao PDR, Myanmar, the Philippines, and Vietnam—the five countries examined in the series.

The reports' findings are concerning: the authors estimate El Niño produces GDP, consumption, and income losses for all households, in all countries, regardless of income level, urban-rural location, or gender. El Niño threatens to raise food prices, with women and poor people set to suffer the most because they spend more of their income on food. Because of this, El Niño could threaten the region's poverty reduction and food security advances from the past decade. Fortunately, the reports also find there may be opportunities to harness the heavier rainfall which occurs during La Niña to achieve some GDP, consumption, and poverty reduction gains.

Regional governments have made inroads in preparing for climate events like floods and other natural disasters, but more could be done to prepare for ENSO specifically. This includes building resilience and preparedness by investing in early warning systems, developing national action plans, and cooperating with other East Asia–Pacific countries on ENSO-related challenges, which are regional in nature. Striking a balance

among these various policy options, and between El Niño and La Niña management, demands concerted effort. It is our hope that this report will catalyze collective action and help governments and other national and subnational stakeholders achieve that balance.

A handwritten signature in black ink, appearing to read "J. Voegelé", with a long horizontal flourish extending to the right.

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Overview

This report’s purpose is to help Vietnam policy makers and stakeholders prepare for future El Niño–Southern Oscillation (ENSO) events. It does this by providing information on ENSO’s agricultural, economic, and poverty impacts in Vietnam and outlining ways forward. The report finds that ENSO’s impacts vary from region to region and harm Vietnam’s people, economy, and agricultural sector. The country prepared for, and responded to, the 2014–2016 El Niño, but there is still room to improve upon these actions. Being proactive to prepare for ENSO is important because of Vietnam’s high exposure to climate shocks, the prominence of the agricultural sector in the national economy, the rural population’s climate vulnerability, and the lack of research on ENSO in Vietnam. Moreover, there is a high likelihood that Vietnam will face another El Niño by winter 2018/2019.¹

ENSO has important impacts on Vietnam’s climate, agriculture, economy, and society

Vietnam is highly exposed to ENSO-related climate shocks. ENSO describes naturally occurring ocean and atmospheric temperature fluctuations that can have major implications on global weather patterns. Historical data show that the two phases of ENSO, El Niño and La Niña, tend to depress and increase average rainfall, respectively. Also, while both phases decrease average rainfall in the north, only El Niño depresses rainfall in the center and south of Vietnam, with La Niña increasing rainfall in both. The South also faces the ENSO-related challenge of saltwater intrusion. In fact, the country’s most vulnerable regions to ENSO are the South Central Coast, Central Highlands, and Mekong River Delta. Complicating matters is Vietnam’s high risk of natural hazards, including floods, drought, and cyclones.² By some measures, Vietnam is the seventh most disaster-prone country in the world, with more than 13,000 deaths and \$6.4 billion in property losses over the last two decades.³ In the case of El Niño, drought and saltwater intrusion during the 2014–2016 event caused an estimated \$3.6 billion in damages to agriculture, fisheries, and aquaculture alone.⁴

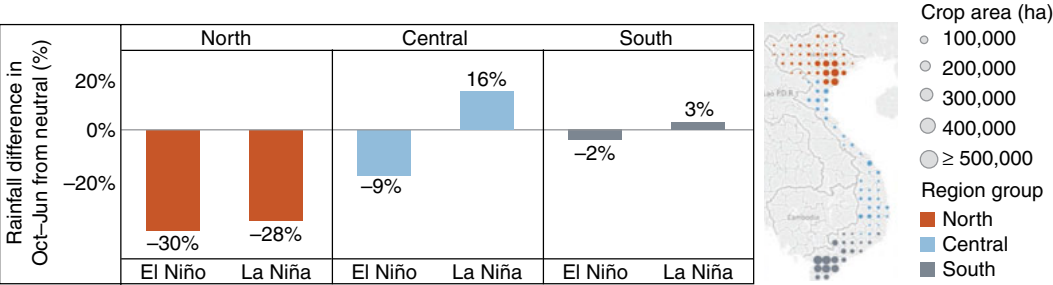
¹NOAA (2018); http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ens0_advisory/ensodisc.shtml

²UN-OCHA (2016).

³Fock (2017).

⁴UN-FAO (2016a); UN-OCHA (2016).

FIGURE A: Differences of Rainfall between ENSO and Neutral Phases in Subregions, October to June, 1980–2015.⁵



ENSO’s impacts on agriculture have economy-wide implications. Agriculture is an important economic sector in Vietnam providing over a fifth of gross domestic product (GDP) and two-fifths of employment. However, when accounting for downstream processing and spillover across sectors, the entire agriculture food system (AFS) provides over a quarter of GDP and over half of employment. As such, any shocks to agriculture lead to reverberations across the entire economy, with serious implications for welfare, food security, and national poverty levels. Figure A shows how average rainfall during ENSO varies in north, central, and south Vietnam and which of those regions are the most important for agriculture.

Crop production losses during El Niño can be partially recovered by crop production gains during La Niña. Over the last four decades, the largest El Niño reductions typically occurred in the Northern Midlands and lower parts of the Mekong Delta, while the largest La Niña gains occurred in Central Vietnam. Maize production gains during El Niño are on par with maize production losses during La Niña in many parts of Vietnam, but rice gains are only about half of rice losses. This is because maize is more drought tolerant than rice. Nevertheless, these results suggest that higher production during La Niña can offset some production losses from El Niño.

There is evidence that ENSO contributes to declines in Vietnamese fisheries and livestock. By the end of the last El Niño in March 2016, domestic fish production was about 38,000 tons, or 2.6 percent lower than the previous year.⁶ Simulations run for this report also estimate that El Niño causes fishery production losses for both capture fisheries and aquaculture. There is no evidence that La Niña contributes to fishery

⁵Authors’ reanalysis using UEA CRU-TS v4.0. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.
⁶Danh (2016).

production losses. ENSO's links to livestock production are less well established. However, La Niña causes more hot and humid days, which increases heat stress on livestock and imposes related costs on producers.

Strong El Niño events lead to GDP losses, while strong La Niña events lead to smaller GDP gains. Simulations for this report show that national GDP losses during a strong El Niño event are \$2.5 billion compared to a \$1.1 billion gain during La Niña. Percentage losses are larger in agriculture, where GDP falls by nearly 10 percent. Even small percentage reductions in national GDP can imply substantial monetary losses. For example, a 1.5 percent drop in national GDP is equal to \$2.5 billion in lost value-added. Overall, simulations estimate about a quarter of the agriculture food system's economic damages during strong El Niño events occur outside of agriculture. Simulations for individual sectors show that La Niña gains in each sector, in percentages and dollar-value amounts, do not match El Niño losses in those same sectors. Since Vietnam is a major rice exporter, international rice markets can also be adversely affected, especially when combined with policy actions that limit exports.

The rural poor are particularly vulnerable to ENSO. Welfare, or consumption, levels in Vietnam are lower in rural areas than urban areas, and lower among the poor than the nonpoor. Simulations show that rural households see a 3.5 percent decline in welfare during a strong El Niño compared to a 2.7 percent decline for urban households. Simulations also show that the poorest households experience the largest welfare declines during strong El Niño events. More specifically, consumption falls by 4.9 percent for households in the poorest quintile, compared to a 3.9 percent decline for all households. Since ENSO contributes to higher food prices, it disproportionately affects the poor, who spend more of their total income on food. This exacerbates food insecurity,⁷ malnutrition,⁸ and consumption poverty. As such, ENSO's effects on rice and maize, for example, have larger implications for poorer consumers, who also tend to be rural, because they spend a large share of their incomes on cereals. Lower income households may also be unable to smooth consumption by selling assets during ENSO-related shocks. Simulations show a strong El Niño event increases the national poverty rate by 1.9 percentage points. This is equivalent to an additional 1.7 million people living below the poverty line during the El Niño period.

Women particularly suffer from El Niño. Women play a central role in agriculture in Vietnam, making them vulnerable to ENSO. The female agricultural labor force

⁷Dawe and others (2009).

⁸Alderman and others (2006).

contributes more hours of labor than men in cultivation, livestock breeding, agricultural processing, and agriculture produce marketing.⁹ Women in Vietnam also make up 80 percent of the rural aquaculture workforce¹⁰ and often lead livestock rearing, especially for poultry.¹¹ In reality, women work in all facets of agricultural activity. This partly explains why they suffer disproportionately from El Niño. Simulations show that the poverty rate for people living in female-headed households increases by 2.7 percentage points during strong El Niño events, which is higher than for people in male-headed households. This is, in large part, because people in female-headed households are more likely to be poor farmers, who are the hardest hit by El Niño.

Vietnam has taken actions to support ENSO preparedness, but there is room for improvement

The government has several mechanisms in place to respond to ENSO and acted as the 2015–2016 El Niño progressed. The government has a well-established system of disaster response, though its mechanisms for dealing with climate change and ENSO are less robust. The government also works with a wide array of partners on these issues, including the World Bank, which supported Vietnam through several salinity-, drought- and climate change-related projects. During the 2014–2016 El Niño, the government mobilized nongovernmental organizations (NGOs), international organizations, and local and national government agencies to support different ENSO response measures. In March 2015, the government initiated response and recovery measures to mitigate the drought that began in late-2014. This included information gathering missions, forecasts from the National Center for Hydro-Meteorological Forecasting (NCHMF), and eventually, financial support to the affected regions. The goal was to mitigate potential disasters in three severely affected regions: South Central Coast, Central Highlands, and Mekong River Delta. In total, the government mobilized \$65 million in aid for El Niño-affected provinces and irrigation operators. Despite these efforts, the Ministry of Agriculture and Rural Development (MARD) calculated that 2015–2016 recovery costs in the 18 drought-affected provinces would reach \$1.2 billion by 2020.¹²

⁹<https://www.adb.org/sites/default/files/institutional-document/32605/women-viet-nam.pdf>

¹⁰Kusabe and Kelker (2001); <http://www.fao.org/docrep/013/i2050e/i2050e.pdf>

¹¹<http://siteresources.worldbank.org/INTGENAGRLIVSOUBOOK/Resources/Module14.pdf>

¹²UNRC Vietnam (2016c).

Government efforts in 2016 revealed areas where it is possible to strengthen Vietnam's preparation for future ENSO events. These include:

Government areas to strengthen

- Existing government policies for slow onset events, such as El Niño, have unfulfilled potential. Strategies for ENSO, climate change, and disaster risk are fragmented. Also, government officials lack capacity in some of these areas.
- ENSO preparedness is underfunded and undercoordinated. ENSO interventions would benefit from a clearer coordination mechanism, ideally building on existing mechanisms or institutions for climate change adaptation and disaster risk management.
- There is an inability to localize climate and weather forecasts and transform them into advisories that local farmers and technicians can more readily use. Current limitations in forecasting data reflect scarce subnational weather and agricultural data.

General areas to strengthen

- Logistical capabilities do not reach their full potential in supporting interventions. For example, during 2015 and 2016 drought and salt tolerant seeds were not available in the quantities needed, planting time adjustments and plans to use short-duration varieties were not prepared, and mechanisms to plant alternative crops were not in place when needed.
- Local farmers and extension workers could improve their capacity to implement alternative preparedness options, such as developing alternative crop value chains or monitoring salinity and adaptation progress.
- Inaccurate or ineffective location-specific information limits local-level support for certain ENSO-related initiatives.
- Women are often unable to assume leadership roles in agriculture despite their central role in that sector.

Different policy interventions can mitigate El Niño's impacts to varying degrees

Policy interventions and investments, especially expanded irrigation, can offset some of the GDP losses associated with ENSO. In-depth modeling carried out under this study simulated six policy interventions—including introducing drought-tolerant crop varieties, expanding irrigation, restricting rice exports, storing and distributing grains, expanding social protection coverage (or social transfers), and applying all of

these policy interventions simultaneously—to understand how they would mitigate El Niño's impacts on GDP, household welfare, and poverty. Expanding the use of irrigation offsets GDP losses by making overall production more resilient to climate shocks. It also raises yields during normal years. Overall, expanding irrigation reduces GDP losses from \$2.5 billion to \$2.2 billion. Compared to other countries where similar analyses were conducted, irrigation's impacts in Vietnam are somewhat muted because most of the country's agriculture already uses irrigation, leaving little potential to expand. For example, for Vietnam's main crop, rice, 85 percent of rice paddies are irrigated in the North, 82 percent in the Central, and 90 percent in the South. Introducing drought-tolerant varieties and depleting grain stores had minimal impacts on offsetting GDP losses. By contrast, introducing social transfers, like cash transfers, or restricting rice exports actually add to GDP losses. The reason is that cash transfers do not directly increase production and require offsetting tax increases, while restricting rice exports lowers food prices, which benefits net consumers and helps maintain demand for nonfood products during El Niño events but also reduces incomes for net food producers. Overall, when all of the interventions considered in this study are combined and implemented concurrently, there is still a sizable GDP loss of \$2.1 billion during a strong El Niño event.

Policy interventions are effective in reducing household welfare losses. Expanding irrigation use and providing drought-tolerant seed varieties reduce consumption losses across the income distribution but do not eliminate all losses. Restricting rice exports, which also has several downsides, and expanding social transfers such as cash transfers are more effective, even when they have tax and income implications for higher income households. Social transfers are especially effective at minimizing consumption losses, since they directly target the poor during El Niño. Of the six policy options considered, social transfers are the most effective intervention for limiting ENSO-related poverty increases. When all policy scenarios are implemented at the same time, total consumption losses during strong El Niño event years are almost eliminated, from a 3.9 percent to a 1.2 percent loss. Welfare improvements are even more dramatic for households in the poorest quintile, reducing losses from 4.9 percent to 0.4 percent.

Rural and female-headed households' welfare declines the most during El Niño, but these households also stand to gain the most from policy interventions. Simulations show that without any policy interventions, rural family consumption falls by 3.5 percent. This is 0.8 percentage points more than urban family consumption losses. Restrictions on rice exports are the most effective in stabilizing urban consumption losses during a strong El Niño. The goal of export restrictions is to curb increases in domestic rice prices during supply shocks. This is a policy Vietnam has implemented

before, albeit temporarily, in 2004 and 2007. Unfortunately, export restrictions also reduce rural farmers' incomes and can negatively impact other countries whose populations depend on imported grains from Vietnam. For similar reasons, rural households benefit less from distributing stored grains than urban households because it reduces farmers' incomes. Social transfer programs, like targeted cash transfers, benefit rural families the most because these families tend to be poorer than urban families. Simulations also show that female-headed households benefit more than male-headed households from policy options. This is especially true for social transfers, in part because female-headed households are more likely to be poor and thus more likely to be the beneficiaries of a progressive transfer scheme.

The government can take additional actions to improve ENSO preparedness in Vietnam

There are many opportunities to improve ENSO preparedness and resilience. In Table A, recommendations are divided into two groups: preparedness and resilience. *Preparedness* are measures specifically geared toward ENSO and should, ideally, be in place before the next ENSO event occurs. These actions will significantly empower people to cope, respond, and recover from damaging ENSO events. *Resilience*, by contrast, are measures that are not specifically tailored to ENSO, but that will build individuals' and organizations' ability to adapt to multiple forms of risks and shocks without compromising long-term development. Recommendations in purple are a high priority; recommendations in yellow are a moderate priority. The final two columns denote short-term (S) actions that could be completed within a year, and medium- to long-term (M/L) actions that require more than a year to achieve.

TABLE A: Summary of Recommendations and Proposed Actions.

	Recommendation	Actions	S	M/L
Preparedness	Identify intervention priorities	• MARD should work with international partners to identify intervention priorities.	X	
		• Develop an action plan to implement these priorities.	X	
	Improve preparedness for slow onset events like El Niño	• Bring together stakeholders and expand disaster risk plans to explicitly include slow onset events, like drought.	X	
		• Expand agricultural research on early maturing and stress-tolerant crop varieties and water use efficiency	X	
	Harness La Niña's rebound	• Increase water use efficiency.	X	X
		• Reduce flood risk in flood-prone areas.	X	X

(continued)

TABLE A: Continued.

	Recommendation	Actions	S	M/L
Preparedness	Prepare risk-potential maps	Prepare maps with spatial distribution and levels of potential impacts and provide access to government officials and outside practitioners.	X	
		Link the maps to recommended actions or best practices.	X	
	Support an effective early warning system (EWS)	Identify partner institutions with forecasting capabilities and EWS capacity to guide MARD.	X	
		Develop an EWS alert system on ENSO's severity with partners based on crop model estimates, three-month forecasts, and best practices.	X	X
		Link the alerts to agricultural risk maps.	X	X
		Update the network of Automated Weather Stations.	X	X
	Develop 3-month ENSO forecasts	Building off the EWS, develop three-month forecasts, with a dissemination mechanism, to help farmers plan.	X	X
	Invest in a communication portal	Strengthen the government's meteorological news portal by generating content on practical actions for farmers.	X	
		Link this information sharing mechanism with the EWS/forecasting systems.	X	X
	Focus on highly vulnerable areas	Target ENSO preparedness interventions toward specific challenges and vulnerable areas using risk-potential maps.	X	
	Identify market policies to smooth price fluctuations	Create a committee to identify potential policies that can be enacted during food price shocks.	X	
		Activate policies when certain price fluctuation thresholds are met.	X	
		If rice export bans are considered, establish trade protocols and procedures to safeguard producers and assure policies can be quickly removed.	X	
	Stock grain stores before El Niño events	Assess the current grain storage capacity in Vietnam. Identify constraints and risks to grain producers	X	
		Make plans to stock these spaces before the next ENSO in areas that are easily accessible.		X
	Expand and adjust social safety nets (SSNs)	Assess constraints to expanding current SSNs and properly targeting beneficiaries.	X	
		Move toward increased funding, skills development, and capacity building to launch or scale up SSNs.		X
		Adjust SSNs to make them more responsive to ENSO events.		X

	Recommendation	Actions	S	M/L
Resilience	Improve government capacity and coordination	Streamline government policies, programs, and departments dealing with ENSO and other climate shocks.	X	
		Clearly identify the roles and operational mechanisms of each institution in relation to these programs.	X	
		Develop a mechanism for national stakeholders to work with subnational actors to create a better flow of information.	X	
		Exchange information through forums or other dialogues.	X	
	Integrate a regional approach to ENSO	Begin dialogues with potential partners in ENSO.	X	
		Identify areas of cross-border vulnerability and potential infrastructural cost sharing.		X
	Strengthen MARD's analytical capacity	Improve capacity through MARD's agricultural research and development program.		X
		Develop a grid-based, countrywide crop systems modeling framework.		X
		Maintain this framework in partnership with academic institutions.		X
	Empower local communities to lead their own ENSO responses	Compose a team to gather local knowledge from high-risk areas and share it with local communities.	X	
		Allow local partners to prepare their own provincial preparedness plans, with federal funding support.	X	X
	Sustain and scale up good practices	Identify Vietnamese best practices on ENSO-related themes.	X	
		Increase human and resource capacity to scale up these practices.		X
	Invest in rural roads and irrigation infrastructure	Assess the prevalence and condition of rural infrastructure, including roads and small-scale irrigation.	X	
		Where feasible, develop plans to expand small-scale irrigation and water harvesting systems.		X
		Develop plans to improve rural roads with a focus on connecting agricultural production to markets.		X
	Target women	Develop a strategy targeting women who are vulnerable to ENSO.	X	
		Empower women in leadership positions in local- or national-level efforts to combat ENSO impacts.	X	



CHAPTER 1

Introduction

This report's purpose is to help Vietnam policy makers and stakeholders prepare for future El Niño–Southern Oscillation (ENSO) events. It does this by providing information on ENSO's poverty, economic, and agricultural impacts in Vietnam and outlining ways forward. The report finds that ENSO's impacts vary from region to region and harm Vietnam's people, economy, and agricultural sector. The country proactively prepared for and responded to the 2014–2016 El Niño, but there is still room to improve upon these actions. Preparing for ENSO is important because of Vietnam's high exposure to climate shocks, the importance of agriculture in the national economy, the rural population's climate and economic vulnerability, and the lack of research on ENSO in Vietnam.

Vietnam is highly exposed to ENSO-related climate shocks. Historical data show that the two phases of ENSO, El Niño and La Niña, tend to depress and increase average rainfall, respectively. Moreover, while both phases decrease rainfall in the North, only El Niño depresses rainfall in the Central and South, with La Niña increasing rainfall in both. The South also faces the ENSO-related challenge of saltwater intrusion. In fact, the country's most vulnerable regions to ENSO are the South Central Coast, Central Highlands, and Mekong River Delta. Complicating matters is Vietnam's high risk of climate shocks, including floods, drought, cyclones, earthquakes, landslides, and tsunamis.¹³ By some measures, Vietnam is the seventh most disaster-prone country in the world, with more than 13,000 deaths and \$6.4 billion in property losses over the last two decades.¹⁴ In the case of El Niño, drought and saltwater intrusion during

¹³UN-OCHA (2013).

¹⁴Fock (2017).

the 2014–2016 event caused an estimated \$3.6 billion in damages within agriculture, fisheries, and aquaculture.¹⁵

ENSO's impacts on agriculture have economy-wide implications. Agriculture is an important economic sector in Vietnam, providing over two-fifths of employment and over a fifth of gross domestic product (GDP). Most poor people live in rural areas and work in agriculture, so they are vulnerable to climate shocks. Agriculture is even more important when considering its linkages with downstream sectors and consumers in domestic and foreign markets. As such, any shocks to agriculture lead to reverberations across the entire economy, with serious implications on welfare, food security, and national poverty levels.

The rural poor are particularly vulnerable to ENSO-related shocks. Poverty remains pervasive in Vietnam and is concentrated in rural areas where two-thirds of the population live. Despite this, poverty indicators and nutritional outcomes have improved.¹⁶ Per capita GDP has climbed from \$433 in 2000 to \$2,185 in 2015.¹⁷ The share of the population who are undernourished fell to 11 percent by 2015 and the incidence of wasting for children under five fell to 4 percent by 2010.¹⁸ However, there were still over 9 million Vietnamese living below the national poverty line in 2016.¹⁹ As shown in section 5, a strong El Niño can increase the impoverished population by over two percentage points. More importantly for the rural poor, ENSO contributes to higher food prices and food insecurity,²⁰ which lead to greater malnutrition²¹ and consumption poverty, since poor families spend more of their total income on food.

This report is timely given the lack of research on ENSO in Vietnam and the high likelihood of Vietnam facing another El Niño in the medium term. ENSO policy is complicated because it is difficult to disentangle ENSO's impacts from those of other climate shocks, natural disasters, and economic cycles. This makes it difficult to design policies and response mechanisms that help mitigate ENSO-related welfare losses and economic damages. There is a growing body of empirical evidence measuring the effects of climate change and variability on Vietnam's agricultural and national economies. Few studies, however, focus on the specific impacts of ENSO events, and no studies measure economy-wide outcomes. Moreover, while there is a

¹⁵UN-FAO (2016a); UN-OCHA (2016).

¹⁶UN-FAO (2016b).

¹⁷In current U.S. dollars, WDI (2018).

¹⁸WB-WDI (2018).

¹⁹<http://povertydata.worldbank.org/poverty/country/VNM>

²⁰Dawe and others (2009).

²¹Alderman and others (2006).

growing literature on how disasters are managed in Vietnam, there are few quantitative assessments of these policies and how they can mitigate ENSO-related losses. At the time of writing this report, forecasts predict at least a 70 percent chance of another El Niño event by the winter of 2018/2019.²²

Roadmap

This report evaluates El Niño and La Niña’s impacts on agricultural production—particularly for crops, livestock, and fisheries—and how these have implications for the national economy and household poverty levels. It then looks at the actions taken by the Vietnamese government to mitigate the losses associated with past ENSO events. This includes the preparation for and response to the 2014–2016 El Niño. Next, the report looks at areas to strengthen Vietnam’s ENSO preparedness and simulates how well certain policy options mitigate ENSO-related GDP and welfare losses. It concludes by recommending actions to enhance Vietnam’s preparedness for future ENSO events. Box 1 provides a brief description of the research’s methodology.

BOX 1: Methodology.

The report synthesizes available evidence and presents new analyses on ENSO’s impacts on Vietnam’s weather, agricultural production, poverty levels, and the broader economy. The evidence comes from a secondary literature review, an analysis of historical data, and a series of simulations. Simulations were carried out using two models. The first is the Decision Support System for Agrotechnology Transfer (DSSAT) model, which is widely used by agricultural researchers to understand crop production system dynamics and simulate different farm management and environmental changes, including climate variability associated with ENSO. The second is a Computable General Equilibrium (CGE) model. The models simulate: (i) potential agricultural productivity under various conditions, including water scarcity, different planting months, and low or high fertilizer use; (ii) the indicative impacts of ENSO on livestock using the Temperature Humidity Index (THI); (iii) economic outcomes associated with these productivity losses (usually during El Niño) and gains (usually during La Niña); (iv) economic outcomes, including spillover effects associated with certain policy changes, such as providing drought resistant crop varieties, increasing irrigated land, imposing trade restrictions, increasing grain storage and distribution, providing social transfers through short-term income support to households, and a combination of these; and (v) poverty impacts on rural households with male and female household heads. Put simply, the model simulates the impact of historical ENSO events if they were to reoccur today and

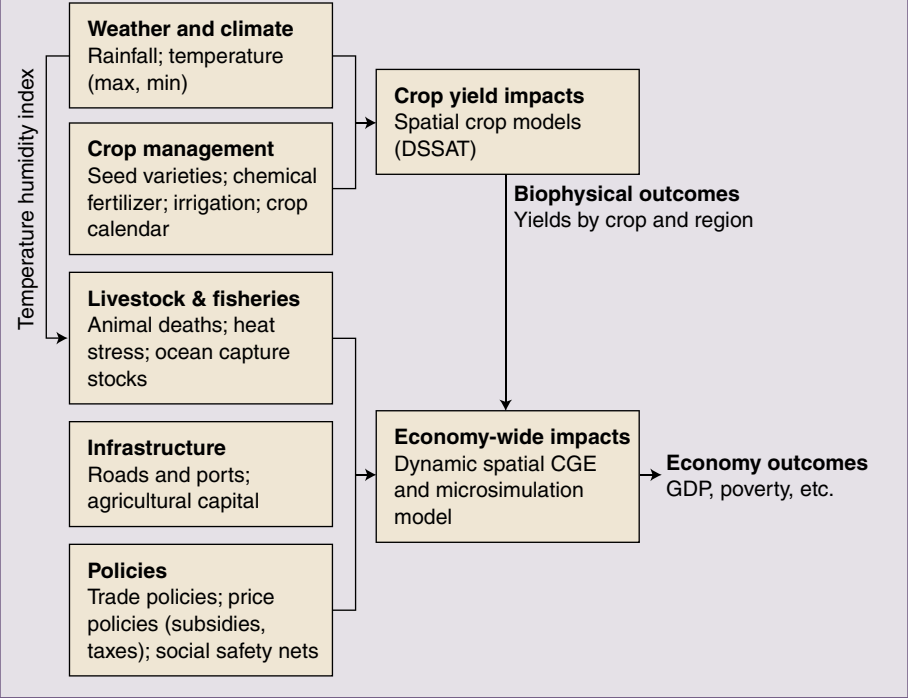
(continued)

²²NOAA (2018); http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml

BOX 1: Continued.

affect the current economy. This is valuable given the lack of systematic historical analyses of ENSO’s impacts on poverty and broader economic growth. The models do not simulate water supply constraints because of a lack of useable data. For the detailed methodology refer to Annex 1. Figure 1 depicts this report’s analytical framework.

FIGURE 1: Integrated Analytical Framework.



CHAPTER 2

ENSO Affects Vietnam

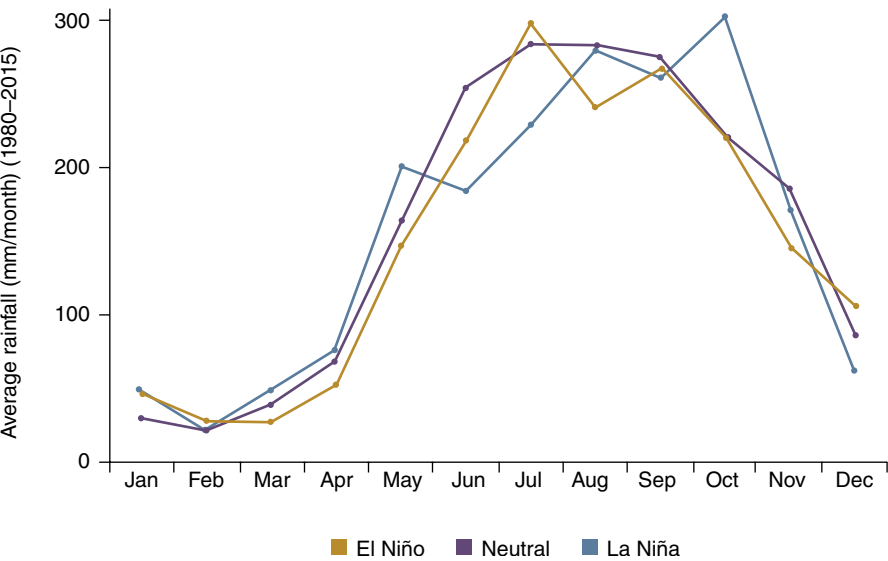
ENSO, or the El Niño–Southern Oscillation, describes naturally occurring ocean and atmospheric temperature fluctuations across the east-central Equatorial Pacific Ocean. These temperature fluctuations are considered ENSO when they are greater than 1 degree Celsius. They can have large-scale impacts on ocean processes and global weather patterns. ENSO consists of two opposite phases: El Niño and La Niña. El Niño is ENSO’s warm phase, while La Niña is ENSO’s cold phase. El Niño and La Niña episodes typically occur every four years and last nine to twelve months or longer. Refer to Box 3 for a distinction between ENSO and climate change.

ENSO’s most notable effect is on average rainfall, which falls during El Niño and rises during La Niña. In Vietnam, on average, El Niño is drier than La Niña, especially in winter and spring. Historical data from 1980 to 2015 show that rainfall during El Niño is 12 percent lower than in non-ENSO years, while rainfall during La Niña is 2 percent lower, but with greater variability (8 percent higher standard deviation). In fact, in most instances, La Niña increases precipitation over much of Vietnam.²³ Studies²⁴ show the number of months with heavy rainfall rise during La Niña years, leading to intensified flooding in Central Vietnam (Figure 2). It should be noted that El Niño’s impacts are most severe during the dry season, from November to March. During El Niño, the rainy season ends about a month early, reducing rainfall in the dry season, increasing the temperature and evaporation rate, and reducing water levels and water flows in rivers. All these factors aggravate drought conditions and salinity intrusion.

²³Zhang and others (2002) and (2004).

²⁴Gobin and others (2016); The study focused on heavy rainfall patterns and their relationship with the ENSO cycle from 1960–2009. Unfortunately, it does not provide specific estimates of the quantity or value of La Niña’s impacts on rice production.

FIGURE 2: Monthly Average of Rainfall Amount in ENSO Phases During 1980–2015.



Source: Authors’ reanalysis using the University of East Anglia Climatic Research Unit-Time Series (UEA CRU-TS) v4.0.

Severe droughts occur in Vietnam during prominent El Niño years (Table 1). Drought occurs in different areas each year, mostly during the winter–spring (January to April) and summer–autumn seasons (May to August). The specific timing of drought varies across agroclimatic zones.²⁵ During El Niño years, average temperatures are higher and total precipitation is lower than preceding, non-El Niño years. Historical data show that severe droughts occurred in Vietnam in four of six El Niño years: 1997–1998, 2004–2005, 2010, and 2014–2016. Frequent rainfall shortages during El Niño led scientists to conclude that droughts are largely caused by ENSO in Vietnam.²⁶ In September 2016, 52 out of 64 provinces in the South Central, Central Highland and Mekong River Delta regions of Vietnam were affected by drought and saltwater intrusion caused by El Niño.²⁷ The 18 most negatively impacted provinces, or a population of about 2 million people, were in urgent need of humanitarian aid.²⁸

ENSO impacts parts of the country differently. ENSO patterns are notably stronger in the northern region during both El Niño and La Niña, about 30 percent less rainfall

²⁵IMHEN and UNDP (2015).
²⁶Hien and Ninh (1988); Tang and Thi (1999); Tang (1998); and Nguyen (2006).
²⁷UNICEF (2016a).
²⁸UNICEF (2016a).

TABLE 1: Severe Droughts in Vietnam since the 1997–98 El Niño.

Event	Description	Peak ONI ²⁹	Duration (months)	Peak time	Affected area	Agriculture land losses (ha)	Estimated economic loss (US\$ million)
1997–1998 El Niño	Rainy season ended 1 month sooner during the end of 1997. Rainfall in the first 6 months of 1998 was only equal to 30 to 70% of the average.	2.3	13	Nov–Dec 1997	Central Highlands, South Central Coast, South Eastern, Mekong River Delta	120,000	445
2004–2005 El Niño	Low rainfall, rainy season ended 1 to 1.5 months sooner than the average.	0.7	10	Oct 2004–Jan 2005	Northern, Central Highland, South Central Coast, South Eastern	142,000	154
2010 El Niño	During the first 6 months of 2010, rainfall was very low, at only about 70% of the average. Some areas saw rainfall drop to only 20 to 30% of the average with a prolonged dry time.	1.3	10	Jan 2010	Most severe in Central region	100,000	135
2014–2016 El Niño	The longest El Niño (18 months). Rainfall and river flows were only 50 to 70% of the average. In some areas, rainfall reduced to only 20% of the average.	2.3	18	Dec 2015	Central Highland, South Central Coast, and Mekong River Delta (MRD)	220,000	674

Source: DMC 2011; United Nations Resident Coordinator (UNRC) Vietnam 2016a.

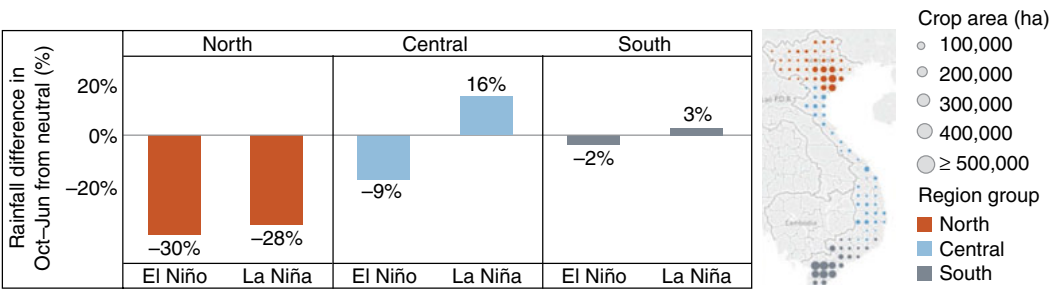
Note: ONI—Oceanic Niño Index.

compared to non-ENSO years (Figure 3). Central Vietnam had the greatest difference in rainfall variability during El Niño and La Niña years, on average, about 25 percent more rainfall during La Niña. Fortunately, as Figure 3 shows, the Central is the least important region for agricultural production. That said, central Vietnam tends to be poorer and perhaps less able to cope with climate variability. Rainfall changes are minimal in southern Vietnam, but other issues, especially saltwater intrusion, are severe.

The Mekong Delta in southern Vietnam is vulnerable to flooding associated with La Niña. One study found that “major floods and droughts in the Mekong, which had significant negative consequences on infrastructure and people’s livelihoods, were

²⁹The Oceanic Niño Index (ONI) is an indicator that monitors El Niño and La Niña. El Niño conditions are present when the ONI is 0.5 or higher, indicating the east-central tropical Pacific is significantly warmer than usual. La Niña conditions exist when the ONI is –0.5 or lower, indicating the region is cooler than usual (Dahlman 2016).

FIGURE 3: Differences of Rainfall between El Niño and Neutral Phase in 1980–2015 in Subregions between October and June.



Source: Authors’ reanalysis using UEA CRU-TS v4.0. The boundaries, colors, denominations and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

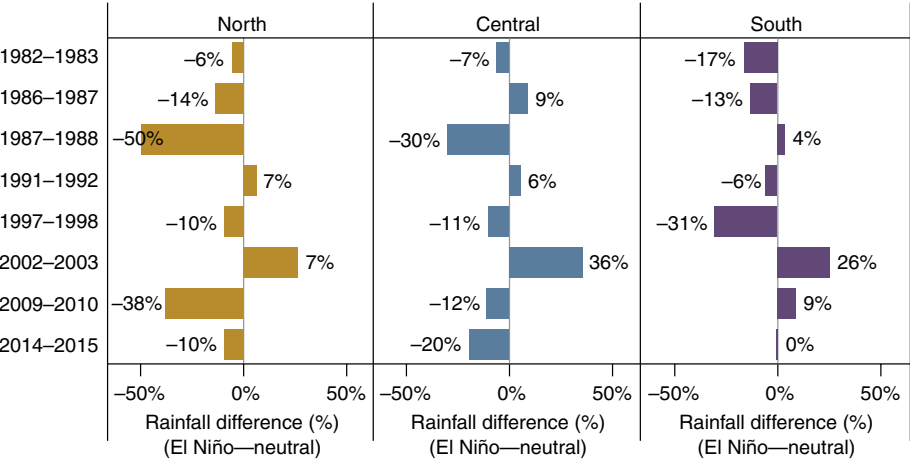
commonly associated with ENSO events.”³⁰ Major floods occurred in the Mekong in 2000, 2001, 2002,³¹ and 2011—three of these years were La Niña years (2000, 2001, and 2011). These floods left a human and economic toll in the region. In 2000 alone, floods led to 800 deaths and \$450 million in economic losses.³² Flood impacts in the Mekong Delta can be particularly damaging given the Mekong’s dependence on agriculture.

Rainfall impacts have varied greatly from one El Niño to the next. Over the 36-year period 1980–2015, there were eight severe El Niño events. The most severe El Niño event in Vietnam occurred in 1987–88 when the rainfall was 50 percent lower in northern Vietnam and 30 percent lower in central Vietnam relative to non-ENSO years. Other El Niño events, like 1991–1992, had less drastic rainfall changes. Despite the tendency for El Niño years to have less rainfall, some, like 1991–1992 and 2002–2003, actually experienced more rainfall on average (Figure 4). Box 2 describes in detail the impacts from the most recent El Niño event in Vietnam, which lasted from 2014 to 2016 and has the most reliable available information.

ENSO affects annual growing seasons differently. The winter dry season in the central and southern parts of Vietnam often starts in November and lasts until March. When El Niño occurs during this season, rainfall is significantly reduced, and drought and salinity intrusion worsen. When El Niño occurs during the wet season (from April

³⁰Räsänen and Kummu (2013).
³¹MRC (2010).
³²MRC (2010), cited in Räsänen and Kummu (2013).

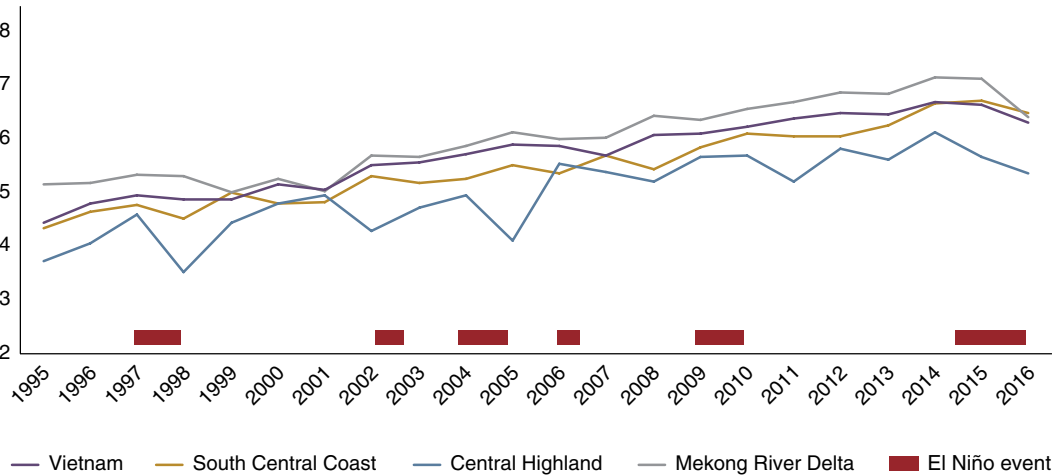
FIGURE 4: Differences of Average Rainfall in El Niño from Neutral in the Northern Regions During Strong Events in Recent Years.



Source: Authors’ reanalysis using UEA CRU-TS v4.0. Underlying rainfall data for the 2014–2015 El Niño is only partial, covering up to December 2015, whereas the El Niño lasted until mid-2016.

to October), low rainfall may have positive consequences, for example reduced flooding, causing crop production to increase slightly. Figure 5 shows changes in rice yields during the winter–spring season in Vietnam, and subnationally in the three regions most vulnerable to El Niño: the South Central Coast, the Central Highlands, and the Mekong River Delta (refer to Annex 2 for a more detailed breakdown of yield and production changes from each region). As can be seen, El Niño typically, but not always, corresponds to depressed rice yields during the winter.

FIGURE 5: Winter–Spring Rice Yields (tons/hectare), 1995–2016.



BOX 2: Impacts from the Most Recent 2014–2016 El Niño.

The most recent El Niño event lasted for 18 months from November 2014 to May 2016, making it the longest lasting El Niño event on record (since 1950). The El Niño peaked in December 2015 with an Oceanic Niño Index of 2.3°C, equal to the strongest El Niño on record in Vietnam, the 1997–98 event. This El Niño caused high temperatures and reduced precipitation, leading to severe droughts and salinity intrusion. The entire country was affected, but the South Central Coast, which is traditionally prone to drought, saw rainfall totals reach only 50 to 70 percent of the previous year's total. In the Central Highlands and Mekong River Delta, rainfall reached 60 to 80 percent of the previous year's total. The Mekong River Delta, one of the country's wettest areas, was also impacted by salinity intrusion.³³ Meanwhile, rainfall deficiencies were observed in Quang Ngai (59 percent of the interannual average), Binh Dinh (45 percent), Phu Yen (48 percent), Khanh Hoa (40 percent), Ninh Thuan (74 percent), Binh Thuan (82 percent), Dak Lak (78 percent), and Dak Nong (87 percent).³⁴ Water levels in major rivers were about 20 to 40 percent lower than 2015 levels. In some rivers on the South Central Coast, water levels dropped by 60 percent. Water reservoirs in the Central Highlands and the South Central Coast were lower than the interannual average level, making them unable to supply downstream areas. For example, water levels in Binh Dinh were 28 percent lower, Khanh Hoa were 28 percent lower, and Ninh Thuan were 30 percent lower.

The peak of the drought, from February to May 2016, had large human impacts. An estimated 2 million people had limited access to water for consumption or domestic use, including 10,000 households with no access to potable water;³⁵ 1.1 million people were food insecure; around 1 million people were threatened by food insecurity and required food relief; and more than 2 million people lost income from damaged livelihoods. Risks of water-related diseases and severe acute malnutrition increased significantly. The total crop production area affected by drought was 820,000 ha, which comprised 355,000 ha of rice and 465,000 ha of other crops. This included 396,000 ha in the Central Highlands, 205,000 ha in the South Central, 157,000 in the Central Coast, and 61,000 ha in the Mekong River Delta. The total crop area that shifted to other crops because of water shortage was 34,000 ha. The total land left to fallow was 127,000 ha. This included about 40,000 ha of fallowed rice fields in the South Central Coast and Central Highlands. In total, this El Niño caused about \$674 million in economic losses in Vietnam.³⁶

³³DMC (2016).

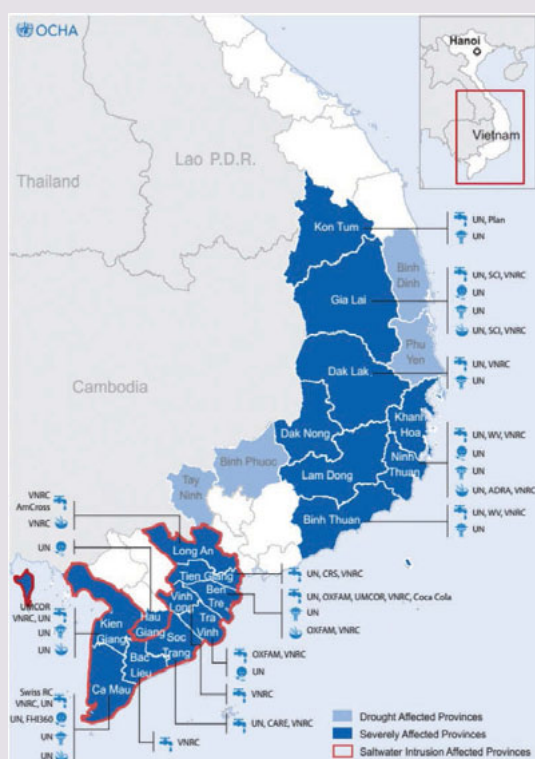
³⁴Institute of Water Resource Planning (2016).

³⁵Institute of Water Resource Planning (2016).

³⁶MARD and others (2016), cited in UN-DRM (2017).

Many provinces throughout Vietnam declared a state of calamity. By June 2015, Nghe An³⁷ in the North Central region, Ninh Thuan³⁸ on the South Central Coast, and Tien Giang³⁹ in the Mekong River Delta had all declared calamity situations. Gia Lai, Kon Tum, and Dak Lak provinces in the Central Highlands declared states of calamity from January and February of 2016. By April 2016, there were 18 provinces that officially announced a calamity situation: three on the South Central Coast (Ninh Thuan, Binh Thuan, Khanh Hoa); five in the Central Highlands (Kon Tum, Gia Lai, Dak Lak, Dak Nong, Lam Dong); and 10 in the Mekong River Delta (Tien Giang, Ben Tre, Kien Giang, Long An, Soc Trang, Ca Mau, Vinh Long, Tra Vinh, Bac Lieu, Hau Giang). All of the 10 affected Mekong River Delta provinces also faced severe saltwater intrusion (see Map 1 for affected areas).⁴⁰

MAP 1: Affected Area by El Niño 2014–2016.



Source: UNRC Vietnam, 2016b.

³⁷<http://nghean.gov.vn/wps/wcm/connect/0d5eaf0048c9ba2fb96ffbd42dc22036/2475.pdf?MOD=AJPERES&CACHEID=0d5eaf0048c9ba2fb96ffbd42dc22036>

38 [http://qpp1.ninhthuan.gov.vn/vbdh.nsf/93df479ea839ba064725734c00318a5f/674EF5E4CB51FEB147257E5F0025BF24/\\$file/QDCT1282-cong%20bo%20han%20han%20tu%20ngay%2001.01.15.pdf](http://qpp1.ninhthuan.gov.vn/vbdh.nsf/93df479ea839ba064725734c00318a5f/674EF5E4CB51FEB147257E5F0025BF24/$file/QDCT1282-cong%20bo%20han%20han%20tu%20ngay%2001.01.15.pdf)

³⁹<https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Quyet-dinh-958-QD-UBND-2015-cong-bo-thien-tai-xam-nhap-man-Tien-Giang-273581.aspx>

⁴⁰UNRC Vietnam (2016b).

ENSO events, and their severity, are difficult to predict with accuracy, especially over the long term. Like other countries, Vietnam relies on international ENSO forecasts as the basis for their own forecasts. Future ENSO events are predicted using Coupled Ocean-Atmosphere General Circulation Models (CGCMs). These models simulate the complex interactions between oceans and climate systems, based on historical Sea Surface Temperature (SST) trends. There are still many technical and scientific challenges to modeling these complex oceanic and atmospheric processes. Moreover, ENSO forecasting is an actively researched area, and understanding is not complete. Internationally, the most reliable forecasts are made by combining and calibrating the output from various independent forecasting systems as multi-model ensembles successfully predicted the timing of ENSO's onset, peak, and decline.⁴¹ However, it is not known why some ENSO-related weather events are more extreme than others. In fact, ENSO severity predictions are largely unreliable. The United States' National Oceanic and Atmospheric Administration (NOAA) assessed its ENSO forecast accuracy with different lead times.⁴² They concluded that ENSO severity forecasting was highly accurate one month in advance, but much less accurate four months or longer in advance.

BOX 3: Distinguishing ENSO from Climate Change.

ENSO and climate change are two separate phenomena that share many attributes, and some key differences. Both are slow onset climate events that may not be immediately perceived by farmers or the wider society. This slow evolution of impacts creates policy challenges for both, since fast and large-scale disasters, such as hurricanes and earthquakes, are more likely to compel action, but slow moving disasters, like drought, may never compel change. As such, ENSO preparedness and climate change preparedness share many of the same actions and priorities. However, there are also key differences. While ENSO is cyclical with impacts that will come and go, climate change impacts are more permanent and are predicted to keep getting worse. Because of this, ENSO interventions in agriculture can be implemented in the short and medium term during ENSO years, and discontinued during non-ENSO years when climate conditions return to normal, whereas, climate change interventions in agriculture are long-term and permanent. In other words, with climate change there is no returning to normal. Climate change can also alter the impacts of ENSO. For example, climate change may make areas previously suitable for agriculture unsuitable. It may also make areas drier and more water scarce, and in the process, make those areas more vulnerable to El Niño.

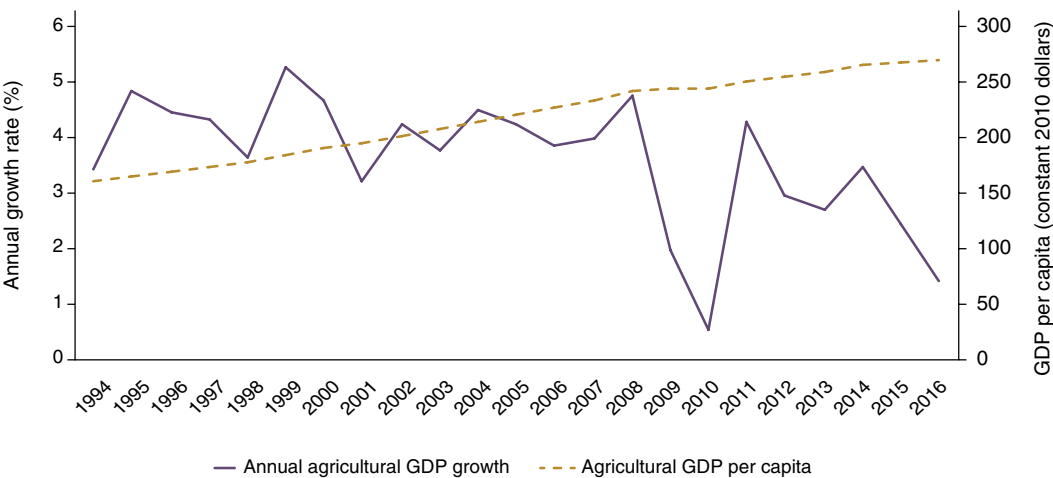
⁴¹Stockdale and others (2017).

⁴²Barnston (2014).

ENSO Affects the Agricultural Sector

Agriculture is an important part of Vietnam’s economy, although its importance has declined slightly. Two-fifths of the country’s 31 million hectares are devoted to agriculture.⁴³ As in other Asian countries, the share of agriculture in GDP has declined with economic development. Agriculture made up 25 percent of GDP in 1996 but only 18 percent in 2016. Employment in agriculture has also fallen, from 70 percent in 1996 to 42 percent in 2017. Despite this, agriculture remains an important source of income for households, especially poor households.⁴⁴ Agricultural GDP growth varies from year to year, but largely remained positive from 1994 to 2016, with the exceptions being 2010 and 2016. Figure 6 shows this variability but also highlights that, despite

FIGURE 6: Growth and Variability of Agricultural GDP in Vietnam.



Source: Own calculations using World Development Indicators (World Bank 2018).

⁴³WB-WDI (2018).

⁴⁴Refer to Table 2.

annual fluctuations in growth rates, agricultural GDP per capita has grown steadily over the last two decades.

Vietnam's agricultural sector is quite diverse. Major crops (listed in order based on harvested land area) include rice, maize, fresh vegetables, coffee, rubber, and cassava. Vietnam is the world's fifth largest rice exporter, providing 8 percent of the global supply. Vietnam's livestock sector mainly comprises pigs, chickens, cattle, buffalo, goats, and sheep. Small-scale rearing of pig, poultry, and buffalo are common in the Mekong and Red River Deltas, while commercial-scale rearing mainly takes place in the Central Highland and South-Central regions. Fisheries, both capture and aquaculture, are another major sector. Fish aquaculture, which is commonly practiced in the Mekong Delta, contributes 41 percent to national aquatic product output.⁴⁵ This production diversity builds Vietnam's agriculture food system resilience.

Crops

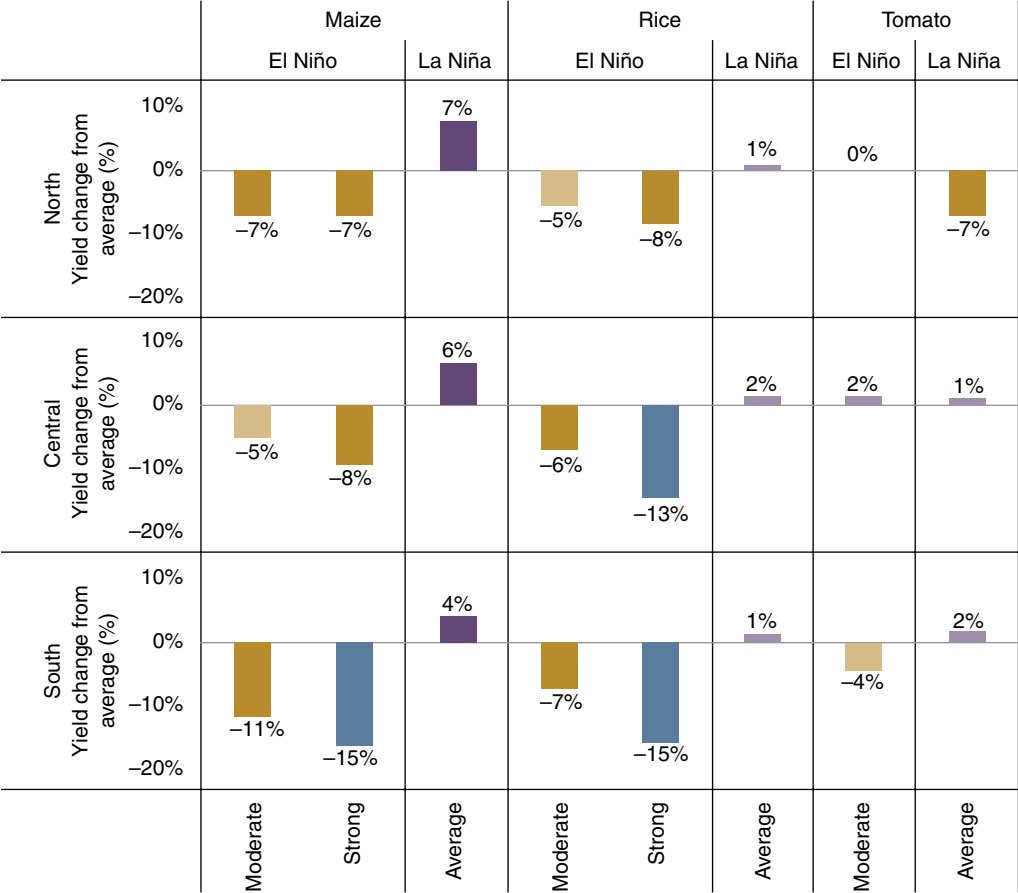
Generally, El Niño reduces crop production and La Niña increases crop production. A study using historical crop production data indicate rice yields decline in winter–spring months during El Niño years.⁴⁶ The largest reductions occur in the Northern Midlands and lower parts of the Mekong Delta. However, the same study indicates that rice yields increase by roughly the same rate in summer months during La Niña years. This held true in almost all agricultural regions, except the Northern Central zone. Crop modeling analyses done for this report reinforce this trend. They shows that moderate⁴⁷ El Niño events reduce rice yields by 6 percent and severe El Niño events reduce rice yields by about 12 percent. Rice yield declines were most pronounced in Central and South Vietnam, declining by 13 and 15 percent during strong El Niño events. Maize, usually grown in relatively dry conditions, had large yield reductions simulated across the regions, especially in the South, under both *Moderate* and *Strong* El Niño conditions. For tomatoes, which are representative of vegetables more generally, simulated yield changes were mostly small except for a 7 percent decline under La Niña in the North and a 4 percent decline under El Niño in the South (see Figure 7).

⁴⁵GSO (2010).

⁴⁶Nguyen and others (undated).

⁴⁷According to this DSSAT simulation carried out by IFPRI, a moderate El Niño assumes water shortages on 10 percent of irrigated lands, and a strong El Niño assumes water shortages on 25 percent of irrigated lands.

FIGURE 7: Crop Model Estimated Deviations in Rice, Maize, and Tomato Yields During “Moderate” and “Strong” El Niño and La Niña Years.



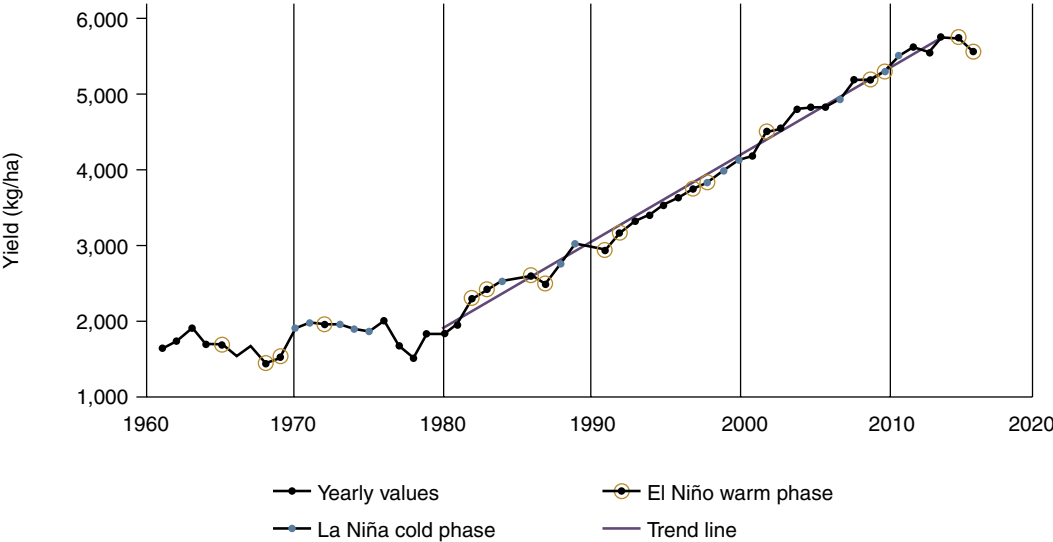
Source: Authors.

Crop production losses during El Niño can be partially recovered during La Niña. During La Niña years, maize production increases are on par with maize production losses in North and Central Vietnam. In South Vietnam, maize production increases during La Niña are only about half the size of maize production losses during El Niño (Figure 7). Rice yield gains during La Niña are much lower than rice yield losses during El Niño. The reason is that maize grows in drier and poorer quality soils and can withstand El Niño conditions better than rice and vegetables. Also, because maize fields are typically rainfed, not irrigated, they may respond more favorably to La Niña than irrigated rice paddies. Still, the positive cases for La Niña on rice and maize may be overly optimistic since simulations do not account for the possibility of flooding induced losses. Nevertheless, these results suggest that higher production during La Niña can provide some cushion during the recovery from El Niño. Historical

subnational crop production estimates⁴⁸ show that nationally, on average, rice production during El Niño was about 5 percent lower than in previous non-ENSO years, and during La Niña was about 3 percent higher than in previous non-ENSO years. By these measures, rice yield increases during La Niña were actually higher than rice yield losses during El Niño in the North and South of the country. See Annex 3 for these results.

ENSO’s impacts on crop production are less clear by other measurements. National production data from FAOSTAT suggest that average rice yields increased linearly after 1980, but that ENSO years do not show a consistent pattern of high or low yields. As demonstrated in Figure 8, one of the few major discontinuities in the time series occurred in 1988 and 1989, a La Niña year, when yields jumped. More importantly, however, this yield increase corresponds with “Resolution 10,” which reduced collective farming and increased land tenure security. The most recent 2015–16 El Niño event shows the clearest decline in national rice yields from the trend line.

FIGURE 8: Vietnam Rice Yield (kg/ha), 1961–2016 Reported by FAOSTAT.



⁴⁸Statistical deviations in average annual rice production during ENSO years are estimated using historical subnational crop production estimates obtained from Vietnam’s General Statistics Office for 1995–2015. This estimate compares production during an ENSO event to production in previous years. To examine if different ENSO phases deviate from the trend, the detrended time series is aligned with corresponding ENSO phase information. Production during ENSO events were compared to the average of the three previous non-ENSO years. Comparing to non-ENSO years avoids the possible amplified production differences in La Niña immediately following El Niño. Linear trends are removed from the time series to isolate ENSO’s effects.

Both ENSO phases can cause extensive crop damage. As described earlier, El Niño reduces water resource availability, increases soil salinity, and damages large areas of crop producing land in Vietnam. Specifically related to crop damage, one study⁴⁹ estimates that average agricultural damage is \$134 million in ENSO-influenced years. On an area basis, the estimated rice area damaged during ENSO years is 326,000 hectares. Both ENSO phases cause land area damage, but El Niño years cause much more damage (408,000 ha) than La Niña years (114,000 ha). Overall, these figures are equivalent to losing 6 percent of the total rice area during El Niño and 2 percent during La Niña.

Industrial crops and orchards are also impacted by El Niño and drought. According to the Department of Agriculture and Rural Development (DARD) in the Central Highland provinces, 111,000 ha of industrial crop production and orchards were affected by El Niño-related drought; of this, 7,600 ha were completely destroyed. In the Central Highlands, there were 7,000 ha of coffee lands with zero production, and nearly 500 ha of black pepper lands that dried out, including 218 ha in Gia Lai province and 277 ha in Dak Lak province.⁵⁰ These are relatively small impacts given the total amount of land allocated to these crops. For example, there are almost 600,000 hectares in regional coffee lands, meaning production losses were only about 1 percent.

Livestock

There are mechanisms by which ENSO events could affect livestock, although direct links have not been made. Livestock generates 6 percent of Vietnam's national GDP while providing nutrition, food security, and supplementary income to rural communities.⁵¹ Reports confirm that frequent flooding, which often occurs during La Niña, is the most common cause of livestock losses in Vietnam.⁵² Other reports note that drought and saltwater intrusion in El Niño years can result in freshwater scarcity, which can lead to animal deaths.⁵³ Livestock can also die of malnourishment brought about by disease or the loss of pastureland from drought in the South Central and Central Highland areas.⁵⁴

There is some evidence that ENSO contributes to declines in Vietnamese livestock. During the 2004–2005 El Niño, 300,000 cattle were affected by a lack of freshwater.⁵⁵

⁴⁹Nguyen (2008).

⁵⁰Hoa (2016).

⁵¹MARD and others (2016); UN-FAO (2016a).

⁵²Nguyen (2016); MARD and others (2016).

⁵³Nguyen (2016); UN-FAO (2016a).

⁵⁴UN-FAO (2016a).

⁵⁵DMC (2011).

Water shortages during the 2014–2016 El Niño reduced fodder, causing malnutrition and food poisoning for animals. This killed 2,468 livestock heads in Ninh Thuan province, including 2,179 sheep and 289 cows and buffaloes. The direct economic loss was estimated to be \$255 million.⁵⁶ Drought and hot spells were the most severe natural disasters affecting animal husbandry in the South Central Coast and Central Highlands.⁵⁷ The 2016 drought forced households from Dong Thap, An Giang, and Ben Tre in South Vietnam to purchase freshwater for their pigs and cows.⁵⁸ Unfortunately, there are very few studies that analyze the link between ENSO and reduced livestock in Vietnam.

ENSO causes hotter days, which may cause increased stress on livestock and related cost increases for producers. More specifically, high Temperature Humidity Index (THI) days stress livestock. THI measures the thermal stress based on the combination of temperature and humidity. Once daily THI reaches 75, cattle begin to experience ill effects from heat stress.⁵⁹ This can cause declines in milk productivity ranging from 0.2 to 0.88 kilograms per additional unit of THI increase. A measure of THI days shows El Niño and non-ENSO years do not increase the number of high THI days, but La Niña, because of its higher humidity, increases the number of moderate-to-severe THI days by 12.⁶⁰ This adds potential costs to livestock production.

Swine dominated Vietnam's livestock sector and is generally less heat tolerant than poultry and cattle.⁶¹ Swine is the most important livestock in Vietnam, making up about three-quarters of Vietnam's livestock sector, by weight. Poultry and cattle are the next most important. Swine begins to see negative outcomes, including in reproductive performance, when temperatures reach 70 degrees Fahrenheit.⁶² A THI of about 80 degrees Fahrenheit causes declines in poultry egg sizes, feed intake, and egg quality.⁶³ Temperatures in Vietnam are regularly suboptimally hot for swine and poultry production, but La Niña only makes this more the case. As such, it is possible that producers are already familiar with dealing with heat stress, so the ultimate consequences from La Niña's added high THI days are muted. Simulations carried out for this report show cattle output falling by 0.3 percent and poultry output falling by 0.1 percent during

⁵⁶Binh and others (2016).

⁵⁷Department of Livestock Production (2017).

⁵⁸MARD and others (2016).

⁵⁹West (2003).

⁶⁰Kalnay and others (1996), based on a NCEP/NCAR reanalysis of daily weather from 1951 to 2010.

⁶¹Xin and Harmon (1998); Myer and Bucklin (2001).

⁶²Wegner and others (2016).

⁶³Lara and Rostangno (2013).

El Niño like events. Output losses include livestock death and reduced milk, meat, or egg production.

Fisheries

Fisheries are an important economic sector for Vietnam, especially in the Mekong Delta. Fishery resources contributed 3.7 percent to national GDP during the first quarter of 2017.⁶⁴ The total fish harvest in 2016 reached 441,000 metric tons, 2 percent higher than the previous year. Fish exports also rose by almost 9 percent (\$1.4 billion) in the last quarter of 2015.⁶⁵ Shrimp and catfish account for 44 and 22 percent of total aquatic export earnings, respectively.⁶⁶ In the Mekong Delta, around 70 percent of communities are involved in capture fisheries, or inland fishing, and over 85 percent practice aquaculture.⁶⁷ See Box 4 for an example of how the Ministry of Agriculture and Rural Development is using climate smart mapping to support the Mekong River Delta.

El Niño can have detrimental impacts on Vietnam’s fisheries and aquaculture sectors. During the drought in the first quarter of 2016, more than 11,000 ha of fish

BOX 4: Good Practice: Climate-Smart MAP in the Mekong River Delta (MRD) of Vietnam.

Climate-Smart Maps and Adaptation Plans (CS MAPs) are being developed throughout the Mekong River Delta. MARD, the Department of Crop Production (DCP), and the CGIAR Research Program on Climate Change, Agriculture and Food Security in Southeast Asia (CCAFS SEA) are collaborating to develop and test CS MAPs. The CS MAPs recognize climate-related risks, identify potentially affected areas, and develop regional and provincial adaptation plans for rice production. Changing rice-based cropping systems and sowing calendars were common adaptive options proposed by the provinces through this process. CS MAP is now at different stages of development in 13 Mekong River Delta provinces. Some provinces implemented the adopted measures and developed corresponding monitoring and reporting tools. For instance, to cope with annual flooding in October and November, An Giang province shifted its autumn–winter rice season, for both its dike system and non-dike system crops, to earlier in the year to ensure safe harvests before the October floods.

Source: Development of Climate-Related Risk Maps and Adaptation Plans (Climate Smart MAP) for Rice Production in Vietnam’s Mekong River Delta.

⁶⁴GSO (2017).

⁶⁵Aquaculture (2016).

⁶⁶UN-FAO (2016a).

⁶⁷UN-FAO (2016a).

farming areas were damaged in the Ca Mau and Kien Giang provinces in the Mekong Delta.⁶⁸ In Ca Mau, salinity damaged over 70 percent of its aquaculture production areas. Kien Giang also saw major aquaculture losses from drought and saltwater intrusion in 2016.⁶⁹ Saltwater intrusion also led to high mortality rates for shrimp and fish fingerlings.⁷⁰ Other downstream provinces affected include Soc Trang, Tra Vinh, and the Hau River in Ben Tre. Overall, droughts damaged 81,000 ha of shrimp breeding areas across Vietnam, but mostly in the Mekong Delta.⁷¹ The Fishery Directorate reported that by the end of March 2016, domestic fish production was about 38,000 tons, or a 2.6 percent decline from the previous year.⁷² Simulations run for this report estimate that El Niño reduces fishery production also by 2.6 percent. This includes both capture fisheries and aquaculture. There is no evidence that La Niña contributes to fishery production losses.

⁶⁸Aquaculture (2016).

⁶⁹UN-FAO (2016a).

⁷⁰UN-FAO (2016a).

⁷¹UN-FAO (2016a).

⁷²Danh (2016).

CHAPTER 4

El Niño Contributes to Economic Impacts

The agriculture sector represents a significant portion of Vietnam’s economy, especially employment. Table 2 shows the service industry is the greatest contributor to Vietnam’s GDP, followed by industry and agriculture. Agriculture directly accounts for only 9 percent of exports and 4 percent of imports. This suggests that most raw agricultural output is used by downstream industries or for domestic consumption. Meanwhile, agriculture is more important for employment, accounting for 45 percent of all jobs in Vietnam. Services account for 33.4 percent of employment and industry 21.5 percent.

Agriculture’s direct and indirect contributions to production and employment make the sector even more important to the overall economy. A social accounting

TABLE 2: National Economic Structure, 2015.

	Share of total (%)			
	GDP	Employment	Exports	Imports
All sectors	100	100	100	100
Agriculture	17.5	45.1	9.1	4.0
Industry	36.5	21.5	79.4	84.8
Mining	9.1	0.5	7.3	0.9
Manufacturing	16.6	14.9	72.0	83.8
Agro-processing	3.1	2.6	13.5	5.6
Other manufactures	13.5	12.4	58.5	78.1
Other industry	10.9	6.1	0.1	0.1
Services	45.9	33.4	11.4	11.2

Source: Vietnam CGE model and 2015 SAM.
Note: GDP is gross domestic product; employment is workers in primary jobs.

TABLE 3: Agriculture Food System GDP and Employment, 2015.

	Share of national total (%)	
	GDP	Employment
National economy	100	100
Agriculture food system	27.7	54.2
Direct production	20.7	47.7
Agriculture	17.5	45.1
Agro-processing	3.1	2.6
Input production	2.4	1.6
Agriculture	1.6	1.1
Agro-processing	0.7	0.5
Trade and transport	3.0	3.0
Agriculture	1.9	1.9
Agro-processing	1.1	1.1
Food services	1.6	2.0

Source: Vietnam CGE model and 2015 SAM.

Note: GDP is gross domestic product; employment is workers in primary jobs.

matrix (SAM) can estimate the size of a country's agriculture food system (AFS), which includes agriculture's downstream processing, input production, and trading and transporting. Table 3 shows agriculture was only 17.5 percent of total GDP in 2015. However, AFS' broader contribution was 27.7 percent. Similarly, agricultural production accounts for 47.7 percent of employment, while the AFS accounts for 54 percent of Vietnam's total employment. This means that Vietnam's AFS employs over half of the population and represents over a quarter of the national economy.

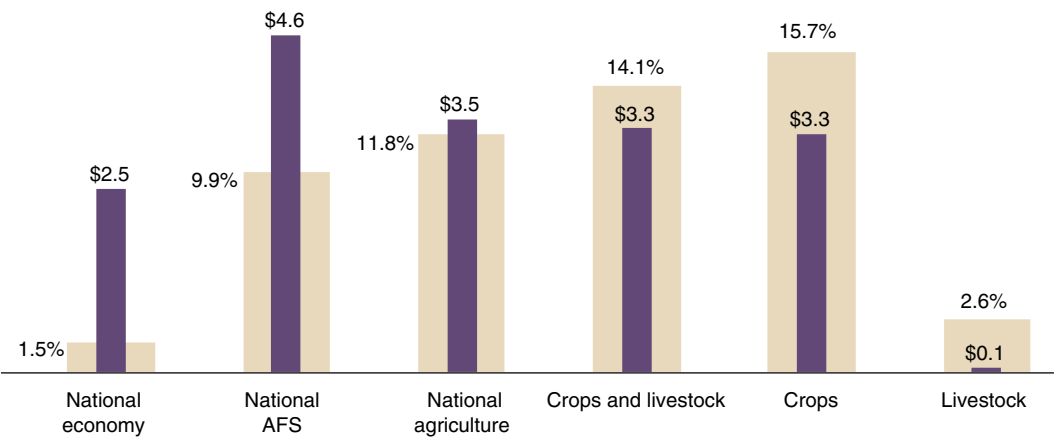
ENSO-related shocks to agriculture can reverberate across the entire economy.

ENSO-related weather shocks to agriculture affect farm workers, downstream sectors, and consumers purchasing foods in local and national markets. Changes in agricultural production lead to changes in farm incomes and producer and consumer prices. For example, El Niño-induced reductions in rice production lead to higher consumer prices for rice. This may encourage households to reduce rice consumption or consume cheaper foods from regions less affected by ENSO. Farmers may respond to higher prices by allocating more resources to rice production to limit output losses. The country may respond with policy changes like increasing food imports or banning food exports. A country's production and trade structure are therefore key determinants of the overall impact of ENSO events. Moreover, as we have seen, AFS contributes to over half of Vietnam's workforce. As such, any ENSO impacts on agriculture could also have enormous human impacts.

Strong El Niño events lead to GDP losses. Figure 9 summarizes CGE modeling results for GDP losses in different sectors during a strong El Niño year. In these cases, national GDP falls by 1.5 percent during strong El Niño events compared to non-ENSO years. Percentage losses are larger in agriculture, where GDP falls by nearly 10 percent. Even small percentage reductions in national GDP can imply substantial monetary losses. For example, a 1.5 percent drop in national GDP is equal to \$2.5 billion in lost value-added, or national income (measured in 2015 prices). GDP percentage losses decline as the sector becomes bigger. For example, percentage losses are greater for crops but less for the larger AFS. At the same time, absolute dollar value losses increase as the focus broadens from agriculture to the AFS. Another reason for this is that lower agricultural production reduces raw material supplies for agriculture-related trading and processing. As a result, GDP losses in the AFS are larger (\$4.6 billion) compared to primary agriculture (\$3.5 billion). Overall, the CGE model estimates that about a quarter of AFS’ economic damages during strong El Niño events occur outside of agriculture. As mentioned earlier, CGE models can track economic spillovers across sectors. The models show that crops have larger GDP losses than livestock during El Niño. Forestry and fishery impacts were included in the estimated GDP losses, but not shown separately in Figure 9.

Strong La Niña events lead to GDP gains, but not enough to offset losses during strong El Niño years. Changes in agricultural productivity during a strong La Niña year expand the economy, but not to the extent that it offsets El Niño losses. Table 4 shows national GDP losses during El Niño are \$2.5 billion compared to a \$1.1 billion gain during La Niña. This is reflected in Figure 10, which shows La Niña gains in each sector, in percentages and dollar value amounts, do not match El Niño losses in

FIGURE 9: GDP Losses During Strong El Niño Events (US\$ billions and percentage reductions).



Source: Simulation results from the Vietnam CGE model.

TABLE 4: GDP Changes During ENSO Events of Different Magnitudes.

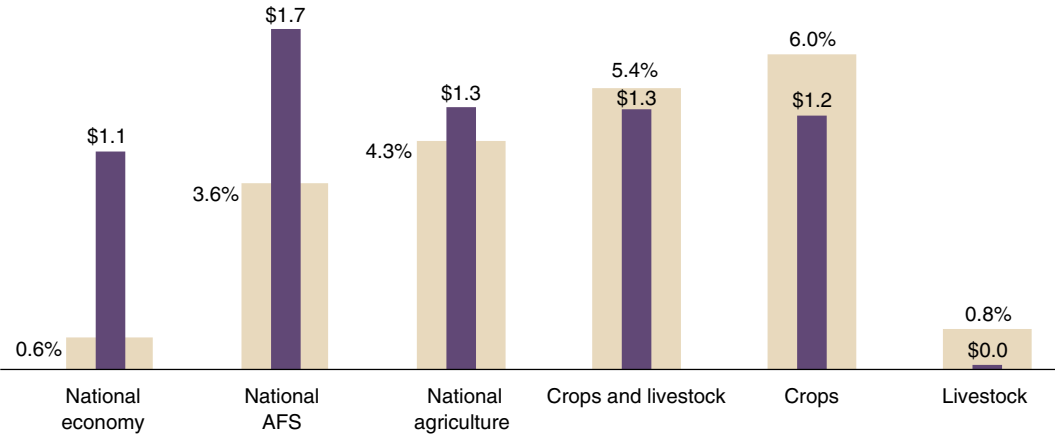
	El Niño events		La Niña events	
	Moderate	Strong	Moderate	Strong
Percentage change in GDP (%)				
National GDP	−0.59	−1.50	0.12	0.64
AFS GDP	−4.14	−9.90	0.85	3.57
Agricultural GDP	−4.88	−11.76	1.03	4.35
Absolute change in GDP (US\$ billion)				
National GDP	−1.00	−2.52	0.20	1.07
AFS GDP	−1.93	−4.61	0.40	1.66
Agricultural GDP	−1.44	−3.47	0.30	1.28

Source: Simulation results from the Vietnam CGE model.
Note: AFS is agriculture food system.

those same sectors (Figure 9). Figure 10 also shows smaller, but still positive, gains in national GDP compared to agriculture or the AFS. This is because higher crop and livestock productivity attracts workers from the non-AFS economy, which outweighs increased demand for nonagricultural products.

Labor movement mitigates or exacerbates ENSO-related GDP losses. When agricultural production faces a climate shock like El Niño, the economy adapts by reallocating labor, which, unlike land, is mobile between farm and nonfarm sectors. As such, agricultural workers and their families can migrate or allocate time to work in other

FIGURE 10: GDP Gains During Strong La Niña Events (US\$ billions or percentage increases).

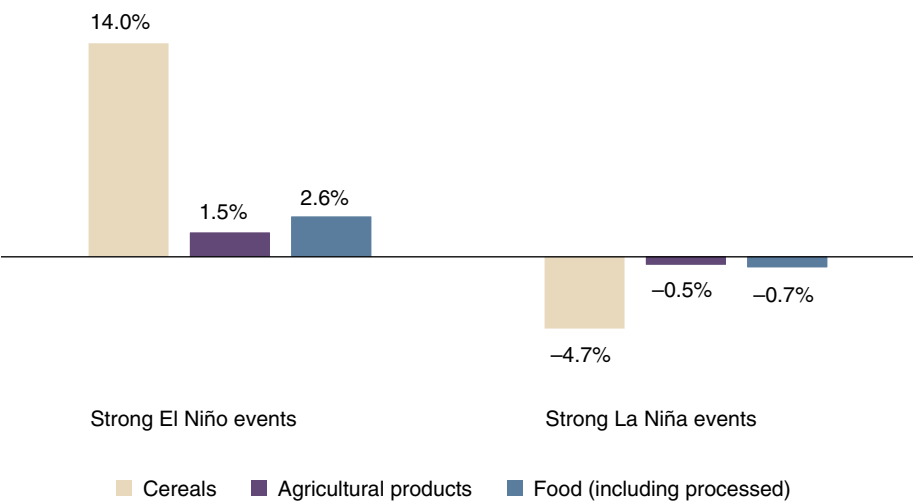


Source: Simulation results from the Vietnam CGE model.

sectors outside of the AFS that are not as adversely affected by ENSO. The opposite dynamic occurs during La Niña when non-AFS workers migrate to AFS work. In Vietnam, agricultural incomes are an important source of demand for nonagricultural goods. Despite this, the reallocation of labor to non-AFS sectors outweighs the lower demand for non-AFS products, leading to smaller national GDP losses (\$2.5 billion) than AFS GDP losses (\$4.6 billion) (Table 4).

Food prices rise during El Niño and fall during La Niña. Price changes are a key mechanism through which agricultural production losses are transmitted to households and other sectors. Figure 11 shows the percentage price changes of cereals, all agricultural products, and all food products. All food products include commodities produced by downstream food industries that are not directly affected by ENSO but use raw agricultural products whose production is affected. Cereal prices increase by 14 percent⁷³ during strong El Niño events. The food price index, which includes cereals and other food products, increases by 2.6 percent. Price changes and income changes explain why real consumption falls and poverty rises, albeit only slightly, for both rural farmers and urban consumers during El Niño (see Table 5).

FIGURE 11: Real Food and Agricultural Price Changes During ENSO Events (percentage).



Source: Simulation results from the Vietnam CGE model.

⁷³Note that these are “real” price changes, which means that they are net of the general change in the consumer price index caused by the ENSO event.



CHAPTER 5

El Niño Contributes to Social Impacts

ENSO has greater impacts on poor rural households. Table 5 shows consumption levels in Vietnam are lower in rural areas than urban areas, and especially low for the rural poor. Poor rural households spend over half of their earnings on food. As such, ENSO’s effects on rice and maize, for example, have larger implications for poorer consumers, who spend a large share of their incomes on cereals. Table 5 also shows that

TABLE 5: Household Income and Consumption, 2015.

	National	Rural	Rural poor	Urban
Population (millions)	89.3	62.8	16.1	26.4
Consumption per capita (US\$)	1,408	1,117	468	2,099
Total food consumption share (%)	100	100	100	100
Cereals and roots	20.1	24.5	39.4	14.0
Vegetables	9.2	9.6	11.1	8.7
Fruits	3.0	2.5	1.6	3.7
Meat, fish, and eggs	34.5	33.8	30.0	35.4
Milk and dairy	4.1	3.4	1.6	5.2
Pulses and oilseeds	1.9	2.2	2.8	1.4
Other foods	27.2	24.0	13.5	31.6
Food share of consumption (%)	38.7	40.0	54.1	37.1
Total household income (%)	100	100	100	100
Agricultural returns	4.8	6.8	9.7	2.1
Labor remuneration	69.5	72.6	75.7	65.5
Capital profits	25.1	19.5	13.5	32.3
Other sources	0.7	1.0	1.1	0.2

Source: Vietnam CGE model and 2015 SAM.

Note: Food consumption excludes meals prepared outside the household. Processed foods exclude products processed and consumed within the household. Other income sources include social and foreign remittances.

poor households are more dependent on agricultural incomes than urban or wealthier rural households. This is because poorer households are often low-skilled laborers. CGE simulations show that all households experience welfare declines during strong El Niño events, but poorer households see the largest declines.

Changes in GDP are distributed across households, investors, and the government. Impacts on private household consumption, or welfare, are larger than impacts on national GDP. This partly reflects the CGE's focus on direct damages to agriculture and food prices, which are more important for household spending than for investments or government spending. Lower income households may also be unable to smooth consumption by selling assets. In the absence of supporting evidence, CGE modeling does not include the short-term benefits or longer term costs of disposing household assets. This means that the percentage changes in incomes reported in the figure may hide the greater resilience of wealthier, higher-income households.

Rural households are more adversely affected than urban households during El Niño events. Rural households in Vietnam are the most likely to earn incomes from agriculture. Table 5 shows that poor and rural households also spend the largest share of their incomes on food consumption. Since food prices rise during El Niño, it is likely that poor rural Vietnamese are affected the most. That said, urban households are also net consumers of food products who are also hurt by higher food prices, albeit to a lesser extent. CGE simulations (see Table 7) show that rural households see a 3.5 percent decline in welfare, or real consumption levels, during a strong El Niño compared to a 2.7 percent decline for urban households. On average, national welfare declines by 3.1 percent. As discussed later, these welfare losses are concentrated among the poor, and as a result, there are 1.7 million more people living below the poverty line during a strong El Niño event than during a typical non-ENSO year.

El Niño events are likely to have significant impacts on health. The CGE model does not assess health impacts, but studies find that short-term shocks, such as droughts during a child's early years, can have long-term negative nutritional impacts.⁷⁴ When such events reduce food consumption levels because households are unable to protect against shocks, they can lead to long-term reductions in height and school achievement.⁷⁵ El Niño shocks in Vietnam that occur from when a woman is pregnant to the third year of her child's life are correlated with less investment in that child and longer term negative impacts on that child's health.⁷⁶ Impacts were greater for families

⁷⁴Alderman and others (2006).

⁷⁵Alderman and others (2006).

⁷⁶Thai and Falaris (2014).

unable to smooth consumption after income shocks. Policies that safeguard children's nutrition and smooth household consumption during pregnancy and early childhood contribute positively to poverty reduction and long-term human development.⁷⁷ Women's health and hygiene are also adversely affected from ENSO-related impacts. In Ben Tre province in the Mekong Delta, saltwater intrusion caused women to suffer skin diseases from the continual use of salinized water.⁷⁸ Also, there are reports that as more women work in agriculture with pesticides and chemical fertilizers they face additional health concerns.⁷⁹

Women play a central role in agriculture in Vietnam, making them vulnerable to ENSO. Female farmers allocate more hours of labor than men to crop cultivation, livestock breeding, and agriculture processing and marketing.⁸⁰ In fact, 44 percent of working women are employed in agriculture, compared to 40 percent of men.⁸¹ Moreover, Vietnamese women are the key source for rice production labor and account for 60 to 70 percent of the food processing workforce.⁸² Women in Vietnam also make up 80 percent of the rural aquaculture workforce⁸³ and often lead livestock rearing, especially for poultry.⁸⁴ In reality, women work in all facets of agriculture activity, including transplanting, weeding and watering, applying pesticides, and harvesting and drying rice.⁸⁵ Moreover, women, particularly female household heads, are more likely than men to own or operate smaller farms and cultivate subsistence crops on rainfed land.⁸⁶ Rainfed lands are generally less resilient to ENSO events than irrigated lands. In 2016, about 39,000 women and 27,500 children became malnourished from that year's water scarcity and food shortages.⁸⁷ In Gia Lai province, girls and women are responsible for collecting water for the family, but during the drought these trips became longer and more frequent.⁸⁸ Therefore, any losses in these sectors have negative repercussions on women. Box 5 shows an effort by the Ministry of Agriculture and Rural Development (MARD) to improve the inclusiveness of disaster risk management projects.

⁷⁷Thai and Falaris (2014).

⁷⁸MARD and others (2016).

⁷⁹Chi and others (2007); <http://www.fftc.agnet.org/library.php?func=view&id=20110725165454>

⁸⁰<https://www.adb.org/sites/default/files/institutional-document/32605/women-viet-nam.pdf>

⁸¹World Bank Gender Portal (2018).

⁸²http://www.fao.org/gender-landrights-database/country-profiles/countries-list/general-introduction/en/?country_iso3=VNM

⁸³Kusabe and Kelker (2001); <http://www.fao.org/docrep/013/i2050e/i2050e.pdf>

⁸⁴<http://siteresources.worldbank.org/INTGENAGRLIVSOUBOOK/Resources/Module14.pdf>

⁸⁵UN-FAO (2016a); and <http://foodsecurity.mekonginstitute.org/story-20150114-the-face-of-women-in-agriculture-in-vietnam>

⁸⁶UN-FAO (2016a).

⁸⁷UN-ESCAP (2016).

⁸⁸MARD and others (2016).

Rural female-headed households are highly affected by El Niño. CGE simulations show that during a strong El Niño, 2.7 percent more people living in rural female-headed households fall into poverty than during non-ENSO years. This is, in large part, because people in female-headed households are the most likely to be poor farmers (Figure 17). People living in rural male-headed households had the next highest rate, with 2.4 percent more people falling into poverty during a strong El Niño. Nationally, simulations show that people in urban male-headed households experience the largest increase in poverty during El Niño, mainly because these households are most likely net food consumers. However, these are changes from baseline poverty rates, which remain lower for urban male-headed households than for female-headed households, even after accounting for the adverse effects of El Niño.

BOX 5: Social Inclusiveness in the Community-Based Disaster Risk Management Plan in Vietnam.

The Ministry of Agriculture and Rural Development (MARD) has made efforts to improve social inclusion in Vietnam's Community-Based Disaster Risk Management (CBDRM) plan. MARD designated the Directorate of Water Resources to collaborate with relevant government agencies and local and international organizations to develop mechanisms to better target women and people with disabilities in their CBDRM plan. As a result, two disaster risk reduction projects were implemented that include disabled persons in Quang Nam province (funded by Malteser International) and Kon Tum province (funded by CBM International). The projects conducted risk assessments for people with disabilities and developed special activities for them in the CBDRM plan. Women were also encouraged to participate in the CBDRM plan's commune search and rescue teams and to help develop the CBDRM plan's social inclusion elements.

Vietnam Has Taken Many Actions to Support ENSO Preparedness

Domestic actions

The government of Vietnam divides responsibilities for ENSO-related preparation among a number of agencies. El Niño and La Niña largely fall within the Ministry of Agriculture and Rural Development (MARD). As such, in 2015 MARD developed “Measures to Prevent and Respond to the Drought, Salinity Intrusion, and Other Impacts of El Niño in 2016.”⁸⁹ This directive provided instructions on how to deal with El Niño impacts to agencies within MARD and provincial-level MARD representatives, or Departments of Agriculture and Rural Development (DARDs). MARD agencies were instructed to carry out the following:

- The Directorate of Water Resources: Monitor the evolution of El Niño, drought, and salinity intrusion; develop responsive and adaptive water resource management plans; and coordinate media outreach to publicize this information to the public.
- The Department of Crop Production, the Department of Livestock, the Directorate of Forestry, and the Directorate of Fishery: Each agency would develop sectoral forecasts and disseminate this information to farmers.
- The Department of Construction: Speed up the construction and repair of dams, canals, and sluices to supply water resources or prevent salinity intrusion, especially in El Niño-affected areas.

Provincial DARDs in affected areas were instructed to carry out the following:

- Review and evaluate drought and salinity intrusion impacts on all agricultural production activities;
- Review water resource availability and develop water use and irrigation plans;

⁸⁹<https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Chi-thi-8718-CT-BNN-TCTL-tang-cuong-phong-chong-han-han-xam-nhap-man-doi-pho-hien-tuong-El-Nino-2015-295479.aspx>

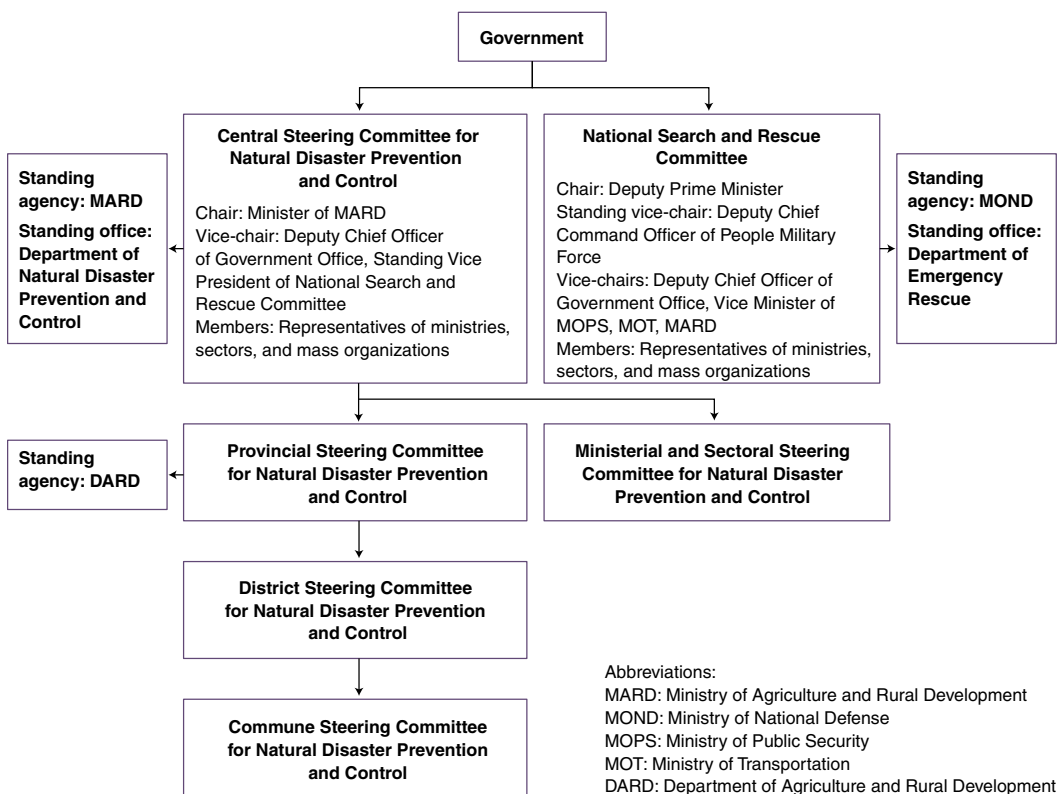
- Adjust crop pattern calendars based on the availability of water resources to avoid negative impacts on crop productivity;
- Apply water saving irrigation techniques, such as micro spray, drip irrigation, rice intensification, and alternate wet and dry (AWD) techniques;
- Use drought tolerant crop varieties with short life cycles to minimize water needs;
- Keep orchards moist by mulching;
- Protect forest areas from fire risk;
- Adjust aquaculture production plans to protect breeding areas from high temperature and high salinity; and
- Plant forage trees and store food and water for poultry and cattle during droughts.

ENSO-related disaster response falls to specific government agencies. MARD is again the lead ministry on disaster response. Disaster response does not include climate change issues, which the Ministry of Natural Resources and Environment (MONRE) coordinates among a number of ministries and government agencies. Instead, disaster response is led through two agencies: (1) the Steering Committee for Natural Disaster Prevention and Control; and (2) the National Committee for Emergency Response, Search and Rescue (NCERSR). The disaster prevention organizational structure is outlined in Figure 12. Box 6 discusses ongoing efforts to manage disaster and climate change risks.

Vietnam's government made efforts to prepare for the 2015–2016 ENSO

The government took action as the 2015–2016 El Niño progressed. The government mobilized NGOs, international organizations, and local and national government agencies to support the different ENSO response measures. The goal was to mitigate potential disasters in three severely affected regions: the South Central Coast, the Central Highlands, and the Mekong River Delta. In March 2015, the government initiated response and recovery measures to mitigate the drought that began in late 2014. This included information gathering missions, forecasts from the National Center for Hydro-Meteorological Forecasting (NCHMF), and eventually, financial support to the affected regions. These steps are described below; Figure 13 shows the government's general response timeline.

In June 2015, a MARD mission made a number of recommendations to respond to drought and salinity intrusion. In response to drought and salinity intrusion in the central provinces, the Department of Crop Production (under MARD) sent a mission in June 2015 to evaluate the situation. The mission assessed crop production and husbandry losses and the water shortage situation. It also identified measures taken

FIGURE 12: Organizational Structure for Natural Disaster Prevention.⁹⁰

by local authorities to address the problem. The mission accepted requests for financial support from some of the affected provinces, including Binh Thuan, Ninh Thuan, Nghe An, Quang Tri. The mission then briefed national leaders on their findings and recommendations, which included: short-, medium-, and long-term activities like rice calendar shifting, crop pattern shifting, water saving and allocation actions, and irrigation infrastructure improvements.

In August 2015, the NCHMF officially announced that El Niño was occurring in Vietnam.⁹¹ In contrast to earlier forecasts of a moderate El Niño, the NCHMF said they expected a strong 2015–16 El Niño, comparable to the 1997–1998 El Niño. NCHMF predicted there was a 90 percent chance El Niño would last until winter 2015 or spring 2016. It also forecast the 2015–2016 El Niño would be the longest lasting El Niño from the last 60 years. NCHMF assessed the hydrometeorological

⁹⁰Adopted from <http://phongchongthientai.vn/he-thong/so-do-chung/-c2.html>

⁹¹Report no.312/BC-DBTW issued by the National Center for Hydro-Meteorological Forecasting, entitled, “Special News on El Niño 2015 and an Assessment of Hydro-Meteorological Trend from September 2015 to February 2016.”

BOX 6: Integrating Disaster Risk Management and Climate Change Adaptation into the Social Economic Development Plans for the Tra Vinh Province.

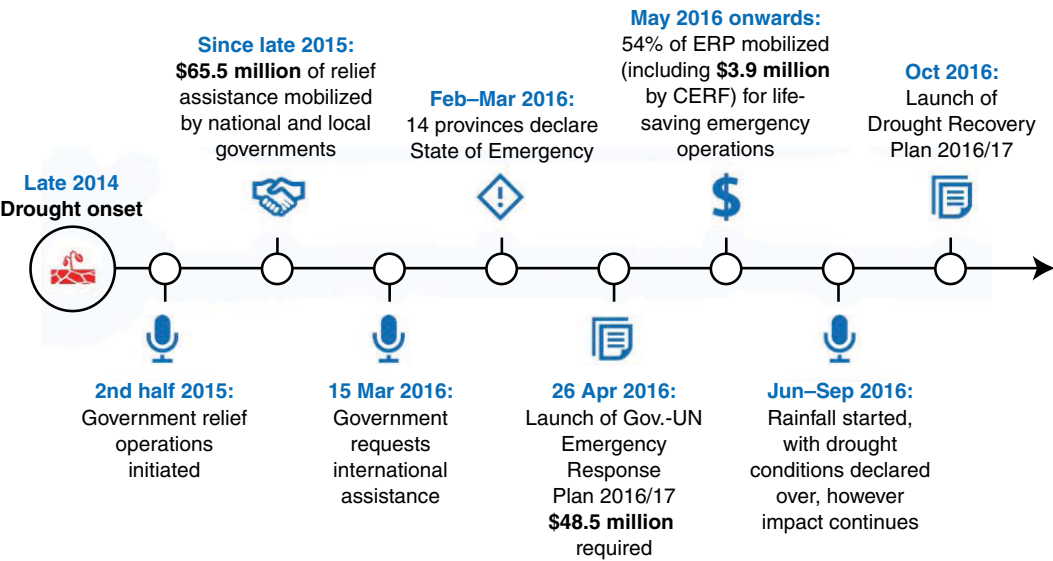
The Tra Vinh Provincial People’s Committee (PPC) mainstreamed Disaster Risk Management (DRM) and Climate Change Adaptation (CCA) into the *National Target Program to Respond to Climate Change in Tra Vinh*. Oxfam supported this process by supporting a local government-appointed Task Force, comprised of commune leaders and sector staff specializing in CCA and DRM, and shared with them information on DRM and climate change vulnerability. As a result of these interactions, climate change, disaster vulnerabilities, and risk reduction issues that arose from the commune risk assessments were integrated into commune Social Economic Development Plans (SEDPs) and then district SEDPs. The Tra Vinh Department for Planning and Investment (DPI) drafted planning guidelines to integrate DRM, CCA, and gender into SEDPs.

In 2014, with Oxfam support, DPI used this approach with 19 communes in two districts (Chau Thanh and Cau Ngang) to incorporate key DRM and CCA issues into their SEDPs. After several years, this participatory and integrated planning approach helped achieve national strategies and meet program targets. Similarly, people in the SEDP Planning Task Groups, technical support groups, and community-based groups benefitted from training, capacity building, and peer-to-peer support. The process integrated gender, climate change, and disaster risk into SEDP planning and raised awareness on these in local communities.

Adapted from: Global Facility for Disaster Reduction and Recovery. 2017. *Toward Integrated Disaster Risk Management in Vietnam: Recommendations Based on the Drought and Saltwater Intrusion Crisis and the Case for Investing in Longer-Term Resilience*. World Bank, Washington, DC. © World Bank. <https://openknowledge.worldbank.org/handle/10986/28871> License: CC BY 3.0 IGO.

Source: VUFO-NGO Resource Centre Vietnam 2015.

FIGURE 13: Response and Recovery Timeline.



Source: UNRC Vietnam 2016c.

trends and predicted lower precipitation and less water flow in the Mekong River Delta and other rivers in South Central Vietnam. They said low precipitation and low river flow caused the prolonged drought in the South Central and Central Highland regions. The NCHMF also forecast there would be less rainfall during the 2015 rainy season (September to November), especially in the Mid Central and South Central provinces. Based on these forecasts, the Central Steering Committee for Natural Disaster Prevention and Control coordinated responses among government agencies, the prime minister's office, and local and international organizations.

In February 2016, the Prime Minister allocated \$3.8 million from the central contingency budget to support recovery measures. This covered six provinces affected during the summer–autumn season of 2015. In March 2016, \$23.5 million more was allocated to help 34 provinces recover losses they suffered during the winter–spring season of 2015–2016. In April 2016, the new Prime Minister, continued financial support by providing \$21.7 million to 21 provinces and two MARD-led irrigation companies. The last support package was allocated in June 2016; this included \$10.4 million for 11 provinces and to the Dau Tieng-Phuoc Hoa Irrigation Company for similar objectives.⁹² In total, the government mobilized \$65 million in aid to El Niño–affected provinces and irrigation operators. Despite these efforts, MARD calculated that 2015–2016 recovery costs in the 18 drought-affected provinces would reach \$1.2 billion by 2020.⁹³

International support

The World Bank supports Vietnam with several salinity-, drought- and climate change-related projects. The government of Vietnam ratified the Paris Agreement in 2016, and the World Bank has been an important partner in providing technical assistance and encouraging policy changes.⁹⁴ Some of the development programs directly related to drought, climate change, and saltwater intrusion are described below.

- Development Policy Financing (\$90 million) assists green growth and climate change related policy reforms to: enhance water, coastal zone, and forest management for climate resilience and greener growth; improve transport and industry norms for cleaner air quality; and encourage cleaner and more effective resource production systems and renewable energy measures to lessen greenhouse gas emissions.
- Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods investment program (\$310 million) supports farmers and fishers in vulnerable areas of

⁹²GoV (2016).

⁹³UNRC Vietnam (2016c).

⁹⁴WB (2016).

the Mekong Delta through flood retention in upper areas, provides financial support for climate-resilient infrastructure, and assists in developing alternative livelihood options in areas affected by salinity intrusion and coastal erosion.

- Toward Integrated Disaster Risk Management in Vietnam focuses on drought and saltwater intrusion by expanding resilience to climate risks and building effective socioeconomic development strategies.
- Other ongoing initiatives include the Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods project, the Vietnam Coastal Cities Sustainable Environment project, and the Vietnam Emergency Natural Disaster Reconstruction Project.

The United Nations supports Vietnam through the Vietnam Emergency Response Plan (ERP) and other initiatives. The ERP was launched on April 2016 and contains humanitarian and recovery components. Both components covered health, water, hygiene, nutrition, sanitation, food security, and early recovery aspects. In May 2016, the United Nations Central Emergency Response Fund allocated \$3.9 million for the eight provinces most severely affected by El Niño. This was carried out through the UN in Vietnam, the government of Vietnam, and NGO partners. UNDP also carries out a number of policy dialogues with the Vietnamese government.

Bilateral agencies also support El Niño efforts in Vietnam. In support of the ERP, the government of Japan donated \$2.5 million; the government of Thailand gave \$100,000; and the government of Lao PDR and other countries donated an additional \$257,000.⁹⁵ This financial aid will be utilized for emergency relief support within the Vietnam ERP. The European Commission also carried out an assessment of El Niño's impacts on food security and livelihoods.

The Food and Agriculture Organization (FAO) supports livestock production efforts in Vietnam. FAO allocated \$400,000 from its own emergency resources to restock poultry and provide feed and vaccinations in Vietnam.⁹⁶ FAO also delivered trainings in Gia Lai, Ninh Thuan, Kien Giang, and Ca Mau on agricultural best practices to recover agriculture production after the drought. Topics in the training included soil salinity–level testing techniques, improved husbandry practices, and bio-safety practices in drought affected areas. In August 2016, FAO, with Action Aid Vietnam, received almost \$900,000 from the European Civil Protection and Humanitarian Aid Operations (ECHO) to assist over 4,500 households in Dak Lak, Gia Lai, and

⁹⁵UNRC Vietnam (2016e).

⁹⁶UNRC Vietnam (2016b).

Dak Nong with unconditional cash transfers, agricultural vouchers, and post-harvest equipment.⁹⁷ In the same month, FAO distributed 152 metric tons of rice, 2.7 tons of maize, and 1,153 tons of fertilizers to over 2,000 households in Gia Lai, Ninh Thuan, Kien Giang, and Ca Mau.⁹⁸ In October 2016, FAO carried out a market assessment to support its cash transfer and voucher scheme intervention. In this program, affected people exchanged vouchers for inputs—such as seeds, fertilizers, water filtration, and storage equipment—to recover livelihoods. The program also prevented the misuse of money in cash transfer schemes.⁹⁹

Many international NGOs (INGOs) support El Niño efforts in Vietnam. CGIAR’s Research Program on Climate Change, Agriculture and Food Security Oxfam supported in-depth drought assessments for the Central Highlands (Dak Lak, Gia Lai, and Kon Tum) and the Mekong Delta (Ben Tre, Kien Giang, and Tra Vinh). Oxfam carried out an Emergency Market Mapping Analysis (EMMA) in Tra Vinh and Ben Tre.¹⁰⁰ Moreover, many INGOs—including Oxfam Novib, Plan International, Action Aid Vietnam, World Vision, Save the Children, CARE International in Vietnam, Catholic Relief Services, and the Disaster Management Working Group—operated humanitarian campaigns and other response activities in the affected provinces. The majority of these efforts focused on water provision and hygiene and sanitation support.¹⁰¹ In 2016, the International Federation of the Red Cross and Red Crescent Societies released approximately \$200,000 from its Disaster Relief Emergency Fund to support humanitarian operations in the Ninh Thuan, Gia Lai, Long An, and Ben Tre provinces.¹⁰² In response to an agreement among United Nations Development Programme (UNDP), INGOs, and the People’s Aid Coordination Committee (PACCOM)—the government agency responsible for coordinating INGO activities in Vietnam—seven INGOs committed \$1.1 million for urgent drought responses, while 22 INGOs pledged longer term support through 30 projects in 13 affected provinces. These projects take place from 2016 to 2019 and have a total budget of \$12.3 million.¹⁰³

⁹⁷UNRC Vietnam (2016d).

⁹⁸UNRC Vietnam (2016c).

⁹⁹Hien Nguyen (2017).

¹⁰⁰UNRC Vietnam (2016e).

¹⁰¹UNRC Vietnam (2016e).

¹⁰²UNRC Vietnam (2016e).

¹⁰³VietPeace (2016).



CHAPTER 7

Despite These Actions, There Are Still Areas to Improve

The Vietnamese government has made a concerted effort to address ENSO-related challenges since 2015, but there were several areas where these efforts could be further improved. As discussed above, as El Niño–related drought conditions worsened, the government carried out assessments, developed an El Niño response strategy, and delivered relief to affected regions. This support was a mix of preparedness and response measures. Yet, despite this, the government faced several constraints related to capacity and readiness. These areas for improvement are discussed in the subsequent paragraphs.

Existing government policies for slow onset events, such as El Niño, are not comprehensive. As mentioned earlier, Vietnam had a comprehensive set of mechanisms to respond to natural disasters. However, there are several areas to improve in how they address slow onset events. First, government capacity, particularly of government officials working with rural communities, needs strengthening, especially for how to carry out impact evaluations and respond to slow onset events. Second, most government extension workers do not have contingency plans for slow onset emergencies, despite being frontline responders to disasters. Third, most of the government’s response plans are for extreme weather events, such as cyclones. However, slow onset events require different advance actions and coordinating partners. Fourth, MARD’s community-based disaster risk management (CBDRM) plan has a limited focus on agriculture-related preparation for slow onset events, even though this has become a recurrent challenge.

Vietnam’s drought response was fragmented and underfunded. The World Bank used the 2015 drought and salinity crisis to examine Vietnam’s strengths and weaknesses in drought response.¹⁰⁴ The main observation was that Vietnam has a patchwork

¹⁰⁴World Bank (2017).

of plans, policies, and agencies that address climate, weather, and water risks. However, those efforts appear to be fragmented, both in terms of plans and in terms of the entities charged with implementing them. Good intentions are further stymied by insufficient funding and a lack of a coordinating authority.¹⁰⁵

Some policies and programs lack consistency and have competing incentives.

These inconsistencies can reduce the effectiveness of El Niño coping measures. In one example, during the 2015–2016 drought, farmers were urged not to plant rice that season.¹⁰⁶ Despite this, a policy was enacted after the drought that compensated farmers for crop damage.¹⁰⁷ However, those who followed the advice to not plant received no compensation. This is because with no rice fields, they were not eligible even though they also lost income from the lack of harvest. In another example, the construction of the Dak Mi 4 reservoir led to a low downstream discharge of the Vu Gia river and caused salinity intrusion in Da Nang and a deficit in irrigation water for agriculture production in Duy Xuyen and Dien Ban districts of Quang Nam.¹⁰⁸

Logistical support to implement relief and preparedness measures was not ready when the drought hit in late 2014.¹⁰⁹

For example, drought and salt tolerant seeds were not available in the quantities needed, planting time adjustments and plans to use short duration varieties were not prepared, and mechanisms to plant alternative crops were not in place. For example, in CGIAR's *Research Program on Climate Change, Agriculture and Food Security in Southeast Asia* there were plans to plant a drought-tolerant rice variety on 300,000 hectares in the Mekong River Delta, which requires 15,000 tons of seeds that must be ready before dry conditions begin.¹¹⁰ However, the seeds were not available when El Nino caused severe drought in the region.

Local farmers and extension workers do not have sufficient capacity to scale up best practices or prepare for ENSO on a larger scale.

For example, farmers lack the capacity and resources to develop alternative crop value chains or monitor salinity and adaptation progress. Indeed, there are many smaller scale measures to adapt to unfavorable farming conditions in Vietnam. Some examples include: in the North Central region, shifting annual crops to tea and developing wind resistant crops; in the Central Highlands, building local water reservoirs; and on the Southcentral Coast, replacing rice with *Sterculia foetida* trees. However, scaling up these initiatives

¹⁰⁵World Bank (2017).

¹⁰⁶WRD (2016).

¹⁰⁷DWR (2016).

¹⁰⁸Bui Nam Sach (2016).

¹⁰⁹CCAFS SEA (2016a).

¹¹⁰CCAFS SEA (2016a).

requires financing mechanisms and the systematic study of environmental and economic impacts, or other activities that farmers or local extension workers do not have the capacity to undertake.¹¹¹

During the 2015–2016 drought, preparedness measures often relied on inaccurate or ineffective location-specific information.¹¹² Many recommendations put forth by research organizations lacked proper implementation guidelines and ignored the local conditions. For example, one project recommended plowing acid sulfate soils to reduce water loss by evaporation, but plowing in these soils can actually increase dryness.¹¹³ Another recommendation was to dam water supplies, but this led to water sharing conflicts among upstream and downstream communities. This disregard for local conditions cost implementing organizations grassroots support.¹¹⁴

There are several areas to improve in Vietnam’s forecasting efforts. First, decision makers and citizens have a limited understanding of weather forecasting, local planting calendars, and detailed knowledge of specific affected locations. Second, the government at all levels requires greater capacity to develop and use forecasting tools for disaster preparedness. Third, forecasting infrastructure is outdated and requires high-resolution forecasts on multiple timescales (daily, weekly, monthly, and seasonal); up-to-date information on future ENSO events; and reliable sources for remote sensing information in near real-time. Fourth, further technical cooperation between regional and international climate prediction centers would be helpful.¹¹⁵ It warrants repeating, that forecasting ENSO events can be inaccurate, problematic, and complicated so improving these capabilities would require significant efforts.

During the 2015–2016 drought, there was an inability to localize climate forecasts and transform them into advisories that local farmers and technicians could use. Weather and climate information is often broadcast to the public through radio, television, and the Internet. However, nationally or internationally provided rain, storm, and temperature forecasts are not specific nor detailed enough to provide local information. Also, the broadcasts often use unfamiliar technical language that is not practical for farmers to make farming decisions. For instance, on the NCHMF news website, broadcasts refer to highly technical concepts like “intertropical convergence zones” or “the high probability of 50 millimeters of rainfall.” Furthermore, local agricultural

¹¹¹This paragraph relies on information from CCAFS SEA-(2016a, 2016b, and 2017); MARD (2015).

¹¹²CCAFS SEA (2016a).

¹¹³CCAFS SEA (2016a; 2016b).

¹¹⁴CCAFS SEA (2016a; 2016b).

¹¹⁵UN-ESCAP (2016).

officials do not sufficiently know risk areas, the infrastructure situation, crop biophysical characteristics, or other concepts that may allow them to translate this information into relevant local farming advisories.

Aid approval processes could be sped up and improved by the government. International organizations responded very positively to Vietnam's call for assistance during the 2014–2016 El Niño event. That said, a number of international organizations identified the long delays by the government in processing and approving proposed interventions as a constraint. For example, representatives from the Asian Development Bank (ADB), UNDP, and Japan International Cooperation Agency (JICA) identified these shortcomings during the March 2016 *Workshop with Development Partners and Donors in Response to the Severe Drought and Saline Intrusion* organized by MARD. JICA said a faster government approval process would allow JICA to also speed up their own approvals.¹¹⁶ Some donors proposed the government could review its procedures to fast-track these processes.

Women face certain constraints in benefitting fully from agricultural assistance despite their central role in that sector.¹¹⁷ As discussed above, women make up the majority of Vietnam's agriculture workforce, yet are still underrepresented in making policy and strategy decisions in agriculture. This has slowly improved but women still lag behind men. For example, Vietnam increased women's land ownership by introducing land titling reforms in 2003 that allow joint registration of land titles, instead of only registering under a husband's name. Since then, over 90 percent of land titles have been registered jointly.¹¹⁸ However, local officials who administer the law are not gender sensitive and often revert to traditions and customary practices, which favor men.¹¹⁹ The most vulnerable are indigenous women who lack knowledge on land rights and face discrimination in accessing land and non-land assets both inside and outside their communities.¹²⁰ Moreover, a joint FAO and UNDP report indicated that female-headed households in Vietnam borrow less, have less access to formal credit, and pay higher interest on loans than dual-headed households.¹²¹

¹¹⁶Vietnam Disaster Management Authority (2016).

¹¹⁷UNICEF (2016b).

¹¹⁸https://www.oecd.org/dev/development-gender/Brochure_SIGI_EAP_web.pdf

¹¹⁹http://www.fao.org/gender-landrights-database/country-profiles/countries-list/land-tenure-and-related-institutions/en/?country_iso3=VNM

¹²⁰https://www.oecd.org/dev/development-gender/Brochure_SIGI_EAP_web.pdf

¹²¹FAO/UNDP (2002); <http://www.fao.org/docrep/013/i2050e/i2050e.pdf>

Policy Interventions Do Not Neutralize ENSO-Related Losses

Different policy scenarios mitigate El Niño’s GDP impacts to varying degrees. Table 6 reports GDP losses during strong El Niño events in absolute and percentage terms, with and without the effects of certain policy interventions. These interventions include: (i) introducing drought-tolerant crop varieties to limit on-farm production losses, (ii) expanding irrigation coverage, (iii) restricting rice exports to curb food price increases in domestic markets, (iv) storing more grains and distributing these through domestic markets, (v) expanding social protection programs, or social transfers, by providing conditional cash transfers to poor households, and (vi) applying

TABLE 6: GDP Changes During Strong El Niño Events and Intervention Scenarios.

Without interventions		With interventions					
		Drought-tolerant varieties	Additional irrigation	Export restrictions	Grain storage	Social transfers	All combined
Percentage change in GDP (%)							
National	–1.50	–1.42	–1.33	–1.28	–1.46	–1.51	–1.23
AFS	–9.90	–9.49	–8.55	–10.22	–9.81	–9.89	–8.10
Agriculture	–11.76	–11.29	–10.15	–12.50	–11.86	–11.73	–9.81
Absolute change in GDP (US\$ billion)							
National	–2.5	–2.4	–2.2	–2.2	–2.5	–2.5	–2.1
AFS	–4.6	–4.4	–4.0	–4.8	–4.6	–4.6	–3.8
Agriculture	–3.5	–3.3	–3.0	–3.7	–3.5	–3.5	–2.9

Source: Simulation results from the Vietnam CGE model.

all these policy interventions simultaneously.¹²² The model considers costs associated with implementing these interventions if they specifically mitigate ENSO's impacts, but does not consider infrastructure costs. The reason is that infrastructure investments lead to a stream of benefits that are not limited to ENSO years. See Annex 1 for methodological specifics of each of these simulated interventions. The CGE modeling leads to several important observations, including the following:

- Expanding the use of irrigation offset GDP losses by making overall production more resilient to climate shocks. It also raises yields during normal years, but this is abstracted from the analysis, which focuses on short-run El Niño effects. Overall, expanding irrigation reduces GDP losses from \$2.5 billion to \$2.2 billion. Irrigation's impacts are somewhat muted because most Vietnamese agriculture already relies on irrigation, leaving little potential to expand. For example, for Vietnam's main crop, rice, 85 percent of rice paddies have irrigation in the North, 82 percent have it in the Central, and 90 percent have it in the South.
- Introducing drought-tolerant varieties, as modeled here, reduces some of the damage caused by El Niño. For example, national GDP losses fall from \$2.5 billion in the "Without Interventions" scenario to \$2.4 billion in the "Drought-Tolerant Varieties" scenario.
- Social transfers are largely ineffective at mitigating GDP losses because they do not directly increase production but do require offsetting tax increases. For example, net transfers between households are zero. However, transfers are incredibly useful in limiting welfare losses and poverty growth (see Figure 14 and Figure 16). Currently, there is no formal government cash transfer program that provides emergency relief to households in climate-affected areas, but there is some interest in other forms of social programs, such as crop insurance for rice farmers.
- Distributing stored grains has a similarly small effect on total GDP. It reduces agricultural GDP because introducing more stored grains into the local market increases competition for current farm output and reduces farmer incomes. As such, any grain storage intervention should be designed to safeguard producers from harmful changes to the domestic grain market.
- Rice export restrictions increase AFS GDP losses but are effective at limiting losses outside of the AFS. This is because lower food (rice) prices benefit net consumers and help maintain demand for non-food products during El Niño events. However, restricting rice exports creates market distortions that lead to longer term risks, particularly for domestic producers and international and regional trading partners.

¹²²These simulations are indicative of broad categories of on-farm, market, and social policies. For instance, cash transfers could be replaced by food aid or crop insurance payments to smallholders, and irrigation infrastructure could be replaced by improvements in crop water use efficiency.

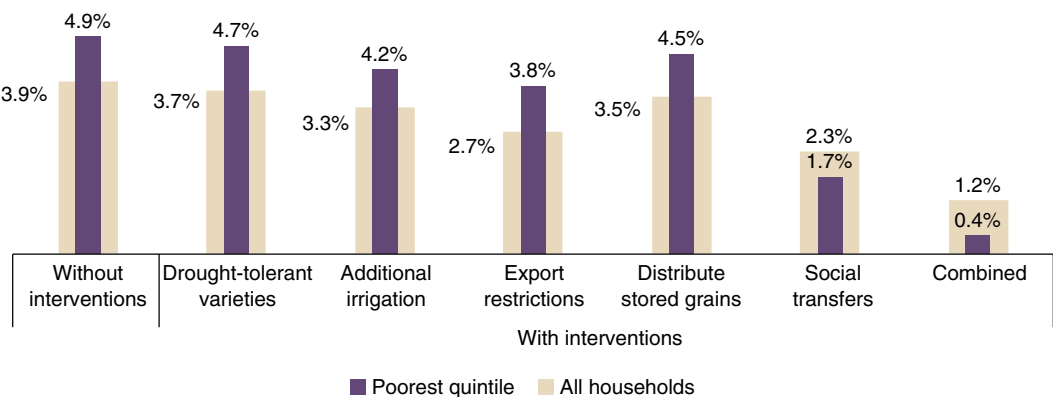
Because of this, Vietnam has abolished all export quotas, but still intervenes in rice exports when local supplies are threatened.¹²³

- Overall, when all interventions are combined and implemented concurrently, there is still a sizable GDP loss of \$2.1 billion during a strong El Niño event.

Policy interventions, especially cash transfers, are more effective in reducing household welfare losses than they are in reducing GDP losses. Expanding irrigation use and providing drought-tolerant seed varieties reduce consumption losses across the income distribution but do not eliminate all losses. A rice export ban and cash transfers are more effective, even when they have tax and income implications for higher income households. For example,

Figure 14 shows that rice export bans, which can also adversely affect international rice markets and cash transfers, reduce losses for all households, including the poor. Cash transfers are especially effective at minimizing consumption losses since they target the poorest quintile, which has the highest consumption losses during El Niño. When all policy scenarios are implemented at the same time, total consumption losses during strong El Nino event years are almost eliminated, from a 3.9 percent to 1.2 percent loss (Figure 15). Welfare improvements are even more dramatic for households in the poorest quintile, from a 4.9 percent to 0.4 percent loss.

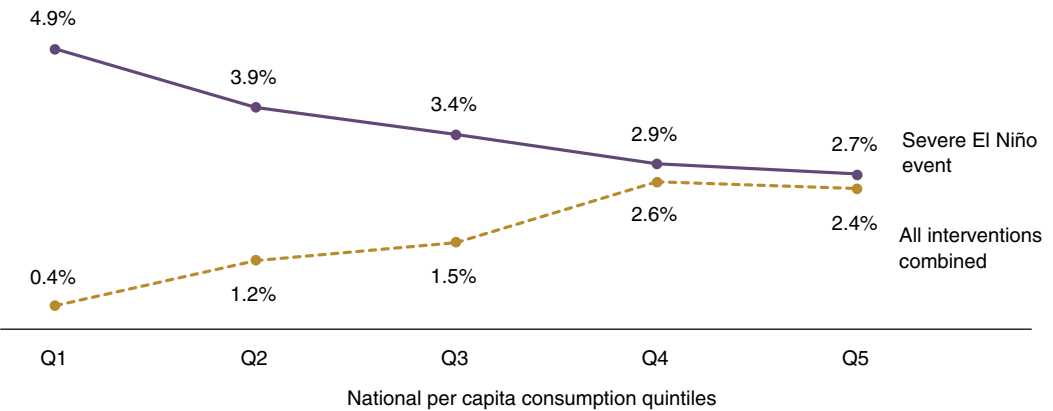
FIGURE 14: Household Consumption Losses During Strong El Niño Events and Intervention Scenarios.



Source: Simulation results from the Vietnam CGE model.

¹²³Gavagnin, Zolin, and Pastore (2016).

FIGURE 15: Household Consumption Losses by Expenditure Quintile and with/ without All Interventions Combined (Q1 is the poorest quintile, Q5 is the wealthiest).

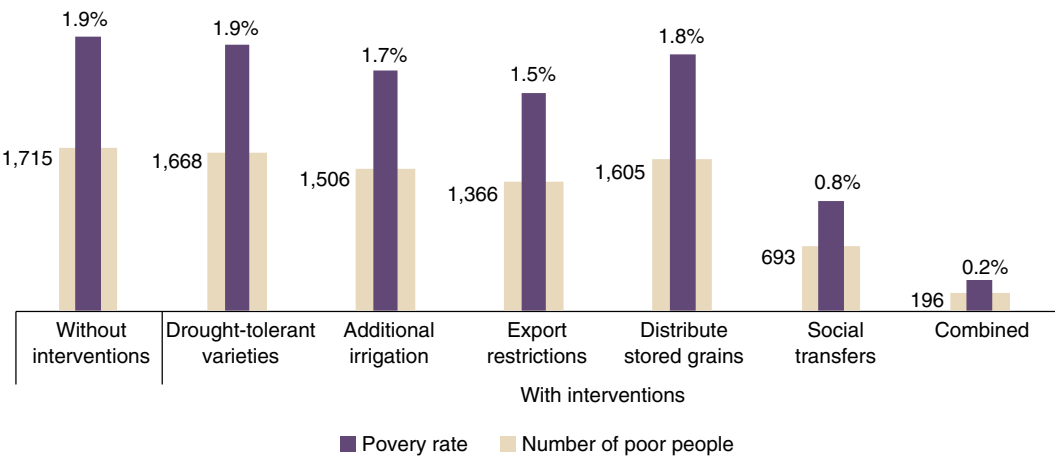


Source: Simulation results from the Vietnam CGE model.

El Niño events contribute to poverty, but policy solutions can partially mitigate this impact. El Niño’s impacts on poor households can be measured by changes in the national poverty headcount rate, which shows the share of the population living below the official poverty line.¹²⁴ Damaging climate shocks, like those associated with El Niño, would theoretically cause more people to enter poverty, raising the poverty headcount rate. Figure 16 shows how a strong El Niño changes the poverty rate and the number of people living in poverty. Without interventions to mitigate impacts, a strong El Niño event causes the national poverty rate to increase by 1.9 percentage points. This is equivalent to an additional 1.7 million people living below the poverty line during the El Niño period, which is defined as the time needed for the agricultural sector to return to normal production levels (approximately one season after the ENSO event has passed). As Figure 16 shows, policy interventions limit increases in poverty incidence. Again, the most effective policy in reaching the poor is social transfers, whereas the least effective policies for limiting poverty increases are introducing drought-tolerant varieties to farmers and distributing grain stores to overcome supply shocks.

¹²⁴The CGE model measures these changes using a survey-based micro-simulation module that links changes in consumption for households in the CGE model to changes in consumption for a more detailed set of households captured in the survey.

FIGURE 16: Changes in National Poverty Headcount Rate and Number of Poor People During Strong El Niño Events and Intervention Scenarios (percentage points and 1,000s of people).



Source: Simulation results from the Vietnam CGE model.

TABLE 7: Rural and Urban Consumption Changes During Strong El Niño Events and Intervention Scenarios (percentages).

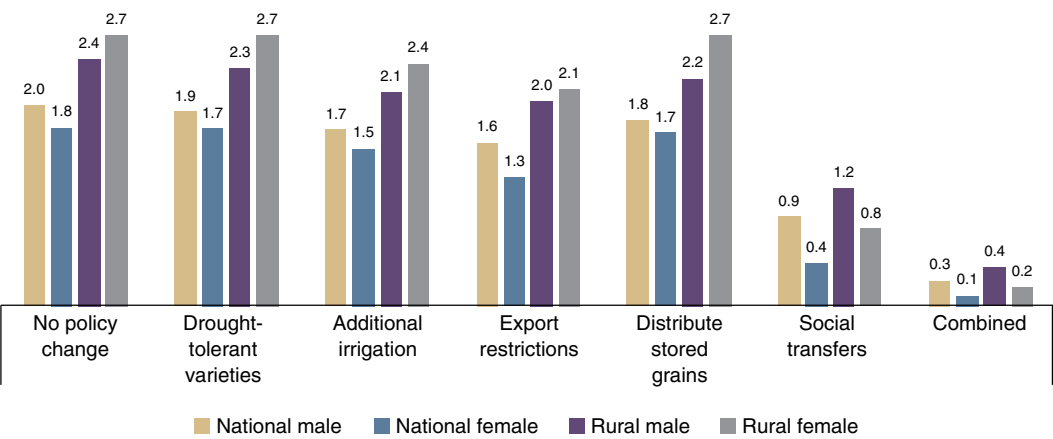
	National	Rural	Urban
Without interventions	–3.13	–3.47	–2.70
Drought-tolerant varieties	–2.94	–3.29	–2.50
Additional irrigation	–2.63	–2.91	–2.28
Export restrictions	–1.05	–1.90	0.02
Distribute stored gains	–2.64	–3.05	–2.11
Social transfers	–3.20	–3.15	–3.27
Combined	–2.07	–2.03	–2.11

Source: Simulation results from the Vietnam CGE model.

Rural families’ welfare declines the most during El Niño. Table 7 shows that without any policy interventions, rural family consumption falls by 3.5 percent. This is 0.8 more than urban family consumption losses. Rice export bans are the most effective policy for stabilizing consumption losses during a strong El Niño. The goal of these bans is to reduce domestic rice prices during supply shocks. This is a policy Vietnam has implemented before, albeit temporarily, in 2004 and 2007. Grain stores benefit urban households, which are net consumers, more than rural households, which are net producers. Social transfers, which target the poorest, benefit rural families the most, since rural families tend to be poorer than urban families.

Female-headed households in rural areas suffer the most from El Niño, but also stand to gain the most from policy interventions. Figure 17 shows that 2.7 percent more female-headed households enter poverty during strong El Niño events, the highest among male-female and urban-rural cohorts. The figure also shows female-headed households benefit the most from policy options. This is especially true for social transfers, in part because female-headed households are more likely to be poor and, therefore, more likely to be targeted in a progressive transfer scenario.

FIGURE 17: Change in Poverty Headcount Rates During Strong El Niño Events and Intervention Scenarios by Location and Gender of the Household Head (percentage points).



Source: Simulation results from the Vietnam CGE model.

CHAPTER 9

The Government Can Take Additional Actions to Improve ENSO Preparedness in Vietnam

There are many opportunities to improve ENSO preparedness and resilience.

Vietnam has been a regional leader in working toward ENSO preparedness, but there are still areas to improve. In the section below, these opportunities are divided into two groups: preparedness and resilience. While there is some overlap between these two concepts, for the purposes of this report they are defined as the following. *Preparedness* are measures specifically geared toward ENSO and should, ideally, be in place before the next ENSO event occurs. These actions will significantly empower people to cope, respond, and recover from damaging ENSO events. *Resilience*, by contrast, are measures that are not specifically designed for ENSO, but that will build individuals' and organizations' ability to adapt to multiple forms of risks and shocks without compromising long-term development. Included in this section are various best practices from around the world that can be emulated. Table 8 outlines these recommendations and prescribes steps that should be taken for each.

Preparedness

Prepare response measures for when ENSO-related climate events occur. Response measures take place during an emergency and include actions to save lives and prevent further property damage. A proper response system requires several plans and actions that should be in place prior to an El Niño or La Niña event. A national task force should be established, or the mandate of an existing task force could be extended, to evaluate ongoing ENSO response and preparedness efforts. These efforts should reflect on the successes and limitations of interventions during the 2015–2016 ENSO event. This would include an assessment of: (1) local drought and flood contingency

plans; (2) ENSO-related budgets and fund disbursements for humanitarian relief; (3) the availability of emergency response inputs and supplies, such as water, food, and agricultural inputs; and (4) infrastructure needs for emergency responses, such as roads and water ports to facilitate access to affected communities.

MARD should work with international partners to identify intervention priorities and build capacity. The World Bank, for example, can provide MARD with information on global best practices, while MARD could provide the World Bank or other partners with local information on challenges and subnational efforts. For MARD's part, they published the *Drought and Saltwater Intrusion Rapid Assessment Report*.¹²⁵ The report listed a number of priority recommendations, including: designing and maintaining water storage facilities for public use; seeking technical assistance in planting drought-, heat-, and saline-resistant crops; regulating prices of critical commodities such as freshwater; building capacity and providing guidance to local authorities prior to implementation of local response plans; raising community awareness of potential disasters, hygienic best practices, emergency preparedness, and cropping methods; exploring alternative income generation and food security options on income generation and food security; and responding to malnutrition deficiencies. For the World Bank's part, in addition to this report, they also published a 2017 report¹²⁶ on integrating Disaster Risk Management in Vietnam, which provided recommendations on the drought and saltwater intrusion crisis and made the case for investing in longer term resilience.

Improve preparedness for slow onset events like El Niño. The government of Vietnam effectively mobilized support from international partners—such as the UN, FAO, IFRC, EU, and CGIAR; international NGOs, such as Oxfam, CARE, and World Vision; and other countries, such as Japan and Australia—to respond to El Niño in 2014–2016. However, most of this support was for disaster response and recovery, not slow onset natural disaster preparedness. To improve upon this, Vietnam could expand its CBDRM plan to include slow onset events like drought and salinity intrusion.

Harness the rebound from La Niña to mitigate some of the damage from El Niño events. On the whole, La Niña gains do not cancel out El Niño losses. However, La Niña events increase rainfall and positively impact agricultural production as long as it does not lead to destructive flooding. To date, the Vietnamese government has instituted measures to prepare for negative ENSO-related impacts but has not tried to

¹²⁵MARD and others (2016).

¹²⁶World Bank (2017).

take advantage of positive ENSO-related impacts, such as increased rainfall and solar radiation. This could be done by expanding planting and improving water catchment during La Niña. At the same time, if policies are enacted to mitigate El Niño's negative impacts, harnessing La Niña's rebound can bring ENSO's positive and negative impacts into balance.

Prepare detailed risk potential maps that describe spatial distribution and levels of potential impacts. ENSO affects drought-prone or flood-prone areas but may not be particularly disruptive in other areas. Also, ENSO's impacts are not always negative. For instance, a mild El Niño can increase rice yields because of fewer cloudy days, more solar radiation, and lower flooding risk. Hence, to better prepare and respond to ENSO, the government and outside practitioner should have access to detailed local risk potential maps. These maps should incorporate information on climatic patterns; topography; hydrology; cropping systems; crop calendars; infrastructure such as roads, dikes, canals, and sluices; and risks such as floods, drought, and saline intrusion. Maps could be linked to recommended actions.

Support an effective early warning system with different alert levels. An effective early warning system would include alerts on ENSO's severity (strength, timing, and duration), farming practice recommendations based on crop model estimates, three-month forecasts, and best practices. The alerts could be linked to agricultural risk maps. The system would be particularly relevant for farmers in areas traditionally affected by ENSO. This would allow more effective preparation of contingency actions. Box 7 describes Central America's early warning system.

BOX 7: Early Warning System in Central America.

The Early Warning System for Central America, called the *Sistema de Alerta Temprana para Centro America*, or SATCA, was developed by the World Food Program Emergency Preparedness and Response team in El Salvador to cover the entire Central America and Caribbean region. SATCA brings together information from more than a dozen donors, governments, leading scientific organizations, and other international organizations. It translates technical jargon into user-friendly information on natural hazards. SATCA uses state-of-the-art technology to collect disaster risk information on droughts, floods, earthquakes, hurricanes, and volcanic activity into a single web platform. The information enables humanitarian agencies and national authorities to anticipate and respond to emergencies. The system was crucial for the rapid delivery of relief aid in recent emergencies in Belize, Cuba, Haiti, Mexico, and Panama.

Source: World Food Program 2009, "Early Warning System Saves Lives in Central America," <https://www.wfp.org/stories/early-warning-system-will-save-lives-central-america>

Develop three-month ENSO forecasts for farmers. A 2007 survey with farmers in the Mekong River Delta reported they need three-month rainfall forecasts to define sowing and harvesting dates.¹²⁷ Three-month forecasts can also help farmers plan storage methods, irrigation activity, and fertilizer application times. As mentioned earlier, ENSO forecasts are most accurate between one and four months before ENSO occurs, so three-month forecasts allow enough time for farmers to plan but also include the most accurate information. The 2007 study also reported the correlation between El Niño 3.4 SST and rainfall variability in the MRD region is the highest (0.6) with a three-month lag.¹²⁸ This means that farmers typically have a three-month window of opportunity between the beginning of El Niño and the manifestation of its climate impacts. These forecasts would represent a part of any ENSO-related early warning system.

Further invest in NCHMF's communication portal and other extension channels.

In 2016, NCHMF launched an online communication portal, *NCHMF News*,¹²⁹ which provides weather forecasts and hydrological information to a public audience. The site contains a dedicated section on the *Seasonal Weather Forecast* with the latest information on ENSO.¹³⁰ The site also contains articles, video clips, and official advisories which are also posted to social media outlets and other news sites. NCHMF News could be further strengthened by generating content on practical actions for farmers. The inability to transform information into helpful actionable recommendations for farmers and fishers was a weakness of Vietnam's ENSO response. The NCHMF portal could be used to improve this. Box 8 describes a global best practice that transfers climate information to farmers in Senegal.

Maximize the cost-effectiveness of ENSO interventions by focusing on highly vulnerable areas. As discussed, during ENSO events, Northern Vietnam has the most dramatic decreases in rainfall, Central Vietnam has the greatest weather variability, and South Vietnam faces specific challenges of saltwater intrusion. By targeting interventions toward these specific challenges, the government and its partners will simultaneously be mitigating the most serious threats and prudently dispersing limited budgets. For example, in the Mekong River Delta, work has been done¹³¹ to identify priority interventions, including ICT based early warning and climate information services, improved natural resource management, crop diversification, and drought- and

¹²⁷Thuan and others (2007).

¹²⁸Thuan and others (2007).

¹²⁹www.nchmfnews.com

¹³⁰<http://www.nchmfnews.com/p/du-bao-thoi-tiet-theo-mua.html>

¹³¹Sebastian and others (2016).

BOX 8: Transmitting Climate Information for Farmers in Senegal: Kaffrine Pilot Project.

The National Civil Aviation and Meteorology Agency of Senegal (ANACIM) partnered with CGIAR Research Program on Climate Change and Agriculture and Food Security (CCAFS) to carry out the Kaffrine pilot project. The goal of the project was to transmit climate information and agricultural advice to farmers in Senegal. This included seasonal rainfall forecasts to help farmers improve their climate resilience by changing their sowing dates and crop varieties. At the close of the project in August 2015, 7.4 million rural people, or about 740,000 agricultural households, benefitted from the project by receiving climate information via text messages and 82 rural community radio stations.

The project started in 2011 in Kaffrine, where CCAFS began training 33 farmers in six villages. They used a multidisciplinary group model that allowed different stakeholders to work together. Stakeholders included farmers, NGOs, the media, climatologists, extension agents, and agricultural scientists. As part of the project, farmers explained to the scientists how they interpret natural signs to predict the beginning of the rainy season, and the scientists explained to the farmers how this knowledge linked to technical weather forecasts. The comparison of traditional forecasting methods with scientific forecasting tools provided insights on where local knowledge gaps existed. The exchange also increased farmers' trust in scientific forecasting. Furthermore, farmers indicated their specific climate information needs and their preferred methods for receiving this information.

Two years later, in 2013, the project was scaled up to all 14 administrative regions of Senegal. The interactive nature of radio programming allowed listeners to provide feedback, seek clarification, or request additional climate information. Text messaging was also used to disseminate climate information, taking advantage of broad cellular coverage in rural Senegal. The process of transferring information was the following: ANACIM texted the climate information to extension agents, who interpreted the data to explain fertilizer use, pesticide application, seed selection, or other practices the farmers could use. The agents then relayed the information to the village through texts, phone calls, or by word-of-mouth.

Source: CGIAR. 2015. The impact of climate information services in Senegal. https://ccafs.cgiar.org/research/results/impact-climate-information-services-senegal#.WW_DiMuouAg

salt-tolerant rice variety planting. Generally, across regions, more accurate and detailed local maps and forecasting systems, as recommended above, would facilitate the ability to target the most vulnerable areas. Better information could also help extension workers encourage farmers to diversify farming into less vulnerable crops (see Box 9).

Explore the potential to smooth price fluctuations through market policies, while safeguarding against possibly harmful market distortions. Managing fluctuations in food and agricultural prices is a major policy concern during ENSO events. CGE

BOX 9: Good Practice: Shifting from Rice to Vegetables and Cash Crops in Gia Lai, Central Highlands, Vietnam.

Farmers in Gia Lai, in Vietnam's Central Highlands, shifted from planting rice to planting vegetables to avoid losses during El Niño in 2016. Gia Lai is a drought-prone province that relies on groundwater reserves during the dry season to grow their main crops, including rice, corn, coffee, and pepper. In a proactive step, Gia Lai's provincial government took note of the federal government's early warning of an impending El Niño to implement specific actions. Before the dry season of 2016, Gia Lai province already supported lower administrative units to repair irrigation infrastructure. Local authorities then counseled farmers to shift from water-intensive rice crops to drought-tolerant vegetables and cash crops, such as soybeans, sesame, and forage maize. As such, most rice farmers skipped the winter–spring rice season to prevent losses. To mitigate the effect of this change, the provincial government provided affected farmers with rice for food and vegetable seeds for planting.

Gia Lai saw immediate benefits from this change in cropping systems. Pleiku City, An Phu commune could see green vegetable farms bloom alongside fallow rice fields. One farm owner reported he draws water from a 60 meter-deep borehole to irrigate his vegetables, and says the borehole provided enough irrigation water for the entire dry season. The farmer also applied sprinkler irrigation to reduce labor and water use. This helped coffee crops and protected black pepper harvests, which is given irrigation priority by farmers because of its higher market returns.

After the El Niño event, Gia Lai province subsidized seed costs for rice farmers who lost their harvests during the crisis and plans to build more reservoirs. In addition, about 2,000 more hectares of rice fields will shift to vegetable and cash crops.

Source: The drought crisis in the Central Highlands of Vietnam.

analysis shows that even small changes in supply can lead to large changes in food prices, which adversely affect household welfare. Improved farm management and technologies cannot completely mitigate production losses, and so market policies become a potential mechanism to smooth price fluctuations and offset food supply shortfalls. For example, restricting rice exports can reduce welfare losses, especially in urban areas, even if they do little to address national and agricultural GDP losses. In the case of export bans, trade protocols and procedures should be established in advance to ensure that, if export bans are implemented, they can also readily be removed. This was the case of Vietnam's previous export bans in 2004 and 2007. Both bans were removed once they were no longer needed. This would allow the agricultural sector to return to normal production and export patterns once the ENSO passed. However, rice import bans should be considered a last resort because they can create distortions within the domestic and international grain markets that can detrimentally affect producers and trading partners.

Stock grain stores before an El Niño event is predicted to occur. Grain stores can also offset food shortfalls and smooth price fluctuations. The CGE analysis shows how using cereal stocks during ENSO events can mitigate consumption losses. However, grain stores require making sure stores are stocked before crises hit and building transportation infrastructure that is sufficiently resilient and well connected. Further research is needed to ensure there is the necessary storage capacity and the resources to replenish depleted stocks. That said, depleting grain stores should be done with caution since this action reduces grain prices, negatively impacting grain producers. Therefore, any such grain store depletion should include producer protections. One model to consider is China's grain reserve system, described in Box 10.

BOX 10: China's Grain Reserve System.

China's national grain reserve system plays an important role in safeguarding the grain market from rising food prices. The system consists of two types of grain reserve programs: the national temporary grain reserve program and the national strategic grain reserve program. The national temporary grain reserve program allows China to cope with grain yield reductions from natural disasters and stabilize the grain market during supply shocks. This allowed China to escape the steep grain price increases that hit other Asia-Pacific countries.

China's vertically managed grain reserve system has two levels of legal entities—the China Grain Reserves Corporation, or Sinograin, at the national level, and the provincial grain reserve corporations at the subnational level. The reserve corporations have a network of branch offices in major grain producing and consuming areas. In August 2003, China enacted regulations on the administration of central grain reserves. These regulations clarified legal responsibilities and grain use, storage, inspection, and supervision processes. In 2004, China liberalized its grain markets and, until recently, Sinograin and its provincial entities purchased grains from producers at floor prices, which were pre-set each year by the central government.

As a result, China accumulated large grain reserves and, during major droughts in 2009 and 2010, the central government sent 1.4 million tons of reserve grains to drought-stricken southern provinces to alleviate local food shortages. This successfully stabilized local grain prices, protecting farmers' incomes, mitigating the impact of steep price increases on poor consumers, and ensuring social and political stability. However, introducing such a large influx of cheap grain also created market distortions that can harm producers.

Sources: Qin Zhongchun. 2009. Formation and Features of China's New Grain Reserve System; FAO. 2009. "Country responses to the food security crisis: nature and preliminary implications of the policies pursued, Initiative on soaring food prices," http://www.fao.org/fileadmin/user_upload/ISFP/pdf_for_site/Country_Response_to_the_Food_Security.pdf

The government should adjust social safety nets to be more responsive to ENSO events. Targeted social safety nets, including cash transfers and public works programs, can mitigate the impacts of environmental shocks caused by ENSO by supporting livelihoods and improving food security and nutrition. The CGE simulations found that cash transfers were the most effective policy intervention (among those considered) at preventing increases in poverty during ENSO events. These programs target the poorest most vulnerable populations, such as women and the rural poor. However, cash transfer mechanisms have not been a preferred social safety net (SSN) in Vietnam, so there may be political economy challenges in implementing any such activity. That said, there is room for the government to adjust social safety nets to be more responsive to ENSO events. This includes strengthening social assistance delivery systems, which also allows for upscaling, and improving targeting procedures that make cash delivery more predictable and transparent.¹³² Another way to make social safety nets more responsive to ENSO is to integrate them with natural hazard preparedness, as is the case in Ethiopia, described in Box 11.

BOX 11: Ethiopia's Productive Safety Net Program Integrated with Early Warning Systems and Disaster Risk Management.

Ethiopia's Productive Safety Net Program (PSNP) is a large national social safety net (SSN) program that includes elements of climate resilience. The PSNP's goal is to improve food security among Ethiopia's poor, and mitigate the impacts from shorter term shocks, mainly droughts. The PSNP is implemented almost entirely through national government systems, which are decentralized through regional and local administrations. The unique aspect of this system is its incorporation of early warning and disaster risk management into its institutional structure.

The Ministry of Agriculture is responsible for program management, with the Disaster Risk Management and Food Security Sector tasked with overall program coordination. The Early Warning and Response Directorate provides early warning information on natural hazards and ensures the PSNP's emergency responses are linked to relief and hazard response activities. The Natural Resource Management Directorate oversees the public works and the Ministry of Finance and Economic Development oversees financial management.¹³³ These federal implementation arrangements are replicated within the PSNP's eight regions and 319 woredas (districts).

Source: GFDRR. 2013. "Ethiopia's Productive Safety Net Program (PSNP) Integrating Disaster and Climate Risk Management," http://www.wcdrr.org/wcdrr-data/uploads/482/SPL_DRM_TK_CS2_Ethiopia%20PSNP.pdf

¹³²World Bank (2017).

¹³³World Bank (2010).

Resilience

Improve ENSO response planning and coordination among government agencies. As described above, there is a proliferation of plans, policies, and agencies that address ENSO, climate change, and disaster risk. These actions could be more integrated and consistent. As such, efforts could be made to integrate ENSO, climate change, and disaster risk strategies and coordinate activities. Currently, PACCOM coordinates INGO aid activities, but there could be a stronger mechanism for coordination among government agencies. The existing Standing Office of the CSCNDPC is one option to do this. The CSCNDPC could coordinate policies, programs, and investments undertaken by MARD, MoNRE, and other relevant ministries and provide overall guidance and oversight across sectors and across national, regional, and provincial levels. In the short term, the CSCNDPC Standing Office could establish a task force, much like MARD's El Niño mission described above, to identify ENSO response measures and develop longer term resilience options.¹³⁴

MARD could strengthen its analytical capacity through its agricultural research and development program. To help assess the potential impacts of ENSO on crop production at subnational levels, MARD could develop a grid-based, countrywide crop systems modeling framework in its agricultural research and development program. For example, the Sub-Institute of Hydrometeorology and Environment (SIHY-METE) carried out a study to develop an ENSO forecast system linked with DSSAT crop models to recommend the optimum planting date.¹³⁵ Such a framework could be developed and maintained in partnership with academic institutions who incorporate crop modeling as a research tool, such as the Ho Chi Minh City University of Technology,¹³⁶ the Hanoi University of Agriculture,¹³⁷ or international agricultural research centers with crop modeling capacity such as the International Rice Research Institute (IRRI) and International Center for Tropical Agriculture (CIAT).

Empower local communities to provide inputs and lead their own ENSO responses. ENSO preparedness should take into consideration local knowledge from high-risk and vulnerable areas. This can improve local political buy-in for preparedness plans and ensure that resources are properly deployed. In such a scenario, local partners could prepare their own provincial preparedness plans, with federal funding

¹³⁴World Bank (2017).

¹³⁵Thuan and others (2007).

¹³⁶Hoang and others (2016).

¹³⁷Vien (2011).

support. This would also provide a mechanism to collect local-level, location-specific information for practitioners and policy makers.

Sustain and scale up good practices. There is an array of local Vietnamese best practices on ENSO-related themes that have been tested and piloted by different actors, mostly INGOs and NGOs. Box 9, for example, describes how Central Highland farmers shifted their crops to adapt to ENSO conditions. There are many successful practices taking place across Vietnam that could be effective at a larger scale. Examples include: sowing delays of winter–spring rice in the Red River Delta; substituting drought-resistant crops, such as maize, groundnut, and cassava, in the Central Region; using salt-tolerant aquaculture species in the coastal areas of the Mekong River Delta; and enhancing veterinary service capacity to address vector-borne diseases in livestock. However, many local best practices cannot be scaled up because of a lack of human or logistical capacity or simply end when the funding runs out. As such, there is also a need to build capacity and develop policies to sustain funding sources.

Invest in rural roads and irrigation infrastructure. The crop modeling and CGE modeling both suggest there are substantial benefits to expanding investment in irrigation. The CGE analysis shows irrigation mitigates damages from severe El Niño events. Currently, over 80 percent of rice paddies are already irrigated, but these can be improved or rehabilitated. Also, selective new investments could be made to expand cost-effective irrigation into new cropping systems, like high value vegetables. Improved and expanded irrigation would stabilize crop yields during El Niño and reduce potential losses. At the same time, an improved rural transportation network would help farmers, especially farmers in the most remote villages, access input and output markets and services and assistance during ENSO events. As part of these improvements, detailed maps that properly identify irrigation and transportation facility locations could be developed to target interventions and diagnose structural and engineering design quality.

Target women to lead agriculture projects or target them as beneficiaries. As discussed, most of Vietnam's agricultural workforce is composed of women. They participate in every facet of agriculture and, as such, are the best positioned to carry out agriculture-related ENSO preparation. This is because they are the most knowledgeable of their crops, fish, and livestock and the climatic conditions of their local environment. They are also the most technically proficient counterparts in agriculture at the local level. In addition, as we have seen, women lag behind men in many key socioeconomic indicators, such as income and access to credit. In this sense, targeting

women creates the double benefit of establishing project counterparts and building the resilience of a vulnerable group.

Vietnam should cooperate with other southeast Asian countries on ENSO-related challenges, which are regional in nature. For example, ENSO-related flooding, salinization, and water scarcity issues are persistent in all the countries of the Mekong Delta, which runs from Vietnam to China.¹³⁸ Increased regional cooperation to develop preparedness measures and meteorological and hydrological services and forecasting would lower common infrastructure costs, and allow for more knowledge exchange on best practices. There are already a number of regional and global institutions that could facilitate such cooperation. These include:

- The World Meteorological Organization (WMO), which houses the Southeast Asia Flash Flood Guidance System, the European Center for Medium-range Weather Forecasts, and the Global Flood Awareness System;
- The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), which coordinates a regional Typhoon Committee;¹³⁹
- The Association of Southeast Asian Nations (ASEAN), which coordinates a Regional Climate Outlook Forum, runs a Subcommittee on Meteorology and Geophysics, and implements the Southeast Asia Radar Network and Composite project;
- The Mekong River Commission (MRC), which shares hydrological data among the Mekong basin countries, including Thailand, Vietnam, Cambodia, and Lao PDR;¹⁴⁰
- The Asian Disaster Preparedness Center, which facilitates satellite imagery and geospatial technology exchanges among Mekong Basin countries;¹⁴¹ and
- The World Bank is also developing a South East Asia flood monitoring and risk assessment platform, or the SEA DRIF Platform, that assesses near real-time flood impacts in Myanmar, Cambodia, and Lao PDR.¹⁴²

In Table 8, recommendations are divided into two groups: preparedness and resilience. While there is some overlap between these two concepts, for the purposes of

¹³⁸World Bank GFDRR. June 2018. “Strengthening the Regional Dimension of Hydromet Services in Southeast Asia: A Policy Note with a Focus on Cambodia, Lao PDR, and Vietnam.”

¹³⁹14 members: Cambodia; China; Democratic People’s Republic of Korea; Hong Kong SAR, China; Japan; Lao PDR; Macao SAR, China; Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; Vietnam; and the United States.

¹⁴⁰<http://www.mrcmekong.org/about-mrc/>

¹⁴¹World Bank GFDRR. June 2018. “Strengthening the Regional Dimension of Hydromet Services in Southeast Asia: A Policy Note with a Focus on Cambodia, Lao PDR, and Vietnam.”

¹⁴²Deltares (2018), “*South-East Asia platform for NRT flood impact assessment*” May (working paper for the World Bank).

this report they are defined as the following. *Preparedness* are measures specifically geared toward ENSO and should, ideally, be in place before the next ENSO event occurs. These actions will significantly empower people to cope, respond, and recover from damaging ENSO events. *Resilience*, by contrast, are measures that are not specifically tailored to ENSO, but that will build individuals' and organizations' ability to adapt to multiple forms of risks and shocks without compromising long-term development. Recommendations in purple are a high priority, recommendations in yellow are a moderate priority. The last two columns denote which actions are short term (S), or should be completed within a year, and which actions are medium- to long-term (M/L), or would not be achievable in less than a year.

TABLE 8: Recommendations and Proposed Activities to Build pre-ENSO Preparedness and Long-Term Resilience.

	Recommendation	Actions	S	M/L
Preparedness	Identify intervention priorities and build capacity	Conduct a systematic review of the successes and shortcomings in responding to the 2015–2016 ENSO event.	X	
		MARD should work with international partners to identify intervention priorities.	X	
		Develop an action plan to implement these priorities.	X	
	Improve preparedness for slow onset events like El Niño	Bring together CBDRM stakeholders.	X	
		Expand the CBDRM plan to include slow onset events like ENSO-related drought and salinity intrusion.	X	
		Expand agricultural research on early maturing and stress-tolerant crop varieties.	X	
		Raise awareness on El Niño resistant practices that are water use efficient.		X
	Harness La Niña's rebound	Appoint a committee or task force to explore agricultural strategies for La Niña.	X	
		Make plans to rehabilitate water storage facilities, increase water catchment, expand planting, shift planting dates and areas, and so forth.	X	
		Take measures to reduce flood risk in flood-prone areas.	X	

	Recommendation	Actions	S	M/L
Preparedness	Prepare risk potential maps	These maps should describe spatial distribution and levels of potential impacts.	X	
		Provide access to detailed local risk potential maps to government officials and outside practitioners.	X	
		Incorporate information on climatic patterns, topography, hydrology, cropping systems, crop calendars, infrastructure such as roads, dikes, canals, and sluices, and risks such as floods, drought, and saline intrusion.	X	
		Link the maps to recommended actions or best practices.	X	
	Support an effective early warning system	Identify partner institutions with forecasting capabilities and EWS capacity to guide MARD.	X	
		Develop an EWS alert system on ENSO's severity (strength, timing, and duration) and farming practice recommendations based on crop model estimates, three-month forecasts, and best practices.	X	X
		Link the alerts to agricultural risk maps.	X	X
		Update the network of Automated Weather Stations.	X	X
	Develop three-month ENSO forecasts for farmers	Building off the EWS, develop three-month forecasts to help farmers plan storage methods, irrigation activity, and fertilizer application times.	X	X
		Develop a mechanism to disseminate forecasts to farmers through extension services, cellular providers, and social media.	X	
		Improve public awareness of ENSO and other climate challenges.		X
	Invest in NCHMF's communication portal	Strengthen the <i>NCHMF</i> News portal, which provides weather forecasts and hydrological information to a public audience, by generating content on practical actions for farmers.	X	
		Link this information sharing mechanism with the EWS/forecasting systems.	X	X

(continued)

TABLE 8: Continued.

	Recommendation	Actions	S	M/L
Preparedness	Focus ENSO preparedness on highly vulnerable areas	Target interventions toward specific challenges, for example Northern Vietnam has the most dramatic decreases in rainfall, Central Vietnam has the greatest weather variability, and South Vietnam faces specific challenges of saltwater intrusion.	X	
		Utilize the risk potential maps and forecasting systems to facilitate the targeting.	X	X
		Provide necessary disaster response equipment to these areas.	X	
		Assist with resettlement planning in case of disaster.	X	
	Identify market policies to smooth price fluctuations	Create a committee to identify potential policies that can be enacted during food price shocks. Risks should also be identified.	X	
		In the case of rice export bans, or other potential policies, establish trade protocols and procedures to assure policies can be quickly removed.	X	
		Activate policies when certain price fluctuation thresholds are met.		X
	Stock grain stores before El Niño events	Assess the current grain storage capacity in Vietnam. Identify constraints.	X	
		Assess the cost-effectiveness and risks of building additional grain storage capacity.	X	
		Make plans to stock these spaces before the next ENSO in areas that are easily accessible.		X
	Expand and adjust social safety nets (SSNs)	Assess constraints to expanding current SSNs and properly targeting beneficiaries.	X	
		Move toward increased funding, skills development, and capacity building to launch or scale up SSNs.		X
		Target poor, rural areas with food-for-work programs, expanded labor market programs, and, potentially, conditional cash transfers.		X
		Adjust these programs to make them more responsive to droughts and other ENSO impacts through better targeting or by expanding these systems in times of ENSO-related crises.		X

	Recommendation	Actions	S	M/L
Resilience	Improve government capacity and coordination on climate-related issues	Streamline government policies, programs, and departments dealing with ENSO and other climate shocks.	X	
		Clearly identify the roles and operational mechanisms of each institution in relation to these programs.	X	
		Assign a special committee devoted to integrating slow onset disasters related to ENSO within PACCOM or CSCNDPC, including members from different government agencies, such as MARD and MoNRE, and civil society.	X	
		Develop a mechanism for state-level stakeholders to work with provincial-level and local-level actors to create a better flow of information on climate challenges and solutions.	X	
		Exchange information through forums or other dialogues.	X	
	Integrate a regional approach to ENSO	Begin dialogues with potential partners in ENSO, including WMO, ESCAP, ASEAN, MRC, the Asian Disaster Preparedness Center, and the World Bank's SEA DRIF Platform.	X	
		Identify areas of cross-border vulnerability and potential infrastructural cost sharing.		X
	Strengthen MARD's analytical capacity	Improve capacity through MARD's agricultural research and development program.		X
		Develop a grid-based, countrywide crop systems modeling framework.		X
		Maintain this framework in partnership with academic institutions who incorporate crop modeling as a research tool, such as the Ho Chi Minh City University of Technology, the Hanoi University of Agriculture, or international agricultural research centers with crop modeling capacity such as IRRI and CIAT.		X
	Empower local communities to provide inputs and lead their own ENSO responses	Compose a team to gather local knowledge from high-risk and vulnerable areas and share information with local communities.	X	
		Allow local partners to prepare their own provincial preparedness plans, with federal funding support.	X	X
	Sustain and scale up good practices.	Identify Vietnamese best practices on ENSO-related themes that have been tested and piloted by different actors, mostly INGOs and NGOs.	X	
		Increase human and resource capacity to scale up these practices.		X

(continued)

TABLE 8: Continued.

	Recommendation	Actions	S	M/L
Resilience	Invest in rural roads and irrigation infrastructure	Assess the prevalence and condition of rural transportation systems and irrigation and water harvesting systems. Include livestock and fishery infrastructure as necessary.	X	
		Where feasible, develop plans to expand irrigation (including drip irrigation) and water harvesting systems, especially in areas prone to drought.		X
		Develop plans to improve rural roads with a focus on connecting agricultural production to markets.		X
		Climate proof these facilities.		X
	Target women	Develop a strategy targeting women who are vulnerable to ENSO (agriculture workers, rural inhabitants, natural resource managers).	X	
		Develop quotas or guidelines to empower women in leadership or coordination positions in local- or national-level efforts to combat ENDO impacts.		X
		Introduce resource-efficient, low-carbon practices for women.		X
		Target women in SSNs.		X

Annexes

Annex 1: Methodological specifics

This annex outlines the specifics of the methodology summarized in Box 1.

General

First, historic climate data is examined, including variability in rainfall and temperature, followed by an assessment of the frequency of ENSO events in the historical record. More specifically, short-term climate fluctuations during ENSO event years are compared with recent “neutral” weather years (without ENSO shocks) to identify deviations in rainfall and temperature variables.

Second, changes in weather variables during the crop growing season are translated into physical, agricultural productivity outcomes using a combination of statistical and process-based models. Process-based crop models to estimate ENSO-affected seasonal yield deviations of major crops in a grid-based spatial analysis framework are also applied to isolate ENSO impacts from other events. Daily historical weather data (spatially interpolated from weather station data), linked with the corresponding ENSO phase, was used as input to the crop modeling framework that estimated crop yield changes for important crops: rice, maize, and tomatoes. Rice and maize are major crops in the country, and tomatoes act as a proxy for a broader array of vegetables (a standard approach in climate studies). The crop models also estimate how yield responses differ when using improved or traditional seed varieties, and with and without chemical fertilizer, or depending on the water management regime (with and without irrigation infrastructure).

Third, non-crop impact channels are also considered, such as livestock and fisheries. In the absence of sophisticated models for these subsectors, we rely on secondary evidence compiled from other studies. These studies typically focus on a specific ENSO year, such as the severe 2016 event. The livestock sector analysis is supplemented with estimated Temperature Humidity Indices to estimate heat stress levels and productivity losses for cattle and poultry.

Finally, the estimated impacts of ENSO events on crop, livestock, and fisheries yields are imposed on a dynamic computable general equilibrium (CGE) model. This class of model captures all producers and consumers in an economy, including the government and interactions with the rest of the world (e.g., imports and exports). All sectors and households are disaggregated across major subnational regions. Region- and crop-specific productivity shocks thus translate into changes in agricultural and national GDP, employment, and prices. The model reacts to crop- and sector-specific productivity changes by reallocating resources and products between sectors and households to minimize overall losses to the economy (i.e., autonomous adaptation). The model is linked to a survey-based micro-simulation module that tracks changes in national and subnational poverty rates.

The integrated approach to measure economy-wide impacts of climate shocks is similar to what is often used for long-term climate change impact studies. The DSSAT and CGE models represent some of the most sophisticated tools available for such analysis, and the high-resolution spatial databases used in both types of models are quite unique, both for Cambodia and developing countries in general. The framework makes it possible to isolate the impacts of ENSO events, as well as to assess outcomes in hypothetical alternative policy environments, such as changes to trade policies or the scaling up of social safety nets.

The CGE modelling

RIAPA is a recursive dynamic computable general equilibrium (CGE) model that simulates the functioning of a market economy, including markets for products and factors (i.e., land, labor, and capital). RIAPA measures how impacts are mediated through prices and resource reallocations, and ensures that resource and macroeconomic constraints are respected, such as when inputs or foreign exchange are limited. RIAPA provides a consistent “simulation laboratory” for quantitatively examining value-chain interactions and spillovers at national, subnational, and household levels.

RIAPA divides the national economy into different sectors and household groups that act as individual economic agents. Producers maximize profits and supply output to national markets, where it may be exported and/or combined with imports depending on relative prices, with foreign prices affected by exchange rate movements. Producers combine factors and intermediate inputs using sector-specific technologies. Maize farmers, for example, use a unique combination of land, labor, machinery, fertilizer, and purchased seeds. Workers are divided by education levels, and agricultural capital is separated into crop and livestock categories. Labor and capital are in fixed supply,

but less-educated workers are treated as underemployed. Producers and households pay taxes to the government, who uses these and other revenues to finance public services and social transfers. Remaining revenues are added to private savings and foreign capital inflows to finance investment, i.e., investment is driven by levels of savings. RIAPA is dynamic, with past investment determining current capital availability.

RIAPA tracks changes in incomes and expenditures for different household groups, including changes in food and non-food consumption patterns. Poverty impacts are measured using survey-based micro-simulation analysis. Individual survey households map to the model's household groups. Estimated consumption changes in the model are applied proportionally to survey households, and post-simulation consumption values are recalculated and compared to a poverty line to determine households' poverty status.

Policy scenario interventions

In order to understand if and how different policy options can mitigate impacts from ENSO events, different policy options are incorporated into the model. Some of the scenarios reflect existing policies in the country, such as relaxing import protections for cereals or expanding current social transfer programs. Other scenarios consider policies that may not exist today or be considered central to the national debate, e.g., irrigation infrastructure, stored grains, and cash transfers. The scenarios are therefore a combination of current and potential policy options, benchmarked to existing policies and evidence to ensure that the scale of policy change is plausible and relevant.

We consider the following six policy scenarios:

- *Drought-tolerant varieties:* We provide farmers in the model with more drought-resistant maize, rice, and vegetable varieties, leading to 1–3 percent higher yields on average for rainfed farming during El Niño years. Rather than assuming universal adoption, drought-resistant varieties are deployed in a limited way to regions that anticipate the greatest water challenges. The International Rice Research Institute (IRRI) has developed and disseminated, via small-scale pilot projects, region-specific drought-tolerant rice varieties. Scaling up the adoption of these seeds would require improvements in both seed and farmer extensive systems.
- *Additional irrigation:* The amount of cultivated land in the model that uses irrigation infrastructure has increased. Rice is already widely irrigated in Vietnam (i.e., 85 percent coverage of rice land in North, 82 percent in Central, and 90 percent in South), and so further expansion is limited. We simulate modest increases in irrigation use (i.e., reaching 94 percent in North, 90 percent in Central, and 95 percent in South). This is a relatively small percentage change in rice irrigation, but may

cover a large land area. Maize is generally not grown on irrigated lands. We assume that maize irrigation remains low in all regions (27 percent in North, 23 percent in Central, and 34 percent in South). Our irrigation scenario assumes that there is adequate water to operate additional irrigation systems. Although we focus on irrigation infrastructure, an alternative option may be to improve water use efficiency (e.g., via alternative wetting and drying practices). Since we do not capture potential water supply constraints, the scenario is equivalent to one that maintains yields during ENSO shocks through more efficient water use.

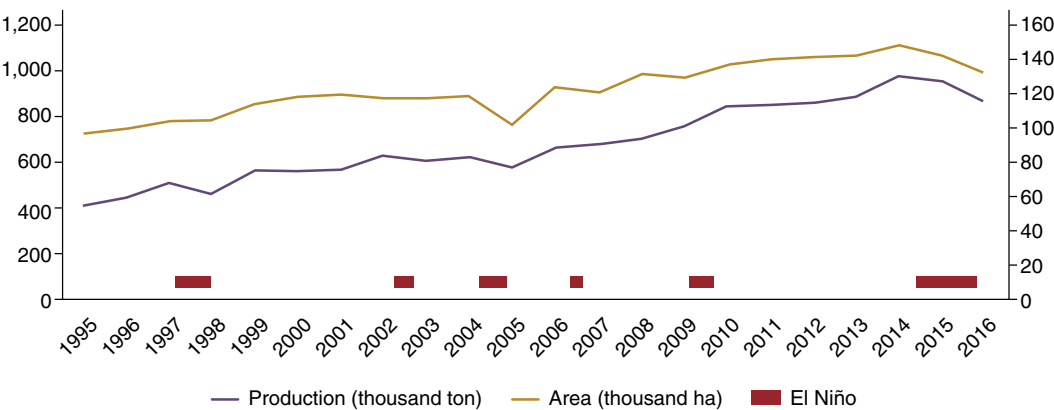
- *Rice export restrictions:* We introduce a partial ban on rice exports implemented over the course of a year. Vietnam has used this policy instrument before to respond to concerns about domestic rice supply shortages. These include temporary bans, like the ones in 2004 and 2007–08. The goal of export bans is to reduce domestic prices for rice consumers, but this also lowers the producer price for exporters. The impact on the poor, who tend to be smallholder farmers, but also net consumers of rice, depends on the complex income and expenditure structures of households living close to the poverty line. Unlike export taxes, export bans do not directly generate revenues for the government. The indirect economic costs of an export ban are internalized in the model, however, via changes to government revenues and fiscal deficits.
- *Grain storage and distribution:* Supply 1 million tons of rice from public and private stocks. Depleting stocks addresses short-term supply shortfalls during ENSO events and offsets some of the price increases caused by production losses. Like export bans, depleting grain stores benefits consumers, but may prevent market forces from limiting farm revenue losses via higher prices for agricultural products. The scenario assumes that storage facilities already have or can be expanded to achieve this capacity. Historical evidence indicates that Vietnam has the capacity to accommodate the scale of drawdown in this scenario. For example, the FAO Food Balance Sheets show that the country depleted collective grain stocks by over a million ton in 2013 (the final year in this data series). This suggests that our grain storage scenario is within the country's capacity to achieve within a given year. Note that we do not consider the financial cost of restocking public and private grain stores in the years following an ENSO event.
- *Social transfers:* Provide short-term cash transfers to poorer households (Quintiles 1–3) equal to about US\$20 per person over a given year. Our cash transfer scenario increases existing national average transfers during El Niño years. Households in the model can use these funds to offset higher food costs, or to purchase non-food products, whose prices may also rise during ENSO events as economic shocks spill over from agriculture to non-farm sectors. The fiscal cost of expanding social transfers is internalized through higher direct taxes (e.g., pay-as-you-earn and

- corporate taxes). The scenario assumes that the distribution of new cash transfers occurs through existing social protection systems and does not increase the administrative cost of this system. This is equivalent to assuming that additional administrative costs (not actual transfers) are borne by foreign development partners.
- *Combined:* All the above policies implemented concurrently. Of course, it may not be feasible to implement all the policies simulated here, and there are undoubtedly other interventions that could be more effective in reaching certain regions or population groups. However, on-farm investments designed to make the agricultural sector more resilient during strong ENSO events may be insufficient.

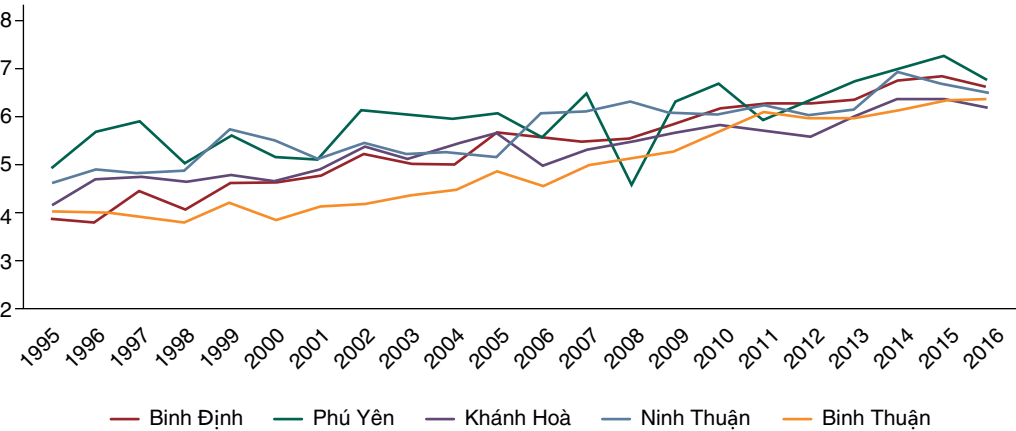
These six policy scenarios do not capture all possible government responses to ENSO shocks. Nor are the scenarios designed to reflect the complexities of specific policies. Such detailed analysis is beyond the scope of this study. Instead, the scenarios are purposefully selected to reflect the range of policy instruments available to the government, including investments in farm production (i.e., seeds and irrigation); trade and price policies (i.e., export bans); and standard emergency responses (i.e., grain stock management and social safety nets). Within each type of instrument there are further options to be considered, such as the targeting and distribution mechanisms for emergency cash transfers.

Annex 2: Rice production under various scenarios

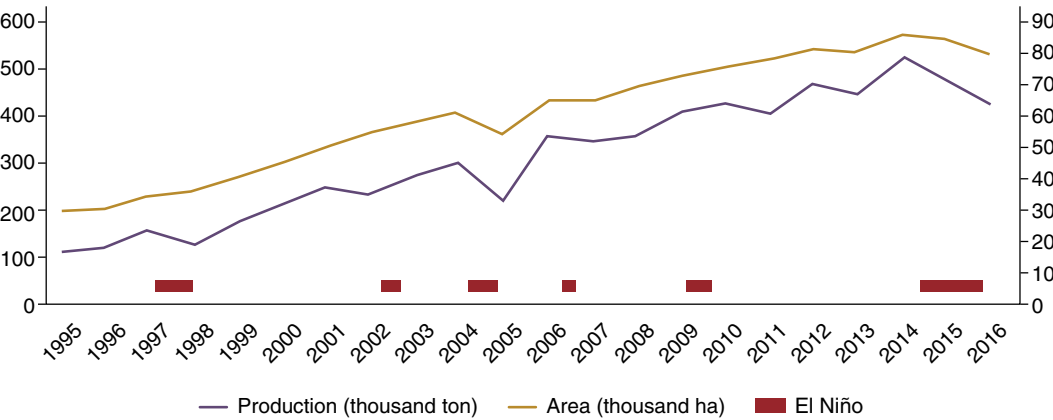
Annex Figure 2a: Winter–Spring Rice Production (1,000 tons) in South Central Coast, 1995–2016.



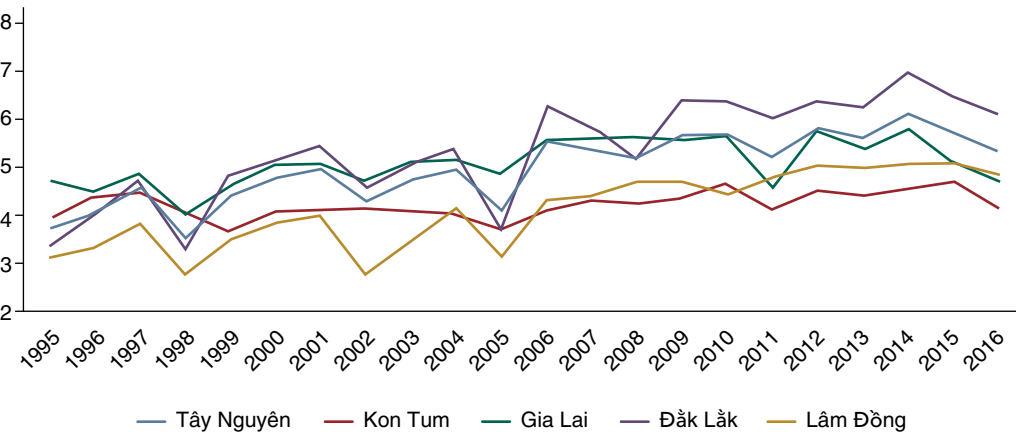
Annex Figure 2b: Winter–Spring Rice Yields (tons/hectare) in South Central Coast, 1995–2016.



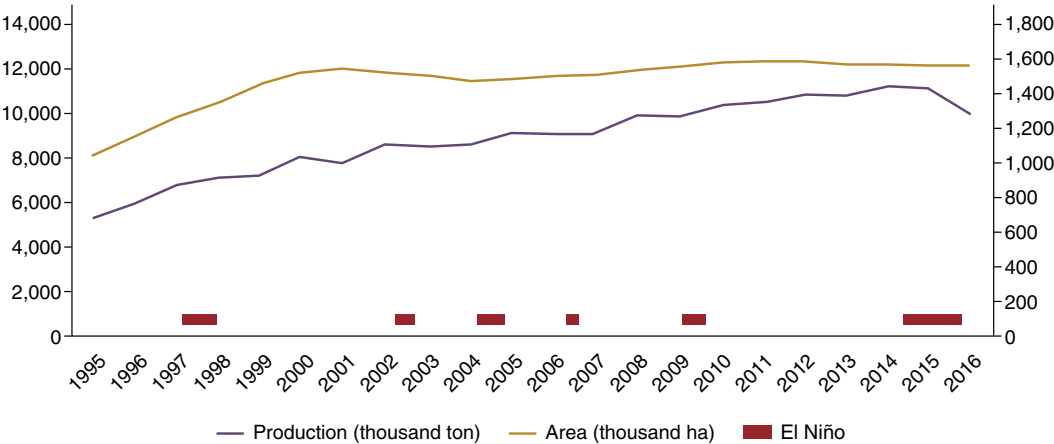
Annex Figure 2c: Winter–Spring Rice Production (1,000 tons) and Area (1,000 hectares) in Central Highlands, 1995–2016.



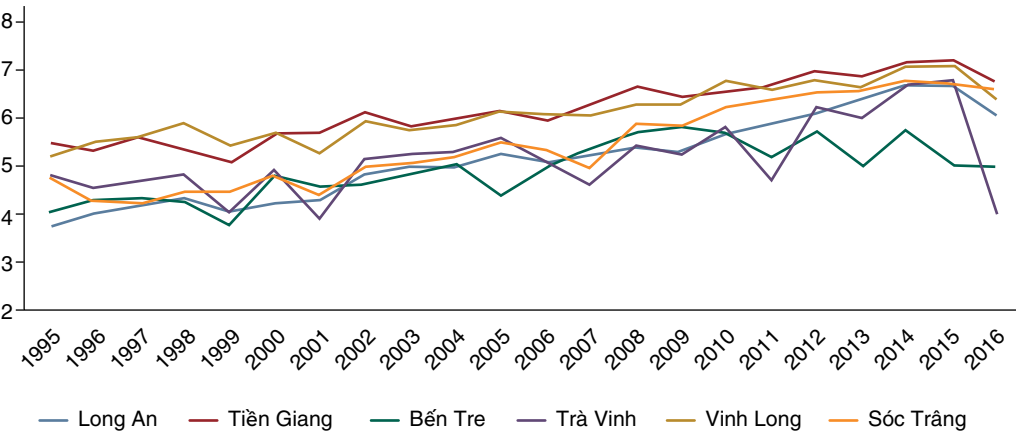
Annex Figure 2d: Winter–Spring Rice Yields (ton/hectare) in Central Highlands, 1995–2016.



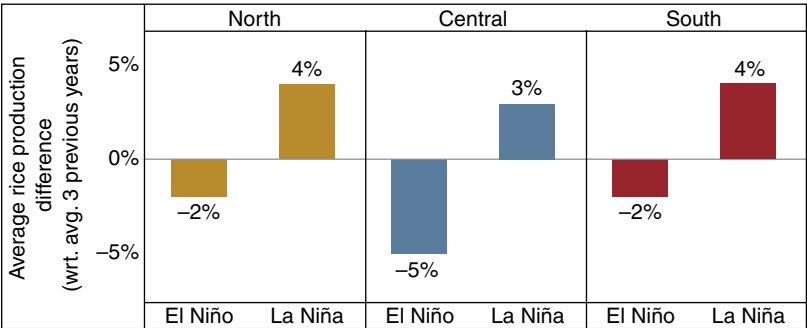
Annex Figure 2e: Winter–Spring Rice Production (1,000 tons) and Area (1,000 hectares) in Mekong River Delta, 1995–2016.



Annex Figure 2f: Winter–Spring Rice Yields (tons/hectare) in Mekong River Delta, 1995–2016.



Annex 3: Statistically estimated deviations in average annual rice production during ENSO years, 1995–2015



Source: Authors' reanalysis from the historical rice production statistics data retrieved from the General Statistics Office of Vietnam.



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