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Contents

Abbreviations

AAGR	Average annual growth rate
ADB	Asian Development Bank
AIT	Asian Institute of Technology
AFPRC	Laos Ministry of Agriculture and Forestry, AFP Research Center
ARF	ASEAN Rice Federation
ASEAN	Association of Southeast Asian Nations
BAAC	Bank of Agriculture and Agricultural Cooperatives
BDP	Basin Development Plan
CDRI	Cambodia Development Resource Institute
CREA	Cambodian Rice Exporters Association
CRF	Cambodia Rice Federation
CRTC	Thailand Council on Rice Trade Cooperation
DTD	Laos Ministry of Industry and Commerce's Domestic Trade Department
ECAFE	United Nations Economic Commission for Asia and the Far East
ENSO	El Niño Southern Oscillation
EU	European Union
EXIM Bank	Export/Import Bank
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Data Base
FAO/RMM	FAO/Rice Market Monitor
FAO/ GIEWS	FAO Country Reports/Global Information and Early Warning Systems
FDI	Foreign direct investment
FTTC	Food and Fertilizer Technology Center
GDP	Gross domestic product
GNI	Gross national income
GMS	Greater Mekong Subregion
GRiSP	Global Rice Science Partnership, International Rice Research Institute

GTZ	Gesellschaft für Technische Zusammenarbeit
GSO	General Statistics Office
IBRD	International Bank for Reconstruction and Development
ICEM	International Center for Environmental Management
IDA	World Bank's International Development Agency
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
LOC	Library of Congress
LMB	Lower Mekong Basin
LMCs	Lower Mekong Countries
LMCM	Lancang-Mekong Cooperation Mechanism
LMI	Lower Mekong Initiative
MAFF	Cambodia, Ministry of Agriculture, Forestry and Fisheries
MARD	Ministry of Agricultural and Rural Development
MC	Mekong Committee
MD	Mekong Delta
MDEC	Mekong Delta Economic Cooperation
MIT	Ministry of Industry and Trade
MJ-CI	Mekong-Japan Economic and Industrial Cooperation Initiative
MoNRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
MSEA	Mainland Southeast Asia
NAFRI	Laos Ministry of Agriculture and Forestry
NMC	National Mekong Committee
OREC	Organization of Rice Exporting Countries
SEA	Southeast Asia
TREA	Thailand Rice Exporters Association
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VFA	Vietnam Food Association
VNMC	Vietnam National Mekong Committee
VNMD	Vietnam Mekong Delta
WB	World Bank
WHO	World Health Organization
WRS	World Rice Statistics
WMO	World Meteorological Organization
WTO	World Trade Organization
WWF	World Wildlife Fund

Chapter 1
Introduction

Abstract This book may be considered as an extension and an update of the 2014 book on "Water Resources and Food Security in the Vietnam Mekong Delta." It is intended for students and researchers who are interested in the rice productivity and water security in the four countries of Cambodia, Laos, Thailand, and Vietnam that are located in Mainland Southeast Asia (MSEA) and share the Mekong River in the Lower Mekong Basin (LMB). Rice crop is the largest user of fresh water provided by the monsoon rains and the Mekong River. The book deals with major issues facing the rice production, trade, and consumption in the four countries that are impacted by climate change, conflicted by the impacts of Mekong mainstream dams on the river ecosystem, and influenced by the roles of great powers in the region.

The book also examines the evolution of the concept of regional cooperation from the Mekong River Commission (MRC) created by the four riparian countries in April 1995, to the Lower Mekong Initiative (LMI) initiated by the United States in July 2009, the Mekong-Japan Summit (MJS) organized by Japan in November 2009, and the Lancang Mekong Cooperation Mechanism (LMCM) led by China in March 2016. The book discusses the effectiveness of the MRC in promoting a river basin organization for the sustainable development of the Mekong water resources and the emerging role of China in a new political, social, and economic Mekong cooperation framework which could determine the future water and rice security of the region.

Keywords Sustainable development of rice and water resources • Mekong ricer • Mekong Delta • Khorat plateau • Rice cultivation and irrigation • Climate change • Political environment • Social environment • Economic environment • Rural population • Urban population • Gross domestic production (GDP) • Regional cooperation • Importing countries • Myanmar • The Phillipines

Since its origins dating back thousands of years, rice has performed many important roles throughout civilizations in peace and in war. As a staple food, rice has provided subsistence, self-sufficiency, and security for millions of farmers, villages, communities, and urban areas in the world. As a commodity, rice has been traded nationally and internationally and has contributed to socio-economic development of poor and developing nations. Today, about half of the world population eats rice, and Asia accounts for over 90% of global rice production estimated at 478 million

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tons, of which about 9%, or 42 million tons, are exported worldwide. China, India, Indonesia, Thailand, and Vietnam are the major rice producers. Moreover, India, Thailand, and Vietnam are the world's biggest rice exporters.

The subject of this monograph is rice and water resources development in the four countries of Cambodia, Laos, Thailand, and Vietnam that are located in Mainland Southeast Asia and share the Mekong River. The history and problems of rice culture in these four countries has been largely influenced by the geographical setting of the Mekong River which is the world's 12th longest river with a total length that is variously estimated at between 4500 and 5000 km and covers a total drainage area estimated at 795,000 km^2.

The study covers both the four countries of Cambodia, Laos, Thailand, and Vietnam and the Lower Mekong Basin. In terms of terminology, to avoid confusion, the total territory area encompassing Cambodia, Laos, Thailand, and Vietnam is referred to as "Mainland Southeast Asia" (MSEA), but excludes the country of Myanmar. The four countries within the LMB are referred to as the Lower Mekong Countries (LMCs) to distinguish them from the MSEA countries.

The Mekong River, one of Asia's most powerful international rivers, may be viewed as the backbone of rice culture that has played a dominant role in shaping the political, economic, and social life of the riparian peoples and states. It runs from the snow-covered mountains of Tibet to the South China Sea through six countries: China, Myanmar, Laos, Thailand, Cambodia, and Vietnam. The Mekong River in China is called the Lancang Jiang. The Mekong River Basin is divided into two parts: the Upper Mekong Basin (UMB) located in China and Myanmar and the Lower Mekong Basin (LMB) situated in the center of peninsular Southeast Asia.

On April 5, 1995, the governments of Cambodia, Laos, Thailand, and Vietnam signed the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin and created the Mekong River Commission (MRC) in charge of establishing new principles, rules, and guidelines for cooperation in using, managing, developing, and conserving the shared water resources of the Mekong River. The MRC's role in managing the water resources of the Lower Mekong Basin under the threats of climate change and mainstream dams is critical for the rice production in the four riparian states.

In 2014, the MSEA area had a combined population of 182.2 million people, produced 90.9 million tons of paddy rice representing about 60 million tons of milled rice, and exported 17.6 million tons, or about 39% of the 45.6 million tons of global rice export. Prior to 2011, Thailand and Vietnam were the world's first and second rice exporters, respectively; however, in 2012, India doubled its rice export to over 10 million tons and became the world's top rice exporter. In 2014, Thailand was the world's second rice exporter and sixth biggest rice producer, whereas Vietnam was the world's third rice exporter and fifth biggest rice producer.

The LMB covers an area of about 642,000 km^2, or about 51% of the MSEA total area estimated at 1,262,000 km^2. The LMB area accounts for almost all of Cambodia (161,000 km^2) and Laos (202,000 km^2), one-third of Thailand (184,000 km^2), and 20% of Vietnam (95,000 km^2) and equates closely to the area designated as the Mekong River floodplain. The Mekong River discharges 475 km^3 of water into the South China Sea every year, of which Laos contributes 35%,

Thailand and Cambodia 18% each, and Vietnam 11%. About 75% of the Mekong annual water flow is from the monsoon rains that fall between July and October. Any reduced water flows in the dry season could lead to reduced agricultural areas, paddy fields, and rice yields. The close link between rice and water demonstrates the importance of making sure that the Mekong River water resources can be sustainably and equitably developed in the LMB.

The LMB had an estimated population of 65.8 million people, up from 57.6 million in 2000. About 80% of the LMB population live in rural areas. The livelihoods and food security of the LMB rural population are closely linked to the Mekong River and its tributaries. The LMB is said to be the "rice basket" with its 2014 production of 53.0 million tons of paddy production representing 58% of the total paddy production of the four riparian states.

Within the LMB, the Mekong Delta in Vietnam and the Khorat Plateau in Thailand are the two most important regions, together accounting for nearly 80% of the total LMB rice paddy production. As an example of their importance, in 2014, the Mekong Delta produced over 50% of Vietnam's total rice production and accounted for about 90% of its rice export; and the Khorat Plateau produced about 45% of Thailand's total rice production, as well as producing the premium-priced, high-quality Hom Mali rice that is in high demand for export. Although smaller, the two countries of Cambodia and Laos doubled their paddy rice production during the period as a result of a 50% increase in both paddy areas and average yields. The LMB paddy rice production of these two countries accounted for 85–90% of their country's total paddy rice production.

The above summary shows the importance of the Mekong River water resources for the rice economies in the four countries and the LMB. The future of rice production in this region is critical because it is the main source of rice supply for over 100 countries worldwide, including Indonesia, the Philippines, and China which is the biggest rice importer from the MSEA countries. Our research study covers three main areas: (1) the four countries of Cambodia, Laos, Thailand, and Vietnam in MSEA (their rice production and policies, consumption, and trade), (2) the LMB (its setting, rice production, impacts of climate change, and Mekong mainstream dams in China that inflicted the whole region), and (3) Mekong regional cooperation for sustainable development of water resources and agricultural irrigation in the LMB (the effectiveness of the MRC after 20 years of cooperative work, the Lower Mekong Initiative created by the United States in 2009, the Mekong-Japan Summit organized by Japan in 2009, and the new Lancang-Mekong Cooperation Mechanism officially launched by China in 2016).

The book is organized in seven chapters. Chapter 2 provides the setting of Mainland Southeast Asian Countries of Cambodia, Laos, Thailand, and Vietnam. The physical and socio-economic setting includes topography, natural conditions and resources, population, workforce, and economic growth of the four countries in the millennium, from 2000 to 2014.

Chapter 3 deals with rice cultivation, production, and consumption in the MSEA countries. The four countries have different lands (agricultural land, paddy land, and harvested land) and various rice farming systems depending upon the topography (low-lying and high elevation areas) and ecological condition of each country and region, not to mention the culture and customs of the populations and villages.

Generally, paddy rice farming in the four countries is water-driven and labor intensive, whether it is rainfed, irrigated, or floating rice in lowlands or uplands. The chapter provides an in-depth analysis of rice production policies, the current and outlook for rice consumption in the four countries in the new millennium, and the impact of increased consumption of non-rice staple products as a result of the gradual migration of rural communities to urban centers and increased living standards as measures by the per capita GDP of the individual countries.

Chapter 4 examines the rice trade opportunities and challenges for Cambodia, Thailand, and Vietnam; Laos was mostly a rice importer until about 2015 when it sent its first rice shipment to China. The chapter is divided into five main sections. The first section gives the backgrounds of rice exports of Thailand, Vietnam, and Cambodia, 1855–1999. The second section examines their rice export policies in the new millennium. The third section analyzes their rice export performances in the world rice market and relative to their national milled rice production. The fourth section focuses on the rice trade of the four countries, their rice trade balance and competition, and their importing countries, particularly China. The fifth section discusses the opportunities and challenges facing all four countries in rice cross-border trade. The last section reviews the proposals of rice regional cooperation, or rice cartels, and explains their failure.

Chapter 5 defines the Lower Mekong Basin and the effects of climate change, floods and droughts, and El Niño/La Niña phenomena and the Chinese mainstream dams on rice cultivation and production which depends on seasonal climatic conditions and the southwest monsoon rains from May to September or early October. Section 5.1 describes the Mekong River, the Lancang Jiang, and the Lower Mekong River. Section 5.2 provides the setting of the Lower Mekong Basin, its topography, population, and economy. Section 5.3 deals with the LMB agricultural land, paddy land and farming, and paddy rice production. Section 5.4 attempts to assess the impacts of climate change, severe floods and droughts, and the unpredictable El Niño/La Niña phenomena. Section 5.5 focuses on the negative impact of China's Mekong mainstream dams on water flows and sediments in downstream countries, as pointed out by several research studies. Rice productivity in the LMB, particularly the Mekong Delta and the Khorat Plateau, needs intensive use of freshwater, irrigation, and sediments.

Chapter 6 examines the evolution of Mekong regional cooperation for the development of water resources and rice security from the MRC in 1995 to the LMCM in 2016. The chapter has four main sections. The first section describes the MRC new structure, the Basin Development Strategy, agriculture and irrigation programs, and the procedures for water utilization and diversion. The second section focuses on the MRC review of proposed mainstream dams in the Lower Mekong Basin, particularly the Xayaburi and Don Sahong mainstream dam projects submitted by Laos, and attempts to assess the MRC progress and achievements as well as failures and new challenges. The third section deals with the Mekong regional cooperation organizations created by the United States, Japan, and China. The last section analyzes the emerging role of China in Mekong regional cooperation.

In conclusion, the study summarizes the rice situation and water resources in the Lower Mekong River Basin and raises some issues concerning the Mekong regional cooperation frameworks for the sustainable development of the Mekong River Basin in the twenty-first century.

Chapter 2
The Setting of Mainland Southeast Asian Countries: Cambodia, Laos, Thailand, and Vietnam

Abstract The four countries of Cambodia, Laos, Thailand, and Vietnam are geographically located in mainland Southeast Asia, which is situated east of the Indian subcontinent and south of China. Mainland Southeast Asia consists of five countries: Myanmar, Thailand, Laos, Cambodia and Vietnam. For the purposes of this study, the term "Mainland Southeast Asia" (MSEA) excludes Myanmar and refers only to the countries of Cambodia, Laos, Thailand, and Vietnam with a total area of 1,262,000 km^2. The land of the MSEA countries has three distinctive features. First, the lowland plains are highly suited to rice cultivation. Second, it has a long coastline facing the South China Sea and the Gulf of Thailand. Third, it is drained by three major river systems, which from west to east are the Chao Phraya River, the Red River, and the Mekong River.

This chapter will describe the topography, natural conditions and resources, population, labor force, and economic growth of Cambodia, Laos, Thailand, and Vietnam in the new millennium, from 2000 to 2014. Statistical data and information are mostly estimates and based on studies by the Mekong River Commission (MRC), Food Agricultural Organization (FAO), the World Bank, and census data from the four countries.

Keywords Topography • Natural conditions and resources • Population • Labor force • Economy • Cambodia • Laos • Thailand • Vietnam

2.1 Overview of the MSEA Countries

The four countries Cambodia, Laos, Thailand, and Vietnam display more diversities than similarities. Culturally, the Thais, the Laotians, the Khmers, and the Vietnamese are ethnically diverse, speak different languages, follow different customs and traditions, practice different religions or different branches of Buddhism, and have different ways of thinking and acting. In addition, hundreds of ethnic groups live in the highlands and have been identified by their different styles in clothing, jewelry, and hairstyles.

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Politically, Cambodia, Laos, and Vietnam were French colonies or protectorates and gained their independence after World War II, whereas Thailand has never been under a foreign rule. Today, all four have different constitutional provisions and types of governments. The Kingdom of Cambodia is a parliamentary constitutional monarchy, the Kingdom of Thailand is constitutional monarchy (with a military government since May 2014), and both the Lao People's Democratic Republic and the Socialist Republic of Vietnam are communist states.

Table 2.1 Land areas, provinces, municipalities/capital cities of Cambodia, Laos, Thailand, and Vietnam

Items	Cambodia	Laos	Thailand	Vietnam	Total
Total country area (000 km^2)	181.0	236.8	513.1	331.2	1262.1
Country % of total area	14.3	18.8	40.7	26.2	100.0
Provinces	25	17	77	58	177
Municipalities/capital cities	Phnom Penh	Vientiane	Bangkok	Hanoi	N/A

Source: World Bank (2014), World development indicators, Land Area; Wikipedia (Provincial data)

The characteristics common to the four countries are fewer but notable and fundamental. First, the monsoonal climate affects them all. Second, hydraulic agricultural development accounts for the cultural, economic, and political dominance of the lowland people: the Khmers in the Tonle Sap, the Laotians in the Lower Mekong, the Thais in the Menam Valley, and the Vietnamese in the Red River and Mekong River Deltas. Most important of all, the international Mekong River is shared by the four countries and considered as the common catalyst for their socio-economic development. Last, but not least, rice is the main staple food for people living in lowlands or highlands, in cities, or in rural communities.

2.2 Topography

The topography of the four countries ranges from rugged mountains, dense forests, narrow gorges, and upland plateaus to low, flat deltaic areas. Natural resources are equally abundant and diverse, including rice, fish, rubber, tin, zinc, and many other mineral deposits. As shown in Table 2.1, the total area of the four countries is some 1,262,000 square kilometers (km^2). Thailand is the largest country covering an area of about 513,100 km^2. Vietnam has about 331,200 km^2, followed by Laos with 236,800 km^2. Cambodia is the smallest country with an area of 181,000 km^2.

2.2.1 Cambodia Topography

Cambodia can be best characterized by the Tonle Sap Great Lake and the Mekong River systems which drain into the Tonle Sap River or into the Mekong River. The Tonle Sap Great Lake is centrally located and occupies about 75% of the country with the remaining 25% consisting of the Cardamom Mountains in the southwest and the Dangrek Mountains in the north. The Tonle Sap Great Lake is also the largest body of freshwater in Southeast Asia and an important part of the Mekong hydrological system. Differences between the water level in the lake and the water level in the mainstream Mekong cause the unique flow reversal in the Tonle Sap River (MRC, Overview of the Hydrology of the Mekong Basin 2005).

The flow of water into and out of the Tonle Sap is seasonal. In September or October, the flow of the Mekong River, fed by monsoon rains, pushes northward into the Tonle Sap increasing the size of the lake from about 3500 km^2 to about 14,500 km^2 at the height of flooding. By November, the ending of the monsoon season coincides with the floodwater draining from the Tonle Sap Great Lake into the Mekong River on its way to the South China Sea. The water depth in the Tonle Sap varies from about 0.5 m at the end of the dry season in April to a maximum depth of 6–9 m in late September/early October (MRC, Overview of the Hydrology of the Mekong Basin 2005).

The geographical location of Phnom Penh, the royal residence, the administrative capital, and the cultural center and business city of the country, is very illustrative of the vital role played by the Mekong River in Cambodia. It is situated just at the junction where the Tonle Sap and the Mekong rivers meet together. The country's river system is an abundant source of fish, while agriculture depends on man-made reservoirs and irrigation channels around which the population tends to concentrate. Commerce uses the Mekong as a principal trade route and best means of communication.

Cambodia is dominated by the tropical monsoons. Basically there are two seasons, both of which are characterized by high humidity (60–90%) and uniform temperature (28–32 °C) throughout the year. From mid-May to mid-September or early October, the wet southwest monsoon is drawn landward from the Indian Ocean and brings the rainy season. From November to March, the northeast monsoon flows in dryer and cooler air (Cambodia 1990, Country Study).

As of January 2014, Cambodia has 25 administrative provinces and the capital city of Phnom Penh. The 25th province, Tboung Khmum, was formed when the province of Kampong Cham was split into two by a royal decree signed on December 31, 2013 (Wikipedia).

Figure 2.1 shows the 25 provinces of Cambodia: Banteay, Meanchey, Battambang, Kampong Cham, Kampong Chhnang, Kampong Speu, Kampong Thom, Kampot, Kandal, Kep, Koh Kong, Kratie, Mondulkiri, Oddar Meanchey, Pailin, Preah Sihanouk, Preah Vihear, Prey Veng, Pursat, Ratanakiri, Siem Reap, Stung Treng, Svay Rieng, Takeo, and Tboung Khmum.

2.2.2 Laos Topography

Laos is a landlocked and largely mountainous country with a territory of about 236.8 million km^2 which borders with Burma on the northwest, China on the north, Vietnam on the east, Thailand on the west, and Cambodia on the south. About three-fifths of the territory is located in the northern region which is characterized by rugged mountains and large hills and the infertile Plain of Jars. The remaining two-fifths of the country lies in the southern panhandle where the Annamite Chain runs along the entire eastern side and the Mekong River on the west serves as a border and a link with Thailand and Cambodia.

Fig. 2.1 Map of Cambodia provinces (Source: Wikipedia)

The Mekong River plays a vital role in the social and economic development of the country. It runs through the country for an estimated 1800 km and is the center of economic life providing fish, water to rice fields, and means of communication and transportation for the majority of people living along the river bank. The Mekong River is more than a state border; it offers potential hydropower for irrigation, energy supply and trade, and navigation. Its tributaries drain all of Laos, except parts of eastern Houaphanh Province and northern Xieng Khouang Province. The main tributaries are the Nam Tha, the Nam Ou, and the Nam Ngum in the north and the Nam Kading, Se Bang Fai, Se Bang Hieng, Se Done, and Se Kong in the south. Other natural resources other than water are coal, iron, copper, gold, gems, lead, and zinc ores (Laos 1995, Country Study).

The climate of Laos is influenced by the monsoon winds that govern conditions in all of eastern Asia from India to Kamchatka in eastern Siberia. Like Cambodia, Laos has two seasons with humidity throughout the year: a wet season during the southwest monsoon from May to October and a dry season during the northeast season from November to April. Temperatures vary depending upon altitude, regions, and monsoons. The higher temperatures (in the 35–40 °C) occur in March and April at the lower altitudes, while the lower temperatures (in the 0–5 °C) occur in December to February in higher altitudes, such as the Xieng Khouang area.

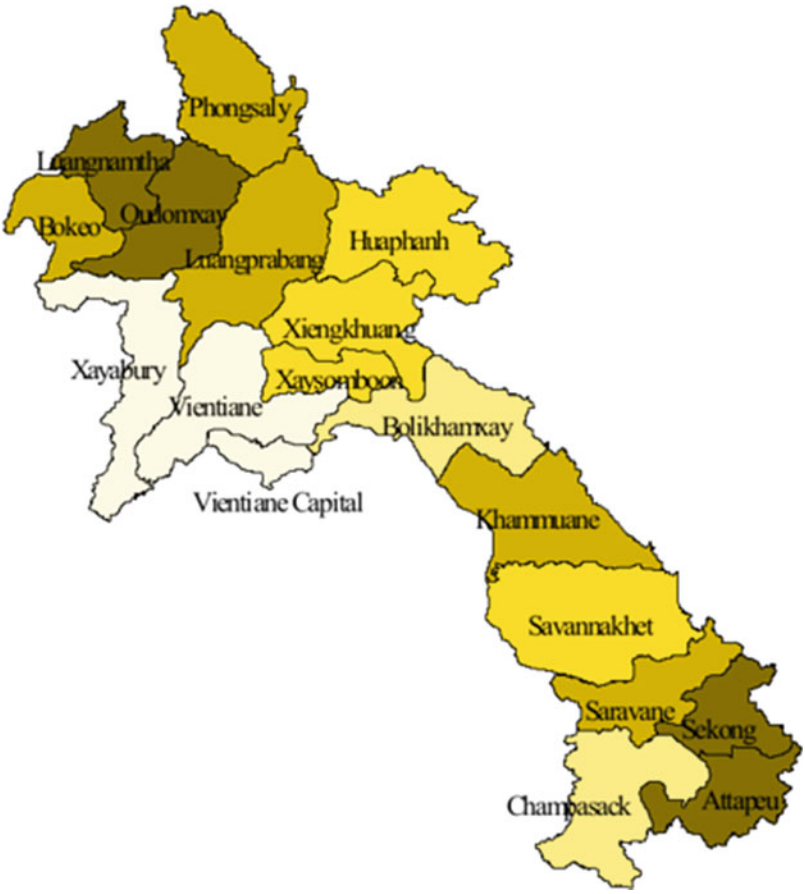

Fig. 2.2 Provinces of Laos (Source: Wikipedia)

The country has 17 provinces and the capital city of Vientiane. The most important principalities have developed along the great river and its tributaries: Luang Prabang, the royal capital; Vientiane, the administrative capital; Champassak; and Xieng Khouang.

Figure 2.2 shows the 17 provinces of Laos: Attapeu, Bokeo, Bolikhamxai, Champasak, Houaphanh, Khammouan, Louangnamtha, Louangphabang, Oudomxay, Phongsali, Salavan, Savannakhet, Vientiane, Xaignabouli, Xekong, Xiangkhouang, and Xaysomboun (created on December 31, 2013 Municipality: Vientiane, capital city).

2.2.3 Thailand Topography

Thailand is the largest of the four countries with a territory of 513,120 km^2, with a landscape that includes high mountains, valleys, a central plain, and an upland

plateau. The Mekong River, while of some significance, is still only a border river between Thailand and Laos. It drains a considerable portion of north and northeast Thailand through the tributaries, such as Kok River and Ing River in the north and Mun River, Chi River, and Songkhram River in the northeast. The topography and drainage define its four main regions: North, Northeast, Center, and South. (Thailand 1989, Country Study).

Mountains cover much of Northern Thailand and along the Myanmar border, making the region the origin of streams and rivers in Thailand. With its natural features of high mountains, steep river valleys, and upland areas, summer storms occur quite often in May–October. The temperature in November–February can be cool enough for the cultivation of temperate zone fruits and plants.

In the northeastern part of the country (known as Isan) is the Khorat Plateau, a region that features a flatland in the center, with rugged hills to the west and the south, and shallow lakes, where the Mun River and other tributaries drain into the Mekong River. The soil is mostly sandy, making water retention almost impossible and resulting in generally dry conditions unfavorable for widespread cultivation. However, the Mekong River flows past much of the northern and eastern edge of the region, enabling local cultivation in several provinces. Most of Thailand's jasmine rice, or Hom Mali, is produced in this region.

The central plain is a lowland area drained by the Chao Phraya River and its tributaries making a fertile basin for wet rice agriculture, fruit cultivation, and fisheries. It is the heartland and "food basket" of Thailand with very hot and humid summers and a rainy season that usually starts in May and ends in October. Bangkok, the nation's capital, is located in this region.

The southern region is a long and narrow peninsular surrounded by the Gulf of Thailand and the Andaman Sea with high mountains in the middle. The seas' influence on the region brings heavy rains for most of the year. Minerals, particularly tin and gypsum, and fishing are the key contributors to the region's economy.

Thailand can be divided into two climatic zones. First, the north, northeast, southeast, and central regions including Bangkok have a climate with three distinct seasons: rainy, from June to October; cool, from November to February; and hot, sunny weather, from March to May. Temperatures in Bangkok typically vary between 20 °C in December and 38 °C in April with an average humidity of 82%. However, winter temperatures in the northern region can fall to approximately 10 °C or lower.

Second, the southern region has a characteristic tropical rainforest climate. Rainfall occurs virtually throughout the year, although a number of microclimates can be found. There is little variation in temperature, which is on average 28 °C throughout the year. March and April are normally the driest months in the south. The periods of maximum rainfall in these areas vary according to climatic subregions.

Thailand has 77 provinces, 17 in north, 20 in northeast, 26 in central, and 14 in south, and the capital city is Bangkok. Figure 2.3 shows the provinces of Thailand.

North: Chiang Mai, Chiang Rai, Kamphaeng Phet, Lampang, Lamphun, Mae Hong Son, Nakhon Sawan, Nan, Phayao, Phetchabun, Phichit, Phitsanulok, Phrae, Sukhothai, Tak, Uthai Thani, and Uttaradit

Fig. 2.3 Map of Thailand provinces (Source: Wikipedia)

Northeast: Amnat Charoen, Bueng Kan, Buriram, Chaiyaphum, Kalasin, Khon Kaen, Loei, Maha Sarakham, Mukdahan, Nakhon Phanom, Nakhon Ratchasima, Nong Bua Lamphu, Nong Khai, Roi Et, Sakon Nakhon, Sisaket, Surin, Ubon Ratchathani, Udon Thani, and Yasothon

Central: Ang Thong, Bangkok Metropolis, Chachoengsao, Chai Nat, Chanthaburi, Chon Buri, Kanchanaburi, Lop Buri, Nakhon Nayok, Nakhon Pathom, Nonthaburi, Pathum Thani, Phetchaburi, Ayutthaya, Prachin Buri, Prachuap Khiri Khan, Ratchaburi, Rayong, Sa Kaeo, Samut Prakan, Samut Sakhon, Samut Songkhram, Saraburi, Sing Buri, Suphan Buri, and Trat

South: Chumphon, Krabi, Nakhon Si Thammarat, Narathiwat, Pattani, Phang Nga, Phatthalung, Phuket, Ranong, Satun, Songkhla, Surat Thani, Trang, and Yala

2.2.4 Vietnam Topography

Vietnam, with a territory of about 331,688 km^2, is a country of tropical lowlands, hills, and densely forested highlands, with level land covering no more than 20% of the total area. It is divided into the highlands and the Red River Delta in the north and, the central mountains, the coastal lowlands, and the Mekong River Delta in the south. Except for the two deltas that are flat and densely populated, the northern and central regions have rugged mountains, extensive forests, and high plateaus. Generally, the coastal strip is fertile and conducive to rice culture (Vietnam 1989, Country Study).

The Red River Delta, a small, flat, triangular region of about 3000 km^2, is smaller than the Mekong River Delta. Once an inlet of the Gulf of Tonkin, it has been filled in by the enormous alluvial deposits of the rivers, over a period of millennia, and it advances on hundred meters into the Gulf annually. The Red River, rising in China's Yunnan province, is about 1200 km^2. The entire region is subject to frequent flooding, and flood control has been part of the delta's culture and economy. An extensive system of dikes and canals has been built to contain the Red River and to irrigate the paddy fields. Hanoi, the capital city, is located in this administrative region.

The central mountains, which have high plateaus, are irregular in elevation and form. The Giai Truong Son, or Chaine Annamitique, forms Vietnam's border with Laos and Cambodia. The northern section is narrow and rugged; the country's highest peak, Fansipan, rises to 3142 m in the northwest.

The Central Highlands is a plateau of about 51,800 km^2 consisting of rugged mountains, extensive forests, and rich soil. The Highlands account for 16% of the country's arable land and 22% of its total forest land. All five provinces of the Central Highlands are partially drained by the Se San and Srepok rivers, two major Mekong tributaries. The Se San originates in the northeast of Gia Lai and Kon Tum. The Srepok originates in the Lam Dong and Dalak provinces.

The Mekong River Delta is described as a vast triangular plain of about 40,519 km^2, accounting for 12.24% of the country's total area. One side of the triangle forms the border with Cambodia to the north, and the other two sides are surrounded by the South China Sea to the southeast and the Gulf of Thailand to the

west, with a coastline of about 600 km. The region is no more than 3 m above sea level and is crisscrossed by a maze of canals and rivers. The Mekong Delta is drained by two main tributaries, the Mekong and the Bassac, which are referred to in Vietnamese as the Tien River and the Hau River, respectively. The Mekong River flow is generally at its lowest in April and highest in October. For hundreds of years, these two tributaries have been the lifelines of the Mekong Delta providing freshwater resources and food security to its people.

Vietnam has a tropical monsoonal climate with a cool and dry season from November to December to March to April and a hot and rainy season during the southwest monsoon from May to June to October to November. The mean annual temperature is about 26 °C throughout the delta, the difference between the mean monthly minima and maxima being only about 5 °C. The difference between summer and winter temperatures is pronounced in the north. The south is warm year-round, with little seasonal variations in temperature. The relative humidity remains high at around 85% throughout the year.

Vietnam has 58 provinces and 5 municipalities (Hanoi, Haiphong, Da Nang, Ho Chi Minh City, and Can Tho), as shown in Fig. 2.4. The distribution of the 58 provinces in the 6 administrative regions is as follows:

Red River Delta (9): Bac Ninh, Quang Ninh, Ha Nam, Hai Duong, Hung Yen, Nam Dinh, Ninh Binh, Thai Binh, and Vinh Phuc

Northern midlands and mountain areas (14): Bac Giang, Bac Kan, Cao Bang, Ha Giang, Lang Son, Lao Cai, Phu Tho, Quang Ninh, Thai Nguyen, Tuyen Quang, Dien Bien, Hoa Binh, Lai Chau, and Son La

North Central Area and North Central Coast area (13): Ha Tinh, Nghe An, Quang Binh, Quang Tri, Thanh Hoa, Thua Thien-Hue, Binh Dinh, Binh Thuan, Khanh Hoa, Ninh Thuan, Phu Yen, Quang Nam, and Quang Ngai

Central Highlands (5): Dak Lak, Dak Nong, Gia Lai, Kon Tum, and Lam Dong

Southeast (5): Ba Ria-Vung Tau, Binh Duong, Binh Phuoc, Dong Nai, and Tay Ninh

Mekong Delta (12): An Giang, Bac Lieu, Ben Tre, Ca Mau, Dong Thap, Hau Giang, Kien Giang, Long An, Soc Trang, Tien Giang, Tra Vinh, and Vinh Long

2.3 Population

The lack of hard and comparable data makes it difficult to provide a complete statistical profile of the population in the four countries that make up MSEA and its growth during the 2000–2014 period. The latest national population censuses were published by Laos in 2005, Cambodia in 2008, Vietnam in 2009, and Thailand in

Fig. 2.4 Map of Vietnam provinces (Source: Wikipedia)

2010. Therefore, for consistency and simplification, our analysis of each country's population and for the region as a whole is based on the data collected by FAOSTAT in 2000 and 2014, as indicated in Table 2.2.

In 2014, the total population of the MSEA was 182.0 million people, an overall 14% increase over the 160 million people in 2010, with the more advanced economies of Thailand and Vietnam averaging a modest annual population growth of 0.6% and 1.0%, respectively, compared to the less developed, but faster growing, economies of Laos and Cambodia that averaged 1.6–1.7% per year, during the same period. Within the MSEA, Vietnam continued to account for 50% of the total with

Table 2.2 Total population of Cambodia, Laos, Thailand, and Vietnam, in 2000 and 2014 (Unit: million persons)

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Total area (000 km^2)	*181*		*236*		*513*		*331*		*1262*	
Total population	12.2	15.3	5.3	6.7	62.7	67.8	80.3	92.4	160.5	182.2
Population density/km^2	67	85	23	28	122	132	243	279	127	144
AAGR (%) population	1.6		1.6		0.6		1.0		0.9	
Female population	6.3	7.9	2.7	3.3	31.7	34.3	40.7	46.7	81.4	92.3
As % of total pop.	51	51	49	49	50	51	51	51	51	51
Male population	5.9	7.5	2.7	3.3	31.0	33.3	39.6	45.7	79.1	89.9
As % of total pop.	49	49	51	51	50	49	49	49	49	49
Rural population	10.0	12.2	4.2	4.3	42.8	34.2	61.2	62.1	118.1	112.8
As % of total pop.	82	80	79	64	68	51	76	67	74	62
Urban population	2.3	3.2	1.2	2.6	19.6	33.1	19.7	30.5	42.7	69.3
As % of total pop.	18	20	21	36	32	49	24	33	26	38

Source: FAOSTAT (2016)

Thailand adding an additional one-third of the total. While the male/female population ratio in the MSEA was unchanged at 51:49, respectively, during the period, there was a major change in the MSEA rural/urban population ratio. Although rural populations increased in absolute terms, the data shows them declining in percentage terms from an average of 74% of the total population in 2000 to 62% of the total in 2014. The decline appears to follow each country's gradual transition to modern mechanized/labor-saving procedures in agriculture which has resulted in an increased population migration from rural areas to urban centers for economic advantage (Table 2.2).

2.3.1 Cambodia Population

In 2014, the population of Cambodia was reportedly 15.3 million, growing at an average annual growth rate of 1.6% since 2000 when the population was 12.2 million. During the period, the female/male population percentage was unchanged at 51/49. The data shows a gradual decrease in the rural population percentage during the period, from 82% in 2000 to 80% in 2014, in line with an increasing migration to urban centers (Table 2.2).

The majority of people live in the rich rice-growing areas along the Mekong River, around the Tonle Sap Lake, and in the capital city of Phnom Penh. The north and eastern parts of the country are less populated. The country's population density was 85 persons per km^2, up from 67 persons per km^2 in 2000, but density varied considerably from the Mekong valley to the upland areas. The low-lying floodplains of the Mekong River around Phnom Penh are densely populated,

whereas the upland areas in southwest and northern regions and the whole area east of the Mekong are sparsely populated. In between these two extremes, the population density is moderate on the fertile floodplains surrounding the Tonle Sap Lake.

2.3.2 Laos Population

Laos has the smallest and fastest growing population among the four nations. It is the youngest of the four countries with the people aged 65 and older representing only 3.1% of the total population. In 2014, the country's total population of 6.7 million people grew at an average annual increase of 1.7% over the 5.3 million in 2000, with the male/female population ratio 51:49 unchanged during the period. A major change during the period was the percentage decrease in the rural population, relative to the population as a whole, from 79% in 2000 to 64% in 2014, which demonstrates the continued migration from rural area to urban centers for economic opportunity. The observed migration was more pronounced in Laos than in the other riparian countries (Table 2.2).

The country's population density increased by 22% from 23 persons per km^2 in 2000 to 28 persons per km^2 in 2014. However, like Cambodia, the country has a diverse population density from different regions with different elevations. The population density was very high in the central region where Vientiane Province had a density of 739 persons per km^2. The population density decreased to about 20 persons per km^2 in the upland regions along the country's eastern border with Vietnam. Lowland areas located along the Mekong River corridor between Vientiane and Pakse, where urban centers are frequent and the lower topography allows rice cultivation, have population densities in the order of about 200 persons per km^2.

2.3.3 Thailand Population

In 2014, Thailand's total population was 67.8 million, an increase of 5.1 million people over the 62.7 million in 2000 growing at an average annual rate of 0.6%, with the female/male population ratio of 51:49 unchanged during the period. The data shows a continued significant rural population migration to urban centers during the period, with the rural percentage steadily decreasing from 68% of the total population in 2000 to 51% in 2014 (Table 2.2).

According to the country's 2010 People and Housing Census, the northeastern region is the most populous region of Thailand accounting for 28.7% of the total population, followed by the central region with 27.6%, the northern region 17.7%, the southern region 13.4%, and Bangkok 12.6%. In 2014, Thailand had an average population density of 132 persons per km^2, an 8% increase over the 122 persons per km^2 in 2000. Of the four regions, the northern region has the lowest population

density, 69 persons per km^2. On the Khorat Plateau in northeast Thailand, population densities are moderate and vary from approximately 40 to 400 persons per km^2. Densities are lower in the west of the region at the edge of the Khorat Plateau where land elevation is higher. Generally, the large towns and cities have higher population densities than the rural districts. Bangkok had a population density of about 5300 persons per km^2.

2.3.4 Vietnam Population

In 2014, Vietnam was the most populous of the four countries with a population estimated at 92.4 million, up from 80.3 million in 2000, growing at an average annual rate of 1.0%. While the rural population continued to grow in absolute terms, from 61 million in 2000 to 62 million in 2014, its importance, expressed as a percentage of the total population, showed a modest decrease from 76 to 67% during the same period, a common trend in the area. The female-to-male population ratio of 51:49 in 2014 was unchanged during the period under review (Table 2.2).

The Red River Delta in the north was the most populous of the six administrative regions. Among the municipalities, Ho Chi Minh City had the greatest population (7.9 million) followed by Hanoi (7.0 million), according to Vietnam General Statistics Office (GSO).

In 2014, Vietnam had the highest average population density among the four countries with 279 persons per km^2, up from an average of 243 persons per km^2 in 2000. The high concentration of people was found in the two delta regions and the southeast region where Ho Chi Minh City had a population density of nearly 4000 persons per km^2, twice that of Hanoi. The Mekong Delta, with an area of 40,576 km^2, had a population density of 432 persons per km^2, whereas the Central Highlands, with a bigger area of 54,641 km^2, had the lowest density in the nation estimated at 100 persons per km^2 (GSO). Like the Central Highlands, the northern midlands and mountains were sparsely populated. The very high population density of the Mekong Delta is due to its geographical environment, particularly the Mekong and the Bassac (Tien River and Hau River in Vietnamese), two important Mekong tributaries that have provided freshwater resources, fertile soils, sediments, and good infrastructure for agriculture.

2.4 Labor Force

This section covers both the total labor force and the agricultural labor force component in the four countries. According to the old FAOSTAT website that was no longer updated after October 23, 2014, the economically active population, or labor force, "refers to the number of all employed and unemployed persons (including those seeking work for the first time). It covers employers; self-employed

workers; salaried employees; wage earners; unpaid workers assisting in a family, farm or business operation; members of producers' cooperatives; and members of the armed forces." All statistical data on labor force during the 2000–2014 are estimates and projections taken from the FAOSTAT cited website.

Using this definition, the total labor force within the MSEA increased from 83 million people in 2000 to 101 million in 2014, representing an increase from 52% of the total population in 2000 to 55% in 2014. At the same time, the male/female ratio within the labor force changed from 48% to 52% in 2000 to 47% to 53% in 2014. The total male workforce was greater than the female workforce and increased by 1% from 52 to 53% of the total population during the 2000–2014 period. The annual growth rate of the total labor force averaged 1.4% during the same period (Table 2.3).

The important agricultural sector of the total labor force, which includes "that part of the economically active population engaged in or seeking work in agriculture, hunting, fishing or forestry," increased by 10%, from 52 million in 2000 to 57 million in 2014. However, the agricultural sector labor force decreased during the period from 63% of the total labor force in 2000 to 56% in 2014. Its average growth was about 0.5% per year compared with 1.4% average growth of the total labor force. The male workforce increased by 1% from 51% to 52% of the total agricultural labor force during the period under review (Table 2.4).

It should be noted that these numbers are gross estimates and indicate a common regional trend. The agricultural labor force has declined because the migration to urban centers and capital cities to find employment and stable income was an important economic factor in the four riparian countries, particularly in Thailand and the Mekong Delta in Vietnam. A number of farmers hold several and part-time jobs, working in the paddy fields for seeding or transplanting and harvesting and laboring in neighboring factories during the raining and growing season.

Table 2.3 Total labor force of Cambodia, Laos, Thailand, and Vietnam, in 2000 and 2014 (Unit: million)

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Total population	12.2	15.3	5.3	6.7	62.7	67.8	80.3	92.4	160.5	182.2
Total labor force	5.7	8.4	2.5	3.7	35.1	38.6	39.6	50.5	82.9	101.2
As % of total pop.	47	55	47	55	56	57	49	55	52	55
Female labor force	2.8	4.1	1.2	1.8	16.4	18.0	19.4	24.4	39.8	48.3
% of total labor force	50	49	50	50	47	47	49	48	48	47
Male labor force	2.8	4.3	1.2	1.8	18.7	20.6	20.2	26.1	42.9	52.8
% of total labor force	50	51	50	50	53	53	51	52	52	53
AAGR (%) total labor force	2.8		2.8		0.7		1.8		1.4	

Source: FAOSTAT, Economically active population, accessed January 19, 2016
Percentages and annual average growth rates calculated by author from the same data

Table 2.4 Labor force in agriculture for Cambodia, Laos, Thailand, and Vietnam, in 2000 and 2014 (unit: millions)

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Total labor force in agriculture	4.0	5.4	1.9	2.7	19.8	17.5	26.7	31.0	52.4	56.6
% of total labor force	70	64	76	73	56	45	67	61	63	56
Female labor force in agr	2.1	2.8	1.0	1.4	9.2	7.8	13.3	15.1	25.6	27.1
% of total labor force in agr	53	52	52	52	47	45	50	49	49	48
Male labor force in agriculture	1.8	2.6	0.9	1.3	10.6	9.7	13.3	15.9	26.6	29.5
% of total labor force in agr	47	48	48	48	53	55	50	51	51	52
AAGR (%) total labor force in agr	2.2		2.5		(0.9)		1.1		0.6	

Source: FAOSTAT, economically active population in agriculture, accessed January 19, 2016
Note: Percentages and annual average growth rates calculated by author from the same data

2.4.1 Cambodia Labor Force

In 2014, Cambodia had a labor force estimated at 8.4 million, a 47% increase over the 5.7 million in 2000, growing at an annual average rate of 2.8%, the highest rate among the riparian countries. The 2014 labor force represented 55% of the total population, up from 47% in 2000, which demonstrates an expanding labor force in a developing, labor-intensive economy. The male/female workforce ratio (51–49%) was essentially unchanged during the same period (Table 2.3).

The country's agricultural labor force was 5.4 million people in 2014, a 35% increase over the 4.0 million people in 2000, growing at an annual average rate of 2.1%, slower than for the labor force as a whole (2.1% versus 2.8%). The data shows that the agricultural sector of the workforce decreases in importance during the period, accounting for 64% of the total labor force in 2014, down from 70% participation in 2000. Unlike the total labor force, the female workforce in agriculture (52%) was greater than the male workforce (48%) (Table 2.4).

2.4.2 Laos Labor Force

In 2014, Laos had a total labor force of about 3.7 million people, a 48% increase over the 2.5 million in 2000, growing at an average rate of 2.8% per year. The 2014 labor force represented 55% of the total population, up from 47% in 2000. The male/female ratio was evenly divided and unchanged during the 2000–2014 period (Table 2.3).

The country's agricultural workforce in 2014 accounted for 2.7 million people, or a 42% increase over the 1.9 million people in 2000, growing at an average rate of 2.5% per year, the highest in the region. However, the agricultural sector accounted

for a declining percentage of the total labor force, 73% of the total in 2014, down from 76% in 2000, but still was the highest percentage among the riparian countries. The female/male ratio of 52% to 48% was unchanged during the period under study (Table 2.4).

2.4.3 Thailand Labor Force

In 2014, Thailand's total labor force was 38.6 million people, a 3.5 million person increase over the 35.1 million in 2000, growing at an average increase of only 0.7% per year over 2000, the lowest growth rate among the four riparian countries. The total labor force accounted for 57% of the country's total population, the highest percentage among the riparian countries, and a small increase from the 56% in 2000. The female/male labor force ratio of 47% to 53% was unchanged (Table 2.3).

The agricultural labor force sector amounted to 17.5 million workers in 2014, down from 19.8 million in 2000, the only decrease of agricultural workforce in the region. The data also shows a decrease in the agricultural labor force from 56% of the total labor force in 2000 to only 45% in 2014. This percentage decrease of the agricultural workforce, relative to the workforce as a whole, shows a pattern of a similar decrease in the total rural population, from 68% of the total population in 2000 to 51% in 2014. Declines in both the agricultural sector and the rural sector as a whole are an ongoing reflection of their decreased importance compared to other sectors. The male/female ratio saw the male component increase by 2% during the period (Table 2.4).

2.4.4 Vietnam Labor Force

In 2014, Vietnam had the largest total labor force of the four countries estimated at 50.5 million, growing at an average rate of 1.8% per year over the 39.6 million in 2000 and representing an increasing percentage of the country's total population (49% growing to 54%). The male/female labor force ratio showed the male component increase by 1% from 51% to 52% of the total labor force during the 2000–2014 period (Table 2.3).

The agricultural total labor force of 31 million in 2014 represented 61% of the total labor force, an absolute increase in numbers over the 26.7 million workers in 2000, but a decrease in importance from the 67% of the total labor force in 2000. Although the agricultural labor force grew at an average rate of 1.0% per year during the period, its growth was slower than for the labor force as a whole, a pattern replicated in the decreased importance of the rural sector (Table 2.2) which accounted for 67% of the total population in 2014, down from 76% in 2000. This trend will continue not only in Vietnam but also in all Mekong countries. The male/female ratio was essentially unchanged during the period (Table 2.4).

2.5 Economy

The MSEA is a vast and diverse region with a young and mobile population, growing economy, and abundant natural resources. The region has displayed a wide spectrum of economic growth. Economically, Thailand enjoys the highest level of development, whereas Cambodia is the least developed country. In 2014, the World Bank classified Cambodia as low-income country, Laos and Vietnam as lower middle-income countries, and Thailand as upper middle-income country.

This section will examine the economic performance of the individual countries in the MSEA during the period 2000–2014 based on the key economic indicators provided by the World Bank World Development Indicators database and the World Bank East Asia and the Pacific Economic Updates. The economic indicators include growth domestic product (GDP), GDP annual growth rate, GDP per capita, agriculture as a percent of GDP, industry as a percent of GDP, services as a percent of GDP, foreign direct investment (FDI), export, and import (Table 2.5).

An analysis of Table 2.5 shows that the MSEA agricultural sector showed little growth from 12.5% of the total GDP in 2000 to 13.7% in 2014, which emphasized its declining importance relative to the region's overall expanded development of its industry and service sectors. However, at the same time, the calculated US$ value for the total agricultural sector shows a significant increase, and the agricultural workforce per capita contribution to the region's GDP increased by almost the same amount as the region transitioned away from labor-intensive practices to an increased level of mechanization.

2.5.1 Cambodia Economy

Starting from a low base, Cambodia's economy grew at an average annual rate of 8% during the first decade of this century, compared with Laos 7.1%, Thailand 4.3%, and Vietnam 6.6%. However, this remarkable performance lacked consistency and continuity fluctuating from 8.8% in 2000 to 6.7% in 2002 and achieving its best rate of 13.3% in 2005. During the last 3 years of the decade, the economy slowed considerably recording an annual GDP growth rate of 6.7% in 2008, 0.1% in 2009, and 6.0% in 2010. The global recession of 2008 severely hurt the country's exports of garment and the tourism industry, an important economic asset and a source of foreign exchange revenues. The imposing temple complex at Angkor, built between the ninth and thirteenth centuries by Khmer kings, is a UN heritage site and a big attraction for tourists.

In 2014, the economy recovered at a lower and more sustainable growth rate of around 7.1% instead of the average annual growth rate of 8% in the 2000–2010 period. Cambodia's GDP per capita income was estimated at US$1095, which is likely to reach the lower middle-income status in 2015, according to the World Bank (Table 2.5). The agricultural sector accounted for 30.4% of the GDP, down

Table 2.5 Key economic indicators of Cambodia, Laos, Thailand, and Vietnam, in 2000 and 2014 (unit: US$)

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
GDP US$ billions	3.7	16.7	1.7	11.9	122.7	404.8	33.6	186.2	161.7	619.6
GDP annual growth (%)	8.8	7.1	5.8	7.5	4.5	0.9	6.8	6.0		
GDP per capita (US$)	299	1095	324	1794	2016	5977	433	2052	1007	3401
Agricultural sector										
Agr. US$ billions (1)	1.4	5.1	0.8	3.3	10.4	42.5	7.6	33.7	20.2	84.6
Agriculture % of GDP	37.8	30.4	45.2	27.7	8.5	10.5	22.7	18.1	12.5	13.7
Agricultural workforce (millions)	4.0	5.4	1.9	2.7	19.8	17.5	26.7	31.0	52.4	56.6
Workforce per capita of Ag. GDP	350	944	421	1222	525	2429	285	1087	385	1495
Other sectors										
Industry US$ billions (1)	0.9	4.5	0.3	3.7	45.2	149.0	11.5	71.7	57.9	228.9
Industry (% of GDP)	23.1	27.1	16.6	31.4	36.8	36.8	34.2	38.5	35.8	36.9
Services US$ billions (1)	1.4	7.1	0.6	4.9	67.1	213.3	14.5	80.8	83.6	306.1
Services (% of GDP)	39.1	42.5	38.2	40.9	54.7	52.7	43.1	43.4	51.7	49.4
FDI (% of GDP)	4.1	10.3	2	6	2.7	0.9	3.9	4.9		
Exports (% of GDP)	49.8	62.8	30.1	40.5	64.8	69.2	50.0	86.4		
Imports (% of GDP)	61.8	66.7	44.2	49.7	51.8	62.6	53.3	83.1		

Source: World Bank World Development Indicators 2015
(1) US$ billions calculated by author using World Bank percentage data

from 37.8% in 2000, compared to the industry and service sectors that increased, during the same period, from 23.1 to 27.1% and from 39.1 to 42.5%, respectively. However, while the agricultural sector, as a whole, decreased in its importance to the country's overall GDP during the period, the data shows the agricultural workforce per capita contribution increased from US$350 in 2000 to US$944 in 2014, reflecting the country's increasing use of labor-saving mechanizations.

Cambodia exports rose from 49.8% in 2000 to 62.8% of GDP in 2014, while imports recorded a smaller increase from 61.8 to 66.7% of GDP during the same period. Major export items included garment, textile, silk, organic rice, rubber, and gems. Exports of clothing generated most of Cambodia's foreign exchange. Imports consisted of petroleum products, cigarettes, gold, construction materials, machinery, motor vehicles, and pharmaceutical products. Principal trading partners were the United States, Germany, Canada, the United Kingdom, Vietnam, Thailand, China, Hong Kong, and Singapore. Cambodia joined the World Trade Organization in October 2004.

Foreign direct investment (FDI), according to a special report on foreign investment in Cambodia, published by Phnom Penh Securities, PLC, on October 14, 2011,

has been recognized as "a core potential contributor to growth and development" and a "stable capital with a longer term commitment to host economy." In 2000–2010, FDI grew from 4.15% of GDP in 2000 to 10% of GDP in 2007, the highest of the LMCs, but fell to 7.9% in 2008 and 4.9% in 2009, due to the 2008 global recession. In 2010, Cambodia was able to attract foreign direct investment from China, Korea, Malaysia, and Vietnam, and FDI recorded 6.5% of GDP. In 2014, FDI contributed 10.3% of GDP, more than double the 2000 rate of 4.1% (Table 2.5).

2.5.2 Laos Economy

Laos is the smallest and fastest growing country of the four countries. During the first decade of the new millennium, the economy grew at an average annual rate of 7.1% to reach 8.5% in 2013, the highest growth rate of the LMCs. In 2014, growth slowed down to 7.5%, but it was the smallest decline among the neighboring countries. The GDP at market prices was estimated at US$1.7 billion with a GDP per capita income of US$1794 per year. By 2014, both the industry and service sectors had increased their importance to the country's GDP, growing from 16.6 to 31.4% and from 38.2 to 40.9% of GDP, respectively. The agricultural sector contribution fell sharply from 42.5% in 2000 to 27.7% of GDP in 2014; however, the agricultural workforce per capita contribution to the country's GDP increased from US$421 in 2000 to US$1222 in 2014, reflecting the increased use of labor-saving equipment by the sector (Table 2.5).

Unlike its neighboring nations, Laos has not pursued the goal of using rice production as a commodity for export and socio-economic development. In this regard, electrical power generated by the Mekong tributary dams represents the single most important element of the country's exports and the largest source of foreign exchange earnings. Moreover, it is worth noting that the targets of the Seventh Five-Year National Socio-Economic Development Plan (2011–2015) assigned to the GDP 2015 the lowest percentage 23% to agriculture, 39% to industry, and 38% to service. In comparison, the Sixth Five-Year National Socio-Economic Development Plan (2006–2010) targeted about the same shares of GDP 36% and 36.4% for agriculture and industry, respectively. According to the actual results at the end of the Sixth Plan, agriculture contributed 30.4% to GDP and industry only 26.1%. Despite the better performance of agriculture, the government plan 2011–2015 gave new priority and significant importance to industry at the expense of agriculture. This raises the issue of rice sustainable growth in Laos in the future.

Foreign economic assistance has been vital for the socio-economic development of the country. In 2014, foreign direct investment (FDI) accounted for 6% of GDP, compared with 2% in 2000. During 2006–2010, the official development assistance (ODA) funds amounted to US$2.44 billion for 2251 projects, and the foreign direct investments (FDI) totaled US$8.81 billion. Most of the investment projects were for the electricity and mining sectors. The biggest investors were China, Vietnam, and Thailand (the Seventh Five-Year National Socio-Economic Development Plan

2011–2015). New development projects include a rail line over the Mekong River linking Thailand and Laos that was funded by Thailand and inaugurated in March 2009 and a new stadium built for the 2009 Southeast Asian Games that was financed by the China Development Bank. In January 2010, the World Bank approved an US$8 million grant for The Technical Assistance for Capacity Building in the Hydropower and Mining Sector Project that will help Laos meet the power and hydro demands of its neighboring countries (World Bank, January 12, 2010). The country will continue to need international community assistance and foreign investment to improve its infrastructure and its hydropower and mining industries and train its workforce to sustain a modern economy.

In 2014, Laos' exports accounted for 40.5% of GDP and imports 49.7% of GDP, with imports being the dominant factor. Electric power represents the single most important element of Laotian exports and the largest source of foreign exchange. It was mostly sold to Thailand. Other trade items included timber, tin, copper, and gold. Imports consist of tractors, machinery, parts, transportation equipment, fuel, oil, and consumer goods. Principal trading partners are Thailand, Vietnam, China, Japan, and France. In February 2013, Laos became a member of the World Trade Organization.

2.5.3 Thailand Economy

Thailand's strong economic performance averaging 8–9% per year in the 1980s and 1990s came to an end by the financial crisis of 1997–1998. In the next decade 2000–2010, the economy grew at an average annual rate of about 4.3%. Like its neighboring countries, Thailand was hurt by the global recession of 2007–2008 which caused the economy to shrink to 2.5% in 2008, the country's lowest growth rate. In 2010, the economy recovered and increased by 7.8%. In 2011, the World Bank upgraded Thailand to the status of upper middle-income economy on the basis of its gross national income (GNI) per capita of US$4210, reduction of poverty, macroeconomic management with a strong fiscal stance, and low public debts and inflation (WB, August 2, 2011).

In 2014, the economic growth slowed down to 0.9% due to political instability, a decline in export activities, a drop in foreign direct investments, and a weak tourism. The GDP at market prices amounted to US$404.8 billion, and the GDP per capita income was about US$5977. The agricultural sector was the only one to show an increase from 8.5 to 10.5% of GDP during the period under review. The industrial growth rate remained unchanged at 36.8%, whereas the service sector registered a decrease of 2%, from 54.7 to 52.7%, in the same period. The continued importance of the agricultural sector to the overall GDP shows the continued importance of agriculture, particularly rice, to the export economy and the increased productivity of the agricultural workforce whose per capita contribution to the country's GDP increased from US$525 in 2000 to US$2429 in 2014 (Table 2.5).

In 2014, Thailand's export share in GDP was about 69.2% of GDP and imports 62.6%. Major export items included rice, fish, textiles and footwear, rubber, jewelry, automobiles, computers, and electrical appliances. Imports included capital goods, intermediate goods and raw materials, consumer goods, and fuels. Principal trading partners were Japan, Singapore, China, Malaysia, Hong Kong, and the United States.

Foreign direct investment has played an important role in Thailand's economic development. During the first decade 2000–2010, FDI growth averaged 3.4% of GDP per year, although it contracted by 2.9–2.3% during the global recession in 2008–2009. In the next 4 years, FDI inflows into the country were uneven because of domestic political instability and uncertainty. In 2011, the share of FDI in GDP dropped to 0.7%, down from 4.3% in the previous year. In 2012 and 2013, it recorded 3.2% and 3.8% in 2012, respectively. However, in 2014, FDI ended with only 0.9% of GDP, which was the second biggest decline in foreign investment.

2.5.4 Vietnam Economy

Soon after Vietnam had adopted its socialist market-oriented or "renovation policy" in 1986, the economy of the country grew at an average annual rate of 8–9% during the next decade 1986–1995. Since 2000, the economy slowed down but remained strong with the GDP real growth rates of 6–7% during the period 2000–2010. In December 2009, the World Bank approved the first loan to Vietnam from the International Bank for Reconstruction and Development. The US$500 million loan was approved to support a program of public investment reforms that would help sustain the country's high economic growth (World Bank, December 22, 2009).

In 2014, Vietnam showed a GDP growth rate of 6% and a GDP per capita income of US$2052 per year. The agricultural sector has sharply decreased its importance in the economy from 22.7% in 2000 to 18.1% in 2014. The industry sector grew from 34.2 to 38.5%, and the service sectors basically remained unchanged at 43.4% during the same period. Although the importance of the agricultural sector to the overall GDP fell during the period, the per capita contribution of the agricultural worker shows a sharp increase from US$285 in 2000 to US$1087 in 2014, reflecting the country's transition away from labor-intensive planting and harvesting to the increased use of mechanization (Table 2.5).

In 2014, Vietnam's exports accounted for 86.4% of GDP and imports 83.1% of GDP. Both showed an increase of about 30–36% during the period under review. Export items included crude oil, rice, seafood, coffee, rubber, tea, garments, and shoes. Imports included machinery and equipment, petroleum products, fertilizer, steel products, raw cotton, grain, cement, and motorcycles.

Major trading partners were Japan, Singapore, China, the United States, Australia, Thailand, and South Korea.

Foreign direct investment was one of the key contributors to the country's economic development. After the Law on Foreign Investment took effect in late 1987, Vietnam licensed 12,575 foreign investment projects with a total registered

capital of US$194.4 billion over 22 years (1988–2009), according to GSO statistics. In 2014, FDI accounted for 4.9% of GDP, up from 3.9% in 2000.

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Chapter 3
Rice Cultivation, Production, and Consumption in Mainland Southeast Asian Countries: Cambodia, Laos, Thailand, and Vietnam

Abstract Rice in the four countries of Cambodia, Laos, Thailand, and Vietnam, also referred to as the Mainland Southeast Asia (MSEA) countries, has been cultivated in highlands and flatlands, in irrigated lands and rainfed lands, and in different seasons according to the monsoon rains and climate. For millions of farmers, rice farming is a way of life providing food subsistence, self-sufficiency, and security for their families, communities, and countries. This chapter examines agricultural land, paddy land, and harvested land, and rice production and consumption in the four countries.

Throughout this study the term "paddy", or "rice paddy", describes the yield of raw ("rough") rice as grown and harvested in the fields. Paddy only becomes "rice" after it has been milled to separate the rice from the matured paddy plant (or "husk"). Inevitably some rice is lost during the milling process with the amount of rice lost varying by crop variety and quality. Overall, finished polished white rice tends to average 67% of rough rice by weight. All rice production data in this study refers to "paddy" grown in the field, whereas all rice consumption data refers to the polished white rice after the milling process.

Keywords Agricultural land • Paddy land • Harvested land • Cambodia • Laos • Thailand • Vietnam • Rice cultivation • Irrigation • Rice paddy • Rice harvested • Milled rice • Rice production • Rice consumption

3.1 Agricultural Land, Paddy Land, and Harvested Land

This section covers three distinctive land areas: agricultural land area used for all cultivated crop, paddy land area allocated for rice cultivation, and harvested area which is the total sum of all land used for rice crops in a calendar year. The harvested area is generally bigger than the paddy area because two or more crops are planted annually on the same land. Our data and analysis are based primarily on the FAOSTAT database (June 2016), supplemented by data from the following sources: Cambodia Census of Agriculture 2013, Lao Census of Agriculture 2010–2011, Thailand Agricultural Census 2013, and Vietnam General Statistics Office (GSO) 2013, Agriculture and Forestry. Note that, in some instances, there are some significant differences in the historical data

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from FAO and data from these other sources; however, to maintain consistency, the FAO data has been the primary source of data in this chapter.

Cambodia, Laos, Thailand, and Vietnam together have an estimated agricultural area of 41.2 million hectares (ha) of which 16.7 million ha are allocated for paddy area or 41% of the total agricultural area. Thailand has the largest agricultural area estimated at 22.1 million ha, followed by Vietnam 10.9 million ha, Cambodia 5.8 million ha, and Laos 2.4 million ha., with the allocated paddy area in each country accounting for 38–42% of the total agricultural area. The harvested area totaled 22.7 million ha, or 6 million ha more than the paddy area, because of multiple crops on the same land during the year. Vietnam's harvested area of 7.8 million ha almost doubled the paddy area of 4.0 million ha because of three rice crops per year in the Mekong Delta. On the other hand, Laos's paddy area and harvested area were the same (958,000 ha) because the country has only one rice crop per calendar year (Table 3.1).

Rice paddy farming systems vary depending upon the topography (low-lying and high-elevation areas) and ecological condition of each country and region, not to mention the culture and customs of the populations and villages. In the MSEA countries, whether it is rainfed, irrigated, or floating rice in lowlands or uplands, paddy farming is water driven and labor intensive. Basically, paddy farming system consists of three main tasks or stages:

1. Land preparation consists of plowing the paddy fields with oxen or buffalos, four-wheel tractors, or handheld working tractors, using chemicals to control weeds and pests, manually applying animal manures or chemical fertilizers, and managing water resources.
2. Rice planting is generally done manually in two ways: planting the selected rice seeds in a seedbed or nursery and then transplanting the rice seedlings into the paddy fields or broadcasting rice seeds directly into the rainfed lowland areas.
3. Rice harvesting: crops cutting and threshing by hand or by machine.

Most of the 22.7 million hectares of harvested paddy area in the MSEA are rainfed with only about 40% of the area irrigated. Vietnam (4.6 million ha) and Thailand (an estimated 2.0 million ha) have the highest percentage of paddy areas irrigated. Except for Vietnam, the MSEA countries have two crops annually, one main crop in the wet season (May–November) and a second drop in the dry season

Table 3.1 Total agricultural area, paddy area, and harvested area in Cambodia, Laos, Thailand, and Vietnam, in 2014 (unit: 000 ha (rounded))

	Cambodia	Laos	Thailand	Vietnam	Total area
Agricultural area	5800	2370	22,110	10,880	41,160
Area allocated for paddy	2200	958	9460	4097	16,715
Paddy area as % of agricultural area	38	42	43	38	41
Harvested paddy area (ha)	3100	958	10,835	7820	22,713

Source: FAOSTAT (June 2016), Cambodia Census of Agriculture 2013; Lao Census of Agriculture 2010/2011 and 1998/1999, Thailand Agricultural Census taken in May 2013, and Vietnam General Statistics Office. Some of the 2014 data are estimated projections based on available data

(December–March). Vietnam has three crops per year, spring, autumn, and winter, with the last two occurring during the wet season.

Rice farming practices within each stage have evolved over the years due to new technologies and the Green Revolution that introduced irrigation systems, chemical fertilizers and pesticides, and modern seeds. The irrigated rice crop now takes, on average, 3–4 months to grow, which allows for more than one crop per year and produces high yields, compared to the traditional rainfed rice crop that requires 5–6 months to grow and generally produces lower yields. While the three basic tasks of rice farming remain the same, rice farming seasons, processes, methods, equipment, number of crops per year, and rice varieties are different in each of the four countries.

3.1.1 Cambodia Paddy Land and Farming System

Cambodia's total agricultural area in 2014 was estimated to be 5.8 million ha of which 2.2 million ha or 38% was land allocated for paddy production. However, because paddy land is used for multiple crop productions during the year, the total harvested paddy area was a reported 3.1 million ha in 2014, an increase from 1.9 million hectares in 2000 (Table 3.2).

Geographically, Cambodia's cultivated rice land can be divided into three areas. The first and richest covers the area of the Tonle Sap Lake Zone and the provinces of Prey Veng, Takeo, Kampong Speu, Kampong Cham, Kandal, Battambang, and Siem Reap. The second area consists of Kampot and Koh Kong provinces along the Gulf of Thailand and some less fertile areas of the central provinces. The third area is comprised of the highlands and mountainous provinces of Preah Vihear, Stung Treng, Ratanakiri, and Mondulkiri (Cambodia, Country Study).

Table 3.2 Cambodia agricultural area and paddy area by region and varieties, in 2014 (unit: thousand hectares; numbers rounded)

Region	Agricultural area[a]	Paddy area	Nonaromatic[b]	Aromatic	Glutinous
Tonle Sap Lake	2900	1100	880	215	5
Plain	1750	660	610	40	10
Plateau and mountainous	870	330	310	10	10
Coastal	280	110	100	10	0
Total	5800	2200	1900	275	25

Source: FAOSTAT, June 2016; Cambodia Census of Agriculture 2013; World Bank Group, Agriculture in Transition, Opportunities, and Risks, May 2015

[a]Breakdown by region is partly estimated

[b]Reports indicate that more than 90% of the region's rice harvest is of the nonaromatic variety

Within these geographic areas, rice in Cambodia is grown in four different ecosystems: rainfed lowland, rainfed upland, irrigated, and deep water. The rainfed lowlands of Cambodia are bunded fields that are almost completely dependent on local rainfall and runoff for water supply. Rainfed lowland rice is cultivated in all provinces with the largest concentration located around Tonle Sap, the Tonle Basaac River, and the Mekong River. The rainfed uplands are unbunded fields that depend entirely on rainfall. They are generally found scattered on rolling lands, some of which are mountainous forested areas. They form only a small proportion of the total paddy land in Cambodia.

Because of the historical dominance of the wet season crop, most of the total paddy area in Cambodia has been rainfed. However, in recent years, ongoing improvements to rice production have included the introduction of modern irrigation equipment that has increased the proportion of paddy area under irrigation from 15% in 2006 to 25% in 2010 (Grist, Rice Almanac). This includes 256,000 ha of the wet season that are fully irrigated, and 225,000 ha of the dry season crop that are partly irrigated (WEPA 2015).

Deepwater or floating rice is grown in low-lying areas and depressions where maximum water depth can reach more than 3 m. Farmers plant floating rice in April–May in the areas around the Tonle Sap (Great Lake) and the Mekong and Tonle Basaac Rivers and their tributaries, which flood and expand their banks in September or early October. Before the flood, seeds are spread on the ground without any preparation of the soil. The floating rice is harvested 9 months later, when the stems are three or four meters depending on the flood's peak. Floating rice has a low yield, about half that of other rice types, but it can be grown inexpensively on lands that have no other use (IRRI/CGIAR, Ricepedia.org).

Cambodia has two rice crops each year, the estimated two million ha wet season monsoon crop (long cycle) and about 225,000 ha dry season "recession" crop, producing three types of rice: traditional nonaromatic varieties, aromatic "fragrant" rice, and a glutinous rice also referred to as "sticky" rice. Glutinous "sticky" rice accounted for a reported 18,000 ha in 2013 with the plains and plateau/mountainous regions accounting for most of the plantings and with the Tonle Sap region accounting for a smaller area (Cambodia Census of Agriculture 2013; World Bank 2015, Cambodia, Rice Sector Review).

The Tonle Sap region and the plains region are the major producing areas reportedly accounting for almost all of the rice plantings. The major monsoon crop is planted in May through July, when the first rains of the monsoon season begin to inundate and soften the land, and is usually harvested 6 months later in December. The monsoon crop is dominated by the traditional nonaromatic rice varieties which account for more than 85% of rice plantings. The dry season crop is smaller, and it takes less time to grow, about 3–4 months from planting to harvest. It is planted in December–January in areas that have trapped or retained part of the monsoon rains, and it is harvested in April–May. The dry season "recession" crop, which matures in about 90 days, is almost entirely devoted to the aromatic rice varieties.

Historically, the rice varieties used during the two growing seasons have been selected based on their sensitivity to sunlight, i.e., the nonaromatic rice varieties must be grown during the rainy season, while the more profitable aromatic rice varieties have been planted during the dry season taking advantage of the increased sunlight. However, new aromatic rice strains have now been introduced that can be grown during the rainy season, and as a result, farmers are increasingly planting the new, more profitable, aromatic rice varieties during the rainy season, at the expense of the nonaromatic varieties. At the same time, farmers are also expanding the area planted with aromatic rice during the dry season (WB 2015 Cambodia, Rice Sector Review).

3.1.2 Laos Paddy Land and Farming System

In 2014 the country's total agricultural land area was 2.4 million ha, with the fertile Central Mekong River valley accounting for nearly 50% of the area. The land allocated for paddy production totaled 958,000 ha or 40% of the total agricultural area, representing a one-third increase over the 718,000 ha paddy area recorded in 2000 (Table 3.3).

Laos has two main rice crops: a wet season, mostly rainfed, crop of 900,000 ha accounting for 95% of the total crop area that is planted between May and July for harvesting in November/December and a dry season, mostly irrigated, crop of 58,000 ha that is planted in December/January for harvesting in April/June. The wet season crop is further divided into a 700,000 ha lowland crop and a 200,000 upland crop. The most important rice-growing provinces are Savannakhet (220,000 ha) and Champassack (101,000 ha).

Paddy farming system is different in lowlands and uplands. In the fertile Central Mekong River valley and the lowland plains in the northwest and the south, rice farming during the important wet season depends on the natural moisture of the monsoon season that runs from May to October. Approximately 50% of the wet season crop is grown in the Central Mekong River valley area, and in this area,

Table 3.3 Laos agricultural land, rice land use by region and season, 2014 (unit: "000 hectares" numbers rounded)

Region	Agricultural area	Paddy area	% irrigated	Wet season rice area	Dry season rice area
North	850	255	30	245	10
Central	1050	485	20	450	35
South	470	218	10	205	13
Total	2370	958	20	900	58

Source: FAOSTAT, June 2016; Laos Census of Agriculture Analysis 2014

paddy fields are diked to retain the water and fertile soil; buffalos or small tractors are used to plow the land; some fertilizers and pesticides are used. About 60% of the 58,000 ha dry season crop is grown in the central region and is cultivated mainly under a rotating cultivation system. Of all the rice varieties grown in Laos, 92% are glutinous rice (Lao Census of Agriculture 2010/2011 Highlights, Vientiane 2012).

At one time, farmers in the highlands and on the mountain slopes used the "slash and burn" method of agriculture as a means of clearing the land, and the resulting layer of ash provided the newly cleared land with a nutrient-rich layer to help fertilize crops and extend the rice-growing season to about 10 months of the year compared to 6 months in a typical lowland growing area. However, under this method, the land stayed fertile only for a couple of years before the nutrients were used up forcing the farmers to then abandon the degraded land and repeat the process. This method of farming is now prohibited (USDA, December 13, 2011).

Planned irrigation of the paddy growing areas varies according to the crop. During the wet season, the crop is almost entirely rainfed from the monsoons. Most of the rice requiring irrigation is concentrated in the drier Northern region where almost one-third of the crop is irrigated. According to the Ministry of Agriculture, in order to increase the level of irrigation in the country, 8000 pumps were installed along the Mekong River and its tributaries in the late 1990s in the three main plains of Vientiane, Savannakhet, and Khammouane provinces. As a result, the total irrigated area of the country increased from 170,000 ha in 1995 to 370,000 ha in 2005 and to 410,000 ha in 2011. Of the 410,000 ha country total in 2011, 191,000 ha (or 46%) was in the total rice area. In 2013, the government designated the central provinces of Savannakhet and Khammouane as model areas for the production of good quality rice for domestic sale and export. According to the Ministry of Agriculture and Forestry, the chosen provinces have large areas of land suitable for rice cultivation and good infrastructure (Vientiane Times, September 2013).

3.1.3 Thailand Paddy Land and Farming System

In 2014, Thailand's total agricultural area was 22.1 million ha, with the northeastern region accounting for nearly 50% of the total agricultural area, followed by the northern region (25%), the central region (15%), and the southern region with about 10%. (Table 3.4) The country's land allocated for paddy production accounted for 9.5 million ha or 43% of the agricultural area, down from 11.5 million ha in 2000. Because multiple rice crops are sown on the same paddy area each year, the harvested paddy area increased to 10.8 million ha in 2014, an increase of 10% from the 9.9 million ha in 2000, as indicated in Table 3.4.

Rice is grown in four different ecosystems: irrigated, rainfed lowland, deep water, and upland. Rainfed lowland is the most predominant, followed by irrigated, deep water, and upland. A total of 6.4 million ha, or 30% of the 2014 total

Table 3.4 Thailand agricultural area, paddy area, and harvested area by region and crop, in 2014 (unit: million hectares; numbers rounded)

Region	Agricultural area[a]	Paddy area	Harvested area[b]	First crop	Second crop
Northeast	10.3	5.9	5.5	5.3	0.2
North	5.3	2.2	3.1	2.0	1.1
Central	3.7	1.3	2.1	1.2	0.9
South	2.8	0.1	0.1	0.1	–
Total	22.1	9.5	10.8	8.6	2.2

Source: FAOSTAT, June 2016; Thailand Agricultural Census, 2013; Grist, Rice Almanac
[a]Regional breakdown is partly estimated
[b]Total harvested area shows the cumulative effect of both the first and second crops planted successively in the same allocated area

agricultural area, is equipped for irrigation, representing an increase of 14% over 5.6 million ha in 2000.

All four regions have the same two-crop annual farming calendar with the northeast, north, and central regions planting their main crop in May–July for harvesting in October–November, followed by a smaller, irrigated, second crop that is planted in December–January and harvested in May–June. In the south, the calendar is different with the major crop planted in September–November and harvested in March–May. The second, smaller, crop is planted in April–May and harvested in August–September. The southern region has only about 10% of the total rice land, and in addition, the soil is acidic. With limited rice paddy fields under cultivation, this region invariably experiences a shortage of rice for local consumption.

The northeast region, or the Khorat Plateau, the largest region with a total planted area of 5.5 million ha, generally grows one important crop each year, mostly rainfed rice, with a very small second crop. Given the undulating terrain, irrigation is limited, and the average size of rice farms is smaller than in other regions. Therefore, farmers depend on rains to plough their paddy fields using water buffalos or a modern mechanical plough. Farming is labor intensive from transplanting seedlings to harvesting with sharp scythes and threshing with two sticks tied together with a rope or with a thresher truck. The northeastern region produces the famous Hom Mali rice, fragrant rice jasmine, and glutinous rice.

The northern region with a total planted area of 3.1 million ha provides both upland rice and lowland rice. Upland rice is grown in the lower altitudes of high hills and in upland areas. Lowland rice is grown mainly in lower valleys and on some terraced fields where water is available.

The central region is an intensively cultivated alluvial area. During the rainy season, the 2.1 million ha of total planted paddy land area accounts for about 20% of the total cultivated rice land of the country. The average farm size is large, and a large proportion of the rice land has access to irrigation facilities, allowing many farmers to grow two rice crops during the year. Almost 75% of the dry season rice grown under irrigated conditions is located in this region. Farm operations are

almost entirely mechanized, and farmers adopt the direct seeding method of crop establishment to save labor. This region produces mostly long-grain rice. The main rice surplus comes from this region.

3.1.4 Vietnam Paddy Land and Farming System

According to FAOSTAT (June 2016), the country's total agricultural area in 2014 totaled 10.9 million ha, of which the land area allocated for rice paddy production was 4.1 million ha, or 38% of the agricultural area. (Table 3.5) Vietnam has three most important paddy areas which are, in order of paddy production, the provinces of the Mekong River Delta in the south, the Red River Delta in the north, and the North Central and Central Coast. In 2014, the total combined harvested paddy area for the three annual crops accounted for about 7.8 million ha with the Mekong River Delta having the largest area (4.2 million ha), followed by the north, central, and central coast regions (1.2 million ha) and the Red River Delta (1.1 million ha). Nationwide, farm size is very small, with about 50% of farmers cultivating an area less than 0.5 ha, and farming techniques and harvesting methods are not very developed and mechanized.

Rice cultivation is governed by hydrology, rainfall pattern, and irrigation. Due to different geographical locations and climates between the north, central, and south provinces, rice is classified according to three ecosystems: irrigated rice, dry land rice, and floating rice. Irrigated rice requires large amount of water and grows mainly in the Mekong Delta and the Red River Delta where elaborate systems of canals and dikes help drain the paddy fields. In 2014, the total area equipped for irrigation was 4.6 million ha, or 42% of the 10.9 million ha total agricultural area. Dry land rice grows in highlands and mountainous areas of the north and central

Table 3.5 Vietnam agricultural area, paddy area, and harvested area by region and crop, in 2014 (units: thousand hectares; numbers rounded)

Region	Agricultural area[a]	Paddy area	Harvested area[b]	Spring crop	Autumn crop	Winter crop
Mekong River Delta	2775	2200	4250	1566	2293	391
North Central/Coast	2025	600	1244	587	346	311
Red River Delta	815	600	1124	559	0	565
Northern Midlands/Mtn	1700	400	689	250	0	439
Southeast	1440	100	274	74	90	110
Central Highlands	2125	200	239	86	6	147
Total	10,880	4097	7820	3122	2735	1963

Source: FAOSTAT, June 2016

[a]Breakdown by region is from General Statistics Office data, January 1, 2014

[b]Total area planted shows the cumulative effect of all crops planted successively in the same allocated area

areas where farmers wait for the first rains for planting rice. In some areas, farmers built terraces to store rainwater. Floating rice grows in the Mekong Delta area that is subject to heavy monsoon rains. When the rain starts, the rice is planted and grows with the level of the floodwaters until it is ripe for harvesting.

Rice cropping seasons are also different in the three rice-growing provinces of the Mekong Delta, the Red River Delta, and the north: The Mekong Delta generally has three annual rice seasons. The winter-spring crop (planted in November–December and harvested in February–March) takes advantage of residual wet season water in the paddy areas for irrigation. It is also fertilized by the alluvia deposited in paddy areas by the wet season floods which contribute to the crop being the best quality of rice. The summer-autumn crop (planted in May–June and harvested in August–September) is planted immediately following the winter-spring crop in the northern and inland provinces and with the onset of the monsoon rains in May in the south. The autumn-winter crop (planted in July–August and harvested in December–January) is generally concentrated in the coastal paddy areas. The last two crops occur during the rainy season that normally starts in May and ends in November. The crop cycle takes 3–4 months from planting to harvesting depending on the strain of rice planted. One of the latest developments in rice farming is the continued research of new higher-yielding strains of rice capable of maturing in 70–80 days.

The Red River Delta provides wet rice cultivation which requires great quantities of water on the fields in the early period of the production cycle and drainage of the fields in the latter period. In the Red River Delta and other regions in the north and central coasts where the weather is cold in the winter and not suitable to farming, there are two crops each year. The spring-summer crop is sown in nursery in mid-December to early February, transplanted in February–March, and harvested June–July. The autumn-winter crop is sown in June–July, transplanted in July–August, and harvested in October–December. The mountainous areas in the north provinces have only one season, from June to October.

3.2 Paddy Rice Production

In the new millennium, statistics on paddy rice production are not lacking. However, they vary depending upon sources, which may use different benchmarks to calculate rice production. Some institutions and national statistical offices compute the harvest per calendar year. Other research organizations and private companies base their calculations on the harvest season, which runs from November to February and thus extends over two calendar years. In addition, estimates of rice production do not always differentiate between paddy rice and milled rice. In terms of weight, milled rice averages about 65–67% of paddy rice. Given statistical discrepancies, our analysis of paddy rice production in Cambodia, Laos,

Thailand, and Vietnam is based on latest and available data per calendar year from the FAO database on rice, national statistics offices of the four countries, and the World Bank and Asian Development Bank reports (ADB 2010a, 2010b) on rice.

In the first 14 years of the new millennium, total paddy production in the four MSEA countries was estimated at 90.9 million tons in 2014, up from 64.5 million tons in 2000, growing at an average annual rate (AAGR) of 2.5%. The total combined harvested area increased from 20.18 million ha in 2000 to 22.72 million ha in 2014, and the total average yield grew from 3.2 tons/ha to 4.0 tons/ha in the same period (Table 3.6).

Of the total 90.9 million tons of paddy production in 2014, Vietnam was the largest producer, accounting for 50% of the total, followed by Thailand with 32.6 million tons or a further one-third of the total. Annual average growth rates (AAGR) of paddy production in the four countries between 2000 and 2014 are a reflection of the relative maturities of the rice industries in the different countries. As an example, Vietnam and Thailand were the largest paddy producers among the four countries during the period with average annual growth rates of 2.4% and 1.7%, respectively, rates that are reflective of mature industries. In contrast, the faster growth rates for Cambodia (6.2%) and Laos (4.4%) during the same period show these two countries' rice industries to be in the more formative growth phase.

In addition, relative increases in harvested paddy areas between countries are also a measure of where a country's rice industry stands in terms of its development. Cambodia's 60 percent increase in its harvested area, from 1.9 million ha in 2000 to 3.1 million ha in 2014, growing at an average annual rate of 3.6%, demonstrates the early growth phase of the country's rice industry. In contrast, Vietnam's harvested area was almost unchanged in the 7.7–7.8 million ha range during the same period.

All countries increased their average paddy yields during the period taking advantage of improved growing techniques and new higher-yielding rice strains. Vietnam was an impressive example of this. Although limited in land area, rice production in Vietnam increased sharply during the period mainly as a result of an increased yield to 5.8 tons per hectare in 2014, up from 4.2 tons per hectare in 2000, the highest among the neighboring countries (FAOSTAT).

Table 3.6 Harvested area, yield, paddy production, and average growth in Cambodia, Laos, Thailand, and Vietnam, in 2000–2014 (Unit: millions; numbers rounded to the nearest '000 mt)

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Harvested area (ha)	1.9	3.1	0.7	1.0	9.9	10.8	7.7	7.8	20.2	22.7
AAGR %	3.6		2.1		0.7		0.1		0.9	
Yield tons/ha	2.1	3.0	3.1	4.2	2.6	3.0	4.2	5.8	3.2	4.0
AAGR %	2.6		2.2		1.0		2.3		1.6	
Paddy production (tons)	4.0	9.3	2.2	4.0	25.8	32.6	32.5	45.0	64.5	90.9
AAGR %	6.2		4.4		1.7		2.4		2.5	

Source: FAOSTAT

3.2.1 Cambodia Paddy Rice Production

The predominance of agriculture, and rice culture in particular, characterized Cambodia's burgeoning economy since independence in 1953. Rice production increased from that time to reach a production level of 3.8 million tons in 1970. During the 1970s and most of the 1980s, rice production was a major casualty of the Second Indochina War (1970–1975) and the Civil War (1975–1979), and it performed poorly due to security problems, adverse weather conditions, and lack of draft animals and farm implements. In the 1980s and into the 1990s, the country struggled to increase its rice production, and it was not until 1990 that it finally reached the 4.0 million tons level as a result of a steady increase of the harvested area to 2.0 million ha and an increase in average yields to almost 2.0 tons per ha. This increase in rice production made Cambodia largely self-sufficient in rice, although with some northern areas experiencing a rice deficit.

Starting the new millennium, Cambodia continued to progress in rice production, more than doubling its rice output from 4.0 million tons in 2000 to 9.3 million tons in 2014, growing at an average annual rate of 6.2%, the highest of the four countries. This production improvement was caused by a more than 50% increase in its harvested paddy area from 1.9 million ha to 3.1 million ha and by a similar increase in its yield, from 2.1 to 3.0 tons per ha, during the same period. The rice yield of 3.0 tons per hectare, however, was among the lowest among the Lower Mekong countries due to lack of irrigation, fertilizers, draft animals, and farm implements (Table 3.6).

As the Census of Agriculture in Cambodia 2013 noted in its preliminary report, Cambodia's agriculture remained largely undeveloped and its arable land unexplored or unused. Rice production had difficulties reaching its potential due to poor infrastructure, unseasonal climate change, high costs of production, low incomes, and untrained workers. On the other hand, Cambodia has rich natural resources (the Tonle Sap basin, the Mekong River, and its tributaries) and a sizable agricultural workforce (65% of the total labor force) that could develop its rice industry to achieve its full potential and to be competitive with Thailand and Vietnam in the twenty-first century.

3.2.2 Laos Paddy Rice Production

Laos is the smallest rice grower in the Southeast Asia with a harvested paddy area of less than 1.0 million ha in 2014. Rice production is low because of three major constraints that are inherent to the country: the topography with its mountains, hills, and forested area covering more than two-thirds of the total land area, the smallest agricultural land area of the four countries, and the farming method of "slash and burn," particularly in the northern region. In addition, Laos has limitations that are common to farmers in neighboring countries, such as the lack of irrigation; high

costs of fertilizers, pesticides, farm implements, and tractors; and adverse weather conditions.

In spite of these limitations, Laos' rice industry has made remarkable progress since the liberal reforms of 1979 that aimed at promoting food production. Paddy rice production grew slowly during the 1960s and 1970s from 500,000 tons (1961) to reach 1.0 million tons for the first time in 1980. In 1985, paddy production reached 1.4 million tons, which reduced imports to a low level and allowed the country to become self-sufficient in rice for food. During the balance of the 1980s and through the 1990s, paddy production increased to reach 2.2 million tons in 2000, with an average annual growth rate of 3.1% (1985–2000), as a result of an increased yield (2.1–3.1 tons/ha) and increased harvested paddy area from 660,000 to 720,000 ha.

During the first 14 years of the new millennium, rice production in Laos continued to expand to 4.0 million tons in 2014, growing at an average annual rate of 4.4%. While the harvested area expansion lacked continuity fluctuating in the 700–800 ha per year, average yields progressed steadily during the period from 3.1 tons/ha in 2000 to 4.2 tons/ha in 2014, the second highest of the four Mekong countries, outperforming both Cambodia and Thailand (Table 3.6).

3.2.3 Thailand Paddy Rice Production

Thailand is a major rice producer in the world. Since the end of World War II, the country has been consistently the fifth or sixth largest rice producer among top Asian producers that include China, India, Indonesia, Bangladesh, Japan (until 1978), and Vietnam (since 1990). From 1950 to 2012, the country's paddy production grew at an estimated average annual rate of 2.5% based on statistical data from the USDA Agricultural Economic Report No. 433 for the years 1950 through 1974 and from the FAOSTAT for 1975 through 2014. The evolution of Thailand's rice production during those 62 years can be divided into several different stages: 1950–1961, 1962–1974, 1975–1993, and 1994–2014.

The first period (from 1950 to 1961) was characterized by unstable growth with paddy production increasing from 8.2 million tons in 1950 to 9.6 million tons in 1961 at an average annual growth rate of 1.4%. However, paddy production levels varied between 6.9 million tons (1954), 10.1 million tons (1956), and 6.7 million tons in 1957. The harvested paddy area also varied between 4.3 million ha (1957) and 5.7 million ha (1961) resulting in an average paddy yield during the period of 1.5–1.6 tons/ha.

The second period (from 1962 to 1974) saw a more stable growth with harvested paddy production steadily increasing from 11.3 million tons (1962) to 13.4 million tons (1974), also at an average annual growth rate of 1.4%. During the same period, the paddy area expanded from 6.5 to 7.3 million ha, with the result that the average paddy yield increased to 1.7–1.8 tons/ha. In 1964, Thailand became the world's first largest rice exporter, which will be discussed in the next chapter on trade.

The third period (from 1975 to 1993) was a period of a slightly lower growth for paddy production, compared to the two previous periods with rice production increasing from 15.3 million tons in 1975 to 19.5 million tons in 1993 and growing at an estimated average annual rate of nearly 1.4%. Although there were individual years during the period when paddy production exceeded 20.0 million tons (1985, 1988, 1989, 1991), it was not until 1994 that Thailand's average paddy yield grew to the level of providing a sustained paddy production of 20.0 million tons per year.

Unlike Vietnam and other top Asian paddy producers, Thailand did not participate in the Green Revolution (1967–1985) which promoted the use of chemical fertilizers and modern high-yield seeds, better use of power-driven pumps, and training of farmers and workers on new technology to boost paddy output and productivity. As a result of this decision, Thailand had the lowest average annual rate of growth in paddy production during the period (3.3%) and rice yield growth (0.9%) among the major rice producers of Southeast Asia, such as Indonesia (5.3% production and 4% yield), Myanmar (4.3% production and 4.4% yield), and the Philippines (3.7% production and 3.7% yield).

For the next 20 years (from 1994 to 2014), Thailand's paddy production increased steadily from 21.1 million tons in 1994 to 32.6 million tons in 2014, growing at an average annual rate of 2.2%. The most rapid growth during this period was from 1994 to 1999, when rice production grew at an average annual rate of 2.7% as a result of an expansion of the harvested area from 8.9 million hectares to 9.9 million hectares and a small increased yield from 2.35 to 2.42 tons per hectare. The next 14 years in the new millennium (2000–2014) saw the largest increase in paddy output from 25.8 million tons (2000) to 32.6 million tons (2014), with significantly higher levels reported for 2010 (34.4 million tons), 2011 (36.1), 2012 (37.5), and 2013 (38.8 million tons). As indicated in Table 3.6, the average annual growth rate of rice production during this period was 1.7%, an increased yield from 2.6 to 3.0 tons/hectare and an expanded harvested area from 9.9 to 10.8 million hectares.

Thailand has not fully "revolutionized" its rice sector with greater use of chemical fertilizers and pesticides and adoption of modern seed varieties producing high yields. In 2014, the Thai rice yield at 3.0 tons per ha was lower than neighboring Vietnam's yield at 5.8 ton per ha and Laos' yield at 4.2 tons per ha. The largest rice producer is the northeast region, and rainfed rice remains the dominant rice of the four rice ecosystems. The key characteristics of rainfed rice are one crop each year, long cycle, no fertilizers, no pesticides, traditional rice varieties, and low yield. The yield of rainfed rice is much lower than the yield of irrigated rice in the central region. However, rainfed rice, like the Hom Mali rice or jasmine rice, is known for its high quality and is preferred not only by local and foreign markets but also by farmers because of its high price. It will be difficult to increase the yield of quality rice that is targeted for exports and foreign currencies when the country gives high priority to modernization, industrialization, and urbanization.

The year 2012 has been viewed by many observers as a "special" year when Thailand lost its title of the "world largest rice exporter" to India and Vietnam. The policy for rice production to be used for export and foreign revenues raised many

issues. The rice subsidy pledge inflated paddy rice output but created fiscal problems for the country. Political instability affected farmers' income. Thailand will face many challenges in maintaining its status as a major rice producer in the new millennium.

3.2.4 Vietnam Paddy Rice Production

The performance of rice production in Socialist Republic of Vietnam depends primarily on the management of land by the state. There is no individual ownership of land, only land use rights provided by laws and decrees. Since the country reunification in 1975, the communist government has introduced many land laws and liberal economic reforms to boost production of rice, considered as the most important crop for food security.[1] During the period under review (1975–2014), three major land reforms enacted in 1987, 1993, and 2003 provided for land allocation, land use rights, and land tenure to farmer households and individuals. Based on the collective land followed by major land laws and economic reforms, Vietnam's rice production can be divided into four periods: collectivization of land (1975–1980), contract system (1981–1987), land and economic reforms (1988–1999), and land and industrialization (2000–2012).

3.2.4.1 Collectivization of Agriculture (1975–1980)

Shortly after reunification, the government launched a massive agricultural collectivization program to unify the economic system and the agricultural sector of the entire country under the communist regime. The collectivization program consolidated individual peasant households and individuals into a system of large state collective farms. While formation of agricultural cooperatives in North Vietnam dated back to 1960, the measures taken to collectivize southern agriculture met with strong resistance. Southern peasants who were mainly freeholders, not tenants, refused to participate in any collective program that attenuated property rights.

The implementation of the collectivization program proved to be counterproductive, and rice production in the postwar period performed poorly. Whereas prior to 1975 rice production had grown steadily to 11.0+ million tons, rice production fell sharply from as high as 11.8 million tons (1976) to 10.6 million tons in 1977 and 9.8 million tons in 1978. Rice yields also fell from 2.2 tons per hectare in 1976 to 1.9 tons per ha in1977 and 1.8 tons per ha in 1978 due to unusually severe drought and typhoons. By 1979, rice production rebounded to 11.4 million tons (1979) and 11.6 million tons (1980), as a result of increased average yields, but the production

[1]The 1944–1945 Great Famine in North Vietnam was a historical human tragedy causing hundreds of thousands of deaths.

levels were still below those achieved in 1976. The average annual growth rate of rice production for the 5-year agricultural collectivization was 2.5%. However, the industry's failure to increase paddy production to achieve food self-sufficiency, and the country's continued reliance on rice imports, forced the government to decollectivize agriculture.

3.2.4.2 Contract System (1981–1987)

In January 1981, a "contract system" was officially established that allowed cooperatives to allocate parcels of land on annual basis to group of farmers and individuals for growing crops and for producing a determined amount of harvested crops for the cooperatives at the end of the crop season. The contract allowed farmers greater freedom to dispose of the surplus products. The cooperatives planned, supervised, and supported production. However, the reform did not change the basic structure of production; farmers were hired laborers, with no security of land tenure; and the responsibility of rice production remained with the collectives.

The contract system had mixed results due to bureaucratic inefficiencies and shortages of agricultural supplies, mainly chemical fertilizers and pesticides. In 1986, rice production reached the high level of 16.0 million tons but fell short of the target of 19 million tons set in the Third Five-Year Plan (1981–1985). In spite of increased rice imports, severe food shortages occurred, and with decreased rice production to 15.1 million tons (1987), the collective model was abolished. A series of land reforms and new economic resolutions and decrees were implemented that changed agricultural productivity and efficiency for the next 12 years.

3.2.4.3 Land Reforms (1988–1999)

This period marked the implementation of land reforms and new economic policies of Doi Moi, or Renovation, that was adopted at the Sixth Party Congress in December 1986. A series of "new economic orientations" gave primordial importance to agriculture and sanctioned private production, efficiency of production, and freedom of distribution. The first land law of the country, enacted in December 1987, ensured farmer households and individuals "stable and long-term use" of agricultural land and freedom in cultivating contracted land.

In April 5, 1988 to implement this provision of the law, the Party's Political Bureau issued Resolution 10 on "renewing agricultural management" that specified that contracting cooperative land to farmer households should be for 10–15 years, not less than 5 years, and that households could retain at least 40% of their average crop yields that were negotiated at the time of contract and should remain fixed for 5 years. If households could not meet the contract quota, they should compensate cooperatives in cash at the going market price. If they exceeded the quota, they could keep the surplus. In sum, the farmer household was a principal production

unit and had greater control of their lives and fruit of their labor. The cooperative management assumed a supporting role in water conservation, pest control, and crop protection in the production process and acted as middlemen between households and states in collecting taxes and overseeing the distribution of contracted land.

In 1993, a second land law was promulgated that granted farmers increased security and tenure over land which they had been allocated. Land use rights were granted for 20 years for land used for annual crops and 50 years for land used for perennial crops. Land use rights also included five rights: the rights of transfer, exchange, lease, inheritance, and mortgage. The 1993 Land Law also put a ceiling on the amount of land that can be allocated to households: for annually cropped land, 2 hectares were allocated in the central and northern provinces and 3 hectares in the southern provinces, and for land planted to perennials, the limit on holdings was 10 hectares. This law also recognized the value of land, and the State has the right to value the land when it is converted to urban and industrial purposes.

The Party Politburo Resolution 10 and the two important land reforms of 1987 and 1993 drastically changed the performance of rice production in the late 1980s and 1990s. This period was a turning point for rice production from chronic rice shortages to steady rice surplus. In 1988, the first year of implementation of the 1987 Land Reform and Resolution 10, rice paddy production increased to 17.0 million tons from 15.1 million tons in 1987. Two years later, in 1990, Vietnam became the world's fifth rice producer with a production of 19.6 million tons. For the next decade, 1990–1999, paddy production rose steadily every single year to reach 31.4 million tons (1999). The average annual growth rate of rice production for the entire period of 1988–1999 was 5.7%.

3.2.4.4 Land Reallocation and Industrialization (2000–2014)

The first decade of the new millennium saw a reduction of agricultural land and productivity caused by urbanization and industrialization that was accelerated by a third land law adopted by the National Assembly in 2003. The Land Law 2003 allowed foreign organizations and individuals to invest in land leased by the State. As it relates to land use, Article 40 of the Law stipulates that "The State shall recover land for use for purposes of economic development in case of investment in the construction of industrial parks, high-tech parks, economic zones and big investment projects as provided for by the Government."

The Land Law 2003 provision on "land recovery" had major implications on agricultural land and paddy land and production. From 2001 to 2010, the government reallocated 0.9 million hectares of agricultural land to land for residential use, commercial nonagricultural establishment use, public works, and other nonagricultural purposes. To ensure national food security, the government issued Resolution No. 63/NQ-CP, on December 23, 2009, which states that by 2020, 3.8 million hectares of land must be reserved for rice cultivation to ensure a paddy production of 41–43 million tons and a volume of milled rice export of 4 million tons a year (Tran Cong Thang 2014, Food security policies in Vietnam).

According to government statistics, in 2014, land allocated for paddy production was reduced to 4.08 million hectares from 4.12 million hectares in 2000. As indicated in Table 3.6, the harvested paddy area increased from 7.7 million ha in 2000 to 7.8 million ha in 2014, with paddy production growing at an average annual rate of 2.4%, a slower growth rate than the rapid 1988–1999 rate of 5.7%. The slower rate reflects the industry's maturity as well as the impact of paddy land reallocation and the natural disasters such as severe floods in 2000 and 2011 and the record drought in 2010 that destroyed many paddy fields. The impact of climate change on paddy production will be addressed in Chap. 4.

3.3 Rice Consumption

Before presenting the analysis of rice consumption in the four MSEA countries, the following is a definition of the categories used in this section:

- Total rice consumption refers only to milled rice and uses the FAOSTAT data referred to as "total domestic supply."
- Rice consumption in food is a subset of total rice consumption, and the data is taken from the FAOSTAT breakdown of use.
- Other staples used in food consumption include wheat, maize, cassava, and potatoes, which are designated by FAOSTAT as used in food and could be considered as being in competition with rice in urban settings or as value-added dietary upgrades.
- Per capita data for food rice and also for food rice plus other food staples show the decreasing importance of food rice in the four countries, relative to total food staple use.

During the period 2000–2014, total milled rice consumption in the four MSEA countries increased from 32.0 million tons to 43.6 million tons, growing at an annual average rate of 2.2%, and average per capita milled rice consumption for the four countries grew by 22% from 199 kg/year in 2000 to 243 kg/year in 2004. Food use has always been a major consumer of rice in the MSEA countries; however, in recent years, its importance has declined relative to total rice consumption. While total food rice consumption for the four countries increased from 22.3 million tons in 2000 to 24.6 million tons in 2014, its importance fell from an average of 70% of the total in 2000 to 56% in 2014.

This decreased importance of rice for food can be attributed to increased consumption of other, non-rice, staples as a result of both a steady decline in the rural percentage of total population, from 74% in 2000 to 62% in 2014, as migration to urban centers increases their exposure to, and consumption of, non-rice "fast-food" staples. As the agricultural component of these four countries become increasingly mechanized and less labor intensive, the observed trend of rural populations moving to urban centers, for economic advantage, is expected to continue along with a decreased consumption of rice for food relative to other non-rice food staple consumption.

Table 3.7 Total milled rice consumption, rice consumption in food, and total staple consumption in food in Cambodia, Laos, Thailand, and Vietnam, in 2000–2014 (unit: million tons (rounded))

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Total rice consumption	2.5	6.3	1.4	2.1	10.4	13.8	17.8	21.5	32.0	43.6
Rice food consumption	2.0	2.5	0.9	1.1	7.3	7.7	12.1	13.3	22.3	24.6
Rice food as % of rice consumption	83	39	64	52	70	56	68	62	70	56
Other staple food consumption[a]	0.2	0.6	0.2	0.4	1.9	2.6	1.6	3.0	3.9	6.6
Total staple food consumption	2.2	3.1	1.1	1.5	9.2	10.3	13.7	16.3	26.2	31.2
Per capita food consumption (all staples) (kg/year)	188	202	207	224	147	152	171	176	163	174
Per capita food consumption (rice only) (kg/year)	168	161	170	164	116	114	151	144	139	137
Rice as % of total food staples	89	80	82	73	79	75	88	82	85	79
Population										
Total population (millions)	12.2	15.3	5.3	6.7	62.7	67.8	80.3	92.4	160.5	182.2
Rural population	10.0	12.2	4.2	4.3	42.8	34.2	61.2	62.1	118.1	112.8
As % of total population	82	80	79	64	68	51	76	67	74	62
Gross domestic product										
GDP ($US, billions)	3.7	16.7	1.7	11.9	122.7	404.8	33.6	186.2	161.7	619.6
Per capita GDP ($US)	299	1095	324	1794	2016	5977	433	2052	1007	3401

Source: World Rice Statistics – FAOSTAT, World Bank, World Development Indicators (2015)
[a]Partly estimated includes food consumption of wheat, maize, soybeans, other grains, and legumes (FAOSTAT definitions)

The other trend is the observed general increase in the populations' living standards, as measured by increased per capita GDP, which results in an expanded diet to include higher-value foods. As a consequence of these trends, the average per capita rice consumption in food fell from 139 kg/year in 2000 to 137 kg/year in 2014, with the per capita, non-rice, food items estimated to account for an additional 24 kg/year in 2000, rising to 37 kg/year in 2014, bringing the estimated total per capita consumption of both rice and non-rice staples from 163 kg/year in 2000 to 174 kg/year in 2014 (Table 3.7).

3.3.1 Cambodia Rice Consumption

The Civil War severely disrupted Cambodia's rice consumption in its early years with its average per capita rice consumption decreasing from 200 kg/year in the

early 1960s to 160 kg/year in 1980. The 1980–2000 period saw a gradual increase in the country's rice consumption to a total of 2.5 million tons in 2000, representing a return to its earlier level of 200 kg/year. After the millennium, the country's total rice consumption continued to accelerate growing at an average annual rate of 7.0%, a significantly higher average rate of growth than the average 1.6% per year shown for the population as a whole during the same period. As a result of the faster growth, the average per capita total rice consumption increased from 200 kg/year in 2000 to 413 kg/year in 2014.

While the country's total consumption of rice continued to increase during the period, the data shows that the importance of rice consumption for food decreased from 83% of the total rice consumption in 2000 to 39% of the total in 2014. The percentage decrease in food consumption stems from both an overall increase in the population's rising standard of living during the period, as measured by a threefold increase in the average per capita GDP, leading to the increased use of higher-value-added foods, as well as the steady migration of the rural population to urban centers, for economic advantage and increased consumption of non-rice "fast-food" items. As a consequence of these changes, the country's average per capita food rice consumption fell from 168 kg/year in 2000 to 161 kg/year in 2014, while the average per capita food consumption of all staples increased from an estimated 188 kg/year in 2000 to 200 kg/year in 2014 (Table 3.8).

Table 3.8 Cambodia's total milled rice consumption, rice consumption in food, and total staple consumption in food in 2000–2014 (unit: thousand tons (rounded))

	2000	2014	AAGR 2000–2014
Total rice consumption	2461	6325	7.0
Rice food consumption	2046	2468	1.3
Rice food as % of rice consumption	83	39	(0.6)
Other staple food consumption[a]	248	616	6.7
Total staple food consumption	2294	3084	2.1
Per capita food consumption (all staples) (kg/year)	188	202	0.5
Per capita rice food consumption (kg/year)	168	161	(0.3)
Rice as % of total food staples	89	80	(0.1)
Population			
Population (millions)	12.2	15.3	1.6
Rural population (millions)	10.0	12.2	
As % of total population	82	80	
Gross domestic product			
GDP ($US, billions)	3.7	16.7	
Per capita GDP ($US)	299	1095	

Source: World Rice Statistics – FAOSTAT, Food supply IRRI, World Bank, and World Development Indicators (2015)
[a]Partly estimated

3.3.2 *Laos Rice Consumption*

In the 1960s, 1970s, and 1980s, Laos total rice consumption depended heavily on imports to provide the population with an average per capita rice consumption in the 215–220 kg/year range. It was not until the end of the 1990s and into the millennium that the country became self-sufficient in rice, except for some small imports designed to balance rice consumption between the northern and southern provinces. Between 2000 and 2014, total rice consumption grew at an average annual rate of 3.0%, sharply higher than the 1.6% average annual population growth, with the result that average per capita rice consumption during the period grew from 257 kg/year in 2000 to 312 kg/year in 2014 (Table 3.9).

It was during this period, 2000–2014, that the population's consumption of rice for food began to change. During the decades prior to the millennium, rice consumption for food accounted for 75–80% of total rice consumption, but beginning in the late 1990s, the percentage consumed in food gradually decreased to 63% in 2000 and to 53% of the total in 2014. This trend is a result of both an overall general increase in the population's average standard of living, as measured by a fivefold increase in the country's per capita GDP, which resulted in an increased consumption of higher-value non-rice foods, and also, the observed migration of rural populations to urban centers, from an average 79% of the total population in 2000 to 64% in 2014, has resulted in their increased exposure to fast-food menus

Table 3.9 Laos total milled rice consumption, rice consumption in food, and total staple consumption in food in 2000–2014 (unit: thousand tons (rounded))

	2000	2014	AAGR 2000–2014
Total rice consumption	1373	2090	3.0
Rice food consumption	860	1110	1.8
Rice food as % of rice consumption	63	53	(1.2)
Other staple food consumption[a]	178	360	5.1
Total staple food consumption	1038	1470	2.5
Per capita food consumption (all staples) (kg/year)	194	220	0.9
Per capita rice food consumption (kg/year)	161	166	0.2
Rice as % of total food staples	83	76	(0.6)
Population			
Population (millions)	5.3	6.7	1.6
Rural population (millions)	4.2	4.3	0.2
As % of total population	79	64	(1.5)
Gross domestic product			
GDP ($US, billions)	1.7	11.9	14.9
Per capita GDP ($US)	324	1794	13.0

Source: World Rice Statistics – FAOSTAT, Food supply IRRI
World Bank, and World Development Indicators (2015)
[a]Partly estimated

of non-rice staples. As a result of these trends, the data show an increased consumption of non-rice staples, with the overall percentage of rice consumption in food decreasing from 83% in 2000 to 76% in 2014.

3.3.3 Thailand Rice Consumption

Thailand, the most economically developed of the four countries in the region, achieved self-sufficiency of rice supply in the 1950s. During the 1960s and 1970s, the country's rice consumption grew at an overall average annual rate of 2.6% (1961–1980) compared to the average annual population growth during the same period of 2.8%. This slower rate of growth for rice consumption continued during the 1980–2000 period at an annual average rate of 1.1% compared to 1.4% for the population as a whole. As a consequence of the country's trend to increased industrialization, the average per capita total rice consumption fell from 184 kg/year (1961) to 178 kg/year (1980) to an average of 140–145 kg/year (1990) before recovering to 166 kg/year in 2000. During the 2000–2014 period, total rice consumption grew at an average annual rate of 2.0% compared to the average annual population growth of 0.6%, resulting in an increased average per capita rice consumption in 2014 of 200 kg/year (Table 3.10).

Table 3.10 Thailand's total milled rice consumption, rice consumption in food, and total staple consumption in food in 2000–2014 (unit: thousand tons (rounded))

	2000	2014	AAGR 2000–2014
Total rice consumption	10,437	13,750	2.0
Rice food consumption	7308	7700	0.4
Rice food as % of rice consumption	70	56	(1.6)
Other staple food consumption[a]	1945	2610	2.1
Total staple food consumption	9253	10,310	0.8
Per capita food consumption (all staples) (kg/year)	148	152	0.2
Per capita rice food consumption (kg/year)	116	113	(0.2)
Rice as % of total food staples	79	74	(0.5)
Population			
Population (millions)	62.7	67.8	0.6
Rural population (millions)	42.8	34.2	(1.6)
As % of total population	68	51	(2.0)
Gross domestic product			
GDP ($US, billions)	122.7	404.8	8.9
Per capita GDP ($US)	2016	5977	8.1

Source: World Rice Statistics – FAOSTAT, Food supply IRRI
World Bank, and World Development Indicators (2015)
[a]Partly estimated

It was during the late 1970s and early 1980s that the average per capita rice consumption for food declined from 137 kg/year in 1980 to 116 kg/year in 2000, as the population's consumption of non-rice staples changed as a result of two factors: the increasing affluence of the population, as measured by a tripling of the country's average per capita GDP, encouraged the increased consumption of higher-value non-rice dietary products and, also, the continued steady decrease of the rural populations, from 68% of the total population in 2000 to 51% in 2014, as a result of its continued migration to urban centers where fast-food menus emphasize non-rice staples. By 2014, per capita food rice consumption had declined to 113 kg/year and accounted for only 74% of the estimated total per capita staple consumption of 152 kg/year.

3.3.4 Vietnam Rice Consumption

Vietnam is also more economically developed than Laos and Cambodia although less so than Thailand. During the period 1961–1980, the country's total rice consumption increased at an annual average rate of 1.9%, compared to the average population annual growth of 2.5%, with the result that average per capita total rice consumption during the period fell from 173 kg/year to 153 kg/year. During the late 1980s, the country achieved self-sufficiency in rice, and total rice consumption increased during the 1980–2000 period at an average annual rate of 3.8%, while average population growth slowed to 1.9%, and the average per capita total rice consumption increased from 153 kg/year in 1980 to 221 kg/year in 2000 (Table 3.11).

Although there was an overall increase in the per capita rice consumption during the 1980–2000 period, the consumption of rice for food decreased from an average of 85% of the total in 1980 to 68% in 2000, as a result of the population's increasing consumption of non-rice staples. Prior to the millennium, the data shows a continuing steady rural population migration from a rural to an urban environment for economic advantage, and this trend continued during the 2000–2014 period, with the rural population accounting for 76% of the total population in 2000 and 67% in 2014. As a result of this migration, the urban setting offered greater exposure to non-rice "fast-food" menus with a corresponding reduction in rice consumption.

The other trend away from food rice consumption is the increasing standard of living by the population, as measured by the 400% increase in the average per capita GDP, which opened up a greater diversity of non-rice foods. As a result of both of these trends to increased consumption of non-rice staples, average per capita rice consumption for food fell from 150 kg/year in 2000 to 144 kg/year in 2014, while the consumption of non-rice staples for food increased from an estimated average of 20 kg/year in 2000 to 31 kg/year in 2014, resulting in an estimated total average per capita consumption of all staples in food at 170 kg/year in 2000 and increasing to 175 kg/year in 2014.

Table 3.11 Vietnam's total milled rice consumption, rice consumption in food, and total staple consumption in food in 2000–2014 (unit: millions tons (rounded))

	2000	2014	AAGR 2000–2014
Total rice consumption	17,768	21,460	1.4
Rice food consumption	12,084	13,300	0.7
Rice food as % of rice consumption	68	62	(0.6)
Other staple food consumption[a]	1617	2955	4.4
Total staple food consumption	13,701	16,255	1.2
Per capita food consumption (all staples) (kg/year)	170	175	0.2
Per capita rice food consumption (kg/year)	150	144	(0.3)
Rice as % of total food staples	88	82	(0.5)
Population			
Population (millions)	80.3	92.4	1.0
Rural population (millions)	61.2	62.1	0.1
As % of total population	76	67	(0.9)
Gross domestic product			
GDP ($US, billions)	33.6	186.2	32.5
Per capita GDP ($US)	433	2052	11.7

Source: World Rice Statistics – FAOSTAT, Food supply IRRI
World Bank, and World Development Indicators (2015)
[a]Partly estimated

3.4 Conclusion

During the period 2000–2014, total paddy rice production in the four MSEA countries increased from 64.6 million tons in 2000 to 90.9 million tons in 2014, growing at an average rate of 2.2% per year. Production of milled rice equivalent grew from 43.1 million tons to 60.1 million during the same period. Three major factors contributed to this achievement:

1. An incremental expansion of the total harvested area from 20.1 million ha in 2000 to a total of 22.7 million ha in 2014, growing at an average rate of 0.8% per year.
2. Higher rice paddy yields reaching a total combined average of 4.0 tons/ha in 2014, a 25% increase over the 3.2 tons/ha in 2000. Increasing use of mechanized agricultural practices, new and improved rice varieties, and controlled fertilizers and pesticides were the main reasons for the improved yields.
3. Increased irrigation programs for the total agricultural area from the 9.8 million ha in 2000 to 11.7 in 2014. Irrigated areas continue to represent 28% of the total agricultural area.

Consumption of milled rice in the region increased from 32.0 million tons in 2000 to 43.6 million tons in 2014, growing at an average rate of 2.2% per year, with the result that there was an overall regional surplus of 11.1 million tons of milled

rice in 2000, increasing to 16.5 million tons in 2014. Per capita rice consumption increased from 199 kg/year to 243 kg/year, growing at an average annual rate of 1.3% during the same period. However, the consumption of rice for "food use" decreased from 70% of total rice consumption in 2000 to 56% in 2014, showing, both, increased rice use in non-food applications, as well as the continuing replacement of rice as a food staple in the four countries. As populations migrate from rural areas to urban centers for job opportunities, the "fast-food" availability of higher value non-rice staples such as wheat and maize encourages the trend away from food rice consumption. In addition, the increased affluence of populations, as measured by the average threefold per capita GDP increase, has also encouraged greater consumption of higher value-added foods.

The future rice development of the four countries is difficult to generalize and forecast because each country has its own rice production policies and faces different challenges in the coming decades. Vietnam's performance of rice production varied according to land management and reforms. In December 2009, the government issued Resolution No. 63/NQ-CP requiring that by 2020, 3.8 million hectares of land must be reserved for rice cultivation to ensure an annual paddy production of 41–43 million tons (Tran Cong Thang, Food security policies in Vietnam). The country's biggest challenge is restricted paddy land which does not allow cultivation of quality and brand rice crop.

Thailand's economy is driven by export, and the goal is "to maintain the lead in world-class rice export of Thailand." Indeed, Thai Hom Mali or jasmine rice is well recognized for its high quality; however, it also has many disadvantages, such as one crop per year, low yield, and high price. It will be difficult to increase the yield of quality rice that is targeted for exports and foreign currencies when the country gives high priority to modernization, industrialization, and urbanization. Thailand will face many challenges in maintaining its status as a major rice producer in the new millennium.

Laos achieved overall self-sufficiency in rice in the 1980s except for the northern region where limited production creates a rice deficit that is met by targeted imports. In addition, unlike its neighboring nations, Laos has not pursued the goal of using rice production as a commodity for export and socio-economic development. In this regard, electrical power generated by the Mekong tributary dams represents the single most important element of the country's exports and the largest source of foreign exchange earnings. Moreover, it is worth noting that the targets of the Seventh Five-Year Socio-Economic Development Plan (2011–2015) assigned to the GDP 2015 the lowest percentage of 23% to agriculture, 39% to industry, and 38% to service. This raises the issue of rice sustainable growth in Laos in the future.

Among the four countries, Cambodia has the greatest potential to expand its unexplored or unused arable land and its rice productivity. The country's improvement of rice production would require more investments in infrastructure, costs of production, and worker's training. Cambodia has rich natural resources (the Tonle Sap basin, the Mekong River, and its tributaries) and a sizable agricultural

workforce (65% of the total labor force) that could develop its rice economy to achieve its full potential and to be competitive with Thailand and Vietnam in the twenty-first century.

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Chapter 4
Rice Trade of the Mainland Southeast Asian Countries: Cambodia, Laos, Thailand, and Vietnam

Abstract Rice is a staple crop providing food self-sufficiency and security to more than 182 millions of people in the Mainland Southeast Asia (MSEA) countries of Cambodia, Laos, Thailand, and Vietnam. It is also an important commodity for domestic and international trade. As an economic commodity, rice plays a major role in international trade by bringing foreign currency revenues to rice exporting countries and food supply to meet the demand of rice deficit nations. As a political commodity, rice has been used to influence the market price artificially and create social, economic, and political instability, such as the global rice crisis in 2008.

The purpose of this chapter is to examine the rice trade opportunities and challenges for the MSEA countries. The chapter is divided into six main sections. The first three sections deal with Thailand, Vietnam, and Cambodia, three major rice exporters: backgrounds of their rice exports (1855–1999); their rice exports policies in the new millennium; and their rice export performances. The fourth section focuses on rice trade balance of the four MSEA countries, their competition, and their importing countries. The fifth section discusses rice cross border trade of the MSEA countries. The last section reviews the proposals of rice regional cooperation, or rice cartels, initiated by Thailand and Cambodia, and explains the reasons for their failures.

Keywords Cambodia • Thailand • Vietnam • Backgrounds of rice exports • Rice exports policies in the new millennium • Rice export performance • Laos • Rice trade • Competition, and their importing countries • Laos national export strategy • Global rice crisis 2008 • Rice cross border trade • Rice regional cooperation proposals • Rice cartels

4.1 Background of Rice Exports of Thailand, Vietnam, and Cambodia 1855–1999

Thailand, Vietnam, and Cambodia have a long history of international trade and rice export dating back in the mid-1850s, when European powers extended their power and rule into the Southeast Asia region, specifically with the British expansion into Burma and French advance into Indochina. Great Britain exerted pressure on Thailand to liberalize trade, and France opened the port of Saigon and developed

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its colonies and protectorates in now Vietnam and Cambodia for natural resources and major exports, particularly rice and rubber.

In contrast, French colonial rule in Laos had no interest in the country's agricultural products partly because a scientific and economic expedition on the Mekong River in 1866 found that the river was not navigable for half of the year, frequent floods inundated the plains of the Mekong River, and the mountainous terrain was not conducive to crops plantation. Unlike the Mekong Delta in Vietnam and the Tonle Sap in Cambodia that were rice-producing areas, landlocked Laos has been a rice importing country during the last two centuries.

4.1.1 Thailand

Thailand's rice export can be traced to the Treaty of Friendship and Commerce, commonly known as the Bowring Treaty, which King Mongkut of Siam and Sir John Bowring of Great Britain signed in April 1855. The treaty took effect on April 6, 1856 and introduced a most liberal trade system that lasted until the end of World War II. The treaty allowed British and Siamese merchants freedom to trade with each other "without the interference, in either case, of any other person." The treaty eliminated state-trading monopolies and removed prohibitions on rice exports.

After the end of World War II, the old free trade system ended when Thailand proclaimed a new Rice Trading Act in 1946 which gave the government control over the rice trade industry (Ammar Siamwalla 1999). The Trading Act of 1946 established a committee with the powers to:

> determine the price of rice and prohibit the sale at a price exceeding such price; determine the price of rice and prohibit the purchase from a farmer at a price lower than such price; and give an order requiring any person who has rice in possession to sell it to any person at the price and in the quantities prescribed by the Committee, or in the case where the Committee's order is resisted, give an order requiring the competent official to seize and compulsorily purchase the rice at the price and in the quantities as prescribed by the Committee, and to prescribe the period and conditions for the payment of the price and for the delivery thereof. (Section 8 of the Act).

Thus, the Trading Act of 1946 ended the free trade system and opened a new era of government intervention in the rice trade. Rice continued to be export oriented, and Thailand was recognized as the world's top rice exporter in 1964 with a shipment volume of 1.9 million tons. In the 1980s, Thailand introduced a major paddy intervention program which allowed rice farmers to pledge paddy as collateral for loans if they wanted to delay selling their crops during the harvesting season (Nipon Poapongsakorn 2010). Assistance to exporters was in the form of subsidized credits. In 2000, 20,000 million *baht* (US$ 487 million) were earmarked for that purpose through an "Export Support Fund" operated by the EXIM Bank. In that same year, exporters were requested to purchase one million tons of domestic rice at the prevailing market prices and to keep them in storage pending a price recovery. In exchange, the government provided interest-free credit to back the purchases and

cover the storage costs (FAO review of policies 2001). By the end of the twentieth century, Thailand's export volume amounted to 6.8 million tons or about 28% of the world's total rice export estimated at 25.1 million tons (World Rice Statistics, IRRI, FAO).

4.1.2 Vietnam

The Vietnamese rice export also started in the nineteenth century shortly after France seized Saigon in 1859 and occupied Cochinchina (now the Mekong Delta region) in 1867 (Brocheux 1995). In 1860 France opened the port of Saigon for foreign trade and granted freedom to export rice, which had been prohibited by Emperor Tu Duc of Vietnam. Rice exports reached 229,000 tons annually in 1870, and taxes extracted from Cochinchina increased tenfold in the first decade of French control (Vietnam 1989, Country Study). Under a special law of January 1892, customs duties on Vietnamese exports to France were reduced, then removed, and replaced in 1928 by a tariff law which established a system of free trade within the French Empire. By 1938 Cochinchina, the only rice-exporting region of country, exported over 1 million tons a year (South Vietnam 1967, Area Handbook). After War World II through reunification of the country in 1975, Vietnam's rice exports were insignificant due to devastations of the two Indochina wars.

Post-1975, the Vietnamese Communist Party in an effort to unify the economic system of the entire country under communism adopted a policy of crackdowns and controls on the free market, particularly in the southern part of the country. The 1980s marked the beginning of "economic renovation" or free market socialist economy that gave highest priority to agriculture, food production, and export commodities. Vietnam started to export rice in the world market in 1989 and established the Food Import-Export Association about 15 years after reunification.

Vietnam's major rice export policies included quotas, taxes, price support, export restriction, and subsidies. Starting in the early 1990s, Vietnam controlled rice export by using the quota policy to ensure food security and contain domestic prices. The government assigned rice export quotas to each licensed rice exporter, with 70% of quota to major state-owned enterprises (SOEs), Vietnam Northern Food Corporation or VINAFOOD1, and Vietnam Southern Food Corporation or VNAFOOD2. To manage the country's export rice, a steering committee was established in February 1999 under Decision 20/1999/QD-TTg of the Prime Minister. Among many tasks, the steering committee monitored the contract signing and delivery schedules on the basis of the national quotas as approved by the Prime Minister. After a decade of implementation, the government ended the quota system because it limited potential rice production and export and farmers' income, provided unfair competition with big SOEs, and created problems in international trade negotiations.

4.1.3 Cambodia

Cambodia's rice export began four decades after France had established its protectorate in 1863. In the early 1900s, the French started to develop Cambodia's agricultural economy for international trade. Under the colonial rule, rice was among crops for production and export, and the fertile provinces of Battambang and Siemreap became the rice baskets of Indochina. Rice exports were carried through the port of Saigon. Cambodia gained independence in 1953 and became an important rice exporter in the 1960s with an average of 263,000 tons per year. The following period 1970–1985 was marked by political conflicts and wars which had a devastating effect on the economy and halted rice export until the late 1990s (Cambodia 1990, Country Study). Cambodia resumed its rice export with a shipment of 5625 tons in 1996 and 3439 tons in 1999, according to FAO statistics of rice exports 1961–2012.

Thus in 1999, Thailand, Vietnam, and Cambodia together accounted for a total rice export estimated at 11.3 million tons or 45% of the global rice trade of 25.1 million tons (FAOSTAT, WRS). Most of the rice export came from the Khorat Plateau in northeast Thailand and the Mekong Delta in Vietnam. In the last decade of the twentieth century, Thailand and Vietnam dominated the global rice export and earned the status of the world's first and second rice exporters, respectively.

4.2 Rice Export Policies of Thailand, Vietnam, and Cambodia in the New Millennium

In the new millennium, the MSEA countries' rice export policies have been characterized as interventionist giving the government the powers to issue rice export goals, prices, bans, restrictions, and/or cancelations. Government intervention in rice trade includes export taxes, quotas, and subsidies. This section will review the MSEA countries' rice policies, their responses to the global rice crisis in 2007–2008, and the rice market.

4.2.1 Thailand

In the twenty-first century, between 2001 and 2014, successive Thai governments issued several intervention policies in the forms of rice-pledging schemes or rice price support programs to gain the support of farmers and influence the domestic and world market prices. The following sections will describe two new paddy pledging programs, similar to the pledging program introduced during the 1980s, and also one income guarantee program that had profound consequences for the rice market and Thailand's leading role in global rice trade.

The first of the most recent paddy pledge programs was introduced in February 2001 by the newly elected government of Mr.Thaksin Shinawatra. The policy allowed farmers to pledge their paddy which served as a collateral to obtain government loans at a low interest rate. The farmers had 90 days to redeem their pledged paddy and repay their loan at 3% interest rate if the market price was higher than the pledging price or forfeit the collateral if the market price was lower than the pledge price. In 2001/2002, the government set the support price at the same level with the market price. But in 2004/2005 and 2005/2006, the government increased the pledge price to 30% higher than the market price, which resulted in increasing the volume of pledged paddy to 37% of paddy production. The policy influenced the domestic retail sale and export in world market and caused trade problems. First, rice exporters were affected by the high pledging rice prices and lost their competitive edge in the global rice market. Second, rice importing countries waited for cheaper rice from other exporting countries to import, which led to distortions in the market place. Third, the fixed and predetermined pledging prices did not give Thailand flexibility to respond to market prices. In the end, the program was suspended in 2006 because it ended up with very large rice procurements and became too costly for the government (Nipon Poapongsakorn 2014 IRRI, FAO, WB).

In January 2008, when the global rice prices surged, the new government of Mr. Samak Sundaravej (January–September 2008) had no rice export policy and took no measures to impose rice export restriction. It reintroduced the rice-pledging program and set a high price of 14,000 baht per ton for 2008 dry season paddy, which resulted in a record 3.98 million tons of pledged paddy. The next government of Mr. Somchai Wongsawat (September 2008–December 2008) reduced the pledging price to 12,000 baht per ton for the 2008–2009 wet season, which brought in 4.55 million tons of paddy pledged, the largest volume in 3 years (FAO 2010, *The Rice Crisis*: *Markets*, *Policies and Food Security*, edited by David Dawe).

A new support program which provided income guarantee for farmers without government intervention in rice trading, milling, or storage was announced in October 2009 by the Abhisit Vejjajiva government (December 17, 2008–August 5, 2011). The policy stipulated that each farm household could insure up to 20 tons of paddy rice and the government would give a guarantee price, which was 10,000 baht per ton of paddy white rice, and 15,300 baht per ton of fragrant rice in 2009. If the market price during the harvesting season was lower than the guarantee price, the farmer would receive the difference as compensation directly from the Bank of Agriculture and Agricultural Cooperatives (BAAC) (Nipon Poapongsakorn, Nov 2010). Unlike the paddy pledging policy, the farmers were guaranteed a minimum income even when they could not deliver their crops because of diseases or natural disasters. The income guarantee for farmers had little impact on the rice market because the subsidy went directly to the farm household and not to the trader. The policy did not distort the marketing mechanism and did not subsidize export (ADB 2012).

In October 2011, the newly elected Prime Minister Yingluck Shinawatra (August 5, 2011–May 7, 2014) implemented a new paddy pledge program that allowed Thai farmers to pledge an unlimited supply of their rice crops to the government which guaranteed them a higher price than the market price,

specifically 15,000 baht per ton for paddy white rice and 20,000 baht per ton for Hom Mali jasmine rice, estimated at 50 and 30% above the prevailing market price. Unlike previous support programs, the new paddy pledge policy set very high guarantee prices and no limit on government purchases. Farmers could bring their paddy to the designated rice mills and receive cash loans from the Bank of Agriculture and Agricultural Cooperatives. They had 4 months to redeem their pledged paddy amount and repay their interest-free loan or forfeit the paddy rice and keep the cash. The new program was "the largest agricultural intervention in modern Thai history" (Nipon Poapongsakorn 2014).

The major purposes of this latest pledged program were to increase farmers' income, regulate the supply of rice, and raise the export prices of Thai rice. To achieve this goal, the government plan was to withdraw export and a large amount of rice supply from the global market which then would drive up the international export prices and give Thailand a good profit. The government miscalculations and international events led to a decline, not an increase, of world rice prices.

However, in a move that was not anticipated, in September 2011, shortly after Prime Minister Yingluck Shinawatra announced the new paddy pledge scheme, India lifted its rice export ban, due to a bumper harvest, and soon Vietnam started to lower its prices to compete with Indian rice. Thailand was unable to meet the lower international prices and its exports dropped from 10.6 million ton in 2011 to 6.7 million tons in 2012 and 6.6 million tons in 2013. Since 2012, Thailand lost its status as the world's top rice exporter for the first time in three decades to India. The paddy pledge program was terminated in May 2014, when the Army declared martial law and took over the government. On August 21, 2014, General Prayut Chan-o-cha was elected Prime Minister.

On May 20, 2015, the new Prime Minister General Prayut Chan-o-cha presided over the opening conference of Thailand Rice Convention 2015 and delivered a keynote speech on "Strategy on Rice Marketing and Thailand's Rice Trade Policy" (Thailand Rice Convention 2015). The Prime Minister declared that his fundamental goal was not only for Thailand to become the world's top rice exporter in terms of volume and value but also to develop Thai rice in a sustainable and fundamental manner to strengthen farmers' livelihood and self-sustainability within the fair market and efficient trade system. To achieve this goal, the Prime Minister announced that his government had developed policies strategies for rice market and trade policy. The seven strategies on rice are set as follows:

1. Sustainable and stable rice development plan
2. Creation of fairness in rice trade system
3. Promotion and implementation of rice production and trade at a standard level
4. Capacity enhancement of rice trade system
5. Promotion of rice consumption value
6. Creation of innovation
7. Capacity enhancement of logistics management

4.2.2 Vietnam

After decades of wars and food shortages, Vietnam has considered rice production first and foremost as food security and national interest and not an export commodity for foreign exchange revenues for economic development. Vietnam joined the World Trade Organization only in 2007, much later than Thailand in 1995 and Cambodia in 2004. Lastly, the Mekong Delta accounts for 90% of the country's export because it is the only region that has rice surplus every year. The following sections will examine Vietnam's rice export policies that aimed at protecting food security in the domestic market and promoting export in the world market.

Vietnam, under the communist leadership, has total control of rice export, which follows a complicated and bureaucratic procedure. The government sets a national target of rice export each year, assigns how many tons of rice to each licensed exporting company, monitors and revises rice export targets during the year, and suspends rice exports when the goal has been reached. The institutions in charge of rice export include the Office of Prime Minister, the Ministry of Agriculture and Rural Development (MARD), the Ministry of Industry of Trade (MIT), the Ministry of Finance, and the Vietnam Food Association (VFA).

In May 2001, the government issued Decision No. 46/2001/QD-TTg for a new Export-Import Management Mechanism for 2001–2005 that removed quantitative limits on exports and allowed all economic agents holding agricultural commodity trade licenses to engage in rice exports. Provisions were made to ensure that state-trading enterprises would remain responsible to negotiate export deals with the most important trade partners. The government provided export subsidies and credit assistance to promote export. In 2005 Vietnam achieved a record export volume of 5.2 million tons, according to GSO (FAO Reviews of Basic Food Policies, 2003).

The year 2008 saw Vietnam's intervention in rice trade in many ways. First, the government changed its export target to 3.5–4 million tons from 4.5–5 million tons for the year. Second, in response to the global rice crisis, Vietnam adopted a policy of rice export restriction, curtailing exports in March and April and banning the signing of new contracts in May–June. The government explained that the main goals of the export restriction policy were to ensure national food security, stabilize domestic prices and consumption, and bring inflation rate to about 9%, down from 12.6% in 2007. Third, on July 21, 2008, the Prime Minister issued Decision No. 104/2008/QD-TTg promulgating specific export tax rates for exported rice, ranging from a minimum VND500,000/ton for an export price valued at US$600/ton to a maximum VND2.9 million/ton for export prices exceeding US$1300/ton. The tax had no or little impact because export prices were mostly below the taxable level.

In January 2009, the tax policy was canceled by the Prime Minister's Decisions No. 16/2009/QD-TTg. Also, all export restrictions were lifted in June in 2009. To ensure national food security, the government issued Resolution No. 63/NQ-CP, on December 23, 2009, that states that by 2020, 3.8 million hectares of land must be

reserved for rice cultivation to ensure a paddy production of 41–43 million tons and a volume of milled rice export of 4 million tons a year (Tran Cong Thang 2014).

Vietnam also used price controls policy by enacting Circular 122 on August 12, 2010, which became effective on October 1, 2010. It introduced three price control mechanisms by the government: price declaration; registration of the applicable prices; and price stabilization. These price control measures were applicable to all private enterprises producing, importing, distributing, and/or selling certain goods, including rice and chemical fertilizers, in Vietnam.

(Ministry of Finance, August 12, 2010, Circular No. 122/2010/TT-BTC).

To improve the management of rice export and exporters, the government issued Decree109/ND/2010 in November 2010 which entered into force in January 2011. To conduct rice export business, rice-exporting enterprises must meet the following conditions contained in the Decree. One, they must own a 5000-ton specialized storage at least. Two, they must own a milling factory of 10 tons/hour at least in a province or city having paddy export. Three, they must maintain a minimum volume of reserves equivalent to 10% of rice exports of 6 months before. The purpose of the Decree is to eliminate the small exporting enterprises that cannot meet the requirements of storage and milling and empower the existing big companies to compete in world markets (Tran Cong Thang, Food security policies in Vietnam). These companies belong to the VFA, a trade agency that approves rice export contracts and implements the government's policies, decisions, and instructions. As of March 16, 2016, the VFA has 137 members and 13 associate members; the two largest rice exporters are VINAFOOD1 and VINAFOOD2.

4.2.3 Cambodia

Cambodia did not have a formal rice export policy until 2010. During the first decade of the new millennium, the official export of milled rice was very small due to lack of processing capability, insufficient storage capacity, no credit assistance and capital, and poor infrastructure. On the other hand, the unofficial, cross-border trade of paddy and milled rice with Vietnam and Thailand was much bigger than Cambodia's rice exports to overseas markets because of the government's lack of capital and credit assistance to purchase the crops from farmers. In sum, Cambodia had no rice trade policy other than elimination of all barriers to rice exports, whether they were paddy rice or milled rice during this period 2000–2009. The exception was a temporary ban on rice exports imposed by the government on March 27, 2008 in response to the global rice crisis. The ban was lifted on May 30, 2008 (RFA, 2008-05-30).

Cambodia issued its rice export policy in the "Policy Paper on The Promotion of Paddy Production and Rice Export" that was approved by the Council of Ministers on July 25, 2010. According to the policy document, the government's vision is to transform the country into a "rice basket" and an important exporting nation in the

international rice market. The policy aimed at producing paddy rice surplus of more than 4 million tons and achieving milled rice export of at least 1 million tons by the target year 2015.

The key principles for implementing this policy are:

- Adopt market principles by encouraging competition to effectively increase export.
- Encourage and support participation of farmers and their organizations to protect their interests.
- Promote cooperation and partnership between the Royal Government and the development partners, civil society, and private sector.
- Enhance efficiency in coordination between ministries/agencies to improve public service delivery related to rice production and export promotion.
- Promote domestic capacity building to export rice directly from Cambodia by encouraging companies to set up offices and export rice officially and meet taxes and other obligations.

For the short and immediate term, to promote export of milled rice, the policy takes a new approach of shifting from the informal export of paddy rice to a formal export of milled rice. For the medium and long term, the focus is to improve competitiveness in rice export through production technology, soil fertility, water management, rice processing quality, physical infrastructure, credit assistance, and exploring market opportunities.

The implementation of the policy involved full participation of all government ministries and agencies and other stakeholders, including the private sector, development partners, and farmers. In February 2012, some 100 rice exporters and millers launched a Cambodian Rice Exporters Association (CREA) in a bid to boost rice export and achieve the export target of 1 million ton of milled rice by 2015. Two years later, in May 2014, the Cambodia Rice Federation (CRF) was founded by 213 members representing the rice exporter federations, farmer federations, rice miller associations, rice exporter companies, and logistics companies. It was recognized by the government as a sole partnership for policy discussion and representative of Cambodian rice sector at international stage and also an institution to develop the event to promote rice in domestic and international stage. The federation has an operating budget of $700,000 for 2 years ending May 2016, which is covered by a one-time Ministry of Economy and Finance allocation, membership fees, and from contributions by its 17 board members. Additionally, the federation collects $1 per ton of fragrant rice exported and $0.50 per ton on white rice from its members.

Since the promulgation of the Policy Paper on the Promotion of Paddy Production and Rice Export, Cambodia has realized one the policy's goals which is to ensure that Cambodian rice be recognized internationally. Indeed, Cambodian rice won the World's Best Rice Award in 2012 in Bali, Indonesia, in 2013 in Hong Kong, and 2014 in Phnom Penh with cowinner Thailand.

4.3 Performance of Rice Exports of Thailand, Vietnam, and Cambodia in 2000–2014

This section first analyzes the rice export performance of Cambodia, Thailand, and Vietnam and their share of world rice export during the period 2000–2014. Secondly, the section looks into the relationship between rice export and milled rice production in the three countries during the period under review.

Our analysis of these three countries' rice export volume in the new millennium is based on latest and available data from the Thai Rice Exporters Association (TREA), Vietnam Food Association (VFA), Cambodian Rice Federation (CRF), World Rice Statistics (WRS), and Food and Agricultural Organization (FAO). Statistics on rice trade, like those on rice production, vary depending on sources and are difficult to reconcile and not always complete. For example, there are significant differences between the data provided by the FAO, the USDA, and the governmental agencies and ministries.

On the other hand, the websites of the three associations of rice exporters (TREA, VFA, CRF) provide monthly and annual data of rice shipments, although they are not always accurate or updated. None of the data has included border trade which was significant in the case of Vietnam's export to China. In addition, Cambodia's rice exports to Thailand and Vietnam sometimes included paddy rice for processing and milling, in which case paddy rice and milled rice was used interchangeable. In spite of these deficiencies and qualifications, we found the data of the TREA, VFA, and CRF reliable and useful for our limited analysis of rice export quantity performance of these MSEA countries in the new millennium.

4.3.1 Rice Export Relative to World Rice Export 2000–2014

In the first 14 years of the new millennium, the global rice export doubled its volume from 23.3 million tons in 2000 to 45.6 million tons in 2014, growing at an average annual rate of 4.9% according to the latest available data from WRS, IRRI, and FAO. During the same period, Thailand, Vietnam, and Cambodia combined rice exports increased by 80%, from 9.9 million tons to 17.6 million tons, growing at an average annual rate of 4.2%. On the other hand, their share of rice export relative to global rice export decreased from 43% in 2000 to 39% in 2014, as indicated in Table 4.1.

The first decade of the twenty-first century was marked by the world rice crisis in 2008 and the global financial crisis in 2009 which caused the world rice export volume to decline for the first time since 2000. The world rice export volume decreased by 3.5 million tons to about 30.0 million tons in 2008 and 2009. In comparison, the MSEA countries combined export volume increased by 4.5 million tons to about 14.5 million tons in those 2 years, accounting for nearly 50% of the

Table 4.1 Rice exports of Thailand, Vietnam, and Cambodia and percentages of world rice export, 2000–2014 (unit: 000 tons, (numbers rounded))

Year	World	Thailand		Vietnam		Cambodia		Total MSEAs	
	export	export	%	export	%	export	%	export	%
2000	23,395	6570	28	3390	15	6		9966	43
2001	26,555	7520	28	3530	13	7		11,057	41
2002	27,400	7196	26	3250	12	4		10,450	38
2003	27,829	7552	27	3920	14	2		11,474	41
2004	28,856	10,114	35	4060	14	5		14,179	49
2005	29,397	7276	24	5200	18	2		12,478	42
2006	30,651	7368	24	4690	15	5		12,063	39
2007	33,564	9497	28	4500	13	3		14,000	41
2008	30,086	9969	33	4697	16	6		14,672	49
2009	30,198	8523	28	6053	20	13		14,589	48
2010	33,618	9001	27	6754	20	105		15,860	47
2011	37,614	10,608	28	7105	19	202	1	17,915	48
2012	39,779	6734	17	7720	19	206	1	14,660	37
2013	37,127	6612	18	6681	18	379	1	13,672	37
2014	45,300	10,969	21	[a]6320	14	388	1	17,677	39
	AAGR 4.8%	AAGR 3.7%		AAGR 4.6%		AAGR 34.1%		AAGR 4.2%	

Source: World Exports: FAOSTAT, retrieved December 24, 2015; World Rice Statistics, IRRI, FAO

Thai Rice Exporters Association, updated October 11, 2013 and January 28, 2015 for export 2014

Vietnam Food Association, Yearly Export Statistics, updated January 6, 2014

[a]Data of 2014 rice export mentioned in an article by Viet Trade, a government agency

Cambodia Rice Exports Association, Exports 2009–2013; FAOSTAT for rice exports 1961–2012

Country exports percentages of world exports calculated by author

world rice export volume, a highest performance during the period 2000–2014 (Table 4.1)

In 2010 the world rice export recovered and continued to grow every year from 33.6 million tons to 45.3 million tons in 2014, due primarily to the greater contribution of exporting countries such as India, Pakistan, and Myanmar. India, the largest rice grower after China, after favorable weather and abundant harvest, doubled its rice shipments from 5 million tons in 2005 to 10.4 million tons in 2012, 10.5 million tons in 2013, and 11.5 million tons in 2014 [FAO]. As a result, the MSEA countries total share of the global rice export was reduced to 37% in 2012–2013 and 39% in 2014 from a near 50% in 2008–2009. The performances of Thailand and Vietnam were also the major factors causing this contraction in 2012–2014.

Except for the last 3 years of the period under review, Thailand consistently contributed about 30% of the world rice and earned the status of the world's first rice exporter. Thailand's rice export rose to 33% of the world rice export during the

world rice crisis in 2008, when many neighboring countries (China, India, and Vietnam) banned or restricted rice exports for keeping food security and inflation under control. Thailand's rice subsidy program combined with the worst drought in years caused the country to drop its rice export to around 6.7 million tons in 2012–2013 from 10.6 million tons in 2011, and although its shipments reached a record 11 million tons in 2014, the country lost its long-standing status as the world's top rice exporter to India for three consecutive years 2012, 2013, and 2014. Thailand's historic loss caused the country to drop to the third place in 2012, behind Vietnam.

Vietnam's rice export volume increased steadily from 3.3 million tons in 2000 to 4.6 million tons in 2008 and averaged 14% of the world rice export during the period 2000–2008. This share of the world rice export could have been higher had the country not banned exports during the 2008 world rice crisis for food security and inflation concerns. The following year Vietnam's rice export volume reached 6.0 million tons for the first time, and in 2012 it outperformed Thailand with an export volume of 7.7 million tons, Vietnam's highest export volume to date. However, this export growth could not be sustained in 2013–2014 which saw a drastic drop to around 6.3 million tons in 2014, not including its unofficial rice exports with China that was unaccounted for. This could be a turning point for Vietnam rice export which is facing new challenges, including competition in the global market, Cambodia's emerging rice export, cross-border trade with neighboring countries, and unofficial rice export to China, which were significant and will be discussed in the next section.

Cambodia, a rice exporter starting from a low base of 6400 tons in 2000, has doubled its rice export volume to 12,600 tons in 2009. Since the government issued its policy paper on rice export in 2010, the rice export has increased steadily every year from 105,300 tons in 2010 to 388,000 tons in 2014, representing about 1% of the world rice export. In 2015 Cambodia exported 538,396 tons and failed to achieve the policy target of 1 million tons of milled rice. The Prime Minister blamed this shortfall on lack of rice millers, warehousing, and capital as well as rising competition with neighboring countries (Khmer Times/Sok Chan, Thursday, December 10, 2015).

4.3.2 Rice Export Relative to Milled Rice Production

A review of statistics of the MSEA countries milled rice export volume and milled rice production during the period 2000–2014 points out that export volume grew at twice the rate of production, as shown in Table 4.2.

Thailand's rice export grew at an annual average of 3.7% compared to 1.7% for rice production. Likewise, Vietnam data show the growth of rice export at 4.6% doubled the growth of rice production at 2.3%. However, there is a difference between the two world's top rice exporters as to the percentage of rice export relative to rice production. Thailand did not show any pattern or trend between export and production, whereas Vietnam indicated a relative relationship between

Table 4.2 Rice export and percentage of rice export to milled rice production in Thailand, Vietnam, and Cambodia, in 2000–2014 (unit: 000 tons, (numbers rounded))

Year	Thailand			Vietnam			Cambodia		
	Export	Production	%	Export	Production	%	Export	Production	%
2000	6570	17,237	38	3390	21,697	16	6	2685	(1)
2001	7520	18,698	40	3530	21,416	16	7	2734	
2002	7196	18,670	39	3250	22,976	14	4	2549	
2003	7552	19,658	38	3920	23,057	17	2	3142	
2004	10,114	19,035	53	4060	24,111	17	5	2781	
2005	7276	20,204	36	5200	23,900	22	2	3992	
2006	7368	19,771	37	4690	23,911	20	5	4178	
2007	9497	21,410	44	4500	23,973	19	3	4486	
2008	9969	21,110	47	4697	25,832	18	6	4786	
2009	8523	21,421	40	6053	25,979	23	13	5059	
2010	9001	22,950	39	6754	26,683	25	105	5499	2
2011	10,608	24,097	44	7105	28,279	25	202	5855	3
2012	6734	24,991	27	7720	29,122	27	206	6196	3
2013	6612	24,053	27	6681	29,374	23	379	6254	6
2014	10,969	21,724	50	[a]6320	29,997	21	388	6209	6
Total	AAGR **3.7%**	AAGR **1.7%**	%	AAGR **4.6%**	AAGR **2.3%**	%	AAGR **34.1**	AAGR **6.2%**	%

Source: World Rice Statistics, production milled rice FAO
Thai Rice Exporters Association, updated October 11, 2013 and January 28, 2015 for export 2014
Vietnam Food Association, Yearly Export Statistics, updated January 6, 2014
[a]Data of 2014 rice export mentioned in an article by Viet Trade, a government agency
Cambodia Rice Exports Association, Exports 2009–2013; FAOSTAT for rice export 2000–2008
Total rice production, export, percentage calculated by author

the growth of export and production despite some fluctuations during the period under review. Starting at a very low base, Cambodia's rice export grew at an annual average of 34.1% compared to the growth of rice production at 6.2%.

Thailand was the world's top rice exporter (except in 2012, 2013, and 2014) but ranked the world's sixth rice producer among top Asian rice producers (China, India, Indonesia, Bangladesh, and Vietnam). The percentage of rice export of rice production has been the largest among the MSEA countries, from a lowest 27% in 2012 to a highest 53% in 2004. As indicated in Table 4.2, there was no causal relationship between the volume of rice export and the milled rice production. For example, the percentage of rice export to production was 38% in 2000 but dropped to 36% in 2005, whereas rice production increased from 17.2 million tons to 20.2 million tons during those 5 years. The reverse example of export percentage is high, but production is low occurred in 2007–2008. The percentage of rice export to production was 47% in 2008, up from 44% in 2007, whereas rice production registered a decrease from 21.4 million tons in 2007 to 21.1 million ton in 2008. In 2014, Thailand rice export amounted to 10.9 million tons, the highest in history,

and constituted about 50% of rice production which declined to 21.7 million tons, the lowest production since 2000 (Table 4.2).

The world's second biggest rice exporter and the fifth largest rice producer, Vietnam's percentage of rice export in relation to rice production can be divided into two periods. During the first period 2000–2008, the percentage of rice export to production was maintained consistently at below 20%, except for 2005 and 2006 when rice exports accounted for 22% and 20% of production, respectively. During the second period 2009–2014, Vietnam's percentage of rice exports to rice production grew at an annual average of 24%. The highest percentage was achieved in 2012 when rice export amounted to 7.2 million or 27% of production. Two years later, Vietnam rice export dropped to 21% of production, the lowest percentage of this period (see Table 4.2).

Cambodia's rice export grew faster than its two neighbors. The country increased its rice export volume from 6400 tons in 2000 to 12,600 tons 2009, but then expanded sharply to 105,000 tons in 2010, to more than 200,000 in both in 2011 and 2012, and to 388,000 in 2013 and 2014. From 2000 to 2009, the percentage of rice export relative to rice production was around 1%. Since 2010, the percentage of rice export grew progressively to reach 6% of rice production in 2013–2014 (Table 4.2).

4.4 Rice Trade of Cambodia, Laos, Thailand, and Vietnam (2000–2014)

During the first 14 years of the new century (2000–2014), Thailand, Vietnam, and Cambodia were the biggest rice exporters, whereas Laos has been a consistent rice importer due partly to its topography consisting mostly of rugged mountains and large hills, lack of infrastructure, and inefficient rice processing and milling.

4.4.1 Rice Trade Balance

According to FAO latest statistics, the four MSEA countries together had a total trade surplus estimated at 17.6 million tons of milled rice in 2014, up from 9.9 million tons in 2000. Total imports increased slightly by a small 1.3% (from 78,000 to 79,000 tons), whereas total exports grew by more than 70% (from 10.0 to 17.7 million tons) during the same period. Thailand and Vietnam had a surplus annual trade balance during the period under review. Cambodia's rice trade balance jumped from a negative 57,000 tons in 2000 to a positive 347,000 tons in 2014. Only Laos continued to have a negative trade balance, although the deficit fell to 11,000 tons in 2014 from 14,000 tons in 2000 (Table 4.3).

Table 4.3 Rice trade balance in Cambodia, Laos, Thailand, and Vietnam, in 2000–2014 (unit: 000 tons (numbers rounded))

	Cambodia		Laos		Thailand		Vietnam		Total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Export	6	388	0	0	6570	10,969	3390	6320	9966	17,677
Import	63	41	14	11	1	21	0	6	78	79
Trade balance	(57)	347	(14)	(11)	6569	10,948	3390	6314	9888	17,598

Source: FAOSTAT; country trade statistics

4.4.1.1 Laos National Export Strategy 2011–2015

Unlike its neighboring states, Laos has not formulated a national rice trade policy. Instead, in January 2010, the government issued the National Export Strategy (NES) for the period of 2011–2015 which consists of nine sectoral export strategies and six cross-sectoral strategies (export quality management, trade finance, trade information services, competitiveness development, marketing, import for export). Of the nine sectoral export strategies, one deals with organic agricultural products, such as rice, fruits, vegetables, and coffee. The vision of the Organic Agricultural Products Export Strategy is "To turn domestic consumption into a market for organic agricultural products within a holistic and comprehensive system." The strategy includes the following steps:

- Build a unified standard for organic agricultural products in the producer markets, wholesale markets, and export.
- Build a network for farmers along with quality control and packaging warehouses and price setting based on quality standards.
- Allocate specific markets for organic agricultural products in provincial areas and reduce the import of chemical substances in crop plantations to reduce costs and save foreign currencies.
- Build the Lao Promotion Organic Product Association's network with foreign sales agents.
- Use organic crops gardens as tourism sites and training sites for youth studies on the ecosystems.

To provide information on trade services and export-import of goods, the government created the Lao Trade Portal in 2012, a website incorporating all trade-related laws, regulations, and policies on import and export that traders need to know to conduct their business. In addition, Laos took steps to comply with the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) to ensure that food supplied to consumers is safe to eat and not threatened by diseases or pests that may inadvertently be brought into the country. In 2013, Laos issued notifications on Sanitary and Phytosanitary Measures (SPS) for EU countries and for Thailand. By 2015 Laos signed phytosanitary agreements for exporting rice and other products to China and other trade partners [Lao Trade Portal].

The NES for 2011–2015 provided no detailed information on the national rice export policy because the export of paddy or milled rice had no added value to socio-economic development and was conducted in small quantities across the border under the responsibility of the local and provincial rice exporters and without coordination with the central government. This situation created a shortage of rice and an increase in the price of rice in 2008 and in November 2010–February 2011, when the price of rice rose by 50%. In these two instances, the government intervention banned exports to ensure price stability and food security and accessibility, which was the highest priority of the nation.

There are two types and levels of trade bans. First, at the provincial level, the trade bans are ordered by the provincial governors and affect cross-border trade, international trade, or interprovincial trade to keep prices under control and maintain political stability. Second, at the central level, the trade bans are directed by the Ministry of Industry and Commerce's Domestic Trade Department (DTD) and Import-Export Department (IED) to keep low prices and maintain domestic price stability. In addition, export bans of paddy rice were used to support the development of local milling industry (WB 2012). The government policy goal was a rice production of 4.2 million tons by 2015, of which 1 million tons would be for export, and a rice production of 5 million tons by 2020 to ensure food security and change the status of Laos from rice importer to rice exporter [Lao PDR Trade Portal].

4.4.2 Rice Trade Competition

Rice trade competition among Thailand, Vietnam, and Cambodia began in 2012 when India entered the global rice market with record export volumes of over 10 million tons annually. As a result, Thailand lost its status as the world's biggest rice exporter to India in 2012–2015. Vietnam's surge of rice exports in 2012 outperformed Thailand, but since that year the country has struggled to compete with its neighbors for rice imports from China, the Philippines, Malaysia, and other markets in Africa. Even Laos planned to sell rice to China, which is Vietnam's biggest rice importer. Vietnam has seen its decline of rice exports and loss of significant markets due partly to the lack of a rice brand. In the high-quality rice market, Vietnam has difficulties competing with Thailand's Hom Mali rice that is well known in the global market and Cambodia that has become a serious competitor with its export of organic rice to European markets (Cambodia Daily, August 28, 2014). Facing competition from neighboring states, Thailand and Vietnam had to find new markets and new approaches, such as government-to-government (G2G) deals.

4.4.2.1 Cambodia

In 2014 Cambodia doubled its rice export to 6% of its rice production, and its export volume jumped to 388,000 tons from only 6000 tons in 2000. In 2014, the country listed 55 export destinations which included France, the Netherlands, Belgium, Spain, the United Kingdom, and Germany among the top ten buyers of Cambodian rice. According to Mekong Oryza, China ranked fifth (importing 23,302 tons) in 2013, third (48,980 tons) in 2014, and first (116,639 tons) in 2015. Cambodia has shown great potential to compete in the global rice market.

4.4.2.2 Thailand

Thailand has struggled to regain its position as the world's biggest rice exporter. The Thai Rice Exporter Association listed about 170 export country destinations, and the top ten countries comprise 6 Africans, 3 Asians, and the United States, in 2012–2015. As indicated in Table 4.4, Nigeria, Benin, South Africa, and Cote d'Ivoire have ranked among the five top importers. China has jumped to the first place in 2015 importing nearly 960,000 tons, up from 176,000 tons in 2012. To make up for the reduction of rice import from the African countries, Thailand competed with Vietnam in securing deals with Asian countries.

Since the coup in 2014, Thailand has signed the government-to-government rice deals with China, Indonesia, and the Philippines, according to the Commerce Ministry. In December 2015 Thailand and China signed a memorandum of understanding under which the Commerce Ministry would sell 1 million tons of newly harvested rice to China. The MoU for agricultural crops was signed on the same day that the Transport Ministry and China signed an MoU to confirm their commitment in a joint train project from Bangkok to Nong Khai (The Nation, December 3, 2015).

Table 4.4 Thailand's top ten export country destinations, quantity (MT), ranking, 2012–2015

Country	2012	Rank	2013	Rank	2014	Rank	2015	Rank
China	176,214	7	327,559	4	734,765	3	958,368	1
Philippines	3323	–	65,138	10	353,044	10	821,088	2
Benin	335,096	5	919,041	1	1,112,602	2	805,765	3
Nigeria	1,182,518	1	175,818	8	1,239,810	1	644,131	4
South Africa	366,745	2	419,373	2	535,645	5	568,751	5
Cote d'Ivoire	356,807	4	310,098	5	719,771	4	542,923	6
Cameroon	278,436	6	282,992	6	517,526	6	449,297	7
Malaysia	70,768	9	144,281	9	422,167	8	443,169	8
United States	361,722	3	386,844	3	475,536	7	431,719	9
Angola	153,546	8	231,282	7	379,637	9	330,186	10

Source: Thai Rice Exporters Association, statistics, and export quantity by destinations 2012–2014 and 2013–2015

4.4.2.3 Vietnam

After achieving its record export volume in 2012, Vietnam's rice export has steadily declined due to strong competition from Thailand and Cambodia, in addition to India and Pakistan which become the emerging rice exporters. The reasons of the country's inability to compete in global rice market are high rice prices, low-quality rice, shrinking traditional markets, and lack of new markets.

In 2014, according to Vietnam Food Association, Vietnam lost many of its traditional markets in Asia (the Philippines, Indonesia, Malaysia) and in Africa, its second largest rice export region, to Thailand that needed to lower its selling prices in an effort to reduce its stockpiles (*Thanh Nien News*, May 08, 2014). With regard to African countries that import huge quantities of cheap, low-quality rice from Thailand and India, Vietnam's rice export is expected to reduce by 60% because it does not have big inventories (Viet Trade, February 10, 2015).

Vietnam's quality rice is another factor which cannot compete with Thailand's jasmine rice, India's basmati, and Cambodia's organic rice. The lack of a Vietnamese rice brand has been a major obstacle for finding new markets in developed countries where rich people prefer high-quality rice. Unlike Cambodia, Vietnam currently does not have rice markets in Europe, particularly France, Belgium, the Netherlands, and Spain.

Since 2013, Vietnam has depended on China to make up for the loss of markets. China has emerged as the largest importer of Vietnamese rice, accounting for more 30% of Vietnam's total rice export. However, even in the Chinese market, Vietnam has started to encounter increased competition from Cambodia with its increased rice export to China from 28,302 tons in 2013 to 116,639 tons in 2015, growing at an average annual rate of 6.0%.

In 17 years since Vietnam began its rice export to the world market, the average rate of rice exported to all continents during the period 1989–2005 is as follows: Asia 47.5%, Africa 25.6%, the Middle East 11.4%, America 10.0%, Europe 5.3, and Australia 1.0%, according to the Vietnam Food Association website. Today, Vietnam's rice export destinations include Asian countries accounting for 67% of total rice export, followed by Africa 16.4%, and the Americas 11.9% (Vietnam News, July 12, 2016). This shows Vietnam concentrates its rice export to Asia and needs to diversify its markets and improve its quality rice. Instead, Vietnamese exporters increasingly use cross-border trade which does not require quality rice and lots of regulations (*Thanh Nien News*, January 01, 2014).

4.5 Rice Across Border Trade of the MSEA Countries

Cross-border trade has many definitions involving goods, services, people and localities. For simplicity and within the contest of rice trade, we define cross-border trade as any economic activity between people of two neighboring states.

The products usually are traded in small volumes and values and require less paperwork than official trading activities. Trading is informal or formal with an agreement between two neighbors. Volume and value of goods exported and imported are known to local traders but not always recorded by management at border gates. Cross-border trade has benefits and risks.

All four MSEA countries have been engaged in cross-border trade by exporting or importing paddy and/or milled rice which were used interchangeably depending on sources. The common reasons for the cross-border trading are convenient location, no transportation costs, no paper work, and no taxes. For Cambodia and Laos, in particular, paddy rice cross-border export to Vietnam and Thailand was motivated primarily by their lack of rice milling ability, storage capacity, and financial credibility. For Vietnam and Thailand, their rice shipments across the border to China increased in recent years when their official exports decreased showing their difficulties in competing in the global markets. Since 2010, China has become the most important rice importer of the MSEA countries.

Reliable data on rice cross-border trade are extremely difficult to find because they are not included in the official reports or databases of international agencies and national governments or private rice exporters associations. In recent years, some information on the MSEA countries rice export across the border became public because of its growing volume, its illegal transactions, and its impact on the national and regional economies.

4.5.1 Cambodia Rice Border Trade with Vietnam and Thailand

Before the government issued its policy of trade promotion in 2010, Cambodia exported its paddy rice across the border to Vietnam for processing, milling, and selling to domestic and foreign markets. According to the World Bank, since 2005, Cambodia's paddy production has increased steadily and reached an exportable surplus which was sent across the border to Vietnam and Thailand. The volumes and values of the rice shipments depend on the price differentials in the neighboring markets in a given year. Typically, about one-third of the surplus flows to west to Thailand and the balance east to Vietnam (World Bank, Cambodia, A more detailed road map for Cambodian rice exports, Technical Working Paper, July 2012).

Another report by the Asian Development Bank indicated that in 2011, the Thai Rice Exporters Association estimated that Cambodia sold up to 1.5 million tons of paddy rice to Vietnam every year, which was then processed and shipped as official export produce to other markets (ADB, The Rice Situation in Cambodia, Technical Assistance Consultants' Report, January 2012).

In 2010, although the policy of trade promotion prohibited cross-border trade, it was reported that Cambodia's 3.5 million tons of annual rice surplus was delivered

to Vietnam and Thailand for milling. However, some Cambodian state-trading companies pointed out that border trade on the banks of the Kampong Trabek River, Prey Veng province, for example, was unregulated and unrecorded, and it would be difficult to know the total volume of paddy rice was sold to the neighboring countries (*Cambodia Daily*, cross-border-trade-a-challenge-for-rice-policy-93,616/)

When Cambodia missed the policy target of 1 million tons export in 2015, many rice experts and economists attributed this failure to continuing cross-border trade and to lack of milling improvement among other factors. Mr. Darren Cooper, a senior economist at the London-based International Grains Council, stated that "Most international forecasters would probably say that shipments are already at that [1-million-ton] level when one takes into account unofficial or border trade for instance" (*Cambodia Daily*, million-ton-rice-export-goal-remains-elusive-76355/).

4.5.2 Laos Rice Border Trade with Thailand, Vietnam, and China

Since 2000, every year Laos had approximately 1 million tons of rice surplus of which over 300,000 tons were exported across border to Thailand, Vietnam, and China. Rice border trade was conducted by local rice exporters, not by the central government [Lao Trade Portal]. As noted, in late 2010 the unregulated and unrecorded cross-border export by the provinces created a shortfall of rice and an increase in rice prices, which forced the government to impose a temporary ban of rice export.

In 2014 Savannakhet, the largest rice-producing and rice-exporting province, sold its first order of 8000 tons to China and looked to increase rice exports to China to more than 10,000 tons a year after the first order. In February 2016, Savannakhet exported over 500 tons of rice to China. A ceremony for the rice delivery to China was held at the 2nd Thai-Lao Friendship Bridge (Savannakhet-Mukdahan) in Savannakhet. The rice export to China is the result of a Memorandum of Understanding signed in December 2014 between the Savannakhet Provincial Agriculture and Forestry Department and the Hunan Food and Drug Administration of China. Under the agreement, the Savannakhet Provincial Agriculture and Forestry Department and the Hunan Food and Drug Administration have committed to cooperate to survey and build modern agriculture zones aiming to transform Savannakhet into a rice research center, strengthen rice-related capacity building, and promote the application of modern farming technologies.

4.5.3 *Vietnam Rice Border Trade with Cambodia, Laos, and China*

Vietnam has imported paddy rice from Cambodia and Laos and exported milled rice to its neighbors mainly via border trade. The amount was small using cash payments. There were no official records of the trade volumes or values, which were considered inconsequential. On the other hand, Vietnam rice cross-border trade with China has intensified recently and raised many issues nationally and internationally.

Vietnam unofficial rice border trade with China started in 2010 in small deliveries which were considered normal and unnoticed. However, in 2013 due to a decline in export to foreign countries, Vietnam rice cross-border export to China increased fourfold to 1.4–1.6 million tons, making China the biggest importer of Vietnam's rice export. According to Deputy Minister of Industry and Trade, many Vietnamese exporters depend increasingly on border trade because the low-quality rice is accepted more easily at border gates than at global markets. However, the VFA noted that border trade with the Chinese companies was always risky because they could cancel their orders with Vietnamese exporters as soon as another exporter offered them a lower price (*Thanh Nien News*, January 01, 2014).

In August 2014, after finding many Chinese traders who imported rice over the border evaded tax payments, China officially banned cross-border unofficial rice imports from Vietnam in order to tighten control over tax payments by Chinese rice importers. The Chinese government planned to establish fixed tax rates over all rice imports from Vietnam for better control (*Thanh Nien News*, August 16, 2014).

According to the VFA, in 2014 Vietnam exported 6.3 million tons of rice, of which 30% was exported to China through official channels, while 2 tons of rice were exported to the market across border gates. The association stipulated that Chinese companies preferred to import rice from Vietnam through unofficial channels – across the border line – to cut costs. If they import rice through official channels, they would have to pay a quota fee of $80 per ton, VAT, and import tax, which would cost them $160 per ton. As such, if they bought Vietnam's 5% broken rice, which is sold at $460 per ton, they would have to pay $620 per ton. Vietnamese businesses also like exporting rice to China because lower-quality products are accepted there (VNNet, March 26, 2015, Ministries amend regulations on cross-border rice exports).

The World Trade Organization stated in a report that trade transactions between the Vietnam and China countries should only be done via the official mechanism rather than across the border. The cross-border trading mechanism has been designed to facilitate traders in border areas to manufacture and exchange goods in small volumes, but the policy has in fact failed to attain its objective. The WTO noted that many traders used the cross-border trade to dodge taxes (*TuoiTreNews*, December 30, 2014).

Vietnamese government officials and rice experts also recognized that the current level of illegal cross-border trade could have serious negative consequences for the national economy if Vietnam did not tighten control over cross-border rice exports. In addition to its high risks, the long-term impact of rice cross-border export on the economy included lack of incentives to improve quality of rice, to boost rice prices, to raise farmers' income, and to develop long-term planning for a sustainable export growth (Voice of Vietnam, June 29, 2015).

4.6 Rice Regional Cooperation Proposals

For various reasons, rice was not a commodity for cooperation or competition among the riparian states until the new millennium when the idea of a regional rice cartel was first proposed. To date, there have been four proposals of rice regional cooperation initiated by Thailand and one by Cambodia. All these attempts at rice cooperation have failed, and competition between Thailand, Vietnam, and Cambodia for rice imports from China and the Philippines has become the new factor in this decade.

Since the start of the twenty-first century, Thailand, the world's largest rice-exporting country, suggested the formation of a Council on Rice Trade Cooperation in 2002, an Organization of Rice Exporting Countries in 2008 and again in 2012, and an ASEAN Rice Federation in 2014. Cambodia and Myanmar also proposed an association of rice-producing countries in 2012. This section will review the rice cartel proposals and explain the reasons for their failures.

4.6.1 Council on Rice Trade Cooperation Proposal in 2002

The idea of regional rice cooperation was first initiated in October 2002 by Thailand in a meeting with senior officials from China, India, Pakistan, Thailand, and Vietnam, which were Asia's five major rice-exporting countries. Thailand, the meeting host proposed the formation of a Council on Rice Trade Cooperation (CRTC) to achieve export rice price stability due to decline of rice prices at the end of 1990s. The timing of this initiative coincided with Thailand's paddy pledge program which resulted in the high pledging rice prices and loss of competitiveness in the global rice market. Another reason is Thailand was facing increasing competition with Vietnam and India which offered lower-quality rice at the lowest rice prices on the world market and could threaten Thailand as the world's top rice exporter. The first attempt at a rice cooperation failed due to the lack of specifics and mechanisms to achieve price stability, which required a strong commitment by its members. (Asia Times, October 12, 2002)

4.6.2 Organization of Rice-Exporting Countries Proposal in 2008

On May 1, 2008, following the global rice crisis, Thailand's Prime Minister publicly proposed a rice cartel, an Organization of Rice Exporting Countries (OREC), in partnership with Vietnam, Cambodia, Laos, and Myanmar "to help each other in trading rice on the world market" (NYT, May 1, 2008). The Thai goal was to influence rice prices and maintain its largest share in international rice market, which failed to realize. At the time, Thai subsidy program and the world rice crisis of 2008 created global rice shortages and increased world rice prices to over $600/ton by the end of March from $385/ton in January. The formation of an organization of rice-exporting countries was designed to exert control over global rice prices, according to government officials. Cambodia endorsed the idea of a cartel that would share market information and help each other in producing rice thereby providing more security to the Cambodian agricultural sector and more investments for growth. Cambodia Daily (May 2, 2008). About a week after making the announcement, Thailand dropped its plans to create a Southeast Asian rice cartel due to food security concerns and criticisms from the Philippines and other importing countries. Some private rice exporters and traders saw a conflict of interest with importing countries that were their customers. (International Herald Tribune, May 6, 2008)

4.6.3 Southeast Asia Rice Association Proposal in 2012

In April 2012, Cambodia's Prime Minister made another attempt at establishing a regional rice cartel during a summit meeting of the Association of Southeast Asian Nations (ASEAN) which he chaired. He proposed a Southeast Asia Rice Association composed of Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam to help stabilize the trade among ASEAN members, which are composed of rice exporters (Cambodia, Laos, Thailand, Vietnam, and Myanmar) and rice importers (Brunei, Indonesia, Malaysia, the Philippines, and Singapore) Radio Free Asia (March 21, 2012). There were no follow up actions, and some private sector rice traders expressed doubt that the cartel would be established any time soon because of starkly different conditions in the five member countries. Thailand and Vietnam are the two leading rice exporters in the world, while rice exports from Cambodia, Lao PDR, and Myanmar are marginal. (Oryza News, April 10, 2012)

4.6.4 ASEAN Rice Federation in 2012

In August 2012, a decade after its first initial idea of rice cooperation failed, Thailand announced that his country would join Vietnam, Cambodia, Myanmar, and Laos to establish the ASEAN Rice Federation (ARF) with the ambitious goal to increase rice export prices by 10% annually and improve rice quality. Thailand called the rice cooperation a first for the region and would help lift prices of rice that is not only a staple but also a main source of exports for the member countries. A meeting in October was held to lay out agreements and minimum high-quality standards for rice quality. But the idea stalled because of weaknesses of small members (Laos and Myanmar) that had difficulties in growing quality rice for export (*Bangkok Post*, August 23, 2012, Thailand and neighbors join together on rice).

4.6.5 Problems of Rice Cartel Proposals

The idea of a rice cartel was appealing to Thailand and other neighboring members because by definition a cartel is formed to control prices and production, eliminate competition, and reduce the cost of doing business. However, all the above rice cartel proposals failed to materialize because they did not meet three basic conditions:

- Equality of participating countries in relation to shares of quantity rice exports
- Firm commitments of participating countries to high standards of quality rice exports
- Good infrastructure because rice, unlike oil or coffee, needs milling facilities, warehouses, and storages

Two international organizations opposed the idea of rice cartel. The Asian Development Bank, which aims to foster economic growth and cooperation, pointed out that the Thai initiative was "impractical" as countries will probably continue to compete with each other and the supply of rice will be uncontrolled. Moreover, the rice cartel "is not a regional issue but a global responsibility," according to ADB (*Bangkok Post*, May 9, 2012, Parista Yuthamanop, ADB scoffs at rice cartel suggestion). The Food and Agriculture Organization representative in Vietnam also raised serious concerns about the legitimacy of price fixing by a number of producing countries under WTO trade rules and questioned the sustainability of regional cooperation because risks outweigh benefits in the long term (*Thanh Nien News*, October 05, 2012, ASEAN rice cartel carries more risks than benefits).

4.7 Conclusion

Thailand, Vietnam, Cambodia, and Laos are facing challenges to sustain rice production and export promotion. Due to political instability and government intervention policies, Thailand lost it status of world's top rice exporter, the worst setback for the rice industry and free trade policy. Thai international trade sector accounted for about 70% of GDP, and rice was a major export commodity contributing to the country's economic development. Some analysts urged Thailand to focus on quality rice production planning and efficiency instead of rice price and global share of export. The rice-pledging program proved to be a disaster, and traders ascertained that markets, not governments, should dictate the right price.

The outlook of Vietnam's rice export depends on solving the serious problems that impact the paddy fields of the Mekong Delta which accounts for 90% of the country's rice export. Of all the provinces in the Lower Mekong Basin, the Mekong Delta is the worst hit by climate change, sea level rise, salt water intrusion, and mainstream dams, which will be explained in the next chapter. Other issues facing Vietnamese rice export industry include low-quality rice, very limited brand name, storage facilities under poor condition, and increasing international competition.

Cambodia set an export volume target goal of 1.0 million and missed it in 2015. Laos targeted a paddy rice production of 4.2 million tons and 1 million ton rice milled export for 2016 although its rice production failed to meet its official annual goals since 2011. Both countries strive to become rice exporters, although Cambodia has more agricultural land and greater potential to succeed in the international rice market than Laos.

China has emerged as the largest rice importer of the MSEA countries and appeared to play a divisive role in making the four countries compete against each other. In recent years China has been the biggest importer of Vietnamese rice, accounting for about 70% of Vietnam's total rice export, if border trade and unofficial rice exports were included.

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Chapter 5
The Lower Mekong Basin: Rice Production, Climate Change, ENSO, and Mekong Dams

Abstract The Mekong River Basin is divided into two parts: the Upper Mekong Basin located in China and Myanmar, and the Lower Mekong Basin (LMB) in Laos, Thailand, Cambodia and Vietnam. These four countries that have parts of their territories in the LMB are referred as the Lower Mekong Countries (LMCs) to be distinguished from the Mainland Southeast Asia (MSEA) countries.

Rice production in the LMB depends on seasonal climatic conditions and fresh water resources which are provided by the Mekong River and the monsoon rains that occur generally from May to September or early October. Since 2000, the LMB agricultural land and paddy rice production have been affected by unusually intense floods, severe droughts, sea level rise, deep saline intrusion, and the construction of Chinese mainstream dams.

The chapter has five sections. The first section introduces the Mekong River from its source in China to the Delta in Vietnam. The second section describes the LMB, its topography, population, and economy. The third section focuses on the LMB agricultural land, paddy land and farming, and paddy production. The fourth section assesses the impacts of climate change, and El Nino and La Nina on the LMB rice production. The last section examines the effects of Chinese dams on the Mekong flows and sediments deposits in downstream countries.

Keywords Mekong River • Lancang Jiang • LMB setting • Topography • Population • Economy • Agricultural land • Paddy land and farming • Paddy production • IPPC Fourth Assessment Report • Climate change • El Nino and La Nina • Floods • Droughts • Khorat paddy production • Mekong Delta paddy production • China mainstream dams • Nuozhadu dam • Xiaowan dam • Sediments deposits

For centuries, the Mekong seasonal flood has been part of the livelihoods and cultures of the people in the Lower Mekong Basin. Farmers in the region have adjusted their activities and their crop calendars to the seasonal floods which are considered beneficial because they bring nutrient sediments for growing crops and

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water for irrigating rice paddy fields. Extreme floods and droughts were the exceptions. During an exceptionally dry season, the Mekong River water resources were vital for rice production.

Since the new millennium, the Lower Mekong Basin has experienced unusually intense and frequent floods (2000, 2001, 2006, 2008, 2011, 2013), severe droughts (2004–2005, 2009–2010, 2015–2016), sea level rise, deep saline intrusion into rivers, and changes in water runoff that have interfered with the normal climatic conditions for rice cultivation. Many academic and technical research studies suggest that these events are attributable to the effects of climate change or natural climate variability, the El Niño and La Niña phenomena of the El Niño-Southern Oscillation (ENSO). In addition to these natural disasters, the construction of the mainstream dams on the Lancang-Mekong River in China has affected the agricultural land and paddy rice production in the LMB at different times and with different intensities.

Lower Mekong Basin (Source: Mekong River Commission Planning Atlas of the Lower Mekong River Basin, 2011)

5.1 The Mekong River

The Mekong River, the world 12th longest river and the third largest in Asia, is shared by China, Myanmar, Thailand, Laos, Cambodia, and Vietnam. From its source in Qinghai province in China through the eastern part of the Tibet Autonomous Region and Yunnan province, the Mekong River is called the Lancang Jiang. Flowing down out of China, the Mekong serves as the border between Burma and Laos. Beyond the tri-point, also known as the Golden Triangle, at which the borders of Myanmar, Laos, and Thailand meet, the river is referred to as the Lower Mekong River.

The entire Mekong River drainage basin covers an area of 795,000 km^2. In terms of discharge, the Mekong River discharges 475 km^3 of water into the South China Sea every year, of which Laos contributes 35%, Thailand and Cambodia 18% each, China 16%, Vietnam 11%, and Myanmar 2% (MRC 2005, Overview of the Hydrology of the Mekong Basin). The Mekong River Basin can be divided into two parts: the Upper Mekong Basin in Tibet and China and the Lower Mekong Basin from the Golden Triangle to the South China Sea.

5.1.1 The Lancang Jiang

The following information is provided by the Chinese Academy of Science which organized an association of exploration for the scientific survey and exploration of the headwater of Mekong River, known as Lancang Jiang in China, in 1999. The extensively and integrated scientific survey found that the true source of Lancang Jiang is Zayaqu that originates in Guosongmucha Shan of an attitude of 5514 m above sea level in Zaqing, Zadoi County, Yushu Tibetan Autonomous Prefecture, Qinghai Province, and that the headwater of Lancang Jiang is a glacier discharge with an altitude of 5224 m above sea level and the geographical location has a longitude of 94 41 44 E and a latitude of 33 42 31 N. The total river length is 4500 kilometers(km), the total area of drainage basin is 810,000 square km (km^2), and the discharge excluding underground water into the sea is eight times of Yellow River (Chinese Academy of Sciences et al. (1999)).

The river basin of Lancang Jiang forms a narrow and rectangular topography, and tributaries flowing into both riverbanks are rather small and short. The drainage basin area in the Chinese territory is 167,486 km^2, the river length is 1826 km, and the mean annual discharge from China to the downstream countries is 76 billion cubic meters, excluding underground water. A potential power generation capacity in the dry season is 32,030,000 kw which ranks fourth in China. Lancang Jiang is recognized as one of the important resources of hydroelectric power generation for development and exploitation. The Lancang River has been the target of exploitation for Chinese development of hydropower for nearly three decades.

5.1.2 The Lower Mekong River

In 2003, the Mekong River Commission published the State of the Basin Report which indicated that the total length of the Mekong River is approximately 4800 km (300 km longer than China's survey in 1999), of which the Lower Mekong River is about 2600 km long. It forms most of the border between Laos and Thailand, crosses the Cambodian territory, runs into Southern Vietnam, and empties its water into the South China Sea.

The LMB has a network of over 100 major and minor tributaries that provide enormous water resources for irrigation, flood control, hydropower, and navigation. Major tributary systems develop in the Lower Basin. These systems can be separated into two groups: tributaries that contribute to the major wet season flows and tributaries that drain low relief regions of lower rainfall. The first group are left bank tributaries that drain the high-rainfall areas of Laos. The second group are those on the right bank, mainly the Mun and Chi rivers, which drain a large part of northeast Thailand.

The importance of the Lower Mekong River for its riparian people cannot be emphasized enough. In the past, the Mekong River played a preponderant role in shaping the political, economic, social, and cultural life of the Khmers, Laotians, Thais, and Vietnamese. These migrant people all strove for the domination of the Lower Mekong Basin. Today, the Mekong River is a major water resource for irrigation, agriculture, and the livelihoods of millions of people in the Lower Mekong Basin.

5.2 The Lower Mekong Basin Setting

The Lower Mekong Basin (LMB) covers an area estimated at 642,000 square kilometers (km^2), or about 51% of the 1,262,000 km^2 total combined territory of the four countries Cambodia, Laos, Thailand, and Vietnam. Table 5.1 shows the importance of the LMB to the four countries of Mainland Southeast Asia (MSEA).

Within the LMB total area of 642,000 km^2, Laos has the largest area (202,000 km^2), followed by Thailand (184,000 km^2), Cambodia (161,000 km^2), and Vietnam (95,000 km^2). These four countries that have land areas and provinces inside the LMB are also referred as the Lower Mekong countries (LMCs). The LMB consists of 86 provinces and three municipalities or capital cities: Phnom Penh in Cambodia, Vientiane in Laos, and Can Tho in the Mekong Delta. The capital cities of Bangkok in Thailand and Hanoi in Vietnam are not in the LMB (Table 5.2).

Table 5.1 LMB and MSEA land areas, population, rice production, and rice consumption

Item	Units	LMB			LMB 2014 as % of MSEA	MSEA		
		2000	2014	AAGR %		2000	2014	AAGR %
Area	Km^2	642			51	1262.1		
Population	Millions	57.6	65.8		36	160.5	182.3	0.9
Agricultural area		N/A	19.9	N/A	31	35.2	41.2	1.1
Paddy area	Million ha	N/A	N/A	N/A	N/A	N/A	16.7	N/A
Harvested area	Million ha	12.3	13.9	0.9	61	20.2	22.7	0.8
Paddy production	Million tons	33.0	52.5	3.4	57	64.6	90.9	2.5
Milled rice production	Million tons	22.0	35.2	3.4	57	43.1	60.1	2.5
Milled rice consumption	Milled tons	N/A	N/A	N/A	N/A	32.0	43.6	2.2
Per capita rice consumption	Kg/year	199	240	N/A	N/A	199	240	1.3
Population density	Persons/ km^2	90	103	0.9	36	127	144	0.9

Source: FAOSTAT, MRC
Percentages calculated by author

Table 5.2 Land areas and provinces of Lower Mekong Basin and Lower Mekong countries

Items	LMB	Cambodia	Laos	Thailand	Vietnam
LMB Area (000 km^2)	642.0	161.0	202.0	184.0	95.0
as % of LMB total area	100.0	25.0	31.5	28.7	14.8
LMB provinces + municipalities	86 + 3	24 + 1	16 + 1	25 + 0	21 + 1

Source: MRC, Planning Atlas of the Lower Mekong River Basin, 2011; MRC 2003 and 2010 State of the Basin Report; MRC, The Mekong Basin Physiography, Climate

5.2.1 Topography

The Lower Mekong Basin consists of five main regions:

1. The Northern Highlands: the highlands run from Northern Laos and Northern Thailand and eastward into the northern end of the Annamite Cordillera in Vietnam.
2. The Khorat Plateau lies largely within Thailand. The Mekong River cuts deeply into the eastern rim of the plateau, forming sheer cliffs above the river in some places and underwater canyons up to 100 m deep in others.

3. The Eastern Highlands: a southern extension of the Northern Highlands, these mountains extend about 700 km from Laos through Vietnam, with altitudes as high as 2800 m. A number of the Mekong River's larger tributaries flow from this part of the basin, including the Sekong, Sesan, and Srepok rivers.
4. The lowlands comprise the Cambodian floodplains and the delta. The Mekong River branches at Phnom Penh, with the Bassac forming the western arm of the delta and the Mekong River proper forming the eastern arm. The entire delta area extends across some 65,000 km^2. Within the Vietnamese section of the delta, there is an elaborate network of canals.
5. The Southern Uplands, located in southeastern Cambodia, are extensions of the Northern Highlands and include the Cardamom and Elephant ranges (MRC 2003. State of the Basin Report).

Among the four LMCs, Laos lies almost entirely within the LMB and is dominated by mountains and uplands. The Khorat Plateau, which includes the Mun and Chi tributaries, is an area of rolling hills and alluvial plains. Cambodia landscape is flat and covered by the flood plains of the Tonle Sap and the Mekong and Bassac rivers. The Mekong Delta in Vietnam is a vast triangular plain of about 55,000 km^2, most of which is lower than 5 m above sea level and under the tidal influence from the South China Sea.

Natural resources are equally rich and diverse including rubber, tin, timber, zinc, precious gems, and many other mineral deposits. Agriculture, particularly water-driven rice culture, is a very important sector of the LMB economic development (MRC (2003/2010), State of Basin Report).

The LMB is known as the world's largest inland fishery. It produces some 2 million metric tons (mt) of fish a year and an additional 500,000 mt of so-called other aquatic animals (frogs, snakes, snails, aquatic insects, etc.). These figures exclude aquaculture and refer only to what is known as "the wild capture fishery." The basin is also home to many species of very large fish. The biggest include the Mekong freshwater stingray, which can have a wingspan of up to 4.3 m, the giant pangasius, Siamese giant carp, and the Mekong giant catfish, which can grow up to about 3 m in length and weigh 300 kilograms. All of these are in serious decline, because of dams, flood control, and overfishing. One species of freshwater dolphin, the Irrawaddy dolphin, was once common in the whole of the Lower Mekong but is now very rare (World Wildlife Fund, report on The Greater Mekong released in 2008).

The LMB climate is affected by the tropical monsoon, which generates wet and dry seasons of more or less equal length. The southwest monsoon generates the wet season which usually lasts from May to June until late September or early October. About 75% of the Mekong's annual flow occurs during the monsoon between July and October**.** Tropical cyclones occur over much of the area during August and September and even October (in the Vietnam Mekong River Delta). The distribution of mean annual rainfall over the Basin follows a distinct east-to-west gradient with the Lao PDR and Cambodia uplands receiving the most precipitation (3000 mm) and the semiarid Khorat Plateau in northeast Thailand the least

(1000–1600 mm). The northeast monsoon brings lower temperatures from China and causes dry weather in the Lower Mekong Basin from late October until April. In March and April, average temperature ranges between 30 and 38 °C depending location and altitude. Coolest temperatures occur between November and February. At higher elevations in the Laos, winter temperature averages 15 °C.

5.2.2 LMB Population

It is extremely difficult to provide an accurate and complete profile of the population of the LMB due to lack of timely, consistent, and comparable data between provinces. Although the three capital cities of Vientiane, Phnom Penh, and Can Tho lie within the LMB, not all of the 86 provinces are located entirely inside the LMB boundaries. For all of these reasons, our description of the LMB population is based on the publications of the Mekong River Commission (MRC), including the IWRM-based Basin Development Strategy 2016–2020; the Planning Atlas of the Lower Mekong Basin 2011, published on December 31, 2011; and the Social Atlas of the Lower Mekong Basin, March 2003. The census data of Cambodia, Laos, Thailand, and Vietnam are also considered in the analysis.

In 2014 the estimated population of the Lower Mekong Basin was 65.8 million, or a 14% increase over the 57.6 million in 2000. About 80% of the LMB population live in rural areas. Within the LMB 2014 population of 65.8 million, Thailand had the largest population (37%), followed by Vietnam (35%), Cambodia (19%), and Laos (9%). Between 2000 and 2014, Thailand's population in the LMB decreased, from 39 to 37%, whereas the populations of Cambodia and Laos increased by one percentage point, and Vietnam's population stayed at 36% (Table 5.3).

Looking to the future, it is expected that the current LMB population, presently growing at around 1.2% per year, will reach approximately 83 million people by 2060. However, there are wide variations in growth across the individual riparian countries, including negative growth in northeast Thailand. Fertility rates have declined sharply, but over 60% of the LMB population is younger than 30 years of age (MRC, the Basin Development Plan Strategy for 2016–2020).

In 2014, the average LMB population density was about 103 persons per km^2, an increase of 15% over an average of 90 persons per km^2 in 2000. However, average densities varied from 20 persons per km^2 to 41,200 persons per km^2 depending upon the topography and drainage. Average density was highest in the municipalities and capital cities, such as Vientiane, Phnom Penh, and Can Tho and lowest in the sparsely populated upland areas in Laos and Vietnam's Central Highlands.

There are over 100 different ethnic groups living within and outside the LMB boundaries, making it a most culturally diverse region of the Asia. The livelihoods and food security of the LMB rural population are closely linked to the Mekong River and its tributaries. The majority of people are farmers and fisherman who live on water resources and other natural resources. Generally lacking means of

Table 5.3 Land area, population, and population densities in the LMB and Lower Mekong countries, 2000 and 2014. Populations are in millions

Lower Mekong Basin										
	Cambodia		Laos		Thailand		Vietnam		LMB total	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
LMB area (000 km^2)	161.0		202.0		184.0		95.0		642.0	
Population in LMB	9.9	12.5	4.8	6.1	22.4	24.2	20.5	23.0	57.6	65.8
Population as % of total LMB	18	19	8	9	39	37	35	35	100	100
LMB population density/km^2	62	78	23	28	122	132	243	279	90	103
AAGR (%) LMB population	1.7		1.7		0.5		0.8		0.9	

Source: MRC, Basin Development Strategy, 2016–2020
MRC, Planning Atlas of the Lower Mekong River Basin 2011
Cambodia, Census of Population 1998, 2008, 2013
Laos Census of Population 1995; Lao PDR Census of Population and Housing 2005
Thailand Census of Population 2000
Vietnam, Census of population 1999; General Statistics Office 2016
LMB population percentages are calculated from the MRC data

transportation and communication, people in the LMB are, on average, poorer than people living in the urban areas and outside the basin (MRC 2010).

5.2.3 LMB Economy

Statistics of key economic indicators of the LMB in general, and its national income growth in particular, are difficult to find or reconcile. For this reason, we will attempt to explain the factors contributing to the LMB economy, not the method of measuring economic growth.

The economy of the LMB is basically tied to the Mekong River and its tributaries that provide freshwater resources for domestic consumption, fish and aquaculture, irrigation for paddy fields, human and commercial transportation, hydroelectric power generated by tributary dams, and mineral deposits. Natural resources are equally rich and diverse including rice, coffee, rubber, tin, timber, zinc, precious gems, and many other mineral deposits.

In spite of these rich and abundant natural resources, the Lower Mekong Basin is still one of the poorest areas in the world. Within the LMB, in 2013, Thailand had the highest gross national income (GNI) per capita estimated at $6705, followed by Vietnam's Mekong Delta US$5070, Laos US$4550, and Cambodia US$2890, according to the latest Basin Development Strategy 2016–2020 published by the Mekong River Commission.

First, agriculture is the largest and most important sector of the GNI with no significant industry and services sectors. It employs a majority of the rural population estimated at 85% of LMB total population and produces rice and other crops and fish for food self-sufficiency, security, and export (MRC, Basin Development Strategy 2011–2015). Of importance is the fact that this successful agricultural performance has not benefitted the small farmers who have not seen their income grow commensurate with their production costs and remain very poor.

The LMB rice productivity is an important sector of the agriculture economy. In 2014, LMB rice paddy production accounted for 57% of the total paddy rice produced by the four countries, a 7% increase over the 51% of the total in 2000. The LMB long-term rice production is forecast to grow at an average rate of 1.5% per year, driven mainly by export markets. However, the agricultural contribution to the LMB economy is expected to decline in percentage terms relative to the industry and service sectors as a result of increased urbanization and modernization.

Second, the LMB displays a wide range of socio-economic diversity and disparity among different parts of the basin. There are growing inequalities between urban areas and rural areas. Urban areas are more populous and richer that rural areas. The labor force is younger and more mobile in the cities than in the provinces. More and more young people leave their parents' farms and migrate to municipalities to find better jobs and higher incomes.

Third, the LMB economy has been more affected by climate change, prolonged droughts, and unseasonal floods than the national economies of the LMCs because of its topography and poor infrastructure. Paddy fields in the Mekong Delta have been destroyed by severe floods and saline intrusion. Some villages in the highlands are very poor and isolated with no transportation and no access to services.

The LMB economy will likely continue to grow because, in addition to agriculture, the LMB hydroelectric generating potential is considerable and the abundant mineral deposits (tin, lead, zinc, gold, silver, and precious gems) could play a major role in the mining industry growth. However, the economic outlook for the future is difficult to forecast because of the uncertainty of climate change, natural disasters, and regional conflict in water use and diversion of the Mekong River.

5.3 LMB Agricultural Land, Paddy Land, and Paddy Production

This section examines the agricultural land, paddy land and farming, and paddy production of the LMB, with particular focus on the Khorat Plateau in northeast Thailand and the Mekong Delta in Southern Vietnam during the period 2000–2014. In 2014, these two regions accounted for more than 75% of all paddy rice produced in the LMB and, as such, have been the two pillars of the LMB supporting its population with rice self-sufficiency and security. In 2014, the Mekong Delta and Central Highlands (MD/CH) area accounted for 56% of Vietnam's total paddy

production, as well as accounting for an estimated 90% of Vietnam's total rice exports. The Khorat Plateau accounted for an estimated 45% of Thailand's total paddy production. These numbers demonstrate the extreme importance of these two regions for food security and sustainable growth of the LMB and peninsular Southeast Asia as a whole.

5.3.1 Agricultural Land and Paddy Land

There are many research studies and reports on the physical, hydrology, water resources, and social and economic development of the Lower Mekong Basin. However, to date, there is no accurate statistical information on the rice farmland and systems in the Lower Mekong Basin. Our data and analysis are based primarily on the MRC Planning Atlas 2011, Cambodia Agricultural Census 2013, Laos Agricultural Census 2010–2011, Thailand Agricultural Census 2013, and Vietnam General Statistics Office (GSO) 2013, Agriculture and Forestry.

The LMB has a total agricultural area of about 19.9 million ha or 31% of the LMB total land area of 64.2 million ha. Of the 19.9 million ha, Thailand's Khorat Plateau has the largest agricultural area estimated at 10.3 million ha, followed by Vietnam with 4.6 million ha, Cambodia 3.1 million ha, and Laos 1.9 million ha. In terms of the agricultural area as a percentage of the LMB total area, the Khorat Plateau in Thailand (56%) and the Mekong Delta/Central Highlands area (49%) are the largest areas compared to Cambodia (19%) and Laos (9%). Within the LMB, Khorat Plateau's agricultural area dominates the area with 52% of the total area, followed by Vietnam (23%), Cambodia (15%), and Laos (10%) (Table 5.4).

According to a study on irrigation for food security published by the MRC in June 2014, the LMB allocated paddy area is estimated at 9.5 million ha or 48% of agricultural area. The irrigated paddy area accounts for 42% of the total paddy area in the LMB, of which Vietnam's Mekong Delta has the largest irrigated area (73%), which allows three cropping seasons. The irrigated paddy areas of the other LMB countries include 27% in Laos and 30% in both Cambodia and Thailand. The majority of rice crop in these three countries is rainfed and is cultivated in Chiang Rai in north and northeast Thailand, in Vientiane plains of Laos, and in Tonle Sap flood plains in southeastern Cambodia. They have two crops annually, one main crop in the wet season (May–November) and a second drop in the dry season (December–March). Vietnam has three crops per year: spring, autumn, and winter; the last two occur during the wet season.

5.3.2 LMB Paddy Production 2000–2014

In 2014, paddy production in the LMB totaled an estimated 52.5 million tons, up from 33.0 million tons in 2000, growing at an average annual rate of 3.4%,

Table 5.4 Agricultural area, allocated paddy area, irrigated area in LMB and LMCs, and cropping seasons (Unit: 000 hectares. Numbers rounded to the nearest 000 ha)

	LMB	Cambodia	Laos	Thailand	Vietnam
Agricultural area	19,910	3100	1900	10,300	4610
Agricultural area as % in LMB	100	15	10	52	23
Paddy area	9531	1647	631	4647	2606
Paddy area as % of agricultural area	48	53	33	45	57
Irrigated paddy area	4023	505	172	1425	1921
Irrigated paddy area as % of paddy area	42	30	27	30	73
Cropping seasons		June–Dec	June–Nov	May–Oct	May–Aug
		Jan–April	Dec–April	Nov–April	July–Dec
					Nov–Feb

Source: MRC, Irrigation for food security, poverty alleviation, and rural development in the LMB, June 2014; MRC Planning Atlas 2011
Cambodia Agricultural Census 2013
Laos Agricultural Census 2010–2011
Thailand Agricultural Census 2013
Vietnam General Statistics Office (GSO) 2013, Agriculture and Forestry

compared with an average annual growth rate of 2.5% by the four MSEA countries during the same period. In 2014, LMB paddy production accounted for about 57% of the total rice paddy produced by the Cambodia, Laos, Thailand, and Vietnam, an increase over 51% of the total in 2000 (Table 5.5).

Within the LMB in 2000, the Mekong Delta and Central Highlands (MD/CH) accounted for about half of total LMB paddy production, followed by the Khorat Plateau, one-third of the total output, Cambodia (12%), and Laos (6%) making up the balance. However, in 2014, Cambodia's share of paddy production had increased to 16.6%, with the MD/CH and the Khorat Plateau's contribution decreasing to 48% and 28%, respectively. Laos increased slightly from 6.4 to 7.4% (Table 5.5).

5.3.2.1 Cambodia Paddy Production

Cambodia's rice paddy production more than doubled from 3.8 million tons in 2000 to 8.7 million tons in 2014, following a 65% in the rice harvested area, and a 40% increase in its average yield during the period (Table 5.5). As a result of this expansion, Cambodia's paddy production grew at an average annual rate of 6.1%, the highest growth in the region, and which was more than twice the growth rate of the Khorat Plateau (2.5%) and the MD/CH area (3.0%) during the same period.

Table 5.5 Harvested area, paddy production, yields in LMB and Cambodia, Laos, Khorat Plateau, and the Mekong Delta, 2000–2014 (Unit: millions. Numbers rounded to the nearest '000mt)

	LMB		Cambodia[a]		Laos[a]		Khorat Plateau[b]		Mekong Delta[c]	
	2000	2014	2000	2014	2000	2014	2000	2014	2000	2014
Area harvested	12.3	13.9	1.70	2.80	0.6	0.9	5.5	5.7	3.9	4.3
AAGR %	0.9		3.6		2.9		0.3		0.7	
Avg. yield tons/ha	2.7	3.8	2.2	3.1	3.5	4.3	1.9	2.6	4.3	5.9
AAGR %	2.5		2.5		1.5		2.3		23	
Paddy production	33.0	52.5	3.8	8.7	2.1	3.9	10.4	14.7	16.7	25.2
AAGR %	3.4		6.1		4.5		2.5		3.0	
Paddy prod. in LMB (%)	100	100	11.5	16.6	6.4	7.4	31.5	28.0	50.6	48.0
% of total production in four MSEA countries	51	57	94	94	98	98	40	45	51	56

Source:
[a]FAOSTAT (2016)
[b]Thailand Agricultural Census (2013), and ADB (2010), The Rice situation in Thailand, Technical Assistance Consultant's Report
[c]Vietnam, General Statistics Office (GSO 2016), Production of paddy be province, 2000–2015

5.3.2.2 Laos Paddy Production

Laos's rice paddy production almost doubled in size between 2000 and 2014 as a result of a 50% increase in the harvested area and a 23% increase in its average yield. Unlike Cambodia, Laos has limited farmland and lacks irrigation systems to ensure adequate water supply. The country's agricultural area accounted for only 9% of the total area of LMB, and about 70–80% of the population live in the highlands with no access to modern technology and good-quality seeds with high yields. In 2013, the government selected the two provinces of Savannakhet and Khammouan as model areas for the production of good-quality rice for domestic consumption and export. The goal is to have a large stockpile of rice, provide rice in time of disaster, and have seeds that are similar in quality and variety to those of other countries (*Vientiane Times*, September 23, 2013).

5.3.2.3 Khorat Plateau Paddy Production

The data for the Khorat Plateau are based on Thailand Agricultural Census 2013 and the ADB report on the rice situation in Thailand. In 2014, the Khorat Plateau produced an estimated 14.7 million tons of paddy, a near 50% increase over the 10.4 million tons in 2000, growing at an average annual rate of 2.5%. In terms of its importance to the country as a whole, in 2014 the region contributed about 45% of the country's total paddy output of 32.6 million tons, compared to 2000 when the region accounted for only 40% of the country's total paddy production of 25.8

million tons. The Khorat Plateau grows long grain rice, glutinous rice, and the premium Hom Mali rice, much of which is targeted for the export market.

Although the 5.7 million ha harvested area in the Khorat Plateau accounts for approximately 53% of the country's total harvested area, its average yield was growing from 1.9 tons per ha in 2000 to 2.6 ton per ha in 2014, which was significantly lower than for the country yield of 2.6 tons per ha in 2000 and 3.0 tons per ha in 2014 (Table 5.5). There are four reasons for this lower average paddy yield in the Lower Mekong Basin: topography, climate change, ecosystems, and exports.

First, the topography of the Khorat Plateau is a low-lying sandstone platform noted for its thin and acidic soils, wet season floods, and dry season droughts. The Plateau is the largest region, covering approximately one-third of the country, and the largest rice area comprising about 53 % of the land dedicated to rice production. The Plateau is a vast, low-lying terrain consisting mainly of sediment and eroded bedrock and surrounded by a rim of highly resistant sandstone. It is an arid region characterized by a rolling surface and undulating hills. The Plateau is drained by the Chi and Mun rivers and is bounded by the Mekong River (north and east on the Laos border), the Phetchabun and Phang Hoei ranges (west), and the Phanom Dong Rak Range (south). The interior has low hills and small lakes. Shallow sandy loams cover a large part of the Khorat Plateau and are not suitable to paddy rice farming. Soils along the main rivers are more fertile, and alluvial loams of high fertility are found along the Mekong River.

Second, the Khorat Plateau is influenced by the southwest monsoon from May to September and the northeast monsoon from November to February. The region has three seasons: rainy from May to October, dry and cool from October to February, and dry and hot from February to May. The Plateau's impermeable soils are flooded during the rainy season and parched during the dry season. Harsh climatic conditions often result in this region being subjected to severe floods and droughts damaging hundreds of hectares of paddy fields.

Third, the Khorat Plateau is dominated by the rainfed rice ecosystem, whereas irrigated rice constitutes a small second crop and accounts for only 35%. Water resource in the region is surface water. Rainfed paddy rice is a major crop planted at the bottom and lower part of the valley only once a year in the rainy season. Therefore, rice production in the Khorat Plateau is affected by the variable nature of the precipitation pattern of each year, which explains yield instability and low performance. The Khorat Plateau is the largest producer of Hom Mali rice which accounts for about 82% of the total Hom Mali production area in Thailand. The major producers in the region are Surin, Buriram, Sisaket, Nakhon Ratchasima, Ubon Ratchathani, and Roi Et.

Fourth, the government has placed great emphasis on exports, and rice has become an important commercial commodity for foreign exchanges. This export priority has raised the standards and prices of rice varieties such as Hom Mali rice, or jasmine rice, that receives quality inspection and certification documents at farming and export levels. Despite Hom Mali's low yield, farmers in the Khorat Plateau prefer to grow this rainfed rice for its high quality and high market prices

compared to other rice varieties. Hom Mali rice is sold worldwide and is in great demand by local and foreign markets.

Within LMB, paddy rice production of the Khorat Plateau was the second largest, but its share showed a downward trend from 32.5% in 2000 to 28% in 2014; its average annual growth of 2.5% for paddy production during the period 2000–2014 was the lowest of the four countries, and its average yield of 2.6 tons per ha in 2014 also was the lowest in the LMB. The Khorat Plateau will face many challenges in dealing with soil erosion, mitigating climate change with frequents floods and droughts, and managing water resources to increase its predominant rainfed rice production.

5.3.2.4 Mekong Delta Paddy Production

Statistical data for the Mekong Delta paddy production are provided by the General Statistics Office (GSO) of Vietnam. According to government statistics, in 2000, paddy production in the Mekong Delta amounted to 16.7 million tons, or 51% of the country's total paddy production of 32.5 million tons. By 2014, total paddy production in the Mekong Delta increased by more than 50% to 25.2 million tons, accounting for 56.0% of Vietnam's total paddy production of 45.0 million tons. The increased importance of the Mekong Delta's paddy production, relative to the country as a whole, was a result of increased paddy planted area, higher-yielding rice strains, and more efficient utilization of water resources. Overall, during the first 14 years of the new millennium (2000–2014), the average annual growth rate of paddy output in the Mekong Delta was 3.0%, significantly higher than a comparable growth of 2.4% for the country as a whole (Table 5.6).

Table 5.6 details the production of paddy, by crop, in the Mekong Delta during the 2000–2014 period. The data shows that, of the three crops, the winter-spring and summer-autumn paddy crops are the most important contributors to the country's total paddy production. In 2014, the two crops together accounted for 23.4 million tons of paddy production, representing 93% of the Mekong Delta's total paddy output and also accounting for more than two-thirds of the country's total paddy output for the same two crops. This compares to comparable data in 2000 when the same two crops accounted for 90% of the Mekong Delta's paddy production and 62% of the country's two crops. This points out the importance of adequate water supply for paddy production in the dry season, particularly for the winter-spring crop which is usually planted with high-quality rice strain targeted for export.

In contrast to the other two crops, the Mekong Delta's autumn-winter paddy crop continued to play a declining and minor role from 2000 onwards with the planted area decreasing in size from 543.6 thousand ha in 2000 to 391.3 thousand ha in 2014 at an average annual (declining) rate of more than 2.2% per year (Table 5.6). While its average yield of 4.8 tons/ha is high by regional standards, its 1.9 million tons of paddy production in 2014 accounted for less than 8.0% of the Mekong Delta's total paddy production and represented only an 0.75% annual average annual growth rate over the 1.7 million tons of paddy production in 2000. In

Table 5.6 Production of three paddy crops in the Mekong Delta 2000 and 2014

	2000	2014	Growth Rate (%/yr)
Winter-spring paddy			
Production (000 ton)	8003.7	11191.7	2.42
Harvested area (000 ha)	1520.6	1562.7	0.27
Yield (tons/ha)	5.26	7.16	2.23
Summer-autumn paddy			
Production (000 ton)	7004.5	12173.1	4.03
Harvested area (000 ha)	1881.6	2292.8	1.42
Yield (tons/ha)	3.72	5.31	2.57
Autumn-winter paddy			
Production (000 ton)	1694.5	1880.8	0.75
Harvested area (000 ha)	543.6	394.0	(2.28)
Yield (tons/ha)	3.12	4.77	3.08

Source: GSO for data and growth rates calculated by author from the same data

2011 the autumn-winter crop was almost decimated by severe flooding in the Mekong Delta that destroyed a thousand kilometers of dikes and a thousand hectares of paddy. The losses and lack of planning for the region raised the issue of the continued viability of the autumn-winter third crop production and its participation in the future (Relief Web, October 22, 2011).

5.4 Climate Change, Floods and Droughts, and El Niño-Southern Oscillation (ENSO) 2000–2015

This section deals with the impacts of climate change, severe floods and droughts, and the El Niño and La Niña phenomena of the ENSO cycle in the Lower Mekong Basin in the twenty-first century. All four Lower Mekong countries Cambodia, Laos, Thailand, and Vietnam ratified the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) in 2002 and adopted the UNFCCC Paris Agreement on December 12, 2015. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report in 2007 defined climate change as "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time whether due to natural variability or as result of human activity" [IPCC.AR4]. Some research studies raise the issue as to whether the Lower Mekong Basin has been subject to climate change or climate variability.

5.4.1 Assessments of Climate Change in the Lower Mekong Basin

In 2007 the IPCC AR4 on climate change indicated there is evidence of global warming with important variations in different regions. More importantly, its analysis of the impact of climate change on the Lower Mekong Basin found that the flow of the Mekong River, so critical for rice cultivation, has been and will be changed over the years. The maximum monthly flow of the Mekong is estimated to increase by 35–41% in the basin and by 16–19% in the delta, with lower value estimated for years 2010–2038 and higher value for years 2070–2099, compared with 1961–1990 levels. In contrast, the minimum monthly flows are estimated to decline by 17–24% in the basin and 26–29% in the delta (IPCC 2007c, Chapter 5, Box 5.3) suggesting that there could be increased flooding risks during wet season and an increased possibility of water shortage in dry season. The 16–24% decrease in the annual water flow of Mekong River by the end of this century will increase water stress and negatively affect rice production.

IPCC AR4 also forecast that the sea level will be about 40 cm higher than it is today (2007) by the end of the twenty-first century even under the most conservative scenario. It is estimated that if the sea level rose by 1 m, about 15,000–20,000 km^2 of the Mekong Delta would be flooded, 2500 km^2 of mangroves would be destroyed, and 1000 km^2 of cultivated farmland and sea product cultural area would become salt marshes. The Report also projected that more than one million people in the Mekong Delta would be directly affected by a sea level rise in 2050 (IPCC 2007b, Sec. 6.4.1.2). Sea level rise will cause land erosion due to climate change and excessive pumping of groundwater for irrigation and reservoir construction upstream.

In 2010, a research paper on "Climate Change, Water, and Agriculture in the Greater Mekong Subregion" published by the International Water Management Institute agreed with the observation of an increased temperature and sea level rise. However, the study states that its own "analysis of historical rainfall records indicates a high degree of variability, but no trend in either overall amount or seasonality of rainfall." According to the paper, the extreme Mekong floods and droughts were not caused by climate change, as many reports claimed, because there is "no convincing evidence" that they occur with frequency and outside of the range of "normal" climate variability. The study made a clear distinction between natural climate variability and climate change, which is important for water management (International Water Management Institute (IWMI) 2010).

In March 2012, another Working Paper on "The Impact and Management of Floods and Droughts in the Lower Mekong Basin and the implications of Possible Climate Change" prepared for the Mekong River Commission (MRC) made three findings that showed no certainties of climate change in the Lower Mekong Basin. First, there is little if any statistical evidence in the hydrometeorological record over the period 1925–2005 of climate change in the LMB. Second, many IPCC-projected climate change scenarios showed a lack of understanding of "natural weather cycles" that are generally apparent in any period of hydrometeorological

data of reasonable length. Third, the changes to flood and drought behavior were "much more modest" than some climate change scenarios predicted. The impacts of floods and droughts would be different in the Mekong countries.

5.4.2 *Impact of Floods and Droughts in the Lower Mekong Basin*

The impacts of the annual floods during the period 2000–2008 varied and differed in terms of human casualties, damaged crops, and costs in Cambodia, Laos, northeast Thailand, and Mekong Delta. Generally during this period, the crops of Mekong Delta and Cambodia were extensively damaged by the floods, whereas northeast Thailand crops were not affected, except in 2005 when 39,500 ha were lost (Table 5.7).

The two most destructive regional floods occurred in 2000 in the south of the basin and in 2008 in the northern part. The floods of 2000, one of the worst Mekong floods characterized by extreme flooding and long duration, damaged 2.0 million hectares of crops in the Mekong Delta, 421,600 ha in Cambodia, 42,900 ha in Laos, and none in northeast Thailand (MRC Working Paper, Table 3.4, Annual Flood Impacts, 2000–2008, Lower Mekong Basin).

The 2008 flood season across the Lower Mekong Basin again illustrated a common feature of the regional flood hydrology which is extreme flooding in one part of the basin and average to below average conditions elsewhere. In August 2008, northeast Thailand experienced the worst Mekong River flooding in many decades. The Mekong River was reported to exceed its highest recorded level of 12.38 m in 1966, which inundated hundreds of homes and submerged many roads. The northern parts of the LMB between the Chinese border and Vientiane

Table 5.7 Annual floods and droughts in the LMB and Cambodia, Laos, northeast Thailand, and the Mekong Delta, 2000–2008 (Unit: Damaged crops in hectare)

Year	Cambodia	Laos	NE Thailand	Mekong Delta	LMB
			August–September		
2000	**421,600**	**42,900**		**2.0 M**	Worst flooding
2001	164,200	42,200			Worst flooding
2002	45,000	33,700			
2003					
2004	247,400	14,400			
2005	55,000	56,000	39,500		
2006	14,500	6900		14,700	
2007	9500	7500		46,400	
2008	18,900	28,500		28,500	

Source: MRC Working Paper, Table 3.4, Annual Flood Impacts, 2000–2008, Lower Mekong Basin, March 2012

witnessed flood levels not seen for almost 50 years, while further downstream in Cambodia and Vietnam, water discharges and levels were average at best (MRC (2009) Annual Mekong Flood Report 2008; Irin News 2008).

Unlike the 2000 floods, the severe drought of 2004–2005 inflicted losses in all regions of the Lower Mekong Basin. The drought damaged over 104,000 ha of rice in the Mekong Delta and affected 14 out of 24 provinces in Cambodia where rice production fell in all provinces. The drought was especially severe in Thailand where 63 of 76 provinces were affected while it caused minor reduction in dry season plantings in Laos (MRC Working Paper, Table 3.4, Annual Flood Impacts, 2000–2008, Lower Mekong Basin).

These devastating floods and droughts, whether they were attributed to climate change or not, did not affect all parts of the Lower Mekong Basin with the same intensity and impact. The Mekong Delta is most vulnerable to drought and saline intrusion which have caused extensive damages to agriculture and paddy fields due to its geographical position and exposure to the sea. At the other end, landlocked Laos is more protected from tropical storms and less affected by the recent droughts and floods than its neighbors due to its topography and low agricultural potential (4% arable land) (MRC Working Paper, Table 3.4, Annual Flood Impacts, 2000–2008, Lower Mekong Basin).

Much has been written on the subject of global warming and the associated increase in sea levels, and while predictions of timelines for sea level increases vary, all agree on the trend to higher sea levels. This issue affects primarily the Mekong Delta region which supplies more than half of all rice production in Vietnam. Unless some coordinated development and management of the Mekong is implementing, the Mekong Delta will eventually be completely submerged because it is barely 1 m above sea level and that within the next several decades there will be increased penetration of sea water into the Mekong Delta. Long before that occurs, rice production in the Mekong Delta will be severely affected as more and more paddy areas become infused with saline, rendering them unfit for rice production, leading to the destruction of the rice economy in the Mekong Delta.

5.4.3 El Niño and La Niña of the ENSO Cycle (2001–2016)

The whole Mekong region is also under the influence of the El Niño-Southern Oscillation (ENSO), a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the central and eastern tropical Pacific Ocean. ENSO occurs every few years (2–7 years) and has two opposite phases: El Niño, the unusual warming of the surface waters, and La Niña, the unusual cooling of the surface waters in the tropical Pacific. El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. Typically, El Niño occurs more frequently than La Niña (National Oceanic and Atmospheric Administration, US Department of Commerce).

These two events of unusual sea warming (El Niño) and sea cooling (La Niña) occur on an unpredictable basis and have a major influence on unusually severe flooding and drought, respectively, which, in turn, impacts rice production, primarily in the Mekong Delta. Published writing, so far, have put forward no basis as to why or when these events take place, except that they may be associated with the global warming issue. As a result, these two weather-related anomalies are included in the analysis because of their demonstrated ability to influence the weather, water resources, and rice production. Whether these two effects will increase in intensity as sea temperatures increase is not known, and no attempt is made to forecast if and/or when these events will take place in the future. It is enough to draw attention to the fact that when they are active, they pose significant threats to the future of rice production in the LMCs.

Since 2000, the Lower Mekong Basin has been inflicted by both El Niño (2002–2003, 2009–2010, and 2015–2016) and La Niña (2000–2001, 2007–2008, and 2010–2011). These warm and cool events upset the regular seasonal farm cycle. During El Niño, the rainfall is generally below average and the flood season shorter than average, resulting in record droughts in 2010 and 2015. During La Niña, the rainfall is generally above average and the flood season longer than average, leading to the major flood years of 2001 and 2011 in the Lower Mekong Basin. Due to lack of accurate information and sporadic statistical data, we focus only on the worst floods (2001 and 2011) and droughts (2010 and 2015).

5.4.3.1 Impact of La Niña Floods in 2000–2001 and 2010–2011

The floods of 2000–2001 and 2010–2011 were among the worst Mekong River floods in the first 15 years of the new millennium. According to the World Bank's estimate, the flood of 2011 ranked as the world's fourth costliest disaster as of 2011, surpassed only by the 2011 earthquake and tsunami in Japan, the 1995 Kobe earthquake, and the 2005 Hurricane Katrina (Wikipedia 2011 Thailand floods).

La Niña Floods 2000–2001

The 2000–2001 floods in the Lower Mekong Basin caused serious physical and structural damages and affected more than 530,000 people. The populations living on the banks of the Mekong River and in the Mekong Delta were not prepared for such unpredictable and disastrous flooding which submerged houses, inundated schools, and damaged agriculture lands. According to government figures, the LMB incurred substantive losses of paddy production: 157,809 hectares of rice field were affected, 56,327 ha of rice destroyed, and 2200 ha seedlings lost (International Federation of Red Cross, August 2001).

La Niña Flood 2011

Ten years later, the LMB was hit by the flood of 2011 which was the worst catastrophic flood inflicting human deaths including children, property losses, and extensive rice field damages. The Mekong River exceeded its previously recorded highest level of 12.38 m in 1966, overflowed its banks and inundated villages and farmland in the four Lower Mekong River basin countries. Flooding was deep and intense due to La Niña event, and the economic cost was very high in all four basin countries, particularly in northeast Thailand and the Mekong Delta in Vietnam. In Cambodia, the National Committee for Disaster Management of Cambodia estimated the cost of destruction at US$521 million with 220,000 ha of rice fields destroyed. In Laos, the value of losses and damages amounted to about US$65 million, according to the National Disaster Management Office (MRC, Annual Mekong Flood Report 2011).

The flooding in Thailand was ranked as the worst ever which also hit northeastern provinces. The floods inundated homes and farmland in the northern province of Chiang Rai all the way to the northeastern province of Nakhon Phanom. In the northeastern province of Nong Khai, the river level was measured at 13.20 m on August 16, 2011, according to the Water Resources. The Mekong and its major tributaries Mae Mun and Mae Chi have all experienced flooding in 2011. In Khon Kaen Province alone, the floods destroyed close to 56,000 hectares of land and stranded 315 families.

In Vietnam's Mekong Delta, floodwaters in the Tien River and the Hau River, two tributaries of the Mekong, rose quickly and inundated the best rice-producing provinces of the delta (An Giang, Dong Thap, Long An, Hau Giang, and Kien Giang). Water levels increased by 3–4 cm daily and over 26,000 hectares of rice paddies were submerged from rapidly surging floodwaters on September 27. In the Long Xuyen Quadrilateral, hundreds of hectares of autumn and winter rice were submerged throughout Kien Giang Province. Farmers in Dong Thap Province's flood-hit districts had to harvest rice manually because machines could not operate in submerged fields (*Viet Nam News*, September 13, 2011).

5.4.3.2 Impact of El Niño Droughts in 2010 and 2015

The droughts of 2010 and 2015 were linked to El Niño, although some regional officials and rice producers also put the blame on the mainstream dams in China, which will be discussed in the next section. The latest El Niños during 2015–2016 were the hottest years on record and the worst droughts. According to the Oceanic Niño Index, the 2015–2016 El Niños were ranked very strong and will become one of the longest El Niños in the past 60 years since there were detailed observations of the ENSO phenomenon (Golden Gate Weather Services 2017).

El Niño Drought 2010

The 2010 drought was characterized by significantly lower than average water levels on the Mekong River largely as a result of the rainy season ending early and a precipitous drop in water flow upstream. The drought affected the socio-economic development of the LMCs and postponed the paddy rice planting and harvesting in the dry season. However, the cost of this record drought on the Lower Mekong Basin is difficult to measure for lack of reliable data and because the lack of rain did not cause deaths, displace families, damage community infrastructure, or destroy properties to the same magnitude afflicted by the 2000 and 2011 floods. The poor people and farmers in the rural areas were most vulnerable to lack of quantity and quality water for domestic consumption, daily activities, and rice cultivation.

In addition to the drought, the Mekong Delta faced a saline intrusion during the dry season, a greater danger that did not affect the other provinces of the LMB. Declining water flows from the Mekong River allowed salt water to reach as far as 50–60 km upriver, whereas in normal years salt water reached only as far as 30 km inland. About one-third of the Mekong Delta's population lacked drinking water. Many farmers used groundwater for crop cultivation and aquaculture, which was depleted in some areas due to excessive groundwater exploitation. The drought and salt water damaged about half of the 1.5 million ha of winter-spring rice crop in the southern coastal provinces (Cosslett TL and Cosslett PD 2014).

El Niño Historic Drought 2015–2016

The 2015–2016 El Niño weather event was one of the most powerful on record which caused considerable impact in all continents, according to the World Meteorological Organization. In 2015, the Mekong River water was at its lowest level since records began nearly 100 years ago. The 2015–2016 drought affected socio-economic activities, agricultural sector, paddy farming, and rice production. The four LMCs experienced a record heat and the worst drought in many decades. In Vietnam, the intensity of the current El Niño was considered equivalent to that in 1997–1998, and in Thailand the drought was the worst disaster for 1 year. In Cambodia, the Tonle Sap was just 50 cm deep, compared to its usual depth of between 1.2 and 1.5 m at the same time in previous years. In Laos, farmers in the northwestern Lao province of Xayaburi are being particularly hard hit during the drought. The prolonged lack of rain, combined with temperatures far above the average, has driven many farmers in certain rural areas of Cambodia, Laos, and Vietnam to leave fields and rice paddies uncultivated. The impact was greatest in the Mekong Delta due to its location at the tip of the Mekong River and its exposure to the sea.

Vietnam recorded the lowest water level of the Mekong River in 90 years since 1926 and the longest drought in the century (from late 2014 to mid-May 2016). Farmers suffered major crop losses due to severe drought and salt water contamination of agricultural land in the Mekong Delta and its 12 provinces. Salinity in the

Mekong Delta has been a growing problem for Vietnam's rice bowl and has been made worse by rising sea levels pushing salt water upstream. Saltwater intrusion appeared 2 months earlier than previous years due to serious river water shortages. Salinity has encroached 40–93 km into major rivers of the delta. According to the Minister of Agriculture and Rural Development, the drought damaged over 200,000 tons of rice resulting in a loss of about $44.64 million to the region. In the winter-spring crop of 2015–2016, more than 339,200 ha of rice in the coastal Mekong Delta provinces were contaminated by saltwater intrusion and drought, accounting for 35.5% of those localities' rice area and 21.9% of the region's total rice area. Officials said dealing with salinization in the Mekong Delta is a matter of life and death as the region provides more than half of rice for the country, as well as 70 percent of fruit and seafood supply (VietnamNet, 17/02/2016, Mekong Delta: Salt intrusion a once-in-a-century disaster).

In Thailand, the worst drought in 10 years caused great damage to its agricultural sector, rice production, and export. In 2015 the rice production dropped to 19.0 million tons (milled basis) down from 21.7 million tons in 2014; and 2015 exports decreased to 9.8 million tons (milled rice) from 11.0 million tons in the previous year. This severely hurt the rice industry, which had already lost its substantial market share to countries such as Vietnam and India in the last 5 years. In February 2016, the Prime Minister told farmers to cultivate less rice to help the country manage its intensifying water crisis (Channel NewsAsia, February 24, 2016).

5.5 Mekong Mainstream Dams in China

Since the end of World War II, the Mekong River has been a subject of several technical investigations for hydropower development, irrigation, and flood control. Currently there is a cascade of 25 dams on the Mekong River mainstream in various stages of planning, construction, and operation. Of the 25 mainstream dams, 14 hydropower plants are located on the Upper Mekong River in China, and 11 hydroelectrical projects are proposed for the Lower Mekong River, in a study on the Mekong Mainstream Run-Of-River Hydropower released by the Mekong secretariat in December 1994. This section examines the development and impact of China's Mekong River mainstream dams on freshwater quality, water flows, and sediment transmission for agricultural and rice productivity in the Lower Mekong Basin (MRC 1994).

5.5.1 Mekong Mainstream Dams in China

In the 1980s, China started its ambitious hydropower development on the Lancang River considered as one of the country's hydropower bases, specifically its "west-to-east" electricity transfer strategy to develop the western region and send

electricity to the populated eastern areas. The plan was to build a cascade of 15 dams on the Lancang River, in Yunnan province, that will have a total electric power generation capacity of 25,000 megawatts (MW) when completed in 2020 (Table 5.8).

The Lancang River is divided into three parts. The river in Tibet is called upper reach, the middle reach is from the boundary of Tibet and Yunnan to Miaowei, and the lower reach is from Miaowei down to the border of China with Laos and Myanmar. Seven hydropower dams were planned for the middle reach and eight hydropower dams for the lower reach of the Lancang River (Peng Cheng 2008).

In 1986, China began the construction of Manwan Dam, its first hydropower plant that has a total power capacity of 1550 MW and a total reservoir capacity of 920 million cubic meters. By the end of 2015, six dams were completed and operational, five under construction, two planned, and one (Mengsong) canceled in 2010. As indicated in Table 5.8, the six completed dams have a total power capacity of 15,600 MW. Ganlanba is the smallest dam without storage and the last one in the lowest part of the Lancang River. The biggest hydropower plant is the Nuozhadu Dam which was fully operational in June 2014 and became China's fifth

Table 5.8 Mainstream dams in the Mekong-Lancang River

Dams	Status	Total power capacity MW[a]	Total reservoir million m^3 [b]	Height meter
Mainstream dams in the middle reach of the Lancang River				
Gushui	Planned	1800	N/A	220
Wunonglong	Under construction preparation	990	212	137
Lidi	Under construction preparation	420	N/A	74
Tuoba	Planned	1400	N/A	158
Huangdeng	Under construction preparation	1900	1613	203
Dahuaqiao	Under construction	900	N/A	106
Mainstream dams in the lower reach of the Lancang River				
Miaowei	Under construction preparation	1400	660	139.8
Gongguoqiao	Operational 2012	900	120	105
Xiaowan	Operational 2010	4200	15,043	292
Manwan	Operational 2007	1550	920	132
Dachaoshan	Operational 2003	1350	940	118
Nuozhadu	Operational 2014	5850	21,749	261.5
Jinghong	Operational 2010	1750	249	118
Ganlanba	Planned	155	-0-	60.5
Mengsong	Canceled in 2010			

[a]Source: MRC, The ISH 0306 Study, First Interim Report – Final, December 2015
[b]Wikipedia, List of major power stations in Yunnan, List of tallest dams in the world, List of the largest hydroelectric power stations by generating capacity, International Rivers, as of December 2014

biggest hydropower project with a generating capacity of 5850 MW. Xiaowan is the second biggest hydropower plant with a generating capacity of 4200 megawatt and ranks the world's third highest arch dam at 292 m. The total reservoir capacity of the six completed dams with water storages amounted to 39,021 million m^3. Nuozhadu Dam has a reservoir capacity of 21,749 million m^3, and Xiaowan Dam with a reservoir capacity of 15,043 million m^3 can store more water than all the Southeast Asian reservoirs combined (UNEP-AIT 2009).

5.5.2 Impact of Chinese Dams in the Lower Mekong Basin

China's cascade of 15 mainstream dams on the Mekong River shared by six nations was planned and constructed without consulting with the downstream riparian states and without fully disclosing water data and information on the construction and operation of the dams (Cosslett TL and Cosslett PD 2014). Due to China's lack of transparency and information on its dams, many riparian communities in the LMB blamed China's dams for the frequent and severe droughts and floods that occurred since the new millennium. Many experts on the Mekong River have raised grave concerns about the effects of dam construction on the river's freshwater quality and quantity, changes in river flow volume and timing, and transmission of nutrient sediments for agriculture downstream. In particular, the Xiaowan and Nuozhadu mainstream dams have been the subject of criticism and studies due to their impacts on the Mekong River water resources, ecological systems, and natural resources for the people living in the Lower Mekong Basin.

In May 2009, the United Nations Environment Programme (UNEP) and the Asian Institute of Technology (AIT) released a report stating that China's construction of big hydropower dams on the Mekong River will be a considerable threat to the future of the river, a significant freshwater source for people of Cambodia, Thailand, Laos, and Vietnam. The report pointed out that Xiaowan's reservoir capacity alone can reduce the water volume and the running speed of water and negatively impact water quality and biodiversity in the Mekong River (UNEP-AIT, May 2009).

In May 2011, a Water Paper on the Mekong River Basin and the Role of the MRC published by the World Bank stated that large hydropower schemes influence the river flow regime and flood pulse, which affect downstream water in many ways. In the dry season, reduced flow from upstream (because water is stored behind dam) can substantially deteriorate water availability downstream causing drought and saline intrusion. On the other hand, in the monsoon rainy season, storing water upstream can help flood control in downstream areas. Changes in the river flood pulse, the water storage, and sediment load can negatively affect agriculture and fisheries (WB Water Papers, Resilience to climate change-induced challenges in the Mekong River Basin, The roles of the MRC, May 2011).

The issue of sediment discharge of the Mekong River is critical for the rice production in the Mekong Delta because sediments bring nutrients, mineral-rich

alluvial deposits, and fertile soils. Dams are highly efficient at trapping sediments. International experts and scientists from the University of Singapore and the National Institute for Environment Studies in Japan who studied the impact of Manwan on sediment discharge downstream before and after its construction agreed that the Manwan Dam construction is a key factor in changing the seasonal hydrodynamics and a reduction of sediment, but they differed about its significance or magnitude. Japan's National Institute for Environment Studies found that after construction of the dam, there was a moderate decrease in peak discharge volume and during the rainy season in August and September and a corresponding increase in the subsequent months. Accordingly, sediment transportation loads were increased in months after the rainy season. The suspended sediment transportation in Chiang Sean was increased from 21.13 to 27.90 (M ton/year).

The National University of Singapore study on the impact of the Manwan hydropower dam in China in the Mekong Delta showed that before the dam was built, 160 million tons of sediment flowed to the delta each year. Since the dam was put into operation, the figure has dropped to 75 million tons. A World Bank study on the Mekong Delta in 2011 indicated that when China's six mainstream dams are fully operational, there would be a significant change in water flow and flood pattern and a reduction of about 50% from the pre-dam sediment level of 160–165 million tons per year (WB May 2011, Climate change on the Vietnam Mekong Delta: expected impacts and adaptations; Lu XX et al. 2006).

Thus, when the record drought of 2010 and the historic drought of 2015–2016 combined with the low record level of the Mekong River inflicted extensive damages to agriculture, rice farmers and villagers in Cambodia, northeast Thailand, and the Mekong Delta blamed China's mainstream dams for restricting the volume and flows of water downstream and reducing sediment loads needed for rice production. In March 2016, Mr. Montree Chantawong from the Foundation for Ecological Recovery said at the press conference in Bangkok that governments of Mekong Basin countries should really take an interest in the prolonged problems caused by Chinese dams for people in downstream countries. He added that they should "urge China to minimise the impacts from their dams, apologise for their action to change the river ecology and remedy the affected people who have suffered from the effects of Chinese dams for more than 20 years" (Nation, March 24, 2016, China should compensate victims of dams).

In Vietnam, the Mekong Delta suffered not only the drought but also salt water intrusion. According to Mr. Nguyen Ngoc Thien, an expert on the Mekong Delta, if all hydropower dams were operational, water would be stored to generate electricity. Consequently, the Mekong Delta would bear the double disaster of lack of freshwater and intrusion of salt water. Mr. Thien also stipulated that Chinese hydropower dams would lead to a 50% reduction in the alluvium volume to Mekong River Delta, from 75 million tons to 42 million. He warned that the sediment decrease would pose a serious risk of "Mekong Delta disintegration."

According to Mr. Duong Van Nhi from Can Tho University, "Deltas will die if they are not fed with sediment" (VNNet, June 29, 2016).

5.6 Conclusion

The Lower Mekong Basin is the most diverse subregion of Southeast Asia with a population of about 66 million, known as the world's largest inland fishery, and rich in natural resources, which all depend upon the Mekong River and its tributaries for water resources, food security, and livelihoods. The LMB area represents about 51% of the total area of the four Mainland Southeast Asia countries of Cambodia, Laos, Thailand, and Vietnam, but accounted for 57% of the total paddy rice produced by these four countries in 2014. This demonstrates the significant contribution of the LMB rice production to food self-sufficiency and rice export of Cambodia, Laos, Thailand, and Vietnam. In recent years, the LMB rice productivity has faced major threats that are likely to affect the availability of freshwater resources, a vital commodity in the production of rice and in the socio-economic development of the LMB and the four LMCs of Cambodia, Laos, Thailand, and Vietnam.

The chapter has identified three major factors that have disastrous impacts on the LMB rice production: one, climate change and the outlook for global warming and associated sea level increases; two, the El Niño and La Niña events that have been shown to be causative factors in some of the severe flood/drought annual weather cycles; and three, the construction and operation of China's mainstream dams on the Lancang River that have changed water flow regimes in downstream countries.

Of the three factors identified, the construction of dams on the Mekong River appears to pose the most imminent threat to both the near-term and the long-term sustainability of rice production in the Lower Mekong Basin. The operation of the current six mainstream dams in China has already resulted in the reduced water flows and sediment deposits from the Mekong River into the Lower Mekong Basin with cumulative effects on rice production. This is of particular importance during the January–April "dry" season when water flows from the Tibet Plateau are at a minimum and any restriction of water flows has the twofold impact of both limiting essential water supplies for the key rice-producing months and allowing increased penetration of seawater into the rice-growing paddy areas of the Mekong River Delta because of reduced freshwater flows into the South China Sea.

A further concern among the LMCs of Cambodia, Laos, Thailand, and Vietnam is that China may divert some water from the Mekong River into its northwestern agriculture-growing areas. Such a step would further aggravate and limit the supply of water from the upper reaches of the Mekong River with the potential for a major threat to rice production in the LMCs.

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Chapter 6
Mekong Regional Cooperation and Development of Water and Rice Security

Abstract The Mekong River has been a source of regional cooperation and conflict. It is a catalyst for cooperation among Cambodia, Laos, and Thailand, and Vietnam when they created the Mekong River Commission (MRC) to develop the Lower Mekong Basin (LMB) in 1995. But, the Mekong is also a cause of conflict when a riparian country takes a unilateral approach to development, as in the case of mainstream dams constructed by China and Laos.

In addition to the Mekong River Commission, there are four major Mekong regional cooperation frameworks launched and supported by an international organization and three great powers to strengthen regional cooperation, bring economic growth, social change, and political stability in this region. The Greater Mekong Subregion was created by the Asian Development Bank in 1992; the Lower Mekong Initiative was formed by the United States in July 2009; the Mekong-Japan Summit was organized by Japan in November 2009; and the Lancang-Mekong River Cooperation Mechanism was led by China in March 2016.

The chapter is organized in four sections. The first section presents the MRC, its structure and its core programs. The second section analyzes the MRC effectiveness in reviewing the Mekong dam projects of Laos and in resolving disputes among the members regarding the dam impacts in the LMB. The third section describes the Mekong regional cooperation frameworks, their purposes and cooperation areas. The last section examines China's role in Mekong regional cooperation for the sustainable development of water and rice in the region.

Keywords MRC: Structure • Secretariat • Financial contribution • Basin Development Plan • Irrigation and Agricultural programs • Procedures for water utilization and inter-basin diversions • Procedures for notification • Prior consultation • Agreement • Assessment • Run-of-River hydroelectric projects • Lower Mekong mainstream dams • Mekong regional cooperation frameworks • Greater Mekong subregion • Lower Mekong initiative • Mekong-Japan summit • Lancang-Mekong cooperation mechanism • China: Role in Mekong regional cooperation

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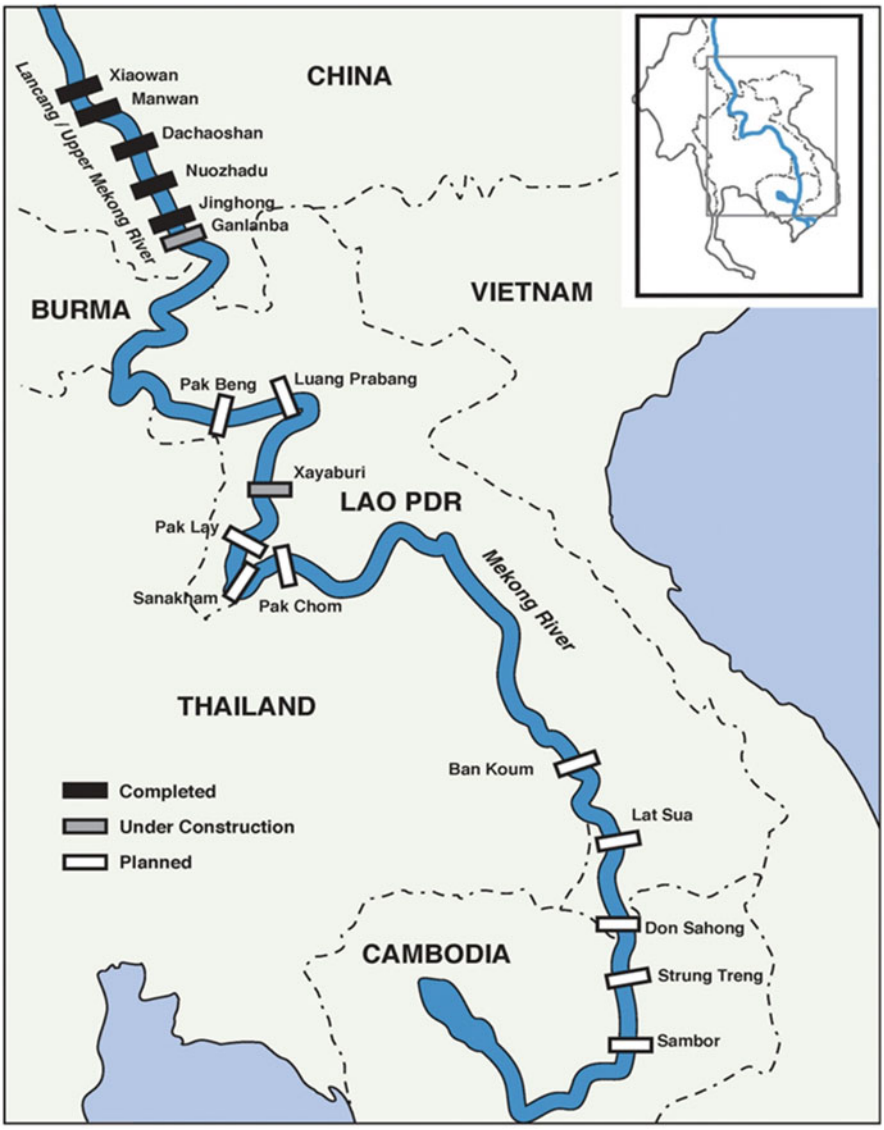

Lower Mekong Mainstream Dams (Source: International Rivers, The Lower Mekong Dams Fact Sheet, Thursday, March 28, 2013)

6.1 The Mekong River Commission

The Mekong River Commission (MRC) is an intergovernmental organization created to implement the "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin" (hereafter referred to as the Agreement) signed on April 5, 1995 by the four riparian states of Cambodia, Laos, Thailand, and Vietnam. Although the Agreement covers the entire Mekong River Basin, China and Myanmar decided not to join but to participate as "Dialogue Partners." The mission of the MRC is "to promote and coordinate sustainable management and development of water and related resources for the countries' mutual benefit and the people's well-being." This section explains the MRC structure, the Basin Development Plan, the irrigation and agriculture program, and the procedures of water use and diversion for agriculture and rice culture.

6.1.1 MRC Structure

The MRC structure is composed of three permanent bodies: the Council of Ministers meeting once a year, the Joint Committee of governmental department heads meeting twice a year and reporting to the Council, and the Secretariat performing technical and administrative functions under the management of the chief executive officer (CEO). In addition to these three bodies prescribed by the Agreement, the MRC operational structure includes the National Mekong Committees established under the national laws and regulations of each MRC member and the Donor Consultative Group composed of donor countries and development partners that funded the MRC programs and projects.

At the first MRC Summit held in Hua Hin, Thailand, in 2010, the heads of governments of Cambodia, Lao PDR, Thailand, and Vietnam decided that the MRC Secretariat would be financially self-sustained by the member countries by 2030. They also encouraged the MRC to explore modalities for the transfer of some river basin management activities to the member countries, particularly their implementation and financial responsibilities. This was the start of the ongoing organizational structure for the Secretariat in an effort to make a leaner and more efficient MRC.

Up until December 2015, the Secretariat was headed by a non-riparian CEO with about 150 staff members based in two offices: one in Phnom Penh, Cambodia, and the other in Vientiane, Laos. In an effort to streamline and decentralize the operational structure, the MRC Council reorganized the Secretariat at its 22nd meeting, in January 2016. It appointed Mr. Pham Thuan Phan of Vietnam, as the first riparian CEO of the Secretariat since 1995, who has extensive managerial experience in international organizations and the private sector. The appointment was part of the riparianization process to make the organization financially self-sustained by the member countries by 2030 (MRC, News and Events, first riparian chief executive officer).

Another organizational reform concerns the physical location of the Secretariat which has changed several times. Initially based in Bangkok, the MRC Secretariat relocated in Phnom Penh in 1998 and moved to Vientiane in 2004. In 2010 the Secretariat Office in Phnom Penh was reopened after the decision had been made to decentralize the Secretariat into two permanent offices. In January 2016, that decision was reversed and the Secretariat will operate out of one single office based in Vientiane, Laos. The MRC Regional Flood Management and Mitigation Centre, opened in 2008, will remain in the Cambodian capital, Phnom Penh. The purpose of this office consolidation is to create a leaner and more efficient organization with a staff of 64 (down from 180) full-time, fixed-term workforce to carry out core river basin management functions for the new strategic plan 2016–2020 (MRC, governance and organizational structure).

6.1.2 MRC Basin Development Plan

The Basin Development Plan (BDP), a core program of the MRC, is the general planning tool and process which the Joint Committee would use as a blueprint to "identify, categorize, and prioritize projects and programs that seek assistance for and to implement the plan at the basin level" as stipulated in Article 2 of the Agreement. In June 1995, the Joint Committee established the first permanent technical subcommittee to assist in monitoring the formulation of the BDP. It was an enormous cooperative joint undertaking of the MRC that required active participation of the four members, continuity and consistency of the basin planning work, advanced technology and latest achievements in basin/national planning, solid foundation of the basin development knowledge, and core human resources for the basin development planning process (MRC, Annual report, 1995).

Formulated in 2001, the BDP was a most comprehensive basin-wide plan for a sustainable development of water resources in the Lower Mekong Basin. The planning process consisted of five stages: analysis of the region, national and subnational plans, analysis of development scenarios, strategy formulation, and compilation of lists of programs and projects. Moreover, instead of a project-to-project approach, the MRC adopted a new 5-year plan strategy which involved a continuing process of review to respond to changes in the internal and external environment. The first 5-year strategic plan (2001–2005) sets goals related to water use and interbasin diversions, environmental and socio-economic systems, and organization strengthening, including a knowledge base and modeling capability and building relationships. (Mekong River Commission (2013), Mekong Basin Planning: The Basin Development Plan Story).

The second strategic plan (2006–2010) emphasized the role of the MRC, which was to support the member states for "more effective use of the Mekong water and related resources to alleviate poverty while protecting the environment." The focus was on water development at national and regional level to respond to growing population and higher demand for water, food, and energy. The primary

achievement was the Basin Development Strategy, which described strategic priorities for basin development as well as for basin management and identified development opportunities to implementation. The Strategy highlighted water development to help reduce poverty and grow the economy of the LMB.

The third strategic plan (2011–2015) was developed after the MRC Summit of April 2010 and marked the move toward cooperation on water development and management and toward comprehensive basin planning, not national or sectoral planning. It focused on integrated water resources management (IWRM), implementation of core functions, and increased contribution of member countries. It was supported by four specific goals and one organization goal that included full riparianization of the Secretariat. The specific goals were application of IWRM basin-based development and related sector strategies, operational systems for basin-wide monitoring, forecasting and knowledge management to support effective decision making, coordination with stakeholders, and capacity building.

The current IWRM-based BDP strategy (2016–2020) recognizes the dynamic changes in the Lower Mekong Basin and takes a long-term approach to deal with water security challenges, including flood, drought, climate change, hydropower, irrigation, fisheries, and industrial development. This updated Basin Development Strategy is further guided by the declaration of the second MRC Summit held on April 5, 2014 in Ho Chi Minh City, Vietnam, in which the heads of governments of the member countries reaffirmed their commitment to implement the 1995 Mekong Agreement and consolidate the spirit of Mekong cooperation and set a number of priority areas for action.

The development priorities for the BDP strategy 2016–2020 include tributary hydropower development, expansion of irrigated agriculture, mainstream hydropower development, and other opportunities that will be updated later based on the results of implementation of the strategy. The priorities are specifically aimed at identifying "optimal" and sustainable development pathways that could increase regional benefits, reduce regional costs, minimize adverse transboundary impacts, and provide water-related security in an equitable manner through cooperation.

6.1.3 MRC Irrigation and Agriculture Program

Agriculture constitutes the predominant economic sector, and irrigation development is essential for the agricultural long-term growth in the LMB. Increased productivity of existing agricultural land areas, especially in northeast Thailand, the Vientiane plain in Laos, Cambodia's Tonle Sap, and Vietnam's Mekong Delta, depends on expanding irrigation water supplies to confront climate change, severe floods, and droughts. There should be an integrated or coordinated irrigation system and procedures or rules on the water diversions to reduce the impact of climate change on rice production. This section assesses the MRC role in irrigation development to improve agricultural and rice production.

Despite the fact that rice is the largest water user in the LMB and the most important contributor to the LMB economy, the MRC programs on agriculture, irrigation, and agricultural water management and development have not received the same priority and urgency given to other programs of the basin development planning, in part because of the complexity of rice crops being grown in many different ecosystems. Although the irrigation and agriculture program was approved by the MRC Council in 2000, work on developing an agricultural strategy began only in late 2008 and focused on water use efficiency in irrigated agriculture to promote more efficient practices and encourage better management in time of drought.

The Strategy Paper, published in September 2009, called for a more active role of the MRC in agriculture and stressed that future agricultural activities should focus on agricultural water management, irrigation, and drainage management and development at the basin scale, among other programs. Improvement of agricultural water management would be a key factor in securing food supplies for increased future demand, as well as reducing poverty in rural areas by enhancing farmers' livelihoods. Upgrading irrigation systems to address deterioration, improving efficiency of use, expanding irrigation area, and preparing for future severe conditions due to climate change would be issues to be addressed by member countries from a basin-wide perspective.

Irrigation became a pressing issue in 2010 when the LMB was hit by a severe drought. Effective management of water for agriculture as part of drought management strategies was one of the emerging challenges noted in the declaration issued by the Prime Ministers of the four riparian countries at the first MRC Summit at Hua Hin, Thailand, in 2010. Irrigation has been shown to improve rice yields, paddy production, rice export, and farmers' income. However, an expansion of irrigation areas without planning and coordinating may cause water deficits or negatively affect water quality due to intensive cultivation and use of fertilizers or chemicals. In addition, irrigation has its own technical and financial problems and risks which include incomplete network, users' low satisfaction with water delivery, low rate of fee collection, poor maintenance, and early deterioration. Therefore, irrigation projects for agricultural water development should be a joint technical and financial collaboration of all the MRC member countries. The effectiveness of irrigation projects should be evaluated and appropriate guidelines should be developed for improving irrigation efficiency in paddy fields.

6.1.4 MRC Rules of Procedure for Water Utilization and Interbasin Diversions

A bigger challenge for the MRC is the water diversion from the Mekong River which reduces the water flows downstream. Since 2001, the MRC member states have approved five rules of procedures for water utilization of the Mekong River in

a reasonable and equitable manner. They were mentioned as a major achievement after 20 years of cooperation "on the basis of sovereign equality and territorial integrity in the utilization and protection of the water resources of the Mekong River Basin" (Article 4 of the 1995 Agreement). The five procedures are:

1. Procedures for data and information exchange and sharing, November 2001
2. Procedures for water use monitoring, November 2003
3. Procedures for notification, prior consultation, and agreement, November 2003
4. Procedures for the maintenance of flows on the mainstream, June 2006
5. Procedures for water quality, January 2011

Of the five procedures, two were tested for the principle of reasonable and equitable use of water resources during the severe drought of El Niño 2015–2016 and the review of Xayaburi and Don Sahong mainstream dams in the Lower Mekong Basin. They are the procedures for water use monitoring (PWUM) and the procedures for notification, prior consultation and agreement (PNPCA), which entered into force on the same date, November 30, 2003.

6.1.4.1 The Procedures for Water Use Monitoring

The Rules of Procedure for Water Use Monitoring define "water use/utilization any water which may have a significant impact to the water quality or flows regime of the mainstream of Mekong River System by any member state." The goal is to promote better understanding and cooperation among the member states through transparency and confidence in the water use monitoring system. The operation and management of the monitoring system involve the MRC Joint Committee, the MRC Secretariat, and the National Mekong Committees (NMCs). The technical guidelines published in 2006 require that the respective NMCs provide data and information on interbasin water diversions, according to Section 3 on Mechanism for Monitoring of Interbasin Water Diversions.

However, this procedure was not always implemented in all cases of water diversions by a MRC member country. A recent case occurred in January 2016, when Thailand diverted water from the Mekong River into its waterways without reporting data and information to the MRC and the NMCs. Four temporary pumps removed a reported 47 million cubic meters of water out of the Mekong River and into the Huai Luang River, in Thailand's Nong Khai province which was severely hit by the drought. Thailand's failure to consult with MRC member countries and obtain their agreement about its diversion of the Mekong River mainstream demonstrates the lack of enforcement of the rules of procedures and a disregard of the principle of mutual benefit. According to Dr. Vo Tong Xuan, a leading rice expert, water diversion from the Mekong River reduces the low water discharge downstream needed for irrigation and creates problems for the Mekong Delta which requires heavy freshwater resources for its high-yield rice

(VNNet, February 14, 2016 Thailand diverts Mekong, Vietnam worries about rice production).

6.1.4.2 The Procedures for Notification, Prior Consultation, and Agreement

The procedures for notification, prior consultation, and agreement involve three successive and separate steps with specific time frames and documentation: First, notification must be provided by a member country to the MRC Joint Committee in a timely manner on its proposed use of water according to prescribed format and content. Second, prior consultation must include timely notification by the member country, plus additional data and information, to the Joint Committee, which would allow the other members to discuss and evaluate the impact of the proposed use upon their uses of water and any other effects, which is the basis for arriving an agreement. Prior consultation is neither a right to veto the use nor unilateral right to use water by any riparian without taking into account other riparians' rights. Third, agreement has the objective to achieve an optimum use and prevention of waste of the waters through a dynamic and practical consensus. The key principles of the procedures are sovereign equality and territorial integrity and equitable and reasonable utilization.

In August 2005, the MRC published the Guidelines on Implementation of the PNPCA which were used to review the proposed mainstream dams of Xayaburi and Don Sahong in Laos. The MRC review of these two mainstream dam projects in compliance with the PNPCA and Guidelines will be discussed in detail in the following section on the mainstream dams in the Lower Mekong Basin.

6.2 Mekong River Commission Review of Lower Mekong Mainstream Dams

The planning, construction, and operation of Lower Mekong mainstream dams have been a most controversial development of the Lower Mekong River Basin and a most critical test of regional cooperation. This section will look into the Xayaburi and Don Sahong dams built by Laos in the Lower Mekong Basin in spite of strong objections raised by Vietnam, Cambodia, and Thailand; the MRC review of the two proposed dams in accordance with its procedures for notification, prior consultation, and agreement and guidelines for implementation; the assessment of the MRC effectiveness in resolving disputes; and the commitment and cooperation of the MRC countries in the field of hydropower to "optimize the multiple-use and mutual benefit all riparians and to minimize the harmful effects that might result from natural occurrences and man-made activities," as stipulated in Article 1 of the Agreement.

6.2.1 Proposed Mainstream Dams in the Lower Mekong River

Since the end of World War II, there have been several surveys and technical investigations undertaken by the United Nations Economic Commission for Asia and the Far East, the United States, Japan, and France to develop the Lower Mekong River for hydropower, irrigation, and flood control. The last study, funded by UNDP and the government of France and released in December 1994, focused on the Mekong mainstream run-of-river hydropower and selected 12 sites for investigations, including Thakho, the 12th project on the list that is a river diversion.

The "run-of-river" hydroelectric projects generally fall into two categories: those without storage reservoirs and those where a small storage reservoir is included. Those hydroelectric generating dams without a storage reservoirs are generally viewed as providing power only when river flows are adequate and shut down when river flows are too low. On the other hand, those run-of-river dams that include a small reservoir for water storage are generally designed to provide a "base load" of power, and the reservoir is there to ensure there is a constant supply of water for the turbines even when water flows are low (Wikipedia, 2016).

Thus, the proposed hydroelectric dams along the Lower Mekong mainstream are much smaller in size with a maximum height of 76 m and a total power capacity of 13,377–15,534 MW, compared with China's Xiaowan Dam alone that is 292 m high with a power capacity of 4200 MW and a reservoir capacity of 15,043 million m^3. After some modifications, 11 mainstream dams were listed for consideration: seven in Laos, two on the border between Laos and Thailand, two in Cambodia, and none in Vietnam, as indicated in Table 6.1. The twentieth century ended with no mainstream dams build on the Lower Mekong River.

Starting the new millennium, the four riparian states of Cambodia, Laos, Thailand, and Vietnam have shown interest in exploiting the natural resources of the Lower Mekong River to deal with increasing energy demand, population growth, food production, and socio-economic development. In 2006, Laos, where the river serves as a long border with Thailand, took the first steps in building dams on the Mekong mainstream primarily to generate and sell electricity to Thailand and use foreign exchange earnings to promote the country's socio-economic development. The first two hydropower projects chosen for planning and implementation were Don Sahong and Xayaburi in Southern and Northern Laos, respectively. Both projects pose serious risks to the Mekong River water resources, sedimentation, and fish migration and face strong criticism and public opposition from international river experts, ecologists, scientists, NGOs, and riparian communities whose livelihoods depend on the Mekong River.

Table 6.1 Proposed mainstream dams in the Lower Mekong River

Project	Country	Power capacity (MW)	Active storage (million m^3)	Reservoir Area (km^2)	Height (m)
Pak Beng	Laos	1230	442	87	76
Luang Prabang	Laos	1410	734	90	68
Xayaburi	**Laos**	**1285**[a]	**N/A**	**49**	**32.6**
Pak Lay	Laos	1320	384	108	35
Sanakham	Laos	700	106	81	38
Pak Chom	Laos-Thailand	1079	12	74	55
Ban Koum	Laos-Thailand	1872	0	133	53
Lat Sua	Laos	686	0	13	27
Don Sahong	**Laos**	**240**	**115**	**2.9**	**30**
Stung Treng	Cambodia	980	70	211	22
Sambor	Cambodia	2600	465	620	56
Totals		13,402	2553	1469	

Source: ICEM 2010, MRC strategic environmental assessment of hydropower on the Mekong mainstream, Final Report, October 2010

[a]Xayaburi's installed power capacity has been changed to 1285 MW from the original proposed 1260 MW

6.2.2 *Mekong River Commission Review of the Xayaburi Dam Project*

The Xayaburi Dam, located about 350 km upstream of Vientiane, is 32.6 m high and 820 m long, with a reservoir area of 49 km^2 and a capacity of 1.3 km^3. The power station has a total installed generating capacity of 1285 MW with a total annual electricity production of 7370 gigawatt hours (GWh). It will be the third biggest power station of Laos which has the vision to be the "battery of Southeast Asia." On May 4, 2007, the government of Laos signed a memorandum of understanding with Ch. Karnchang Public Company Ltd., Thailand's major construction company, for a feasibility study of the Xayaburi hydroelectric power project, which was completed in October 2008. The Environmental and Impact Assessment report was finalized in August 2010.

On September 20, 2010, the government of Laos submitted the documents on the Xayaburi project to the MRC Secretariat for review by Cambodia, Thailand, and Vietnam, in accordance with the 1995 Agreement. The proposed dam is subject to the procedures for notification, prior consultation, and agreement (PNPCA) which requires all members to jointly review any development project proposed for the mainstream with an aim to reach a consensus on whether or not it should proceed and, if so, under what conditions. According to the Agreement, prior consultation is neither a right to veto nor a unilateral right to use water by any riparian without

taking into account other riparians' rights. The consultation process normally takes 6 months and can be extended, if necessary.

On October 22, 2010, the Xayaburi PNPCA process officially started after all members had received copies of the documents submitted by Laos. The prior consultation process involved working group meetings, public participation, technical reviews, and report evaluations by the riparian members and experts. On March 24, 2011, the MRC Secretariat released its independent technical review of the Xayaburi Dam which identified significant gaps in Laos project documentation and recommended further collection baseline data and transboundary impact studies. On April 19, 2011, the MRC Joint Committee announced that the MRC members could not reach a consensus on how to proceed with the project and decided to take the prior consultation for the Xayaburi project to the ministerial level. On December 8, 2011, after discussion and evaluation of the impact of the proposed project upon the downstream riparian countries' uses of water and any other affects, the MRC Council concluded that there was a need for further study on the sustainable development and management of the Mekong River including impact from mainstream hydropower development projects.

While the PNPCA process was proceeding, the government of Laos signed a concession agreement with Xayaburi Power Company Limited (XPCL), a subsidiary of Thai construction company Ch. Karnchang Public Company Ltd., on October 29, 2010 to develop the project on a build, own, operate, and transfer (BOOT) basis. Under the agreement, XPCL designs, constructs, and operates the 1285 MW hydropower plant for a period of 29 years on the first day of commercial operation. At the end of the concession period in 2048, the entire project will be transferred to Lao PDR. In October 2011, the Electricity Generating Authority of Thailand signed a power purchase agreement with XPCL to purchase 95% of electricity from the Xayaburi Dam.

In March 2012, preliminary construction of roads and support facilities began at the Xayaburi Dam site. Cambodia's government immediately reacted to the announcement, threatening to take Laos to international court if they chose to build it unilaterally. On November 7, 2012, Laos broke ground on the US$3.8-billion Xayaburi project without waiting for the MRC Council's final decision. In April 2016, the project was considered to be nearly 60% completed and was expected to start commercial operations in 2019 as planned (MRC News and Events, MRC chief executive officer and German ambassador visit Xayaburi Dam site).

6.2.3 Mekong River Commission Review of the Don Sahong Dam Project

Don Sahong was the first run-of-river hydroelectric dam considered to be built on the Lower Mekong River. The proposed hydropower project is located at the

downstream end of the Hou Sahong channel between Don Sahong and Don Sadam islands, in Southern Laos. The dam is 30–32 m high and 100 m long, with a reservoir capacity of 2.9 km^3. Its total installed capacity would be 260 MW. Most of the produced electricity would be exported to Thailand and Cambodia. The dam will span a major channel of the Mekong just two kilometers from the Cambodian border. Its construction is controversial due to its location, the water flows of the Mekong, and the distinction between notification and prior consultation required by the 1995 Mekong Agreement.

In March 2006, the government of Laos signed a memorandum of understanding with the Malaysian engineering and construction company Mega First Corporation Berhad (MFCB) for a feasibility study of the project. In February 2008, a Project Development Agreement was signed that authorized the MFCB to conduct negotiations with the government of Laos and potential electricity buyers and finalize the details of the project by September 2009. However, the Don Sahong Dam development was put on hold after several studies pointed out the negative impacts of the project with respect to the fishing and fishery-based livelihoods.

On September 30, 2013, the government of Laos submitted to the MRC Secretariat a "notification" on the Don Sahong hydropower project along with project documents such as the feasibility, environmental impact assessment, and the social impact assessment. Laos noted that the Don Sahong Dam is "not on the Mekong mainstream" which only needs to apply the "notification" process instead of the "prior consultation" process. Three days later, on October 3, 2013, the Lao government notified the MRC of its decision to proceed with the dam development. The project's construction was expected to start in November 2013 and finish by February 2018. The commercial operation would begin in May 2018. The energy generated by the project will be fully sold to the national power utility, Electricite du Laos (EDL), to supply the increased domestic power demand (MRC, Laos submit notification on Don Sahong hydropower project, October 3, 2013).

In their initial responses, Cambodia, Thailand, and Vietnam stated that the project should be subjected to the procedure of prior consultation. The notification requires the submission of relevant information of the project to the notified countries, while the prior consultation requires a formal consultation and technical assessment. They called on Laos to honor its pledge to consult and cooperate with its neighbors before moving forward with the Don Sahong project. On January 16, 2014, the MRC's Joint Committee, comprised of representatives from Cambodia, Vietnam, Thailand, and Laos, held a special meeting to discuss the Don Sahong Dam. At the meeting, Thailand, Cambodia, and Vietnam reiterated that the project should undergo the prior consultation and raised concerns over the dam's transboundary impacts and unproven mitigation measures. Laos maintained that notification was sufficient.

On April 1, 2014, Representatives of Rivers Coalition in Cambodia (RCC) and Tonle Sap and Mekong communities sent an open letter to the four Prime Ministers of the Lower Mekong countries asking them to halt construction of the Don Sahong Dam and to reconsider the development of the Mekong Mainstream Dams. To support their demand, the signatories mentioned the lack of these four documents:

the in-depth study on fishery resources and fish migration from the lower to upper Mekong River; the prior notification procedure consent and agreement; the strategic environmental assessment in the downstream countries; and the transboundary environmental impact assessment in Cambodia as well as in the Mekong Delta (mrcmekong.org). On June 30, under sustained pressure from its neighbors, Laos submitted an official notice to the MRC Secretariat informing Cambodia, Thailand, and Vietnam of its intent to have the project undergo the prior consultation process. The Don Sahong PNPCA started on July 25, 2014 and ended in 2015 without official resolution.

On January 27, 2015, at a special meeting to discuss the PNCA process for the Don Sahong Dam, Cambodia, Thailand, and Vietnam all called for an extension to the prior consultation process, highlighting the need for further baseline studies, greater assessment of the project's transboundary impacts, and additional consultation. Laos however insisted that the PNCA process was complete. As all four countries could not reach an agreement as to how to proceed with the Don Sahong Dam, the decision was deferred to the ministerial level. On June 19, the MRC announced that after deliberations, the member countries could not agree on how to proceed with the project and decided to send the matter to be resolved at government level through diplomatic channels.

On September 15, 2015, the Malaysian engineering and construction company Mega First Corporation Berhad (MFCB) informed that its subsidiary, Don Sahong Power Company, has entered into a concession agreement with the government of Laos to build, operate, and transfer the project over a period of 25 years. On October 1, 2015, MFCB announced that a power purchase agreement for the Don Sahong Dam had been signed with Laos' state-owned utility Electricite Du Laos. The Don Sahong hydropower project, expected to begin commercial operation in early 2020, will generate 2000 GWh of electricity a year. The total project cost is approximately US$500 million, which is expected to be funded by internally generated funds and long-term debt (Bloomberg, Don Sahong Power Company Ltd. enters into concession agreement with the government of the Lao People's Democratic Republic).

In early January 2016, the government of Laos announced a groundbreaking ceremony to start the construction of its second mainstream dam. Construction has progressed at a rapid pace, and as of June 2016, the Hou Sahong channel was completely blocked (International Rivers, Media kit on the Don Sahong Dam).

6.2.4 Studies on Impacts of the Lower Mekong River Mainstream Dams

The proposed development of the 11 proposed dams in the Lower Mekong Basin has raised important transboundary issues dealing not only with the water resources and ecosystems of the Mekong River but also with agricultural and rice production particularly in the Mekong Delta. In 2009, the Mekong River Commission

commissioned a strategic environment assessment of hydropower on the Mekong mainstream. The final report completed in October 2010 recommended a 10-year deferral for mainstream hydropower development due to the uncertainties regarding the scale and irreversibility of risks in such a complex river system.

The strategic environment assessment report indicated that the transport of fine-sized sediment was significantly reduced, which poses a major issue for agriculture and rice crop. The cumulative downstream impacts of the 11 dams proposed in the Lower Mekong River needed to be studied.

In addition, there are two comprehensive studies assessing the impacts of the 11 dams on the Mekong River: the Delta Study by Vietnam and the Council Study by the MRC. The Delta Study, or formally known as the Study on the Impacts of the Mainstream Hydropower on the Mekong River, was presented to the MRC for review in April 2016 after 30 months of study with the participation of Denmark's DHI Group and experts from Vietnam, Cambodia, and Lao PDR. The MRC and governments' agencies provided scientific data. The 94-page final report, together with the two volumes of the impact assessment reports (800 pages), assessed the impacts of the 11 dams proposed on the Lower Mekong mainstream on the natural, social, and economic systems of the Lower Mekong Basin, in particular the Mekong Delta. It concluded that the planned mainstream hydropower projects would cause "high to very high adverse effects on some of the key sectors and environmental resources in Cambodia and Vietnam," if no mitigation actions were taken. Of particular concern to the Mekong Delta is the significant reduction of alluvium which will seriously affect the local agriculture and rice culture, people's livelihoods, and the region's socio-economic development.

The Council Study, or the Study on Sustainable Management and Development of the Mekong River including Impacts of Mainstream Hydropower Project, is the MRC's flagship study commissioned by the MRC Council in late 2011. It assesses how different water resources use will impact the river basin, using various development scenarios for several themes including hydropower, irrigation, agriculture, flood protection, and navigation. Together with the Delta Study, it is expected to provide a scientific evidence-based data for better understanding about potential risks and benefits of development initiatives in the Lower Mekong Basin. The Council Study is expected to be completed in 2017.

With regard to Xayaburi and Don Sahong projects, several studies and technical reviews of environmental impact assessments found that adverse impacts outweighed benefits for the riparian communities, particularly those living in the Mekong Delta. The MRC's technical review of the Xayaburi Dam, released in March 2011, pointed out that the dam's ability to generate power would be severely compromised in 30 years since its reservoir would silt up. Experts said the dam would devastate the flow of vital fish population and nutrient-rich silt to the Mekong Delta, Vietnam's rice bowl. The technical review of 2013 environmental impact assessment of Don Sahong also highlighted the effect of sediment flows in the vicinity of the project and recommended that active sediment management strategies be put in place to prevent continuing sediment deposition within the headpond. The problem of the rate and volume of sediment flow in the Mekong

mainstream could become a major threat to agriculture and the survival of the Mekong Delta when the cascade of 11 mainstream dams is completed.

Both projects encountered public opposition and strong criticism from riparian communities whose livelihoods depend on the Mekong River. On June 18, 2009, a "Save the Mekong" petition, signed by more than 16,000 persons from the Mekong region and around the world, was delivered to the leaders of the four riparian states urging them to abandon plans for hydropower development along the river's mainstream. The petition, written in seven languages, was signed by fishermen and farmers living along the Mekong River's mainstream and tributaries, as well as by monks, students, city folk, and even some of the region's well-known celebrities. Another 6000 people around the world signed the postcards and an online petition (International rivers, June 18, 2009).

In August 2012, a group of 30 villagers from communities along the Mekong River in North and Northeastern Thailand initiated their lawsuit with the Administrative Court in Thailand against five Thai government agencies for their involvement in that the government's plans to buy electricity generated by the Xayaburi Dam in violation of the Thai constitution and the 1995 Mekong Agreement. In February 2013, the Administrative Court declined to hear the case. The following month, the villagers appealed to Thailand's Supreme Administrative Court, and on June 24, 2014 the Court agreed to hear the case. On December 25, 2015, after hearing the testimony from the plaintiffs, the Court delivered its final verdict that state agencies involved in the Xayaburi Dam had complied with Thai law. The villagers appealed the decision on January 26, 2016 (Business and Human Rights Resource Center, Xayaburi Law Suit, https://business-humanrights.org/en/xayaburi-dam-lawsuit-re-laos-thailand).

6.2.5 Assessment of the Mekong River Commission

After 20 years of regional cooperation, the MRC has made significant progress in implementing the programs and projects mandated by the 1995 Agreement. On the other hand, the organization has failed to deal effectively and positively with the review of the Xayaburi and Don Sahong mainstream dam projects and related issues. The restructure and decentralization of the MRC Secretariat may make it self-sufficient financially by 2030, but they risk to jeopardize the process of institutional building and regional cooperation among agencies needed for the sustainable development of the Lower Mekong Basin. Lastly, we will analyze the financing of the organization which is critical for its performance in the future.

6.2.5.1 The MRC Activities and Achievements

The MRC list of activities and achievements is notably long ranging from meetings, seminars, and public participations to research projects and technical investigations.

First, among the activities, the MRC hosted two successful summits of Lower Mekong Leaders in Hua Hin, Thailand, in 2010, and in Ho Chi Minh City, Vietnam, in 2014, in spite of political changes in the four country members, disputes on water uses and diversions, and competition on rice trade. The conference of the heads of states of the four member countries has served to raise the importance of the MRC and the political commitment of the leaders to river basin cooperation. The Mekong Summit will become a major event every 4 years in the MRC calendar. Second, the list of research studies and technical investigations is impressive and has contributed to river basin planning and management, including forecasting floods, mitigating climate change, and assessing water quality. Other important documents include the procedures for water utilization of the Mekong River in a reasonable and equitable manner, which were used to review the mainstream dams in Laos and needed improvement.

6.2.5.2 The MRC Review of Xayaburi and Don Sahong

The review for approval of the Xayaburi and Don Sahong hydropower projects revealed many technical, institutional, and political problems of Mekong regional cooperation. First, the PNCA was inefficient and its application was subject to diverse interpretations. One of the criticisms pertains to the 6-month consultation process which is too short because it involves working group meetings, public participation, technical reviews, and report evaluations by the riparian members and experts. Moreover, there was a question as to whether the Don Sahong was subject to the procedure of notification or consultation. The terms of the procedure need to be more specified to avoid misinterpretations for future hydropower projects.

Second, both the Xayaburi and Don Sahong projects demonstrate the lack of adequacy and competence of the MRC in dealing with disputes over international rivers, particularly such a complex river like the Mekong. The institutional failure of the MRC Council, the highest governance body consisting of water and environmental ministers, can be explained by its limited mandate and resourcefulness. The 1995 Agreement provides no veto power and no enforcement mechanisms to resolve riparian disputes. Article 35 provides that in case the MRC is unable to resolve an issue, it "shall be referred to the Government to take cognizance of the matter for resolution by negotiation through diplomatic channels within a timely manner." In both cases, no agreement was reached at the Joint Committee level and was referred to the MRC Council, the organization's highest governance body with the ministers from the four member countries. The Council also was unable to reach a unanimous conclusion on the cases.

Last, but not least, the Xayaburi and the Don Sahong unilateral projects are political decisions made by Laos after the MRC's strategic environment assessment of hydropower on the Mekong mainstream, published in 2010, recommended a 10-year deferral for mainstream hydropower development due to the uncertainties regarding the scale and irreversibility of risks in such a complex river system. Both cases show a lack of agreement and acceptance that unity of a river basin in relation

to riparian rights of water use is a key principle of cooperation in development of international rivers. Matters concerning national interests for socio-economic development, common respect for international laws and regional agreements on the use of water resources, and consultation in development of international rivers are political issues that cannot be resolved by technocrats, experts, and scientists. Perhaps the 1995 Agreement anticipated the political problems of Mekong cooperation and provided the governments of the four member countries with two avenues to solve them: a negotiation through diplomatic channels or a mediation through a party mutually agreed upon and in accordance with the principles of international law. In the end, the disputes were resolved through what the MRC called "water diplomacy."

6.2.5.3 MRC Secretariat Restructuring and Institution Building

At this writing, it is too soon to evaluate the institutional evolution of the MRC and the reorganization of the MRC Secretary which just has started and raised more questions than answers. The structure of the Secretariat is important for planning and management of the river basin, and its performance depends upon staff capacity and continuity which the MRC Secretariat has been lacking. Since its inception, the MRC Secretariat office has been moved between Phnom Penh and Vientiane. In 2010, the MRC Secretariat had a total workforce of 154 people when the decision was made to have two permanent offices, one in Vientiane with a staff of 61 people and the other in Phnom Penh with 93 people. In 2014, the total number of staff was 150, but the composition of staff in each office numbers was reversed: 60 in Cambodia and 90 in Vientiane. In January 2016, that decision was reversed, and the Secretariat will operate out of one single office based in Vientiane with a total workforce of 64 people in 2017. This lack of stability is not good for staff morale and performance.

The decision to decentralize some core functions and tasks to individual National Mekong Committees was intended to make the organization leaner, efficient, and self-sufficient by 2030. However, the decentralization must define what functions and responsibilities the four National Mekong Committees will assume successfully, given their different level of development, infrastructures, resources, human capacity, and financial condition.

6.2.5.4 Financial Funding of the MRC

Sustainable financing is necessary to the vitality and work progress of a river basin organization. Since its inception, the MRC has relied heavily on contribution from development partners (that include international institutions and foreign countries), which consistently accounted for about 90% of the total revenue. To be self-sustained financially by 2030, the MRC must increase its contribution to replace

the funding provided by foreign countries that have already reduced their contributions in 2015, except for the European Union, Finland, and Japan.

As indicated in Table 6.2, the contribution of the four riparian states increased from $1.56 million in 2010 to $2.34 million in 2015, representing an increase of 49.7% over 5 years.

On the other hand, the contribution from development partners decreased by $3.3 million, from $19.7 million to $16.4 million, or a decrease of 16.7% during the same period 2010–2015, as shown in Table 6.3. The total combined contribution of the MRC countries and the development partners decreased by $2.6 million, from $21.3 million in 2010 to $18.7 million in 2015, representing a 13% decrease from the 2010 total. Although there was a decrease of 13% in total revenue, the contribution of the development partners still accounted for about 87.5% of the

Table 6.2 Contribution from MRC countries in USD currency, 2010 and 2015

	2015	2010	% Increase
Cambodia	476,734	337,057	41.4
Laos	476,734	337,057	41.4
Thailand	722,356	458,523	57.5
Vietnam	660,316	427,520	54.4
Total MRC countries	2,336,140	1,560,157	49.7

Source: MRC Audited Financial Statements 2010 and 2015

Table 6.3 Contributions from development partners and MRC member countries in USD currency, 2010 and 2015

Development partner	2015	2010
Australia	943,171	3,560,150
Belgium	–	3,832,240
Denmark	1,858,011	3,208,060
Deutsche GTZ	722,369	285,662
European Union	3,578,207	107,739
Finland	4,363,485	2,675,906
France	–	1,200,677
Germany (KfW)	151,011	–
Japan	1,136,368	305,851
Luxembourg	520,000	–
Netherlands	–	1,730,386
New Zealand	–	350,000
Sweden	1,640,229	2,264,480
Switzerland	–	–
United States of America	40,000	20,000
Asian Development Bank	–	183,000
Miscellaneous	1,474,530	9203
Sub-total	**16,427,381**	**19,733,354**
MRC countries	2,336,140	1,560,157
Total	**18,763,521**	**21,293,511**
MRC countries as % of Total	12.5%	7.3%

Source: MRC Audited Financial Statements 2010 and 2015

total revenue in 2015. At this rate, it is questionable as to whether the MRC will meet its goal by 2030, unless some functions and projects will be eliminated or transferred to the National Mekong Committees.

6.3 Mekong Regional Cooperation Frameworks

In addition to the MRC, there are four main Mekong regional cooperation frameworks that were developed and supported by an international organization and three great powers: the Asian Development Bank, the United States, Japan, and China. Unlike the MRC, they all include Myanmar in their membership.

6.3.1 Greater Mekong Subregion

The Greater Mekong Subregion (GMS) consists of China (specifically Yunnan province and Guangxi Zhuang Autonomous Region), Myanmar, Cambodia, Laos, Thailand, and Vietnam. It has a territory of 2.6 million km^2 and a population of 326 million people. The GMS was created in 1992 with the support and funding from the Asian Development Bank (ADB) under the leadership of Japan to promote economic cooperation and relations among the six Mekong riparian countries. The Greater Mekong Subregion Economic Cooperation Program supports the implementation of high-priority subregional projects in ten program sectors: agriculture, energy, environment, human resource development, information and communication technology, tourism, transport, transport and trade facilitation, urban development, and other multisector and border economic zones (Asian Development Bank, Greater Mekong Subregion).

However, it should be noted that the GMS Economic Cooperation Program has excluded water resources development of the Mekong River. This important exclusion can be explained by the simple fact that in 1957 the ADB, along with several United Nations agencies, played an instrumental role in the establishment of the Committee for Coordination of Investigations of the Lower Mekong Basin which was composed of the four riparian states of Cambodia, Laos, Thailand, and Vietnam. It was the first Mekong regional cooperation organization and the predecessor of the Mekong River Commission. The ADB has been a major donor and contributor to the Lower Mekong Development Project since its inception.

6.3.2 Lower Mekong Initiative

In July 2009, the United States launched the Lower Mekong Initiative (LMI) at the ASEAN meeting in Phuket, Thailand. The LMI is described as a multinational

partnership among the United States to the five Lower Mekong countries of Cambodia, Laos, Thailand, Vietnam, and Myanmar. It serves as a platform to address complex, transnational development and policy challenges in the Lower Mekong subregion. It is composed of six "pillars" or areas of cooperation, a coordination hub, a Master Plan of Action 2016–2020, and a sustainable infrastructure partnership (US State Department).

The LMI six main pillars are (1) agriculture and food security, (2) connectivity, (3) education, (4) energy security, (5) environment and water, and (6) health. Cooperation in cross-cutting areas such as gender issues is also mentioned. Under the LMI Environment and Water Pillar, the United States is working with the riparian countries to develop a regional approach to sustainable environmental management and strengthen capacity to manage shared water resources. A Mississippi-Mekong Sister relationship was established to develop regional capacity in advanced river modeling tools and techniques while also building institutional capacity. The US Agency for International Development is providing assistance to the Mekong River Commission and National Mekong Committees to increase regional cooperation on issues of shared water resources. The US Army Corps of Engineers is providing modest assistance to the Mekong River Commission for the development of planning processes and tools to better manage the diverse needs of the river and the countries through which it flows (US State Department).

The LMI Coordination Hub was formed in July 2012 to strengthen information sharing, outreach, and stakeholder cooperation under the LMI. The Hub, housed in Bangkok, Thailand, coordinates information sharing on activities across the six LMI pillars. The Hub then synthesizes and organizes the information in order to identify areas of overlap, windows of opportunity, and potential collaboration. The LMI Coordination Hub carries out activities designed to strengthen collaboration on addressing transboundary issues in the Lower Mekong subregion among the LMI partner countries, donors, regional institutions, private sector partners, and civil society organizations.

The new Master Plan of Action 2016–2020 was approved by the LMI members in August 2015 with the goal to develop collaborative approaches to address complex, transnational development and policy challenges. In December 2015, the LMI Eighth Regional Working Group (RWG) met and started to work on integrating the cross-cutting areas of the water, energy, and food security nexus and gender equality and women's empowerment into the six LMI pillars.

In late July 2016, the foreign ministers of the United States, Cambodia, Laos, Thailand, Myanmar, and Vietnam convened in Vientiane, Laos, for the ninth Lower Mekong Initiative Ministerial Meeting. In his speech, the US Secretary of State emphasized that "At the heart of the Lower Mekong Initiative is one concept: sustainability," highlighted that the Mekong region is severely "imperiled" by climate and land use change, and announced a new "sustainable infrastructure partnership" to improve regional infrastructure planning and performance while mitigating environmental impacts.

Unlike its active participation in the Mekong Project in the 1950s and 1960s, the US involvement in the MRC mission has been marginal, and its contribution has

been insignificant compared to other donor countries. The LMI shows a new US interest in the Lower Mekong region; however, the sustainability of US engagement is difficult to ascertain in view of the uncertainty of the US foreign policy in Southeast Asia in the next decade and China's growing influence and investment in the region.

6.3.3 Mekong-Japan Summit

Japan has participated and contributed to the Lower Mekong Development Project since its creation in providing technical and financial assistance in the investigations of the Mekong tributaries among other projects. Japan has been a major donor to the MRC fund. In the new millennium, Japan has open partnership with the leaders of the Lower Mekong countries including Myanmar. It has undertaken such initiatives as the "Japan-Mekong Partnership Program" in 2007 and the "Mekong-Japan Exchange Year 2009," the Mekong-Japan Foreign Ministers' Meetings in 2008 and 2009, and the Mekong-Japan Economic Ministers' Inaugural Meeting in Hua Hin, Thailand, in October 2009 (Japan Ministry of Foreign Affairs).

Japan held its First Mekong-Japan Summit in November 2009 with the five states of Cambodia, Laos, Myanmar, Thailand, and Vietnam to establish "A New Partnership for the Common Flourishing Future" between Japan and the five Mekong countries for further development of the Mekong region and further expansion of cooperation between Japan and the Mekong region. Moreover, Japan has emphasized that regional cooperation between Japan and the five Mekong countries would bring "further mutual benefits for both Japan and the Mekong region." Regarding the Mekong region as a prioritized area, Japan will continue the policy to expand its official development assistance (ODA) to Cambodia, Laos, and Vietnam, respectively, as well as to the Mekong region as a whole. Japan committed more than 500 billion JPY of ODA in the next 3 years for the Mekong region.

The Tokyo Declaration of November 2009 listed the following priorities:

1. Comprehensive development in the Mekong region
2. Construction of a society that values human dignity
3. Expanding cooperation and exchanges
4. Enhancing cooperation with other frameworks in the Asia-Pacific Region
5. Mekong-Japan-related meetings

Japan attached importance to a regular schedule of Mekong-Japan-related meetings to move the Mekong-Japan cooperation forward. The Mekong-Japan Summit Meeting is to be held in Japan every 3 years and on the occasion of multilateral meetings in other years. The Mekong-Japan Foreign Ministers' Meeting is to be held regularly, hosted by a Mekong region country if it is the ASEAN Chair and by Japan in other cases; the Mekong-Japan Economic Ministers' Meeting will be held regularly to promote cooperation based on the Mekong-Japan Economic and

Industrial Cooperation Initiative (MJ-CI); and the Mekong-Japan Senior Officials' Meeting will be held annually to follow up and prepare for the summit meeting and the Foreign Ministers' Meeting.

The Seventh Mekong-Japan Summit took place in Tokyo on July 4, 2015 and adopted the "New Tokyo Strategy 2015 for Mekong-Japan cooperation" for the next 3 years (2016–2018) with the aim of ensuring regional stability and achieving "quality growth" in the Mekong region. For this purpose, Japan committed around 750 billion JPY in ODA to the Mekong region for the next 3 years.

Mekong-Japan cooperation is based on the following four pillars over the next 3 years:

1. Hard efforts: industrial infrastructure development in the Mekong region and strengthening hard connectivity
2. Soft efforts: industrial human resource development and strengthening soft connectivity
3. Sustainable development toward the realization of a Green Mekong
4. Coordination with various stakeholders: coordination with frameworks of the Mekong region countries; coordination with international organizations, relevant NGOs, and private sector; coordination with partners concerned

Japan has been a long-lasting, reliable, and indispensable partner for the Mekong region. The question remains as to what extent Japan's foreign policy and interest in Southeast Asia can challenge China's growing influence and penetration in the Mekong region.

6.3.4 Lancang-Mekong Cooperation Mechanism

The Lancang-Mekong Cooperation Mechanism (LMCM) was initiated by China at the China-ASEAN Summit meeting in Myanmar, in November 2014, following Thailand's 2012 idea of enhancing Lancang-Mekong subregional cooperation. At the meeting, China proposed a new framework of regional cooperation that consists of all six riparian states of the Lancang-Mekong River – China, Myanmar, Cambodia, Laos, Thailand, and Vietnam. The following year, on November 12, 2015, the foreign ministers of the six riparian states convened in Jinghong City, southwest China's Yunnan province. They adopted the concept paper on the Lancang-Mekong River cooperation and established the Lancang-Mekong Cooperation Mechanism. On March 23, 2016, China officially launched the Lancang-Mekong Cooperation Mechanism in the city of Sanya, in China's Hainan province. The first LMCM summit meeting was cochaired by Chinese Premier and the Prime Minister of Thailand.

The new LMCM framework purports to promote cooperation in three key areas: political and security issues, economic and sustainable development, and sociocultural affairs and people-to-people exchanges. The first five priority areas during the

initial stage of LMCM include connectivity, production capacity, cross border economic cooperation, water resources, and agriculture and poverty reduction.

In his key address at the first LMCM summit in March 2016, the Chinese Premier placed great importance to the cooperation in connectivity, such as building the "Silk Road Economic Belt and the twenty-first-century Maritime Silk Road" and cooperation in production capacity of various sectors ranging from electric power and production of building materials to light industries and equipment manufacturing. To fund the projects, China will set up a RMB10 billion yuan concessional loan and a US$10 billion credit line, including a US$5 billion preferential export buyers' credit and a US$5 billion special loan on production capacity cooperation, to support infrastructure and production capacity cooperation in the subregion.

Like Japan, China gives great importance to regularity of LMCM meetings to improve institutional building and solve future cooperation needs. The LMCM heads of states are required to meet every 2 years, the foreign ministers every year, and the senior diplomatic officials as needed to map out strategic planning for long-term LMCM development.

The Sanya Declaration issued at the end of the summit meeting listed 26 "measures" dealing with cooperation in political, security, socio-economic, financial, environmental, technical, and cultural areas, including the following measures that are unique to LMCM:

- Support the establishment of a law enforcement cooperation institution to facilitate such cooperation (measure #3).
- Enhance cooperation against nontraditional security threats, including terrorism, transnational crimes, and natural disasters; promote cooperation in addressing climate change impacts and humanitarian assistance and ensuring food, water, and energy security (#4).
- Advance the China-ASEAN strategic partnership, and strengthen cooperation under the framework of ASEAN + 3, East Asia Summit, ASEAN Regional Forum, and other regional cooperation mechanisms (#5).
- Emphasize the importance of a stable financial market and sound financial structure, financial supervision and regulations, use of bilateral currency swap, local currency settlement, and cooperation among financial institutions (#13).

With regard to water resources management and utilization, the Sanya Declaration measure #10 proposed "the establishment of a center in China for Lancang-Mekong water resources cooperation to serve as a platform for LMCM countries to strengthen comprehensive cooperation in technical exchanges, capacity building, drought and flood management, data and information sharing, conducting joint research and analysis related to Lancang-Mekong river resources." However, Mr. Chaiyut Sukhsri, a technical adviser to Thailand National Mekong Committee, said he would not fully support it "because there is already an existing system among the lower Mekong Countries" (*The Straits Times*, March 24, 2016, China woos Mekong states with loan pledges).

On the subject of agriculture, measure #11 calls for more agricultural technology centers and high-quality, high-yield demonstration stations (bases) to be set up in Mekong countries, strengthening cooperation in fishery and animal husbandry and food security and elevating the level of agricultural development. In contrast, the Deputy Prime Minister of Vietnam asserted at Sanya that the agricultural sector, which is more important in downstream countries that in China's Yunnan province, should play a crucial role for the stability and sustainable development of Mekong-Lancang nations. He said that Vietnam would cooperate with other countries to develop "a sustainable agriculture that is competitive and adaptable to climate change, thus ensuring a harmony between food security and water resource security" (Vietnamnet, March 24, 2016, Vietnam Deputy PM stresses sustainable use of water resources in Mekong River).

6.4 China Role in the Mekong Regional Cooperation

The LMCM is the first Mekong regional cooperation group led by China, which does not belong to the Association of Southeast Asian Nations (ASEAN) or the MRC where it participates as a dialogue partner. In 1992–1995 when the four governments of Cambodia, Laos, Thailand, and Vietnam were negotiating the future framework of cooperation in the Mekong River Basin, China was in the process of implementing a cascade of hydropower dams in the upper Mekong River regimes, which could negatively change the downstream flow regimes. Therefore, the four riparian states felt the need to invite China in the new cooperation framework after they had signed the "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin," and created the MRC in April 1995. China declined the membership and has not been contributed any technical or financial assistance to the MRC since its inception. To date, China, as an "upstream superpower" in many transboundary river basins, has not signed any water treaties or participated in any regional organizations where water resources cooperation is the main objective.

Hydropower development in China that has caused tensions with its downstream neighbors was not discussed in the LMCM. China was silent about the construction and operation of mainstream dams on the Chinese Lancang River that have been blamed for causing damages to agriculture and paddy fields in downstream countries, particularly in Vietnam's Mekong Delta. During the historic drought of 2015–2016, around 140,000 hectares of rice have been damaged in the Mekong Delta, which prompted Vietnam to ask China to increase the outflow from its dams in Yunnan province. Just before the LMCM summit meeting, China discharged water from its Jinghong dam on the Mekong River from March 15 to April 10, 2016 to help mitigate a severe drought in some Vietnamese provinces (*The Nation*, Asia News Network, March 19, 2016, Water diplomacy by China offers drought relief). However, it was reported that because China released water too rapidly and in short period, the water levels increased suddenly and adversely affected fishing and tourism in Thailand's

Chiang Khan District in Loei (*The Nation* (Thailand), by News Desk, March 20, 2016, Leaders of Mekong nations urged to consider environment at summit).

China is a member of the Greater Mekong Subregion Economic Cooperation Program which does not include water resources development. This raises the question as to what extent the LMCM programs and projects duplicate, expand, and eventually replace the GMS bilateral and multilateral projects in transport, energy, infrastructure, environment, human resource development, tourism, trade, and agriculture.

Unlike the other Mekong regional cooperation frameworks created by the United States and Japan, China's LMCM does not contain provisions regarding coordination or collaboration with other regional organizations. This omission was pointed out by Vietnam that stressed the need for the LMCM to work with other subregional cooperation organizations, particularly the Greater Mekong Subregion and the Mekong River Commission. It appears that China uses the Mekong River as a path to access and influence the development of mainland Southeast Asia.

It is too early to know which directions China will take to pursue its LMCM goals. Will China cooperate with the other five riparian countries and international organizations to help the integrated Mekong basin development that no country alone could achieve, given the complex, international character of the Mekong River? Will China as a regional superpower use its leadership to influence and negotiate water and territorial disputes with its neighboring countries? One change is certain: China that has never contributed to the MRC in the past will become the dominant donor or investor in the Mekong region.

6.5 Conclusion

The year 2016 marked a new chapter in the history of Mekong regional cooperation with the restructuring of the MRC and the creation of the LMCM. Among the four regional cooperation organizations, only the MRC and the LMCM are composed of leaders of riparian states that share the Mekong River. The LMI and the Mekong-Japan Summit have other regional cooperation priorities and objectives in addition to the regional cooperation for sustainable development of the Mekong River water resources for agricultural and rice production.

The MRC started a new chapter with a new riparian CEO as part of the riparianization process, restructuring its Secretariat, decentralizing some functions to the National Mekong Committees, and declining contributions from donor countries. China could have seized this opportunity to join the MRC membership to play a major role in integrated river basin cooperation and management of the entire Lancang-Mekong River Basin. Instead, China created the LMCM using the Lancang-Mekong River as a strategic path to achieve transborder economic and political development of mainland Southeast Asia under its control and leadership.

This raises the question about the future of the MRC after achieving 20 years of stable and strong regional cooperation for the sustainable development of water

resources and rice security in the Lower Mekong Basin with support and funding from international organizational organizations and foreign donors. Would the MRC continue to strive to achieve the status of a true and unique river basin organization in the Mekong region? The future of the MRC is not promising in view of many challenges facing the MRC, particularly the construction of mainstream dams that cause conflicts and weaken cooperation among the riparian states.

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Chapter 7
Conclusion

Abstract Today, rice production in Cambodia, Laos, Thailand, and Vietnam can no longer revolve around the May-October monsoon rains and the Mekong river water. It needs to adjust and/or adapt to climate change, rising sea levels, and increasing sea water temperatures that would impact not only each country's economy, but also its traditional way of life. These natural disasters damage rice fields in the Mainland Southeast Asian (MSEA) countries with unequal intensities and at different times.

More importantly, the Mekong River has become a source of exploitation for the construction of mainstream dams in China and Laos. These dams would constitute a devastating threat to the rice production in downstream countries, particularly in the Mekong Delta, if China chose to limit the Mekong water flows and sediment deposits for rice cultivation.

The Mekong River Commission (MRC), created in 1995 to develop sustainable water resources and rice security for people in the Lower Mekong Basin (LMB), is facing new problems ranging from structural reorganization, members' financial contribution, review of rules and procedures implementation, and disputes resolution among members. Whether the MRC can meet its new challenges depends on the national interests of its leaders.

The concept of Mekong regional cooperation took a new definition with the Lancang-Mekong Cooperation Mechanism (LMCM) launched in 2016 by China in a new world and environment. The prospects for future rice production and water security in MSEA and the LMB will depend upon China's emerging roles and ambitions in the Mekong region and its relationships with its riparian neighbors.

Keywords River Basin Organization • Mekong regional cooperation • China dialogue partner

Rice has performed different functions in the economies of Cambodia, Laos, Thailand, and Vietnam. The priority and importance given to rice varies according to each country's history, geography, ecosystem, and economic development. For Thailand, rice is an export commodity, given the importance of trade policy in its development. In contrast, for Laos rice is functional food subsistence and is less important than electric power, which is the country's largest source of foreign

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exchange earnings. For Cambodia, rice is an important staple crop for food self-sufficiency and is gradually entering the export market with surplus product. For Vietnam who experienced the historical famine causing millions of deaths in 1944–1945, rice is first and foremost food security and national interest.

Of all the crops, rice is the largest user of freshwater that is provided by the monsoon rains and the Mekong River. The importance of the Mekong River is vital for millions of people who depend on its water for domestic consumption, agriculture, and business. The Mekong River provides freshwater resources and sediments for agriculture and rice culture that form the main source of livelihood in the rural areas; offers opportunities, irrigation, flood control, and power production; promotes socio-economic development; and facilitates transportation and trade.

Today, rice production in the Lower Mekong Region is facing multiple threats ranging from climate change or climate variability, severe floods and droughts, and El Niño and La Niña to sea level rise and saline intrusion. A greater danger than natural disasters is the construction and operation of the Mekong mainstream dams which could cause long-lasting, negative effects on the water flows and on the sediment deposits which are so critical for rice culture.

China has claimed its right to control the water flows by constructing a cascade of hydro-electric-producing dams, of which six are operational, on the upper reaches of the Mekong River. These mainstream dams have the potential to have a crippling effect on the supply of water to those paddy areas in the lower Mekong River that have historically depended on the river for paddy field irrigation during the 6-month, December–May, dry season. In fact, the impact of the Chinese dams on the river water flows has already been noted in recent years. In 2015–2016, an extreme and long drought that threatened the winter-spring crop in the Mekong Delta prompted Vietnam to ask China to release water from its dam's reservoirs. Upon Vietnam's request, China increased the outflow from its Jinghong dam from March 15 to April 4, 2016, just a few days before the Sanya Summit meeting.

The Lower Mekong Basin (LMB) produces nearly 53 million tons of paddy rice per year, accounting for about 58% of the total 91 million tons of paddy rice production of Cambodia, Laos, Thailand, and Vietnam and feeding a population of 66 million people. Moreover, Thailand and Vietnam earned their world's status as the largest rice exporters thanks to rice grown in the Korat Plateau of Thailand which produces the high-quality Hom Mali rice and the Mekong Delta which is responsible for 90% of Vietnam's rice export. The future of rice production in this region is critical because it is the main source of rice supply for over 100 countries worldwide, including Indonesia, the Philippines, and China.

However, during the period under study, the LMB paddy production of the two biggest rice producers and exporters (Thailand and Vietnam) showed a declining percentage of the total, whereas the trend was upward for Cambodia and Laos. The Mekong Delta and Central Highlands paddy production decreased from 51% of the total in 2000 to 48% in 2014, and the Korat Plateau paddy production decreased from 32% of the total to 28% during the same period. Both regions face problems of adequate water supply for the rainfed rice production and the high yield rice in the

dry season. As a result, any reduction in rice production from these two areas could affect the global rice market.

This trend to lower productivity presents opportunities and challenges for the Mekong River Commission to strengthen cooperation among its members in developing sustainable water resources to meet the needs of rice productivity and security in the LMB. After 20 years of existence, the MRC is recognized as an established organization with strong support from international institutions and foreign donors. However, the MRC will face enormous and daunting challenges as it moves forward to a new strategic plan for 2016–2020 with new work priorities, including a new organizational structure, decentralization of functions to national committees, a new revised set of procedures for water uses and diversions to make their application efficient and effective, increased financial contribution, and strengthening regional cooperation for the development and maintenance of the Mekong River water resources. In the final analysis, the LMB growth depends on the national interests of Cambodia, Laos, Thailand, and Vietnam to work together and strategically develop the economic potential of the Lower Mekong River system in a sustainable way.

In 2016, the concept of regional cooperation for the development of the Mekong River took a new meaning in a new environment with China's creation of the "Lancang-Mekong Cooperation Mechanism" which is not an institutionalized cooperation between China and the downstream riparian countries. There are no signed agreements, no rules, and no procedures for the shared Mekong water uses and diversions. Based on past experiences, it appears unlikely that China, as an upstream superpower, has any intention to create a river basin organization since it already has full control and use of the Lancang-River water. This begs the question about the incentives and purposes of China in setting up such cooperation mechanism: Would it be for political and security development of the entire Southeast Asia region, like the Organization of American States or the Organization of African Unity? Would it be for regional economic integration like the European Economic Community? Would it be simply for the principles of cultural, economic, and political cooperation among riparian states with the generous aid of Chinese loan and grant pledges? Would it be for solving tensions with the Lower Mekong countries and strategically exerting its power, investment, and influence on the Southeast Asian region and the South China Sea?

A more pressing question is: What will be the nature of relationship and cooperation between the new Lancang-Mekong Cooperation Mechanism and the Mekong River Commission where China has persistently declined to be a member and preferred to participate as a dialogue partner with no obligations, no commitments, and no contributions? Will China respect, adopt, and include in the LMCM the MRC 1995 Agreement on Cooperation for the Sustainable Development of the Mekong River Basin? Will China work and cooperate with the MRC on its basin development strategy? Will China and all four MRC member nations be treated as equal partners that must respect and abide by the rules of water utilization and interbasin diversions according to the principles of equitable and reasonable water use of the Mekong River and its tributaries?

The development of the LMB, one of the largest and poorest subregions of Southeast Asia, depends on water management, irrigation, and flood control to increase rice productivity. The Mekong regional cooperation of all six riparian states of China, Myanmar, Thailand, Laos, Cambodia, and Vietnam will be critical and needed to achieve a sustainable development of water resources for rice productivity and food security for millions of people. On the other hand, a water conflict among the riparian countries, controlled by China, would be a serious setback of regional cooperation considered as the best framework to bring about socio-economic growth and political development in the region.

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