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**The Impacts of Climate Change on Child
Malnutrition in Lao PDR**

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Table of Contents

1.	Introduction.....	1
1.1	Research questions.....	1
1.2	Methods.....	1
2.	Historical and future climate scenarios in Lao PDR.....	1
2.1	Historical of climate scenarios.....	2
2.1.1	Temperature.....	2
2.1.2	Rainfall.....	2
2.1.3	Climate Hazards.....	2
2.2	Future climate change scenarios.....	2
2.2.1	Temperature.....	2
2.2.2	Rainfall.....	3
3.	Current status of child malnutrition in Lao PDR.....	3
4.	Impact of climate change on child malnutrition.....	5
4.1	Food security.....	5
4.1.1	Rice production.....	6
4.1.2	Cultivation of food crops.....	7
4.1.3	Livestock.....	8
4.1.4	Food price.....	8
4.1.5	Access to markets.....	9
4.2	Health conditions.....	10
4.2.1	Infectious diseases.....	10
4.2.2	Water supply, hygiene and sanitation.....	11
5.	Overview of existing policies on Child malnutrition and Climate Change.....	12
6.	Conclusion.....	12
	References.....	14

List of Tables

Table 1: Number of natural hazards and affected populations in Lao PDR from 1992-2012.....	2
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Table 2: Impacts of climate events on food crops in Lao PDR, 1992-2012	7
Table 3: Impacts of climate events on livestock in Lao PDR, 1992-2012	8
Table 4: Impacts of climate events on damaged roads in Lao PDR, 1992-2012	10
Table 5: Cases of infectious diseases in Lao PDR in 2013-2016.....	10
Table 6: The percentage of the population who suffered infectious diseases by regions, 2011-2012.....	11

List of Figures

Figure 1: Child malnutrition status in Lao PDR, 1993-2015	4
Figure 2: The percentage of stunted children (height-for-age) ranked by provinces in 2015	4
Figure 3: The percentage of children wasting (weight-for- height) ranked by provinces in 2015.....	5
Figure 4: Historical evolution of rice production and the harvested area, 1961–2010	6
Figure 5: Rice surplus/deficit as percentage of consumption by province, 2010.....	6
Figure 6: Rain-fed rice fields damaged by flood (1996 – 2005) in hectares Severe drought occurred in 1998 and 2003.	7
Figure 7: Glutinous price trends in selected provinces, 2010-2012	9
Figure 8: The percentage of people gaining access to improved sanitation facilities and water sources from 1994 to 2012	11

Acronyms

ADS	Agriculture Development Strategy
CRED	Centre for Research on the Epidemiology of Disasters

CU5	Children Under age of five
FAO	Food and Agriculture Organization
GCMs	Global Climate Models
GCMs	General Circulation Models
GDP	Gross Domestic Product
MAF	Ministry of Agriculture and Forestry
MDGs	Millennium Development Goals
MoH	Ministry of Health
MRB	Mekong River Basin
NAPA	National Adaptation Programme of Action
NDMO	National Disaster Management Office
NSEDP	National Socio Economic Development Plan
NTFPs	Non-timber Forested Products
OFDA	Office of U.S. Foreign Disaster Assistance
SDGs	Sustainable Development Goals
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WB	World Bank
WFP	World Food Programme
WHO	World Health Organization
8th NSEDP	8th Five-Year National Socio-Economic Development Plan (2016–2020)

1. Introduction

Lao PDR has succeeded in reducing the very high level of child malnutrition as a of the country's effort to invest in nutrition and food security,[1] to develop health care services, and reduce poverty.[2] However the problem of child malnutrition continues to be reflected in the figures for stunting, wasting, and underweight children as well as fetal malnutrition. Despite this success in reducing child malnutrition, the country was not able to achieve its MDG targets in reducing child malnutrition to 34 percent of stunting, to 5 percent of wasting and 25 percent of underweight by 2015.[3] The promotion of nutrition is therefore an urgent priority for development in the country as stated in National Nutrition Strategy to 2025 and plan of action 2016-2020.[4]

Climate change has occurred in Lao PDR over the past decades. It affects child malnutrition through food insecurity, lack of clean water supplies, and poor health of many children. From 1970 to 2010, several natural hazard events occurred, affecting much of the country (mostly floods and droughts).[5] These natural hazard events affected food production patterns, food security and household food yields. In addition, people, especially children, had difficulty accessing clean water, sanitation and health services during these extreme periods.[2] Climate change also increased sickness of children due to poor sanitation and hygiene practices during the extreme events.[6].

A number of studies have provided some data to assess the impacts of climate change on child malnutrition, yet there have been no efforts to synthesis these findings. Therefore, this study seeks to synthesize previous studies to identify the impacts of climate change on child malnutrition in Lao PDR. The specific research questions are as follows:

1.1 Research questions

- What are the historical and future climate scenarios for Lao PDR?
- What is the current status of child malnutrition in Lao PDR?
- To what extent has climate change impacted child malnutrition in Lao PDR?
- What are the government policies relating to the issue of climate change and child malnutrition in Lao PDR?

1.2 Methods

This paper reviewed secondary data and existing reports from the Ministry of Health, the Ministry of National Resource and Environment, the Ministry of Agriculture and Forestry, the Ministry of Planning Investment (Bureau of Statistics). As well, it reviewed data from UNICEF, WHO, WFP, FAO, WB, USAID who worked in the field of climate change, food security and child malnutrition in Lao PDR. The key words that were used for the searching were: climate change, child malnutrition, food security and climate and child health in Lao PDR.

2. Historical and future climate scenarios in Lao PDR

Lao PDR has been recognized as one of the countries most vulnerable to climate change impacts due to its particularly high dependence on climate-sensitive natural resources and the country's low adaptive capacity. The two climate variables in Lao PDR are rainfall and temperature.[7] The historical and future climate scenarios in Lao PDR are described below.

2.1 Historical of climate scenarios

2.1.1 Temperature

In the past years, the temperature in Lao PDR increased between 0.1 to 0.3 per decade between 1951 and 2000.[5] This means the annual mean temperature in Lao PDR had risen by as much as 0.05 °C/year from 1970-2010, especially in the south of the country. [7] From 1977-2003, the medium average temperature in the northern provinces was 23.2°C, in the central provinces 26.6°C and in the southern provinces 27.3°C.[8]

2.1.2 Rainfall

Rainfall decreased between 1961 and 1998 with the average rainfall of 800 mm/year, and the driest year on record was 1998.[5] From the 2000s to 2015, rainfall data indicated the increasing trend of seasonal and annual rainfall in the country, with rates of 2,046 and 2,741mm/year respectively in a last fifteen years. These upward trends were associated with the increased frequency of extreme events related to heavy rainfall in the regions. Some parts of the country including Phongsaly, Oudomxay, Bokeo, Xayabury, Vientiane and Borikhamxay tended to have relatively high rainfalls.[7]

2.1.3 Climate Hazards

From 1992 to 2012, 2,097 natural events were registered in Lao PDR and many people were affected (Table 1). The main natural events include droughts, floods, storms, epidemics and plagues. It was found that all provinces suffered from more than one hazard event.[9]

Table 1: Number of natural hazards and affected populations in Lao PDR from 1992-2012

Events	NO. of events	Affected people	Deaths
Drought	165	525,593	0
Flood	1,286	3,458,571	148
Storms	741	555,948	38
Epidemics and plagues	164	207,655	186
Total	2,356	4,747,767	372

Source: DesInventar data 2012 (1992-2012)

According to WHO's Collaborating Centre for Research on the Epidemiology of Disasters (CRED), the areas most affected from flood, drought and storms were the central and southern regions. The study of the climate vulnerability mapping of South East Asia in 2009, showed some provinces in northern part of Lao PDR were considered hotspots for the impact of multiple hazards, including floods, droughts, landslides, and storms.[5]

2.2 Future climate change scenarios

2.2.1 Temperature

According to Global Climate Models (GCMs), by the end of 21st century, Lao PDR will face rising temperatures across the country for all seasons and annual temperatures are expected to increase by 2.6°C. The south will experience more rapid warming than the northern and north central, and the lower region of the Mekong River by 1.4°C to 4.3°C. The Basin will be 1°C or 2°C warmer. Decreasing rainfall in the northern part of the country could have serious impacts, especially on highland paddy production. Drought months are also expected to

become longer in the southern part of the country and conversely, shorter in much of north, due to higher temperatures in the dry season.[5]

2.2.2 Rainfall

From 2040-2059, the projected rainfall in Lao PDR will tend to decrease between October and March, leading to more severe drought periods, with implications for agriculture and irrigated land. On the other hand, increases in rainfall that might cause flooding and increase the threat of food insecurity and deaths are projected between April and September.[5]

By the end of the 21st century, the mean annual rainfall is projected to increase by 4.2 % in the whole country. The total annual precipitation in the eastern and in southern areas will increase by about 10%-30% and 4.2% respectively. In the northern area, the most significant increases are expected in the wet season. The projection showed an overall increase in the number of wet days across the southern area of the Mekong River. Higher and more intense rainfall is linked to more severe floods which can significantly waterlog key cash crops.[5]

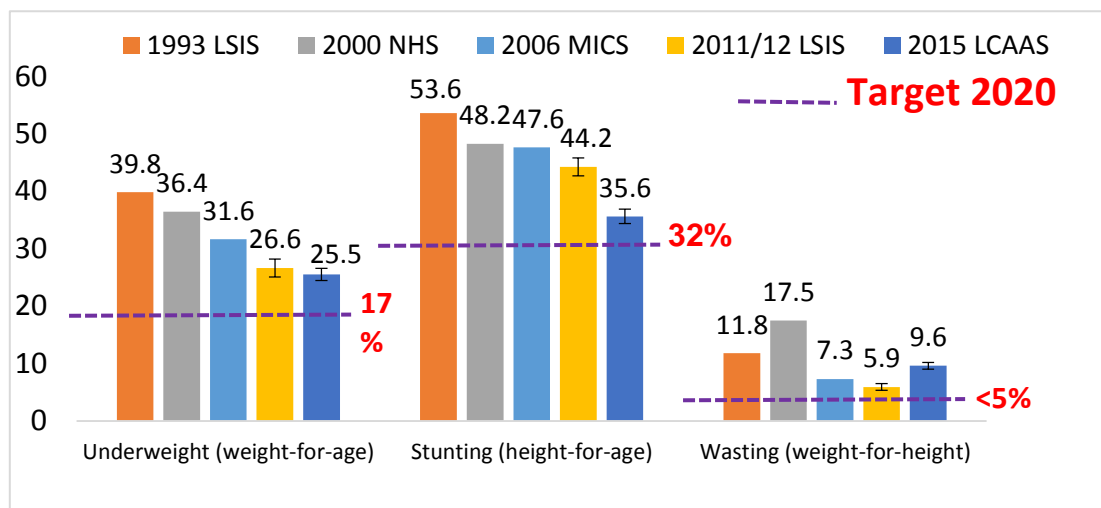
To sum up, according to Global Climate Models (GCMs), from the first half to the end of 21st century, Lao PDR will face climate change in the form of increasing rainfall and rising temperatures in all parts of the country. Climate change and the increase in frequency and magnitude of these events are expected to make more people food insecure, particularly in the rural areas. Increasing rainfall and a tendency towards more concentrated rainfall can lead to higher flood risks in the eastern central and southern areas. Rising temperatures in the dry season can exacerbate drought risk prior to the rainy season in the southern part, and to shorter terms in the northern part. A combination of drought and flood can significantly stress rural livelihoods and food security.[10]

3. Current status of child malnutrition in Lao PDR

Lao PDR has the 12th highest stunting rank in the world and one of the highest in Southeast Asia [4] with 35.60 % of children under the age of 5 classified as stunted (2015) [11] compared with 32.40% for Cambodia (2014), 35.10 % for Myanmar (2009) and 16.30 % for Thailand (2012) (the survey year data of each country), according to WHO.[12] 17,300 Lao children under the age of 5 years die each year, with 40 % of these deaths related to malnutrition.[4] The burden of malnutrition may cost the country approximately 2.4 percent of GDP.[2] The cost of child malnutrition for those who are in their first 1000 days accounts for 142 million USD or 73 percent. [11, 13]A reduction in child malnutrition in Lao PDR is therefore necessary to contribute to development and poverty reduction.

Lao PDR has experienced a slow progress in reducing child malnutrition from 1993-2015, especially among children under five (CU5).[13] In 2015, 35.6 percent of children under the age of five were stunted, 25.5 percent were underweight, and 9.6 percent were wasted (Figure 1).[14]

Figure 1: Child malnutrition status in Lao PDR, 1993-2015



Source: Ministry of Health (MoH) report in 2016.

WHO growth standards in 2015 showed that the rates of stunting and wasting of children in Lao PDR varied by provinces. Child stunting was often found in provinces in the Northern part of the country such as Oudomxay, Phongsaly, Huaphan, while child wasting often occurred in the Southern provinces, such as Saravane, Sekong and Attapeu, and also in some provinces of Central, such as Khammouane and Savannakhet (Figure 2 and 3).

Figure 2: The percentage of stunted children (height-for-age) ranked by provinces in 2015

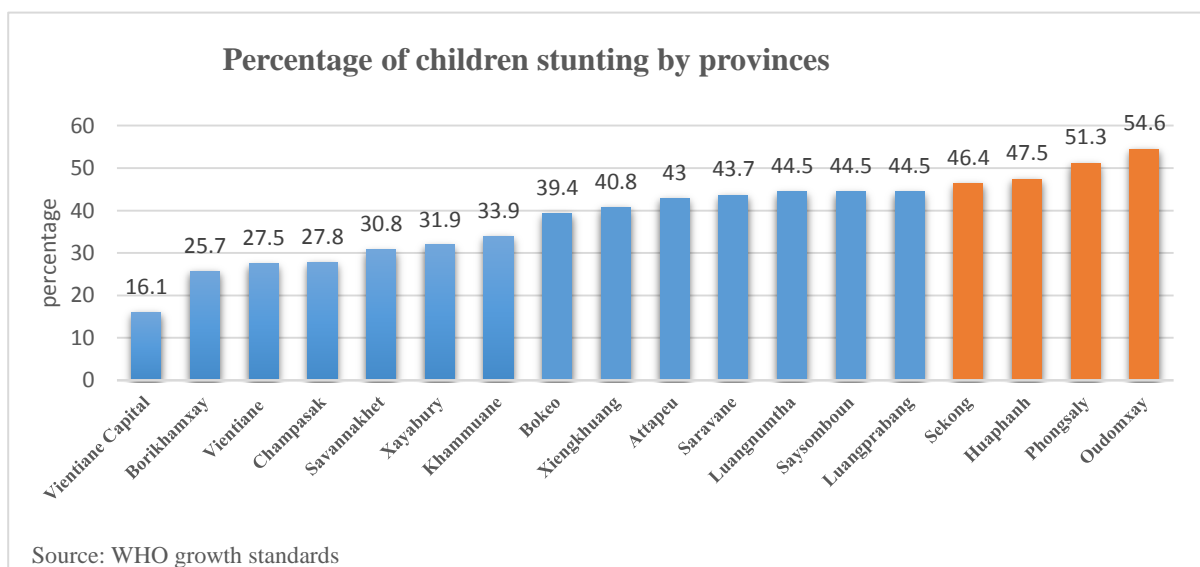
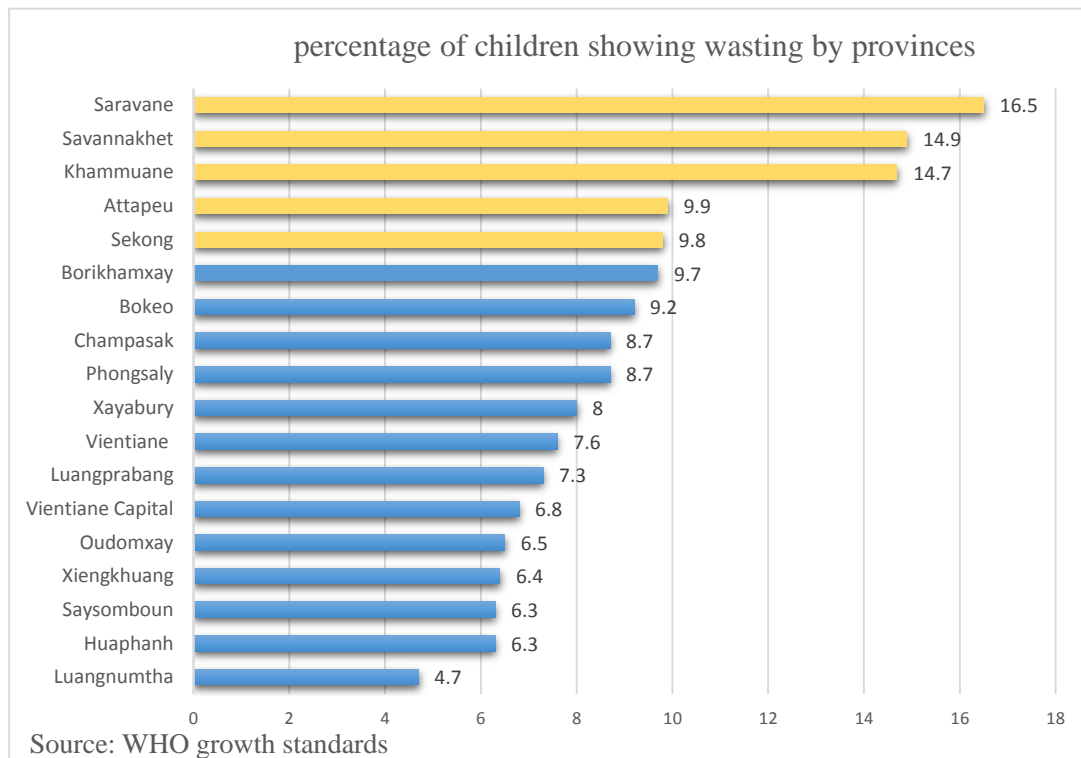


Figure 3: The percentage of children wasting (weight-for-height) ranked by provinces in 2015



The reasons for child stunting in the north is due to the fact that the areas are mountainous and are prone to natural hazards such as earthquakes, storms, landslides, flooding, drought and epidemics. Children in ethnic groups who live in these areas often face difficulties in accessing healthcare due to poor infrastructure. However, in the south, even though the areas have better infrastructure conducive to crop cultivation and livestock raising, children in some provinces are still vulnerable because of low food production caused by rising temperatures, drought and less rainfall. The impact of climate change on child malnutrition in Lao PDR is described below.

4. Impact of climate change on child malnutrition

4.1 Food security

Food security refers to a situation that "exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World food summit, 1996). The components of food security and nutrition in Lao PDR include: food availabilityⁱ, food accessibilityⁱⁱ, food safety and nutritionⁱⁱⁱ, and food stability^{iv}. [15] For the purpose of this study, rice, crop and livestock production were used to assess food availability, and food price and market access were used for assessing food accessibility related to child malnutrition. [5] More details on the impact of climate change on food security are as follows:

ⁱ capable to supply sufficient food at the national level and self-sufficient in the household as food sources

ⁱⁱ food sources from the forest and self-cultivation as the plantation for self-consumption, buying from markets and exchanges

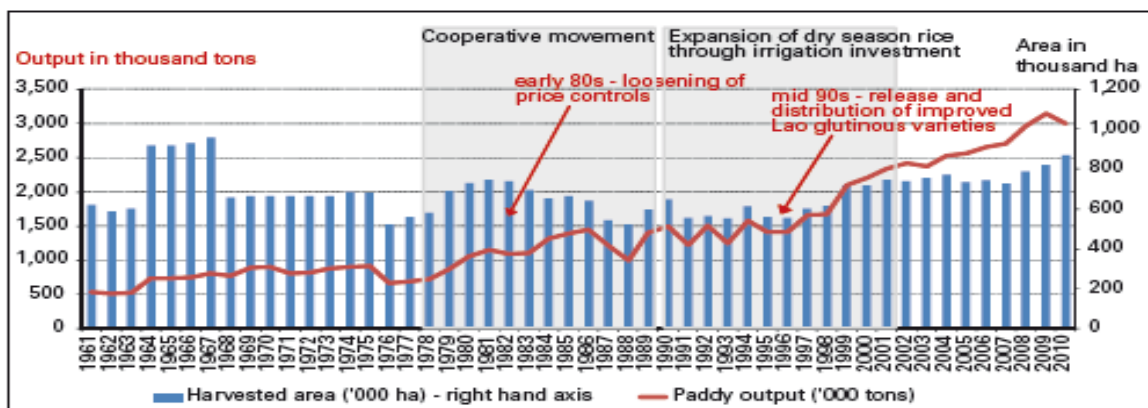
ⁱⁱⁱ storing food for consumption in the shortage season and, safety and sanitation in preparing food

^{iv} reducing food shortage in certain season

4.1.1 Rice production

Rice production in Lao PDR is affected by floods and droughts. Historical data on rice production in Lao PDR showed that although rice output in the country increased considerably from 1961 to 2010, due to the agricultural reforms in the early 1980s and the expansion of dry season rice through irrigation investment in the 1990s, both harvested areas and paddy output in Lao PDR dropped significantly in 1976-1978 due to extreme droughts and floods in 1976 and 1978 (Figure 4). This loss had put around half of the country's population at risk of rice shortages between 1976-1978.[16]

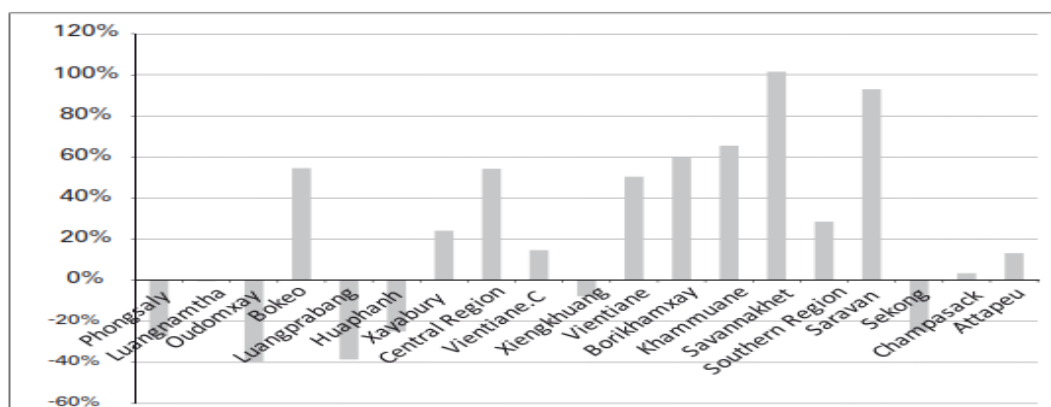
Figure 4: Historical evolution of rice production and the harvested area, 1961–2010



Source: FAOSTAT data from www.fao.org as of August 2012.

Also, since the 1990s, flood and droughts had depleted rice production in several provinces and even caused rice deficits in some provinces. For example, the most rice deficit provinces in 2010 in the northern part of the country were Phongsaly, Oudomxay, Luang Prabang and Huaphanh, and in the southern part, Sekong province (Figure 5).[16]

Figure 5: Rice surplus/deficit as percentage of consumption by province, 2010

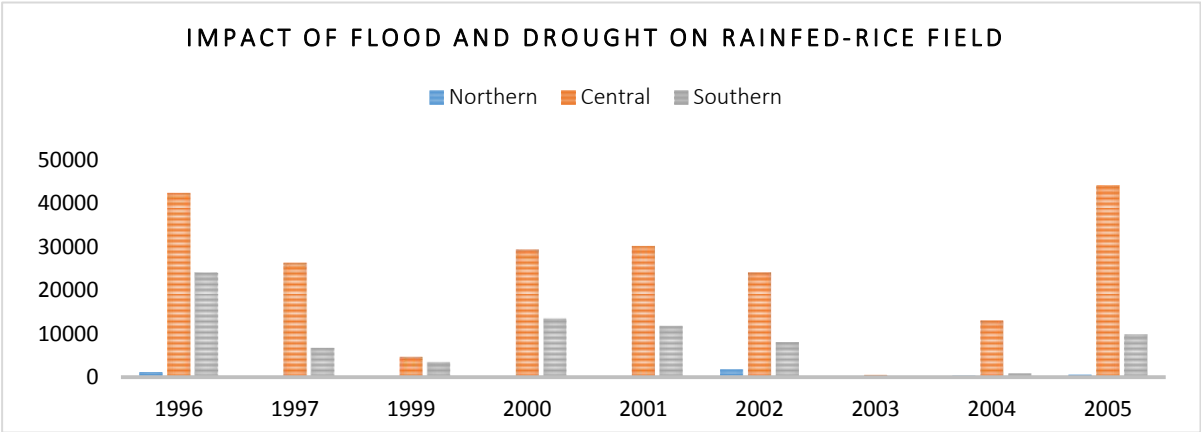


Source: MAF, NBS data and the authors' calculations.

It was found that the extent of rice field damage by flood and droughts differed by regions. with some regions suffering more than others. For example, from 1996 to 2005, provinces in the central region, (Borikhamxay, Khammouane and Savannakhet) and southern

region,(Saravan and Champasak) provinces were the most affected by floods and droughts (Figure 6). The implication of this was that children who lived in those provinces, did not have enough rice to eat. This was either due to production losses, or their families could not afford to purchase food.[8]

Figure 6: Rain-fed rice fields damaged by flood (1996 – 2005) in hectares (ha). Severe drought occurred in 1998 and 2003.



Source: Department of Planning, Ministry of Agriculture and Forestry, 2005.

4.1.2 Cultivation of food crops

In Lao PDR, food crops were also affected by extreme climate events. According to DesInventar data in 2012 (Table 2), from 1992-2012, Lao PDR lost a large number of food crops, due to floods, drought, storms, and epidemics and plague. Floods contributed to the most of the food crop loss in Lao PDR between 1992 and 2012.

Table 2: Impacts of climate events on food crops in Lao PDR, 1992-2012

Events	NO. of events	Damaged crops (ha.)
Drought	165	142,913
Flood	1,286	1,188,296.18
Storms	741	265,453
Epidemics and plagues	164	255,113
Total	2,356	1,851,775

Source: DesInventar data 2012 (1992-2012)

Food crops are important for children, especially those who lived in rural areas. Rural households need these crops to add to their main meals in order to maintain food diversity of children.[17] The World Bank Group study claimed if children, especially those under 2 years of age, had eaten a diet with low food diversity, they could encounter risks of undernourishment. [2]

4.1.3 Livestock

Livestock in Lao PDR were also affected by climate events and in some years, there were many natural hazards affecting household livestock. It is common that heavy rains affect people throughout the country and leave them without livestock. It is also important to note that all parts of Lao PDR have experienced lost cattle through climate events such as: drought, floods, flash , floods, heavy monsoon rain and epidemics (Table 3).[18]

Table 3: Impacts of climate events on livestock in Lao PDR, 1992-2012

Events	NO. of events	Lost Cattle
Drought	165	1876
Flood	1,286	11,552
Storms	741	11,925
Epidemics and plagues	164	170
Total	2,356	25,523

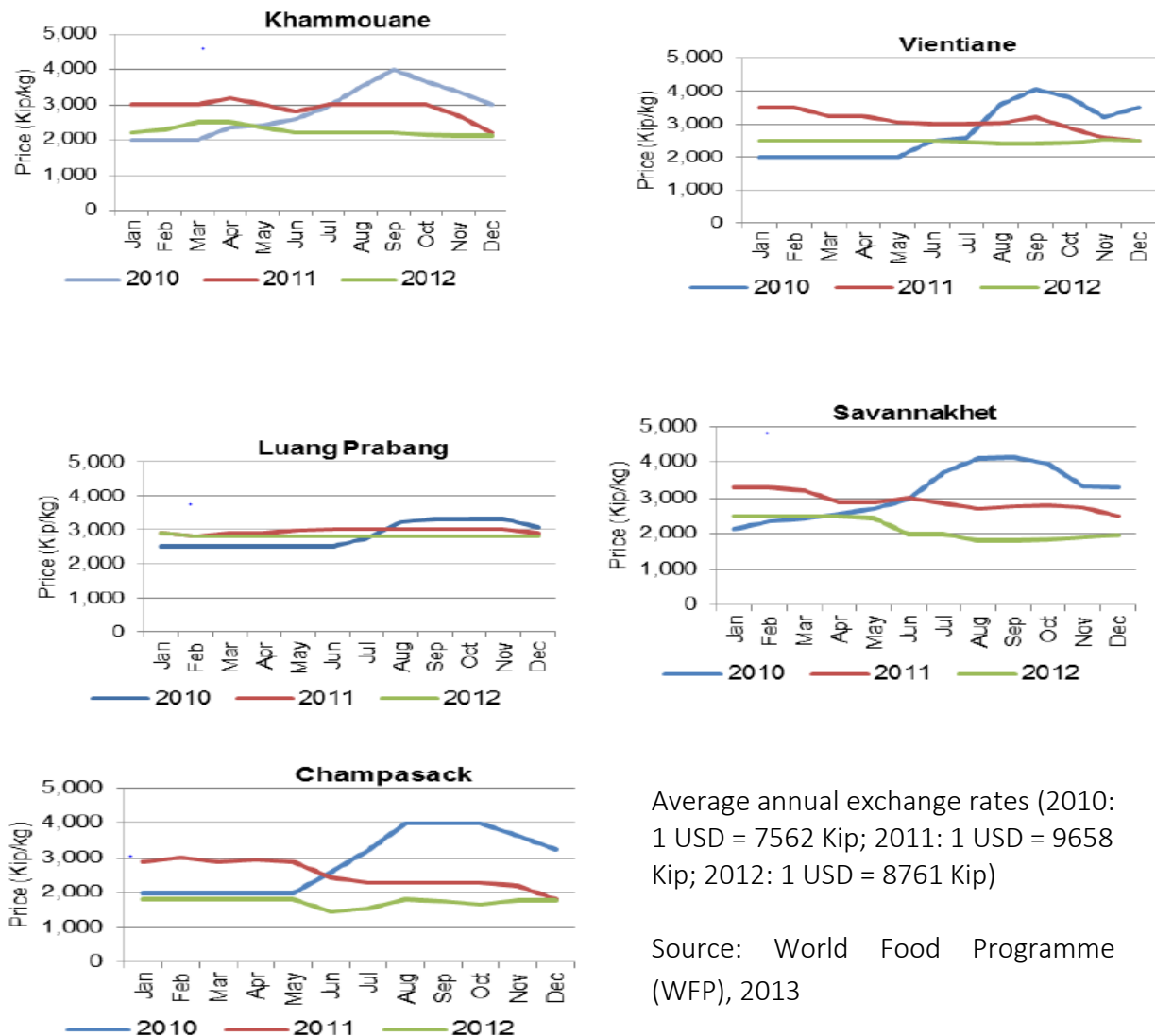
Source: DesInventar data 2012 (1992-2012)

The loss of livestock significantly affected rural households, and children. Besides serving as food for the family, livestock are also a valuable asset and a safety net for rural people to cope with medical emergencies. Cows and buffaloes also play a key role as draught animals for farming. According to WFP, the nutritional status of children from households depending on agricultural livestock production would be affected when their families encountered livestock loss due to extreme climate events.[9]

4.1.4 Food price

Extreme climate events affected food production and then food prices in Lao PDR. Figure 7 shows that, the price of rice always fluctuated in Lao PDR between 2010 and 2012, but in 2010 the price was very high between August and October. This was due to the presence of Typhoon Ketsana at the end of 2009 that affected provinces in the southern part of the country such as Champasak and in the central part such as Khammouane and Savannakhet. Those three provinces were the largest rice cultivation areas that supplied rice to the whole country. Also in 2010, the central provinces of Khammouane and Savannakhet experienced more severe local flooding and heavy rain that exacerbate rice production resulting in higher prices for rice.

Figure 7: Glutinous price trends in selected provinces, 2010-2012



Average annual exchange rates (2010: 1 USD = 7562 Kip; 2011: 1 USD = 9658 Kip; 2012: 1 USD = 8761 Kip)

Source: World Food Programme (WFP), 2013

he rise of food prices affected household consumption in Lao PDR and children were the main victims. According to WFP, many households needed to purchase food for consumption to meet their food requirements and higher food prices could pose negative impacts on food security for those households, especially families living in low-income and crisis-prone areas with children being among the most affected.[19]

4.1.5 Access to markets

According to the World Food Programme (WFP), only one third of villages nationally, had temporary produce markets.[20] Market access was extremely difficult in some rural areas during the rainy season or floods. Floods destroyed several rural roads in Lao PDR (Table 4)[20] and about one out of three village has no access to roads seasonally. Access to markets outside of the village is dependent on good road infrastructure, which is limited in Lao PDR due to natural disasters.[9]

Table 4: Impacts of climate events on damaged roads in Lao PDR, 1992-2012

Events	NO. of events	Damaged road Mts.
Drought	165	39
Flood	1,286	2,217,569.54
Storms	741	13,931
Rains	62	4321.79
Total	2,254	2,235,860.90

Source: DesInventar data 2012 (1992-2012)

4.2 Health conditions

4.2.1 Infectious diseases

During floods, droughts and periods of high temperatures, the increased burden of infectious diseases is influenced by unsafe water, poor sanitation, and hygiene practices. Infectious diseases spread at such times include diarrhea, malaria, respiratory tract infections, pneumonia and parasites.[2] Table 5 shows that from 2013 to 2016, the cases of Malaria and Pneumonia had dropped considerably, but diarrhea cases continued to increase significantly. The numbers of diarrhea cases were highest in 2015 and many children died. Diarrheal disease is in fact linked with pneumonia as the second largest killer of children under five, which is closely associated with poor sanitation and hygiene.[21] Malaria is one of the most prevalent diseases in rural areas that usually occurs after the rainy season.[22] Infectious disease is a contributing cause of children's under nutrition. Children's inability to both absorb and utilize nutrients, leads to problems of stunting, wasting and low weight. [2]

Table 5: Cases of infectious diseases in Lao PDR in 2013-2016

Diseases	2013		2014		2015		2016	
	case	death	case	death	case	death	case	death
Malaria	44,318	95	1,716	-	1,972	-	2,135	9
Diarrhea	38,128	2	47,567	1	53,850	20	8,537	2
Pneumonia	7,806	9	9,072	22	7,282	8	4,714	3

Source: Ministry of Health (MoH) report, 2016

The level of infectious diseases is higher in the northern provinces compared to the central and southern provinces (Table 6). However, in the central provinces, the percentages of malaria and pneumonia has been higher than other parts of the country, especially in Khammouane and Savannakhet where rainfall, floods and extreme events often occurred.

Table 6: The percentage of the population who suffered infectious diseases by regions, 2011-2012

Diseases	North %	Central %	South %
Malaria	14.2	16	5.9
Diarrhea	15	7.4	7.9
Parasitic	71	39	0
Pneumonia	59.9	65.3	45.6

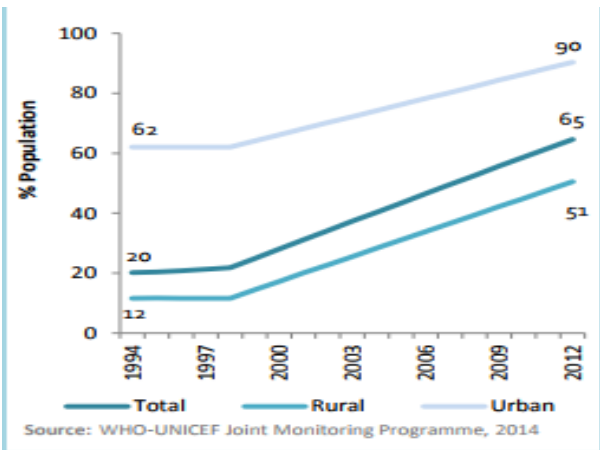
Source: LSIS 2011/2012

4.2.2 Water supply, hygiene and sanitation

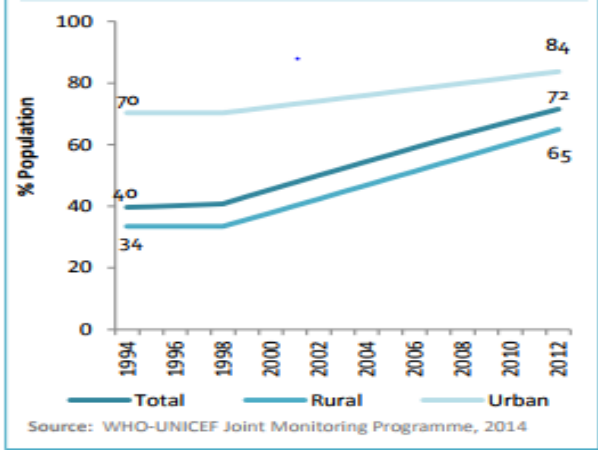
Access to water and sanitation in Lao PDR has significantly increased in the last two decades. Figure 8 indicates the increasing percentage of the population having improved sanitation facilities and water sources from 1994-2012.

Figure 8: The percentage of people gaining access to improved sanitation facilities and water sources from 1994 to 2012

Access to Improved Sanitation facilities



Access to Improved Water Sources



However, many children who live in remote areas still lack safe water and have no sanitation facilities. Natural hazards such as floods or droughts constrained people from accessing safe water or utilising water for domestic use. Some provinces, such as Huaphanh and Phongsaly can be affected by drought every year, so they often face severe water shortages. Typhoon Ketsana hit the southern provinces in 2009; Khammouane and Savannakhet were affected by floods in 2010; and areas near the Mekong River were hit by floods in 2008 and a severe tropical storm in 2011.

These disasters affected water supply and sanitation, and thus contributed to a high incidence of disease. According to UNICEF, unsafe drinking water is harmful to children health. [23] Young children living in households without access to improved water and sanitation have a higher prevalence of diarrhea.[24] About 30 percent of child mortality has been attributed to inadequate water supply, sanitation and hygiene.[25] In Lao PDR, unsafe drinking water, poor sanitation and hygiene were a common cause of several diseases. These problems cause the deaths of children under five each year and many millions of disease episodes.[21]

5. Overview of existing policies on Child malnutrition and Climate Change

The link between child malnutrition and climate change has been mainly addressed in four policies in Lao PDR. Firstly, the National Strategy on Climate Change was approved in March 2010, with a vision to secure a future where Lao PDR is capable of mitigating and adapting to changing climatic conditions. This strategy recognizes that climate change contributes to child malnutrition and suggests adaptation measures be integrated into the health sector. The key adaptation options for improving nutrition in the face of climate change are to ensure access to safe water and improved sanitation to reduce diarrheal diseases, malaria and other infectious diseases.[26]

Secondly, in December 2015, Lao PDR developed the National Nutrition Strategy 2025 and Plan of Action 2016-2020 that aims to reduce the malnutrition rate of women and children and improve nutrition of multiethnic people in Lao PDR. The strategy defines 4 strategic directions, 11 strategic objectives and 29 interventions to be implemented. Climate change is mentioned under strategic direction #2, and it has been considered as the underlying cause of child malnutrition. To deal with child malnutrition, according to the strategy, it is important for stakeholders to ensure available agricultural production for adequate food consumption as well as improved clean water, sanitation and environment.[4]

Thirdly, in June 2016, the 8th Five-Year National Socio-Economic Development Plan (2016–2020) “8th NSEDP” was developed, with a long term vision until 2030. The 8th NSEDP partly seeks to continue addressing child malnutrition improvements that were not yet achieved under the MDGs and continue to be incorporated in the SDGs. The policy also acknowledges the contribution of climate change to the problem of malnutrition. Addressing child malnutrition and climate change is reflected under outcomes # 2 and # 3 of the policy.[3]

Fourthly, in May 2015, the Agriculture Development Strategy to the year 2025 (ADS 2025) was developed. The ADS 2025 defines clear objectives and goals in developing the agriculture sector until the year 2020 and then to 2025 and the vision to the year 2030 which are to ensure; food security, sufficient agricultural commodities, and clean, safe and sustainable agriculture for national economic growth. Nutrition and climate change are also defined in the Agriculture Development Strategy 2025, which maintains that it is important to ensure that people receive minimum dietary energy of 2,600 Kilocalories per person per day. An improvement in food diversity, especially among children is also a target of the policy to resolving hunger and malnutrition in Lao PDR.[15]

6. Conclusion

This paper, which synthesized previous studies, shows that Lao PDR has encountered severe climate variability in the past and will continue to do so in the future. Climate change has a connection with child malnutrition problems in the country. The paper shows that climate change contributed to child malnutrition in Lao PDR through reducing food availability and food accessibility to households, causing infectious diseases among children and reducing access to water supplies, hygiene and sanitation. Children are often the main victims of food shortages and diseases when there are floods and droughts. The paper also showed that the extent of these impacts varies from region to region.

Lao PDR has recognized the importance of the impact of climate change on child malnutrition, and four policies had been put in place that recognizes the link between child malnutrition and climate change. These four policies intend to ensure access to safe water and improved

sanitation to reduce infectious diseases, to ensure available agricultural production for consumption, and to ensure food security, and clean, safe and sustainable agriculture for the people of Lao PDR. The results of this study suggest that in response to child malnutrition and climate change in Lao PDR, there is a need for all stakeholders across food, water and health sectors to coordinate and cooperate to implement policies in order to improve climate resilience among rural households, especially with a focus on the needs of children.

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