



**IMPACT OF CLIMATE CHANGE ON UNDERNUTRITION  
AMONG WOMEN AND CHILDREN IN VIETNAM: WHAT ARE  
THE EXISTING INEQUITIES AND PROPOSED SOLUTIONS  
FOR THE FUTURE?**

**BY**

**TUYEN NGUYEN THI THANH**

**AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENT FOR THE DEGREE  
OF MASTER OF PUBLIC HEALTH IN GLOBAL HEALTH  
FACULTY OF PUBLIC HEALTH  
THAMMASAT UNIVERSITY**

**2022**

**COPYRIGHT OF THAMMASAT UNIVERSITY**

**IMPACT OF CLIMATE CHANGE ON UNDERNUTRITION  
AMONG WOMEN AND CHILDREN IN VIETNAM: WHAT ARE  
THE EXISTING INEQUITIES AND PROPOSED SOLUTIONS  
FOR THE FUTURE?**

**BY**

**TUYEN NGUYEN THI THANH**

**AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENT FOR THE DEGREE  
OF MASTER OF PUBLIC HEALTH IN GLOBAL HEALTH  
FACULTY OF PUBLIC HEALTH  
THAMMASAT UNIVERSITY**

**2022**

**COPYRIGHT OF THAMMASAT UNIVERSITY**

THAMMASAT UNIVERSITY  
FACULTY OF PUBLIC HEALTH

INDEPENDENT STUDY

BY

TUYEN NGUYEN THI THANH

IMPACT OF CLIMATE CHANGE ON UNDERNUTRITION AMONG WOMEN AND  
CHILDREN IN VIETNAM: WHAT ARE THE EXISTING INEQUITIES AND PROPOSED  
SOLUTIONS FOR THE FUTURE?

was approved as partial fulfillment of the requirements for  
the degree of Master of Public Health in Global Health  
on 22<sup>nd</sup> September 2022

Chairman



(Associate Professor Uma Langkulsen, PhD)

Member and Advisor



(Associate Professor Stephen J. Atwood, MD, FAAP)

Member



(Assistant Professor Li Liang, PhD)

Dean



(Associate Professor Sasitorn Taptagaporn, PhD)

Thesis Title	Impact of climate change on undernutrition among women and children in Vietnam: What are the existing inequities and proposed solutions for the future?
Author	Tuyen Nguyen Thi Thanh
Degree	Master of Public Health in Global Health
Major Field/Faculty/University	Public Health Thammasat University
Thesis Advisor	Associate Professor Stephen J. Atwood, MD, FAAP
Year	2022



## ABSTRACT

**Background:** Climate change is seen as a global problem that requires immediate action to prevent and minimize its impact as much as possible. Climate change has a direct and severe impact on food security and nutrition in developing countries. Vietnam is being loaded by the double burden of climate change and undernutrition in the general population. However, the impact of climate change on the nutritional status of women and children in the affected areas is not clear.

**Objectives:** The aim of this study was to identify the nutritional status and nutritional inequalities that exist as adverse outcomes of climate change on the population of children and women in Vietnam.

**Method:** A documentary review was conducted for this study and 30 out of 4577 topics were eligible which were retrieved from PUBMED, SCIENCEDIRECT, SCOPUS, and some from other sources.

**Results:** The nutritional security inequalities reported in this paper are that households do not have enough food to eat, there exists reduced food consumption during the period of extreme weather events. For households in mountainous areas, food is mainly based on wild crops, with high potential for toxic substances. 10 out of 32 studies examined the impact of climate change on child undernutrition in Vietnam. The reported nutritional problem is mainly stunting and HAZ scores in the child population, as a consequence of climate change. The study did not find data to report nutritional status in women related to climate change. Lastly, the current policy of Vietnam is focused on climate change adaptation and mitigation. Nevertheless, there are still policies that are not ready to respond to the impacts of climate change along with inadequate food distribution programs and policies related to it for the people living in affected areas.

**Conclusion:** Climate change results to undernutrition in the general child population, causing long-term consequences for physical and mental development if not promptly intervened. Addressing the "dual goals" of climate change and undernutrition at the same time requires the Vietnamese government to be more resolute, requiring multi-sectoral, multi-stakeholder cooperation efforts from the local to the central level, and increased calls for support from international organizations.

**Keywords:** Climate change, undernutrition, children, women, Vietnam, food security, nutritional inequalities.

## **ACKNOWLEDGEMENTS**

Master's thesis topic in Public Health: " Impacts of climate change on undernutrition among the population in Vietnam: What are the existing inequalities? And proposal solutions for the future. " is the result of the author's constant efforts, as well as the help and encouragement of teachers, friends, colleagues, and relatives. Through this page, the author would like to thank those who have helped us during the past time of the study - scientific research.

I express my deep respect and gratitude to Assoc. Prof. Dr. Stephen J. Atwood, MD, FAAP- The scientific supervisor who directly guided enthusiastically as well as provided necessary scientific information for this study. At the beginning, I personally just thought of this as a thesis I needed to complete as one of the requirements of this course. However, after working with Ajarn Steve in this article, I was provided with a lot of important knowledge, necessary skills as well as a professional working attitude. I am very grateful to Ajarn Steve for what Ajarn helped me to complete this research.

I would also like to thank the Board of Directors of Thammasat University, Faculty of Public Health for creating favorable conditions for me during my study and implementation of this scientific research topic.

I am really grateful and want to say thank you to the Southeast Asia One Health University Network, Scholarship Program with the generous support of the American people through the United States Agency for International Development (USAID) One Health Workforce - Next Generation (OHW-NG) Award 7200AA19CA00018, for supporting me with a scholarship to participate in this course, I had the opportunity to study and exchange knowledge in an international environment, meet and interact with friends from different cultures, thanks to this support, I found myself growing more, changing the perception of the importance of Public Health to the globe, not only my country, but also the people of the whole world, I don't think I have the capacity to change the world, but I will try to contribute a small part, my youth, my ability with the goal of contributing to the improvement of the general health of the community.

Finally, I would like to express my deep gratitude to my family, friends, colleagues, and working units who have supported me during the implementation of this thesis.

**Author**

**TUYEN NGUYEN THI THANH**

# TABLE OF CONTENTS

## ABSTRACT

## ACKNOWLEDGEMENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATIONS

## DEFINITION OF TERM USED

<b>Chapter 1: Introduction .....</b>	<b>1</b>
1.0. Background .....	1
1.1. Overview of climate change.....	1
1.1.1. Global.....	1
1.1.2. Vietnam.....	2
1.2. Climate change and nutrition .....	3
1.2.1. System mapping for climate change and nutrition .....	7
1.2.2. Conceptual frameworks for climate change and nutrition.....	8
1.2.2. Impacts of climate change on nutrition outcome in global scope.....	10
1.2.3. Impacts of climate change on nutrition outcome in Asia .....	10
1.2.4. Impacts of climate change on nutrition outcome in Vietnam .....	11
1.3. Statistics on the frequency of disasters occurring due to the influences of climate change	
12	
1.3.1. Global.....	12
1.3.2. Vietnam.....	12
1.4. Studies examining the effects of climate change on issues connected to nutritional problems in affected populations .....	14
1.5. Problem statement .....	15
1.6. Purpose and design.....	17

1.6.1. Research questions.....	17
1.6.2. Research objectives:.....	17
<b>Chapter 2: Methodology.....</b>	<b>18</b>
2.1. Inclusion and exclusion criteria.....	20
2.2. Data selection process .....	20
2.3. Data mining .....	22
2.4. Data extraction: .....	22
2.5. Ethical issue.....	23
<b>Chapter 3: Results.....</b>	<b>24</b>
3.1. Literature search results .....	24
3.2. Characteristics of the studies.....	24
3.3. Climate change and food security in Vietnam .....	27
3.3.1. In the past.....	27
3.3.2. Prediction for future.....	29
3.3.3. Consequence of effects of climate change on agriculture .....	30
3.4. Climate change and nutrition security in Vietnam.....	31
3.5. Climate change and nutrition status in Vietnam .....	33
3.6. The current policy’s response related climate change and nutrition in Vietnam. ....	38
3.6.1. Statistics of central-level policies in response to climate change and nutritional status of the Vietnamese population .....	38
3.6.2. Vietnamese Government response to climate change impacts that are in practice .....	39
<b>Chapter 4: Discussion .....</b>	<b>41</b>
<b>Chapter 5: Conclusion and recommendations .....</b>	<b>62</b>
<b>References.....</b>	<b>67</b>
Appendices 1: Summary of studies on the effects of climate change on nutritional status of the affected population: .....	82
Appendices 2: Characteristics of selected studies .....	85



Appendices 3: Summary of climate change scenarios at the end of the century .....	96
Appendices 4: The RABIT Model of Resilience (Ospina, 2013).....	99
Appendices 5: Statistics of central-level policies in response to climate change and nutritional status of the Vietnamese population .....	101



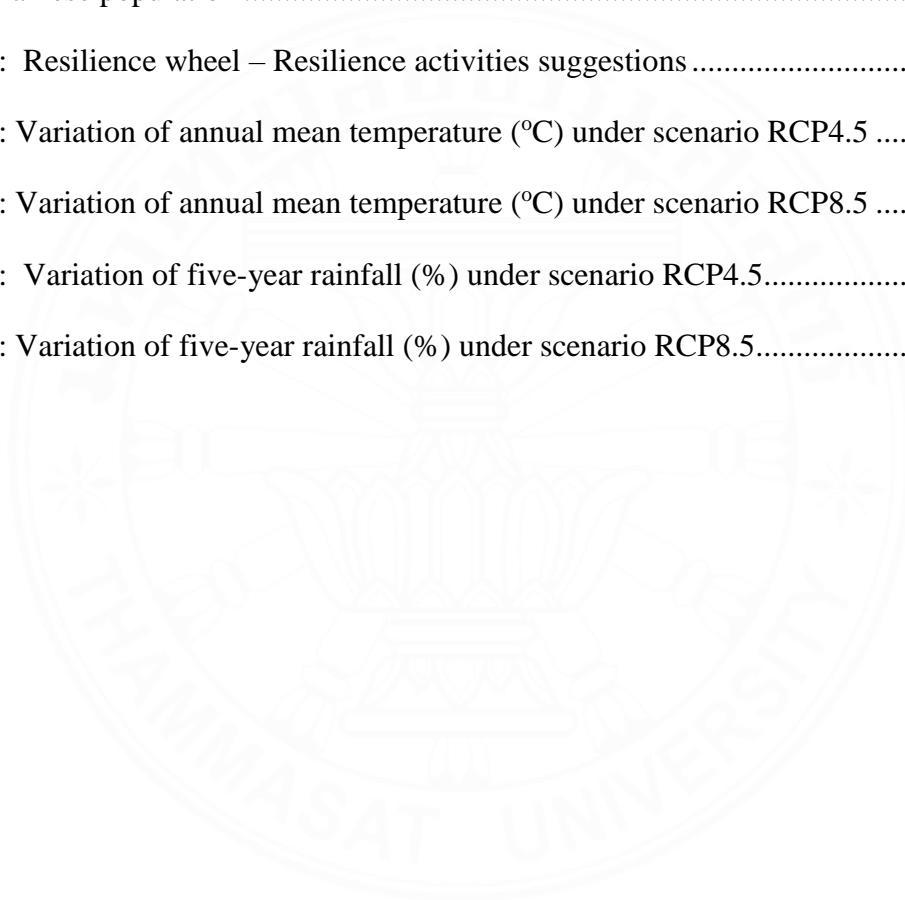
## LIST OF TABLES

Table 1. 1: Statistics of natural disasters linked to climate change around the world .....	12
Table 1. 2: Statistics of natural disasters linked to climate change in Vietnam and impacts of these events .....	13
Table 3. 1: Impacts of Climate change and nutritional status in Vietnam.....	33
Table 3. 2: Nutritional status distributed by region and population in Vietnam.....	37
Table 4. 1: Priority actions to improve resilience .....	57



## LIST OF FIGURES

Figure 1. 1: Systematic diagram showing the factors influencing the association between climate change and nutrition.....	7
Figure 1. 2: Conceptual framework for climate change and undernutrition.....	9
Figure 3. 1: Characteristics of the studies .....	25
Figure 3. 2: Distribution of publications deemed .....	26
Figure 3. 3: Statistics of central-level policies in response to climate change and nutritional status of the Vietnamese population .....	38
Figure 4. 1: Resilience wheel – Resilience activities suggestions .....	56
Figure 4. 2: Variation of annual mean temperature (°C) under scenario RCP4.5 .....	97
Figure 4. 3: Variation of annual mean temperature (°C) under scenario RCP8.5 .....	97
Figure 4. 4: Variation of five-year rainfall (%) under scenario RCP4.5.....	98
Figure 4. 5: Variation of five-year rainfall (%) under scenario RCP8.5.....	98



## LIST OF ABBREVIATIONS

<b>Symbols</b>	<b>Terms</b>
BFA	Body mass index for age
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CRI	Climate Risk Index
DHS	Demographic Health Survey
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
HAZ	Height for age – Z score
IPCC	Intergovernmental Panel on Climate Change
LMICs	Low- and middle-income countries
OR	Odd ratio
PR	Prevalence ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCP	Representative Concentration Pathways
RNI	Reference Nutrient Intakes
SD	Standard deviation
SDGs	Sustainable Development Goals
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
WHO	World Health Organization

## DEFINITION OF TERM USED

**An extreme (weather or climate) event** is generally defined as “*the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends (‘tails’) of the range of observed values of the variable.* (Seneviratne et al., 2012).

**Climate change:** is used by the Intergovernmental Panel on Climate Change (IPCC) to describe like “*a change in the state of the climate that can be identified (e.g. 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 a result of human activity*” (IPCC, 2018a).

**Climate-related events or episodes:** This study based six main types of climate related events or episodes “*ozone air pollution, heat waves, hurricanes, outbreaks of infectious disease, river flooding, and wildfires*”(Knowlton et al., 2011).

**Food security** is defined by Food and Agriculture Organization of the United Nations (FAO) as “*Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life*” (FAO, 2003).

**Global warming** is defined by IPCC as “*An increase in global mean surface temperature (GMST) averaged over a 30-year period*” (IPCC, 2018b).

**HAZ (Length or height-for-age z-score)** is one of the indicators used to assess nutritional status among children under 5 year olds according to WHO recommendations, depending on gender and age, the HAZ cut-off point varies(WHO., 2009).

**Hunger** is defined by FAO as “*an uncomfortable or painful physical sensation caused by insufficient consumption of dietary energy. It becomes chronic when the person does not consume a sufficient amount of calories (dietary energy) on a regular basis to lead a normal, active and healthy life*”(FAO., 2021).

**Low birth weight** infants are defined by the World Health Organization (WHO) as birth weight less than 2500 g (WHO, 2014).

**Nutrition security** is defined as exists when an individual at all times has access and availability of an adequate diet that provides the Recommended Dietary nutritional needs. This state is achieved when the environment the individual lives in has adequate water, sanitation, and health services, education, income, political will, etc.

**RCP** defined by IPCC as “*RCP usually refer to the portion of the concentration pathway extending up to 2100, for which Integrated Assessment Models produced corresponding emission scenarios. Extended Concentration Pathways (ECPs) describe extensions of the RCPs from 2100 to 2500 that were calculated using simple rules generated by stakeholder consultations, and do not represent fully consistent scenarios*” (IPCC., 2022).

+RCP4.5 according to IPCC that “*one of two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W m<sup>-2</sup> after 2100 (the corresponding ECPs assuming constant concentrations after 2150)*” (IPCC., 2022).

+RCP 8.5 according to IPCC that “*RCP8.5 is one high pathway for which radiative forcing reaches greater than 8.5 W m<sup>-2</sup> by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250)*” (IPCC., 2022)

**Resilience:** is defined as “*the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt naturally to stress and change*” by IPCC (IPCC., 2007).

**RNI** is defined as “*is the amount of a nutrient that is enough to ensure that the needs of nearly all a group (97.5%) are being met*” (British Nutrition Foundation., 2021).

**The link between climate change, global warming and climate-related events:** Increasing temperature is a characteristic manifestation of global warming, and is also a factor affecting the change of weather and climate patterns in different regions. Besides, the influence of climate change will make these weather patterns even more extreme such as floods, droughts (US Environmental Protection., 2021).

**Undernutrition** is an indicator used to measure the current nutritional status, which is measured and categorized by age, height, and weight, included three groups: wasting, stunting and

underweight. It makes children much more susceptible to disease and death in particular. (WHO, 2021a). According to The WHO Child growth standards median (WHO, 2022a), (WHO, 2015):

+ Wasting is measured by weight-for-height  $\leq -2$  SD

+ Stunting is measured by height-for-age  $\leq -2$  SD

+ Underweight is measured by weight-for-age  $\leq -2$  SD

**Weather** is defined as *“the conditions in the air above the earth such as wind, rain, or temperature, especially at a particular time over a particular are”* (Cambridge Dictionary, 2022).

**Z score** - the following definition is taken from Investopedia: *“The Z-score, or standard score, is the number of standard deviations a given data point lies above or below mean. Standard deviation is essentially a reflection of the amount of variability within a given data set.”* (Investopedia., 2021)



## **Chapter 1: Introduction**

### **1.0. Background**

Climate change is seen as one of the biggest challenge to efforts to reduce hunger and poverty, especially in low- and middle-income countries (LMICs). Vietnam is considered worldwide as one of the most vulnerable countries to climate change, and children and women are particularly at risk. The decrease in the manufacture of staple foods such as maize, wheat, and rice puts many infants and young children, pregnant women, and ethnic minorities at risk of severe malnutrition in all later stages of the child's development such as growth retardation, weakening of the immune system and limiting the child's later development. In addition, climate change reduces incomes, degrades natural resources, loses assets and damages infrastructure. It reduces mobility, decreases access to jobs or services, and increases morbidity and mortality. All of which lead to a decrease in labor productivity. If the world truly sees climate change as a threat to humanity's health, the Vietnamese government needs to realize the gravity of the situation, particularly the possibility that health-care and protection agencies would be overburdened in the future.

### **1.1. Overview of climate change**

#### **1.1.1. Global**

Climate change is no longer an unfamiliar term in our society today. It is known as a consequence of both natural risk factors and human activities, but it can be seen that human activities have significant impacts on climate change today. More important, these effects have worse and longer-lasting effects on our next generations. From the global population explosion to the vigorous development of industrialization and modernization, deforestation to occupy the land for agriculture, strong migration to dense urban areas, and transportation activities are typical examples where human activities have been and are increasingly making climate change worse. The scientific evidence further highlights that " climate change is a threat to human wellbeing and the health of the planet" (IPCC, 2022a).

Over the past 10 years, we have witnessed and recorded numbers that take over the significant influences of climate change on our lives, floods are a typical example with more than 2 billion people affected worldwide from 1998 to 2017 as stated in the report of the World Health Organization (WHO, 2022b). In Asia, by 2020, floods and storms will have impacted over 50



million people, with over 5,000 people killed due to these impacts (World Meteorological Organization (WMO, 2021a). Unfortunately, there are some predictions that are even scarier, for example, with projections made between 2030 and 2050, there will be an additional 250,000 deaths in the world each year related to malnutrition, malaria, diarrhea, and heat stress as a result of climate change (WHO, 2021b). Next, threatening global food security, adding 32 to 132 million people into extreme poverty over the next decade, increasing mortality from problems related to rising temperatures, cardiovascular disease, and other diseases in terms of mental health problems under the impact of climate change (IPCC, 2022b), (CDC, 2021). More alarmingly, with 3.3 billion-3.6 billion people living in countries vulnerable to climate impacts, climate change is therefore further exacerbating vulnerabilities in these populations, with global hotspots concentrated in developing countries such as the Islands, the Arctic, South Asia, Central and South America, and much of sub-Saharan Africa, thereby contributing to an increase in inequality that affects social and economic poverty, and increase opportunities for emerging diseases (IPCC, 2022b). Climate change has had, and will have even more severe impacts on every country globally, not a particular country or people (IPCC, 2022b). And this emphasizes the need for greater cooperation and effort in reducing risk factors affecting the influence of climate change.

### **1.1.2. Vietnam**

In the report about the Global Climate Risk Index 2020, particularly in terms of the Long-Term Climate Risk Index (CRI), Vietnam has ranked 6th and is also one of the 10-most affected countries from 1999 to 2018 (Global climate risk index, 2020). Vietnam ranks first with Bangladesh as the country that is highly affected by floods in particular. In Vietnam floods are the biggest risk and have a strong economic impact, accounting for about 97% of the average annual loss to the economy caused by natural disasters (Climate Change Knowledge Portal, 2022). With the length of Vietnam's coastline of 3,444km stretching from North to South, from Mong Cai in the North to Ha Tien in the Southwest, it is ranked 42<sup>nd</sup> out of 225 coastal countries, islands, and territories around the world in vulnerability, and when the sea level rises, it will definitely make a big impact on Vietnam (CIA World Factbook, 2022). A sea-level rise in Viet Nam's coastal area of about  $3.50 \pm 0.7$ mm/year (1993-2014) and an average temperature increase of about 0.62o C in the period 1958-2014 is what Vietnam has faced under the influence of climate change (Ministry of natural resources and environment in Vietnam, 2016). In addition, if Vietnam does not take appropriate measures to cope with the problem of temperature and rainfall that continue to increase

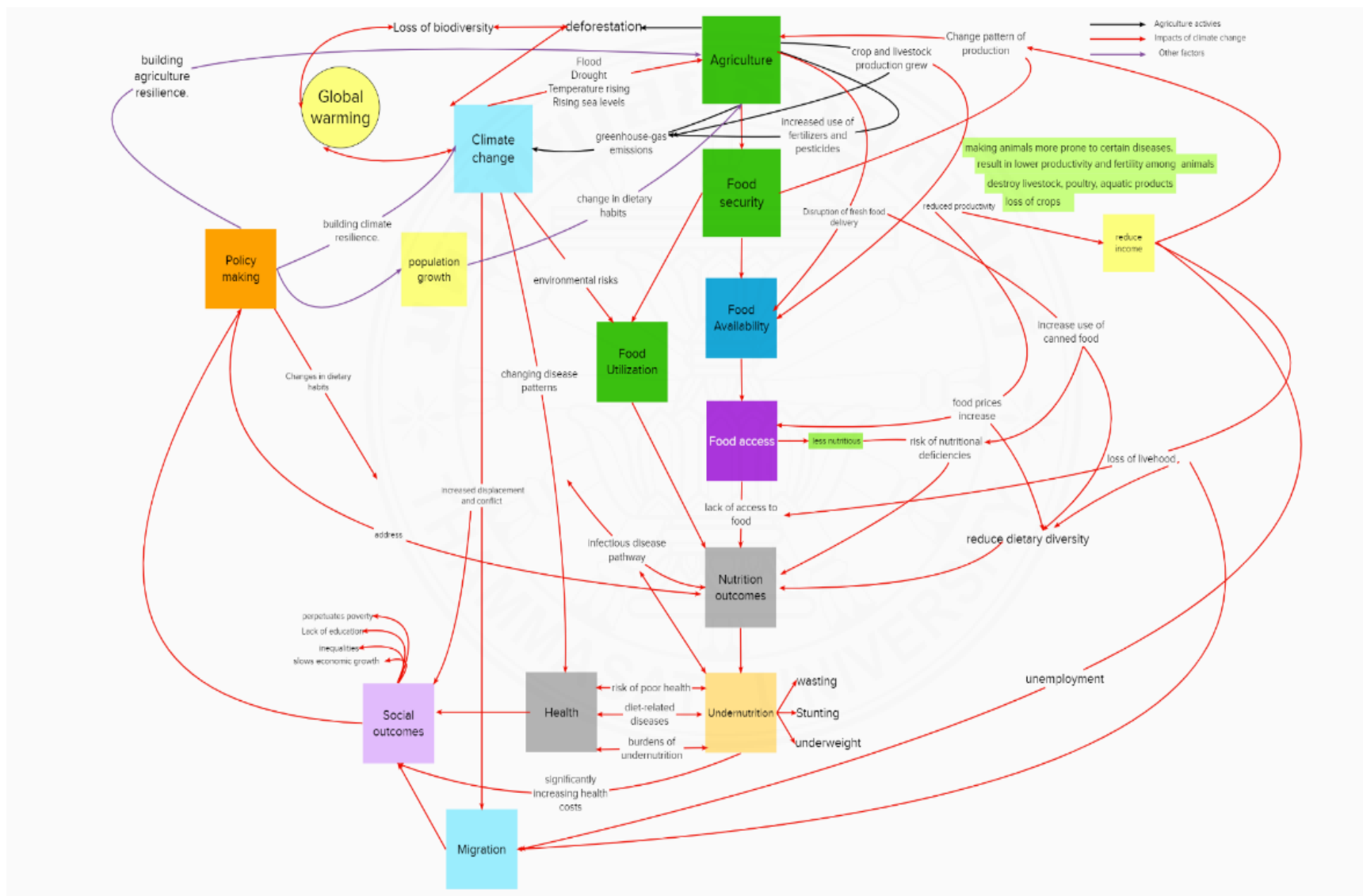
in the coming time, it is estimated that when the sea level rises by 100cm, 40,000 km<sup>2</sup> of land may be lost, represents approximately 12.1% of the total area of Vietnam and affecting an estimated 17.1 million people (Government of Vietnam, 2015). The 5th largest exporter of rice worldwide, rising sea levels will make the Mekong Delta of Vietnam, one of the largest rice granaries in the whole country and region, become extremely vulnerable (World's Top Exports, 2020). The result would be food insecurity not only for Vietnam but also for the international public.

## **1.2.Climate change and nutrition**

When it comes to climate change's impact on food security, it's not only a lack of food resources but also food that doesn't have enough nutrients to meet daily needs, that contribute to increasing undernutrition in the population. However, it is critical to evaluate the direct effects of climate change on maternal, infant, as well as child health through maternal nutrition. Nutritionists are more interested in measuring stunting because they consider it a better indicator of malnutrition in both children and women (USAID, 2020). The 1000-day concept helps measure a child's most vulnerable period of development from the time of conception, through pregnancy until the child's has reached 2 years of age (i.e. 24 months) (UNICEF, 2017). This concept also means that the nutritional status of young women entering pregnancy is very important because it determines the environment of the fetus around conception. The reason for this mention is because it links the impact on both women and children (Kuehn & McCormick, 2017).

### 1.2.1. System mapping for climate change and nutrition

Figure 1. 1: Systematic diagram showing the factors influencing the association between climate change and nutrition



It can be seen that this system diagram above (figure 1.1) show:

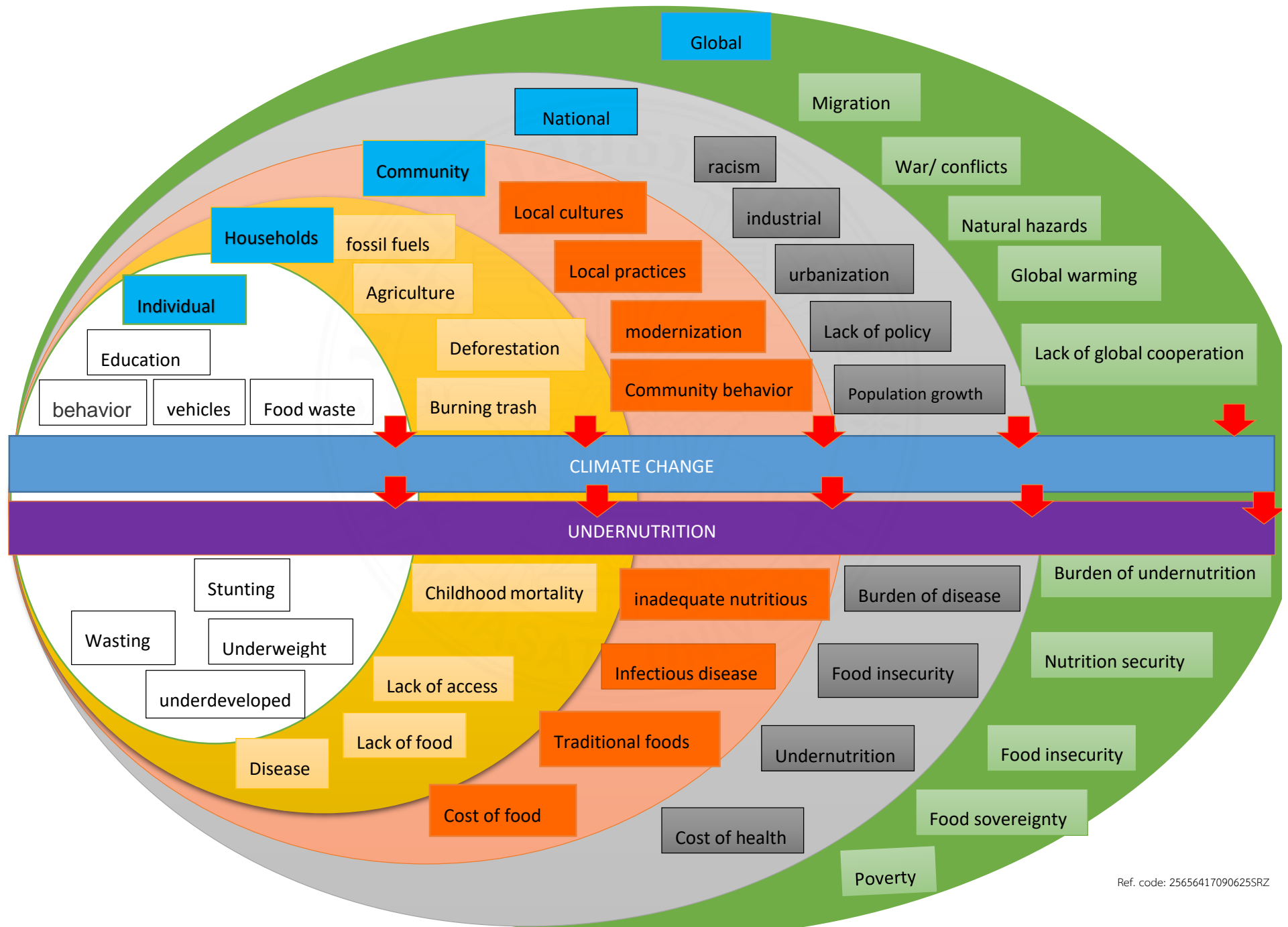
+ **A feedback loop between climate change and agriculture** is shown. Current agricultural activities such as animal husbandry, cultivation and processing is emitting significant amounts of methane and nitrous oxide, two powerful greenhouse gases that contribute to climate change. And climate change has already had severe impacts on agriculture such as decrease in crop yield due to extreme heat and reduced rainfall, mass mortality of livestock due to heat shock or diseases caused by weather changes, and the undernutrition variable is seen as the outcome variable of this relationship.

+ **Impacts of food security on nutrition:** Food availability requires readily available food that meets both quantity and quality, as well as a variety of foods that help meet basic human nutritional needs on a daily. However, if this basis availability is met only for prepackaged foods, not raw foods, this could affect nutritionally relevant outcomes due to lack of nutrients, minerals, and vital nutrients that can only be obtained from raw foods. Food access emphasizes the cost of food that people can afford. Despite the fact, the poor tend to consume disproportionately specific foods — often less favored crops. The potential for increased food prices due to climate change could reduce dietary diversity and thereby reduce the nutritional value of the diet, affecting nutritional status. Food utilization considers external factors affecting the use of food, ensures safe access to and uses of food, and ensures absorption of important nutrients from food. If exogenous factors affect the use of food, for example a lack of clean water due to the impact of climate change, it will lead to a number of nutrition-related diseases, thereby reducing the absorption and use of essential nutrients by the body. Finally, stability emphasizes the co-existence of the above factors, in terms of food availability, food access and food use contributing to the improvement of overall nutritional status.

+ **Undernutrition is the outcome variable due to impacts of climate change on nutrition in this study.** It has important effects on the health and development of people, especially the most vulnerable groups, which are children and pregnant women. In addition, other factors need to be considered, such as policies for sustainable agricultural development, policies to adapt to the changing climate, and policies to support food under the impact of climate change. Reviewing and developing reasonable and timely policies contributes to reducing the effects of climate change on people's lives, particularly in climate-affected places, and people all over the world in general.

### 1.2.2. Conceptual frameworks for climate change and nutrition

Figure 1. 2: Conceptual framework for climate change and undernutrition



The above system diagram (figure 1.1) shows a general picture of factors affecting or being affected by climate change on nutritional status. This concept (figure 1.2) shows the sociopolitical impacts of climate change on nutritional outcomes at different levels. If viewed horizontally from left to right, it can be seen that the impact is growing at the individual, household, community, national and international levels, and vice versa from the international level, this perspective shows significant impact on the country, the country on the community, the community on the household, and finally the household on the individual. On the other hand, if looking at it vertically from the top, contributing factors to climate change will vary to each degree, and the consequences on nutritional outcomes are separated at each level.

### **1.2.2. Impacts of climate change on nutrition outcome in global scope**

Under the impact of climate change, weather phenomena become more extreme and agriculture is the most affected sector. For example, prolonged drought will affect crop yields globally, ranging from 8 to 30% for rice, maize, wheat and soybean products (Hendrawan et al., 2022). In 2019, a 1°C increase in temperature increases the likelihood of severe food insecurity globally by 1.64% (Romanello et al., 2021). And it is forecast that if the temperature increases by 4 degrees Celsius (when compared to previous pre-industrial temperatures), 1.8 billion people will be pushed into poverty globally (WFP, 2021).

Of the 35 countries that are reported to be most at risk from the effects of climate change, between 8 and 10 are experiencing severe food insecurity, with an estimated 117 million people suffering from severe food insecurity whom living in crisis or worsening hunger, the impact on nutrition and health outcomes may be worse. Children, pregnant and lactating women are most vulnerable to the consequences related to nutritional deficiencies and the later development of young children (Action Against Hunger USA., 2021). Specifically, micronutrient deficiencies reduce health and increase the risk of disease in pregnant women. For children, this leads to malnutrition, rickets, anemia, dry eyes, and mental and physical retardation.

### **1.2.3. Impacts of climate change on nutrition outcome in Asia**

Asia is known to be home to more than half of the total population worldwide affected by nutrition-related climate change with about 305.7 million of people in South Asia, 48.8 million of people in Southeast Asia undernourished (WMO, 2021a). Existing research has shown a significant link between climate change impacts and nutritional security in several areas of Asia.

For example, a study in rural India reported an 86% higher risk of stunting among children living in flooded zones than those living in non-flooded zones, (PR = 1.86, 95% CI = 1.04-3.30) (J. M. Rodriguez-Llanes et al., 2011). A study in Pakistan has also shown that the number of underweight children in areas impacted by severe flooding was higher than in moderately affected areas, 46 - 48% and 39 - 40% respectively, but this difference is not statistically significant (Hossain et al., 2013). In Bangladesh, exposure to drought in pregnant mothers had negative effects on child physical development, namely a 0.11 decrease in weight-for-height and a 0.11 decrease in weight-for-age in children under 5 years old (Kien. Le & My. Nguyen, 2022).

#### **1.2.4. Impacts of climate change on nutrition outcome in Vietnam**

In Vietnam, nutrition issues are getting more and more attention through nutrition intervention programs and policies of the government, national and international organizations. However, stunting is a considerable problem in Vietnam, with more than 1.8 million children under the age of 5 years suffering from the condition (UNICEF, 2022). As a country with agriculture as the dominant role, Vietnam is vulnerable to the impact of climate change and associated natural hazards. It also has a number of social and economic risk factors (e.g., 54 ethnic groups living together, different cultures, household economic factors, and poverty) that increase its vulnerability to the impact of climate change on food shortages and hunger.

Therefore, the goal of this research is to review and evaluate the impacts of climate change on the nutritional status of Vietnam's population, particularly on women and children. More than that, the three main research objectives will focus on nutritional problems caused by climate change impacts in different regions, thereby drawing out what inequalities exist between different populations, and between different geographical conditions. And finally, whether the solutions and policies of the Vietnamese government are adequate to solve this problem, and contribute to promoting Vietnam to soon achieve the Goals of the 2030 Agenda for Sustainable Development (SDGs), especially goals on climate action (goal 13) and food security (goal 2) (United Nations, 2015).

### 1.3. Statistics on the frequency of disasters occurring due to the influences of climate change

#### 1.3.1. Global

**Table 1. 1: Statistics of natural disasters linked to climate change around the world**

**(05 disasters with the highest death rate):**

No	Types of disasters	Deaths	The number of people are affected	Regions/ countries are most affected
1	Droughts (WHO, 2021c), (Statistic, 2021)	650.000*	About 55 million people globally (reported in 2020)	Africa, including Zimbabwe, Djibouti, and South Africa
2	Storm/ hurricane (WHO, 2022c), (The Borgen Project, 2017)	577.232*	Storms also affected an estimated 726 million people worldwide (reported from 1998 – 2017)	China, The United States, Cuba
3	Floods (World Bank Blogs, 2020)	58.700 deaths	Around 1.47 billion people are at risk of severe flooding, with nearly 600 million of them being poor. (reported in 2020)	The great majority of people live in countries with low and moderate incomes. (accounted for 89%)
4	Extreme temperature/ heatwaves (WHO, 2017a), (WMO, 2021c)	more than 166 000 people died	Around 125 million (reported from 2000 and 2016)	Russian, Arctic Siberia, the United States, Republic of Sakha
5	Landslides (WHO, 2017b), (Resourcewatch., 2018)	More than 18.000 people died	Approximately 4.8 million people and (reported from 1998 – 2017)	Italy, Austria, China, the Philippines and Ethiopia.

*\*Number of deaths reported from 1970 to 2019 (WMO, 2021b)*

According to table 1.1 collected by this study, among disasters linked to climate change, drought caused the most number of deaths, followed by storm/ hurricanes and floods. In addition, it is noteworthy that these phenomena occur mainly in disadvantaged areas, low-middle income countries.

#### 1.3.2. Vietnam



**Table 1. 2: Statistics of natural disasters linked to climate change in Vietnam and impacts of these events**

Years	Events linked to climate change							Damages			
	Storm	A tropical depression	Mild earthquake/ droughts/ salinization	Hailstorm, thunderstorm, lightning	Heavy rain, floods, flash floods	River bank landslide	Temperature shocks: heat wave, harmful cold	People	House	Livestock	Farming
From 2021 to 29/8/2021	4	2	88	279	62	153	7	42 dead, 64 people were injured;	225 houses completely collapsed, 7,604 houses were damaged or broken;	2,514 cattles and 3,502 birds died	This damaged about 70 thousand hectares of rice and vegetables and 6.5 thousand hectares of crops
2020	14	-	90	265	120	-	-	357 dead and missing 876 people were injured	3,429 houses collapsed, 333,084 houses were damaged, roofs removed, urgent relocation; 511,172 turns of houses flooded.	51,923 cattle and 4.11 million birds died, washed away	This damaged about 144 thousand hectares of rice and 54 thousand hectares of crops
2019	8	4	-	222	73	13	17	133 dead and missing 183 people were injured	1,319 houses collapsed, 32,294 houses were damaged, roofs removed, urgent relocation; 47,165 turns of houses flooded.	3,082 cattle and 296,037 birds died, washed away	This damaged about 79.7 thousand hectares of rice and 21 thousand hectares of crops
2018	14	-	-	212	45	-	38	224 dead and missing 170 people were injured	1,987 houses collapsed, 31,490 houses were damaged, roofs removed, urgent relocation; 81,508 turns of houses flooded.	30,228 cattle and 781,643 birds died, washed away	This damaged about 205 thousand hectares of rice and 61 thousand hectares of crops

Source from: (Vietnam Disaster Management Authority, 2021)

Vietnam is a country heavily influenced by global climate change. Vietnam suffers from a number of types of natural hazards each year, with great intensity and increasingly serious nature, leading to the great loss of life and property. Table 1.2 shows the frequency of extreme weather events in Vietnam from 2018 to 2021 with severe impacts on people, houses, and the agricultural sector (in particular, livestock and farming). And over time, these phenomena develop very complicatedly, unpredictably in extreme directions, and require appropriate prevention and response measures.

#### **1.4. Studies examining the effects of climate change on issues connected to nutritional problems in affected populations**

Drought has been shown to be associated with undernutrition in children, especially with regard to height in the first 5 years of life, decrease in mean height of 1% - 2 % (Bauer & Mburu, 2017), (Woldehanna, 2010), (Alderman, 2010).

Precipitation was also reported to be associated with rates of child malnutrition, with malnutrition rates also 1.86 times higher among children living in flooded communities (95% CI 1.04 to 3,30) (J. M. Rodriguez-Llanes et al., 2011). Similarly, the mean level of stunting will increase by 0.242 if there is an increase in the standard deviation of precipitation, and vice versa, it will decrease by 0.216 (Hagos et al., 2014). In contrast, the HAZ (height for age Z score) of children born in years with higher rainfall (increased precipitation) was 0.427 SD higher when compared with children born in years with low rainfall (increased precipitation) (Akresh et al., 2011).

Some researchers found a significant link between exposure to hot days and reduced birth weight (Lawlor et al., 2005), (Deschênes et al., 2009). On top of that, an 8.6% rise in the prevalence of reported preterm births (95% CI = 6.0 - 11.3) was associated with an increase in mean weekly temperature (approximately 10°F, 5.6°C) (Basu et al., 2010).

The proportion of stunting in children is found to be common in areas particularly affected by climate change, specifically, the rates of stunting, wasting, low birth weight, and anemia are 32%, 42%, 45% and 63% respectively were found in the study conducted in India (Mahapatra et al., 2021). By 2050, it is estimated that the average prevalence of stunting is 1 to 29% due to climate change impacts, increasing from 23% in the sub-Saharan Africa region to 62% in South Asia (Lloyd et al., 2011). A literature review of 22 studies considered and examined the effects of drought, flooding, and climate change on one of the indicators of malnutrition (Lieber et al., 2022). Specifically, most scientific research informed a meaningful link between the effects of climate change and undernutrition, for example, leanness and low birth weight were significantly associated for those living in arid climates (OR = 1.46; 95% CI:1.05 - 2, p-value = 0.04) and (OR 1.46, 95) %CI 1.01-2.11) respectively (Lieber et al., 2022).

One thing in common among the studies listed above is that they all measure the effects of climate change on child growth, especially on the issue of stunting (*Appendix 1*). There is a reasonable explanation for this since it is a measure of chronic malnutrition, this indicator considers the impact of the child's development over a longer period of time, which is better suited to climate change since it itself is a more chronic problem that extends over months, years and decades. It is not only something immediate like drought or famine that will lead to wasting (i.e., low weight for height), and that is the main reason that stunting is the main variable in this study. In addition, it is important to add that it is impossible to talk about child malnutrition without talking about maternal malnutrition and childhood malnutrition. However, at each stage of development from conception, to birth, to adulthood, to becoming a mother, there are very different nutritional needs. In it, special emphasis is placed on "nutrition in the first 1,000 days". As, 1,000 days from pregnancy to two years of age offers an important opportunity to create brighter, healthier futures. How well mothers and children are nurtured and cared for during this time has a profound effect on a child's ability to grow, learn and thrive in the future. However, this time is also potential for many injuries. Poor nutrition during the first 1,000 days can cause irreversible damage to a child's developing brain, affecting their ability to do school and work afterward — and families find it harder to get out of poverty. It can also set the stage for obesity, diabetes, and other chronic diseases that can later lead to health problems lifelong. That's why in this study want to put even more emphasis on calling for more investment in maternal, infant and toddler nutrition and health as a way to create a brighter and prosperous future for all of us.

### **1.5. Problem statement**

Although, having a remarkable economic growth rate, Vietnam is still one of the low-income countries and is severely impacted by climate change (Sustainable Development Goals, 2018). Agriculture plays a great role in the growth of Vietnam not only in terms of economy but also in ensuring jobs and livelihoods for Vietnamese people. This is a positive thing, but like other regions in the world, Vietnam is also being heavily impacted by climate change and global warming. With the geographical feature of a country with a long coastline, the population living in this area is easily affected by high sea levels, storms, and tsunamis. Moreover, people living on offshore islands are at risk of being submerged by sea-level rise, floods, and landslides. For the delta, the land is flooded, storm surges, and millions of people may be displaced if the sea level

rises, and increased salinity reduces productivity and output. In addition, due to sea-level rise, changes in the coastal flow regime will cause shoreline erosion, landslides, and many associated consequences. For mountainous areas with a distribution of many ethnic minorities with low education levels, the impacts of climate change will limit resilience. In general, increasing temperature will be more serious than water shortage. In the dry season, when the temperature drops, it will affect livestock and poultry raising, especially buffaloes and cows. Especially, when the temperature became too cold, a series of buffaloes and cows in the northern mountainous areas died. These are the prominent features that climate change has been affecting in Vietnam, threatening the quality of life, happiness, and the ability of people to survive in these areas due to impacts of climate change, especially ethnic minorities, who are vulnerable to climate change. Unsatisfactory quality of life, poverty, food insecurity, and inadequate nutrition are what the people around the world are facing in general, and Vietnam in particular under the impacts of climate change.

In terms of global, the effects that climate change has on human health are both physical and mental, in which nutrition has also been noticed due to the influences of climate change on problems related to food security. This is especially important because undernutrition affects more than one population and individual health through threats to child survival, reduced immune function, increases in maternal mortality, raised susceptibility to communicable diseases, and stunted development (M. M. Blakstad & E. Smith, 2020). Poor nutritional status can cost a country to lose up to 3% of GDP annually (World Bank, 2019). These negative consequences require Vietnam to act immediately to have policies and timely adaptation solutions as climate change progresses, ensuring the lives of people in the places affected by climate change. This will increase the resilience of people, secure people's food, and, longer-term, promote the implementation of the common global goal of sustainable adaptation to climate change, minimizing actions that can affect regional and global climate change.

## **1.6. Purpose and design**

As mentioned above, the main objective of this study is to review and assess the impacts of climate change on the nutritional status of the Vietnamese population, especially for women and children. Two main questions of this study are raised to solve this situation (section 2.1), and besides that four objectives are developed (section 2.2) to address these questions. The results from this study will contribute a concrete picture of the current nutritional status of Vietnamese population from the impact of climate change, and contribute effective evidence for policy makers in developing the "dual policy" that both sustainably adapts to climate change and addresses the issue of population nutrition.

### **1.6.1. Research questions**

1. How has climate change impacted on undernutrition among the vulnerable population in Vietnam?
2. What are the inequalities related to nutrition security that exist due to impacts of climate change among vulnerable population living in different areas in Vietnam?

### **1.6.2. Research objectives:**

1. Identify which nutritional problems are a result of climate change's impact on women and children in Vietnam.
2. Identify the inequity in nutrition security among women and children living in different areas in Vietnam due to the differential effects of climate change in those areas.
3. To assess whether the government's current response is focused on addressing the nutritional problems due to impact of climate change equitably among Vietnamese population in different areas.
4. To propose solutions based on the analysis from this study to help improve this problem in Vietnam in particular, and help other countries or regions around the world in general.

## Chapter 2: Methodology

Documentary review is used for this study. Three main sources of electronic databases, such as PUBMED, SCOPUS, and SCIENCEDIRECT. The search conducted in May 2022.

Searching for data is done in the following ways:



**Table 2. 1: Table of search strategies on database sources**

No	Database (n=6)	Search keyword	Structure of search terms	Time	Results (n=4.533)
1	PubMed		+ “Climate change” AND nutrition AND Vietnam + “Climate change” AND stunting AND Vietnam + “Climate change” AND wasting AND Vietnam + “Climate change” AND underweight AND Vietnam	June 10, 2022	34
2	SCOPUS	“climate change” nutrition, Vietnam, children, population, malnutrition, stunting policy, flood, drought, “temperature shock”, “social outcomes”, “nutritional policy”, “environmental protection”, agriculture, underweight, wasting women, pregnancy	+ “Climate change” AND nutrition AND children AND Vietnam + “Climate change” AND nutrition AND population AND Vietnam + “Climate change” AND malnutrition AND children AND Vietnam AND policy + Flood AND nutrition AND Vietnam + Drought AND nutrition AND Vietnam + “Temperature shock” AND nutrition AND Vietnam + “Climate change” AND nutrition AND children AND “social outcomes” AND Vietnam + Vietnam AND “nutritional policy” AND climate change	June 10, 2022	71
3	Science Direct		+ Vietnam AND environmental protection AND agriculture + Vietnam AND women AND undernutrition and “Climate change” + Vietnam AND pregnancy AND undernutrition and “Climate change”	June 10, 2022	4428

## 2.1. Inclusion and exclusion criteria

INCLUSION	EXCLUSION
Sources with relevant data on nutrition and climate change published from 2012 onwards in English, Vietnamese for which the full text is available and are relevant to the review question and objectives.	Sources which are unrelated, duplicates, unavailable full texts, or abstract-only papers.
Peer-reviewed papers providing data and current information on the climate change impacts on food security in Vietnam.	Conference abstracts, editorials, sources providing only contextual and information with no correlation to improve climate change and nutritional problem in Vietnam.
Peer-reviewed papers providing data and current information on the climate change impacts on nutrition security in Vietnam.	
Peer-reviewed papers providing data and information on the effects of climate change on nutritional status in Vietnam	
Peer-reviewed papers that explore the relationship through analysis between climate change and nutritional outcomes.	

Studies were selected for inclusion by a researcher using the inclusion and exclusion criteria above. If any questions arise during the selection of studies, the advisor will participate in the evaluation, discussion and final decision.

## 2.2. Data selection process

This study preferred Reporting Item for Systematic Review and Meta - analysis (PRISMA) (Moher et al., 2009). The collection strategy is carried out according to the following steps:

Step 1: After searching for studies using the above keywords in three electronic database sources, there will have A1 studies.

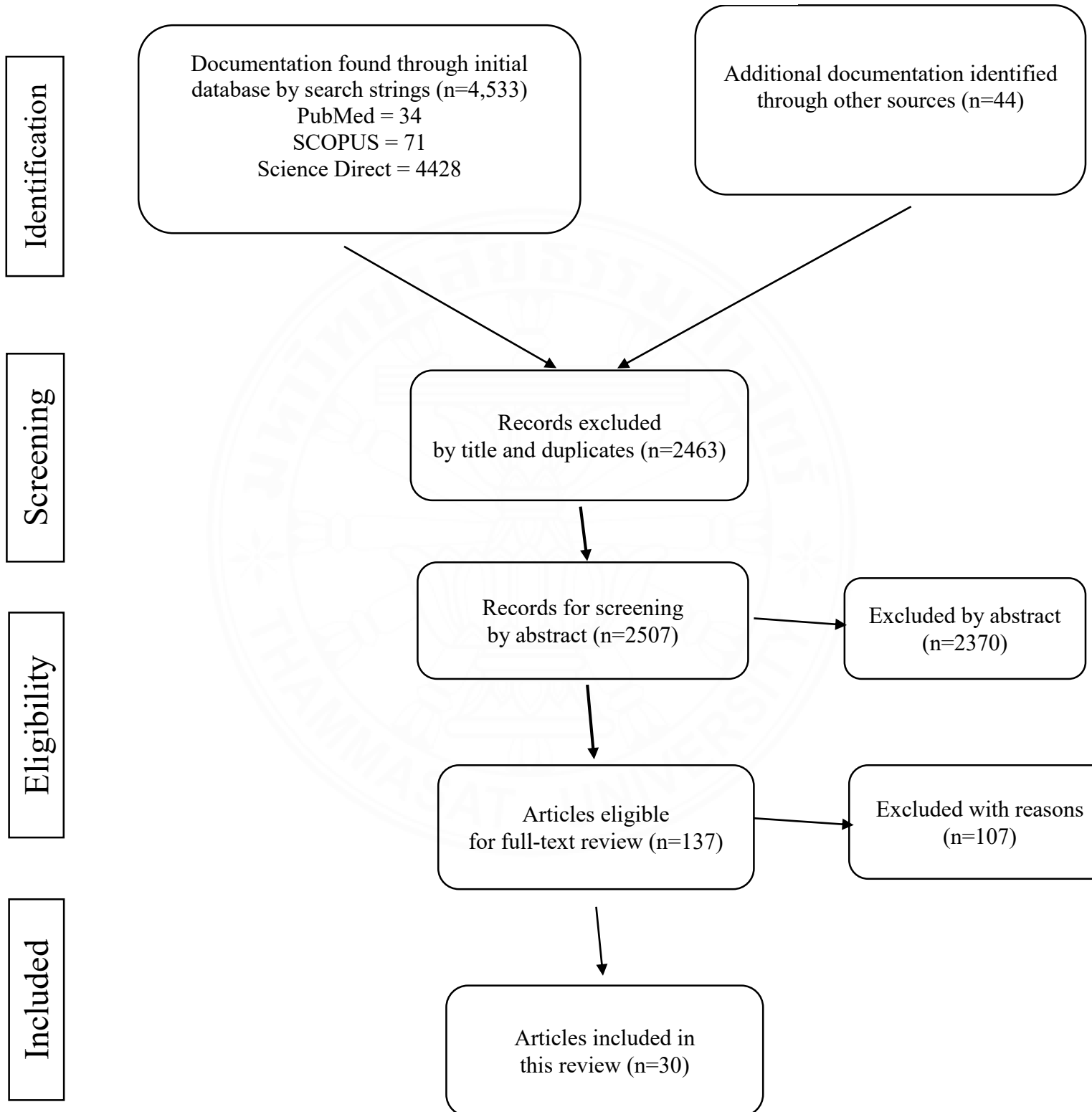
Step 2: Duplicate studies were eliminated using Endnote X9 (Thompson Reuter, USA). The remaining number of studies are B studies.

Step 3: Screening articles through titles and abstracts, this study gets the number  $C = A1 - B$  studied.



Step 4: Assess the quality and risk of research bias through the full-text article to select D valid study and exclude D1 study with multiple causes.

**Figure 2. 1 : PRISMA study flow diagram**



### 2.3. Data mining

The information extracted from the studies is as follows:

**Table 2. 2: The form to collect the studies contains the data to be mined**

No	Authors & year	Journal	Research Question/ Objective	Group of study populations	Context	Types of climate change	Outcomes	Summary of relevant results

For outcome item, this study will divide into 03 main outcomes:

- + Food security
- + Nutrition security
- + Nutritional status

**Note that:** Food security is considered a contributing factor to nutrition security (Poblacion et al., 2022), so in this study, if an article raises both food security and nutrition security issues, this study will rank the outcome type of that paper as nutrition security.

### 2.4. Data extraction:

Databases searched for this study included: PUBMED, SCOPUS, SCIENCEDIRECT, and some other sources, number of initial studies is A1.

Then, the study used the PRISMA method, with the inclusion and exclusion criteria, the number of articles eligible for analysis in this study is D articles. The researcher developed a data extraction matrix. The data and information were discussed with and reviewed by the researcher's supervisor regularly during the development of this study. The completed data extraction matrix is attached as an appendix.

## 2.5. Ethical issue

This study collects secondary data from studies that are eligible for inclusion, cites the authors, showing respect for the contributions of the authors, after completing this study, a turn it in report will be generated to check the transparency and uncover any plagiarism in the text.



## Chapter 3: Results

### 3.1. Literature search results

Searching and selecting data according to the process of PRISMA (Moher et al., 2009) and the strategy was given, the study collected 34 studies in PubMed database, 71 studies in SCOPUS database, 4533 studies in the SCIENDIRECT database, 44 studies in other database. The total number of studies collected from database sources was 4577 prospective studies.

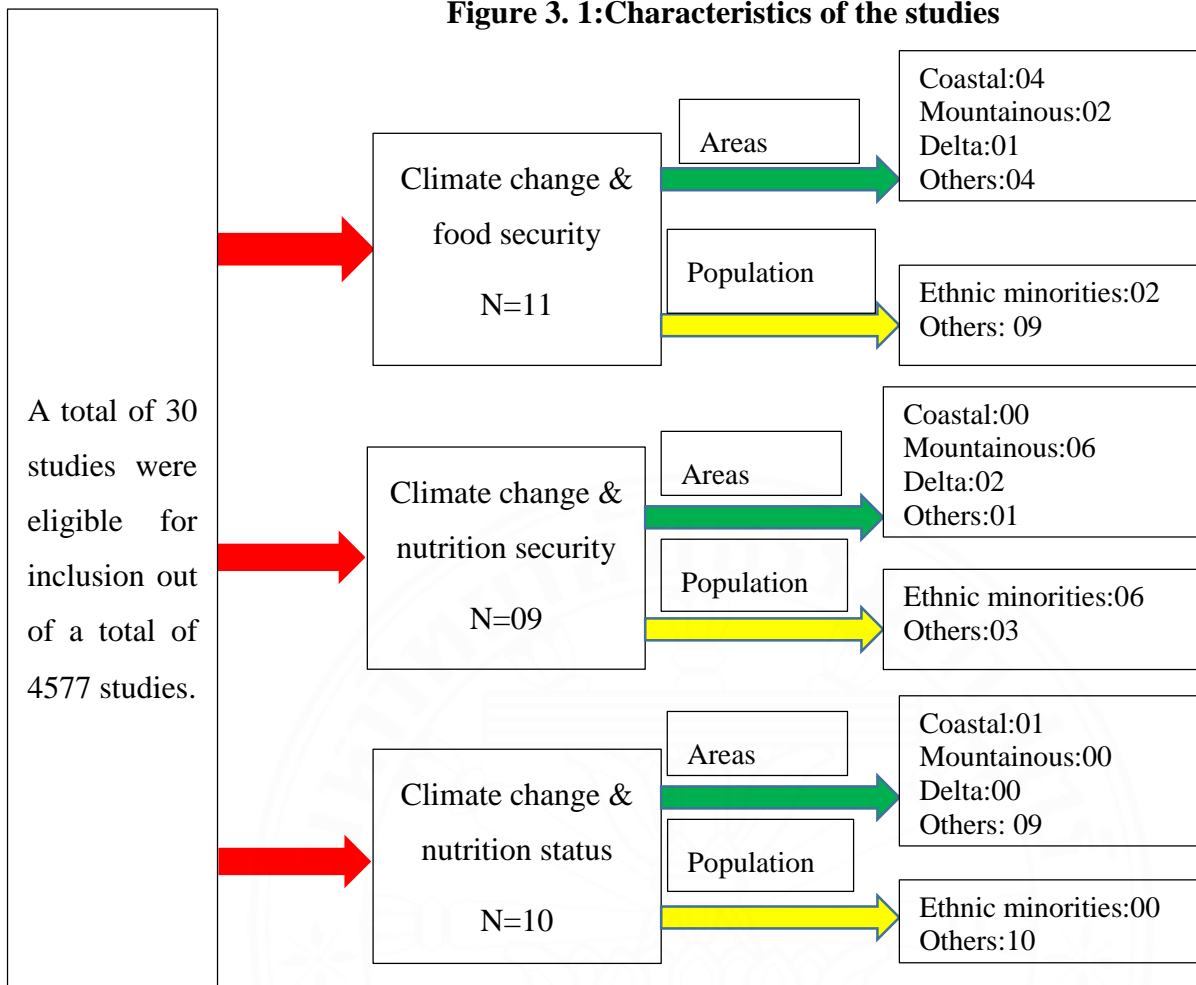
Next, the duplicate articles were removed through Endnote X9 (Thompson Reuter, USA) and manually rescanned the remaining 2507 studies to include in the first round of screening from titles and abstracts. Then, screening articles through the inclusion and exclusion criteria, this study selected 30 studies to be included in the second round of full-text screening. In the end, 107 articles were excluded for the following reasons: no full text, data could not be extracted or there was not enough data to be collected, language other than English and Vietnamese (Figure 1.3).

### 3.2. Characteristics of the studies

A total of 30 studies were included in this study, the specific characteristics of which are described in the Appendices 2. The publication period of the studies ranged from 2012 to 2022.

The studies were divided into 3 main groups for statistics and analysis as shown in Figure 3.1 below:

**Figure 3. 1: Characteristics of the studies**



Overall, the number of studies classified into each outcome variable was quite similar. Firstly, on “climate change and food security”, there are only two articles on ethnic minorities, and the main reporting site is mentioned in the coastal area of Vietnam. There is no specific mention of the study area. Secondly, for topics classified as climate change and nutrition security, most of the research has been carried out in mountainous areas, and has focused heavily on ethnic minority groups. Finally, with 10 studies reporting on climate change and nutritional status in the general Vietnamese population, most of the studies report on the nutritional status of children under 15 years of age, without any studies reporting nutritional status among ethnic minority children.

**Figure 3. 2: Distribution of publications deemed eligible for the study by areas in Vietnam.**

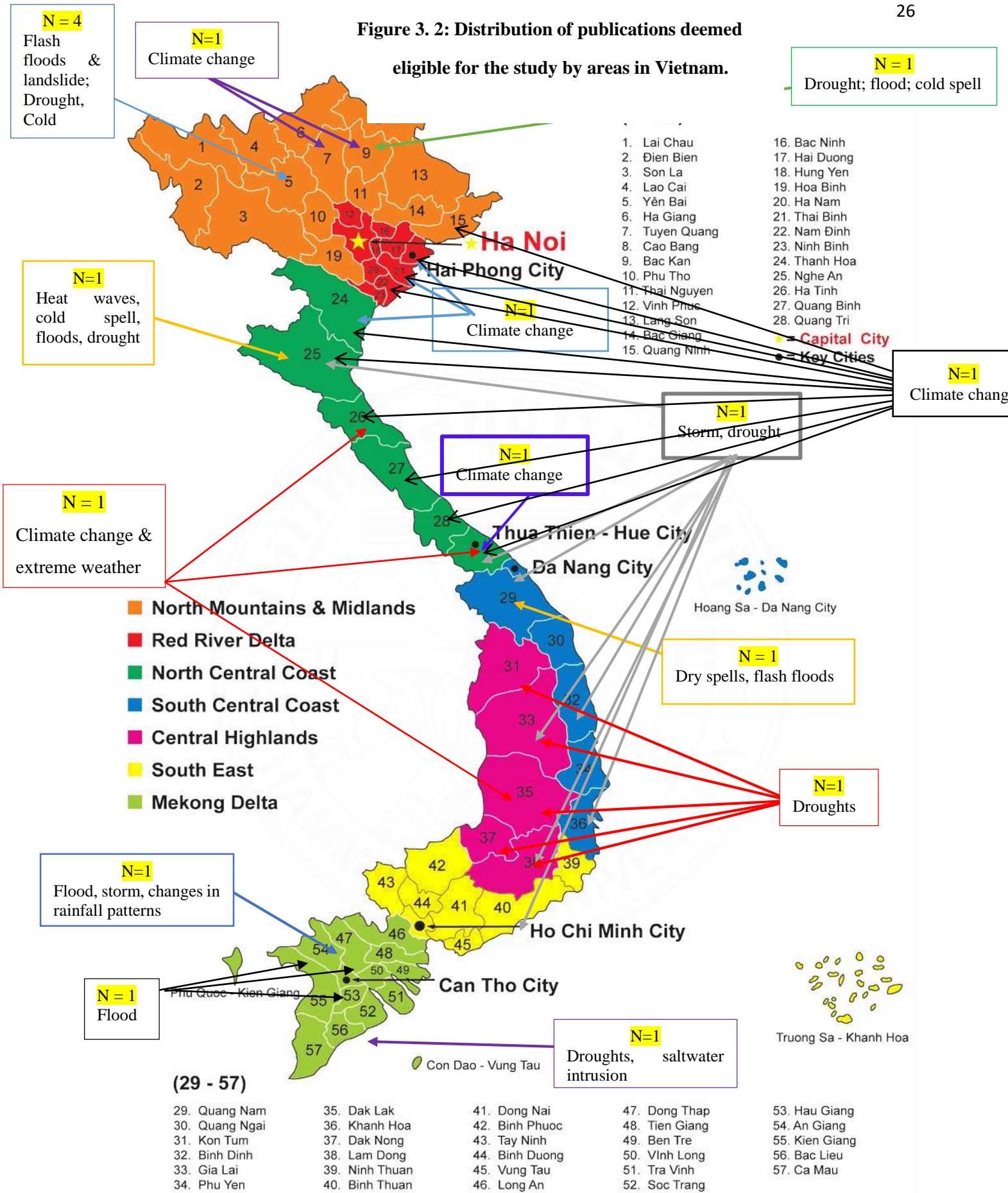


Figure 3.2 shows the distribution of studies by geographical area selected for this study, it can be seen that:

- + Most of the coastal provinces/cities have been studied for the effects of climate change, except for the provinces in the South East and Mekong Delta regions which are still not widely studied.

- + The number of studies carried out in the northern mountainous region is still small, as well as the two large deltas in Vietnam, the Red River Delta and the Mekong Delta, still lack data related to climate change.

- + The remaining studies are scattered from North to South in Vietnam.

However, a limitation can be found in the lack of studies evaluating individual events of climate change in specific regions, the studies selected for this study only reported aggregated data on many areas, no separate data.

### **3.3. Climate change and food security in Vietnam**

#### **3.3.1. In the past**

##### **Impacts of climate change on agriculture**

An assessment of the impact of the drought crisis conducted in five provinces in Vietnam's Central Highlands region showed that nearly 170,000 hectares of crops were affected by the drought. In Kon Tum province, 2,106 ha are affected with 1,226 ha of rice, 857 ha of industrial crops (mainly coffee and black pepper) and 23 ha of cash crops. This figure in Gia Lai is 5,378 hectares of rice, 8,653 hectares of crops, 6,317 hectares of coffee and 1,650 hectares of black pepper (Tum et al., 2016). In addition, (Phuong et al., 2018) reported that rice and sweet potato are the two crops most affected by drought, as these crops require more water and are more sensitive to temperature and atmosphere. Drought not only reduces crop yield, but also leads to increased investment costs, reduced arable land, and lack of water for cultivation (Trinh, 2018). Besides, drought and high temperature are the main causes for the increase of plant pests and diseases (International Maize and Wheat Improvement Center., 2020). Previously, farmers only sprayed 2-3 times/crop, now they have to spray up to 7 times/crop, which not only increases the cost of agricultural production, adversely affects the environment but also adversely affects health

of farmers as well as consumers (Phuong et al., 2018), (Carvalho, 2017). Changing rain patterns, extreme weather, saline intrusion and drought are reported to have a negative impact on people's food availability and income as crops are negatively affected, leading to reduced energy yield or crop failure (van der Geest et al., 2012), (Tran et al., 2021). As a result, 1.1 million people are food insecure due to drought-related impacts (United Nations., 2016). Nearly 65% of all households said the most important livelihood activities, namely the cultivation of rice, maize and cardamom, were negatively affected by drought, in which insufficient rainfall and high temperatures caused drought. withered and stunted trees (Delisle & Turner, 2016), (Son & Kingsbury, 2020) and (Pham et al., 2016) also reported similar results, with drought reducing rice yields by 50% to 100% in ethnic minority households.

Flooding is associated with increased severity of food insecurity in Vietnam (Dornan et al., 2014). Surveying over 405 households in remote areas, the results show that 93% of households believe that the impact of flash floods and landslides has a significant impact on agriculture, crop failure, and long-term damage can lead to malnutrition(Pham et al., 2020). In an in-depth interview with a woman who experienced the flash flood in 2008, she said it was the most terrible flash flood that she has witnessed in the past 40 years in the study area. As a result, her house was completely destroyed, all crops grown on agricultural land (about 0.072 ha) were wiped out, worth about 100 million VND (equivalent to 4350 USD) (Pham et al., 2021). More than 90% of ethnic minority households reported crop and livestock damage due to flooding in 2008 (Son & Kingsbury, 2020). In contrast, in Khanh Hoa, the level of food security before and after the storm was not affected, although it still suffered the most damage from the storm (G. Pacillo et al., 2022).

In addition, 42.2% of respondents said that they were severely damaged by climate change in the cultivation of food crops and non- food crops, 38.8% of households suffered severe damage, 4.9% of households have completely lost their food crops and 6.4% of households have completely lost their crops (Hang, 2014). For an ethnic minority woman, her average annual harvest dropped from 300 kg to just 50 kg for fresh cardamom in 2010 due to snowfall. In 2014, many households across the valley lost half to three-quarters of their crops due to unusually heavy snowfall (Delisle & Turner, 2016).



### **Impacts of climate change on fisheries and livestock**

Climate change also adversely affects the livestock industry; animals are susceptible to illness or even death due to adverse events such as unusual temperature rises or falls. Feed supply for livestock is also gradually reduced due to inclement weather, leading to increased investment costs for livestock (Rust, 2019),(Grace et al., 2015). Phuong et al reported that 47% of households said flash floods and landslides caused disease in their livestock and poultry. One participant interviewed for this study replied that "...we have to use more drugs to control disease and invest more than necessary to regulate the air temperature for livestock" (Phuong et al., 2018). About 77% of the interviewees (46/60) reported that buffaloes were lost due to extreme cold, or severe illness or someone in the family was affected in this way (Delisle & Turner, 2016).

For fishing and aquaculture, losses range from 14% to 19% of the total surveyed households (Hang, 2014). Thai Binh is the province assessed to have the highest vulnerability index to the effects of climate change on aquaculture (about 0.6) (Thành, 2017).

#### **3.3.2. Prediction for future**

Based on 02 climate change scenarios RCP 4.5 and RCP 8.5 in terms of temperature and precipitation (Appendix 3), the yield reduction value is up to -10% for rice for the whole country (Le Toan et al., 2021). Based on statistical data through the META-ANALYSIS method, (Le Toan et al., 2021) also predicted that the temperature increases by one degree, the rice yield is estimated to decrease by 7.09%. Frequent droughts also show negative and obvious impacts, not only reducing crop yields, but also affecting business efficiency, with higher intensity than hurricanes. An index increase of 1 unit will reduce the added value of the enterprise by 1.85% (Do et al., 2021).

When the sea surface temperature increases by 1°C, the rainfall increases by 1%, the total catch decreases by 19.61%, 0.44% respectively. The catch will drop by 2.76% if there is one more storm in the year. The severity of storms also negatively affects production, with productivity decreasing by 0.18% when maximum wind speed increases by 1% (Do et al., 2021), (Nguyen, 2022).

### 3.3.3. Consequence of effects of climate change on agriculture

Climate change has caused significant reductions in agricultural productivity in the areas selected for this study. However, in the Mekong Delta, the People's Committee of Lich Hoi Thuong Commune announced believes that food security is not significantly impacted by natural disasters. Because most of the farmers have enough food and savings from previous years, as well as support from local authorities and relatives (Tran et al., 2021).

Gender contributes significantly to a household's vulnerability to climate change-related pressures, suggesting that a male-headed household is more vulnerable, compared with other households, because they are the main breadwinner in earning money to pay for family life (Tran et al., 2021). In contrast, another report conducted on ethnic minority communities in Quang Nam province showed that, besides the climate change impacts on agricultural productivity, land loss, this leads to men not having many jobs, so women experience a lot of pressure to find other jobs to sustain the family (Pham et al., 2016).

During periods of crisis, when droughts or floods damage crops and decrease household incomes, forest exploitation will increase dramatically. Children and the elderly often exploit non-timber forest products. Illegal logging and hunting of animals to sell to traders are also seen as a way to earn extra income to cover life due to the impacts of climate change (Son & Kingsbury, 2020). However, this problem will leave many serious consequences for the ecological environment if deforestation is excessive.

Migration is the most common phenomenon when climate change affects people's crops, leading to them to losing food, not being able to support their families and pay other expenses. Many authors have reported on this issue, for example, seasonal migrants can find work in other areas, these migrants send money back to their family members to help them overcome the hardships caused by the floods, and these migrants often return home to work in agriculture during the dry season. There were about 5,000 seasonal migrants in Thanh My Tay commune, An Giang province, in the Mekong Delta in 2009 (Nguyen & James, 2013). Only 23% of non-poor households have members who migrate to work, while in very poor households, this figure is 60% (van der Geest et al., 2012). Tuyen Quang, Bac Kan, a convergence was found between these two groups in socio-economic adjustments regarding diversification beyond the farm and migrating to find jobs elsewhere, and this was mainly circular migration. However, these strategies

were more frequently applied by the Kinh than the ethnic minority households. The collection of forest fruits, vegetables, bamboo shoots and other products was a wide-spread adaptive strategy of ethnic minority households (45%) when their agricultural production failed due to climate variations. Meanwhile, only 11 percent of the Kinh households applied this strategy to diversify their livelihoods because of their limited access to forests (Bui, 2021).

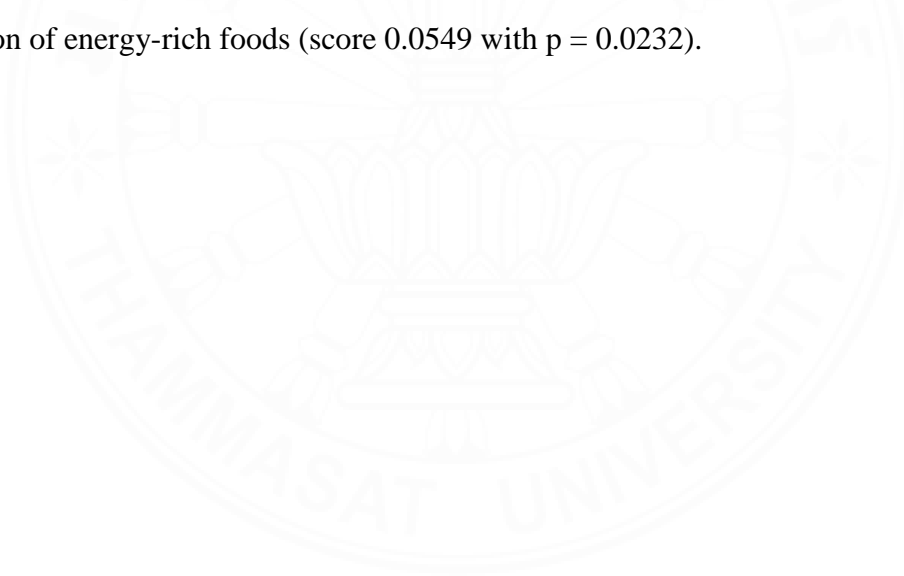
### **3.4. Climate change and nutrition security in Vietnam**

Floods, rainfall, and storms affect household calories per capita by affecting crop quality and crop yield (Le Toan et al., 2021). Furthermore, about 34% to 47.62% of households do not have enough food from their own farm due to natural hazards such as flash floods and landslides. An interviewee in An Thinh commune said: “Our farms are fragmented, the irrigation system in my village is very poor, so we don't have enough food from our farm, especially in this case. We are influenced by flash floods and landslides” (Pham et al., 2020).

Food shortages are also reported among households in remote regions, where is lack of natural resources, land is difficult to cultivate, and climatic conditions are difficult. Farmers reported that 30% of households in the village once faced food shortages in the months of February to April or before the first harvest of the crop (Pham et al., 2015). More than half of the respondents in the study (Delisle & Turner, 2016) pointed to extreme weather events as the immediate cause of their food shortages. In the delta region, food insecurity reaches its peak during period of the rainy season, from September to November, especially for the landless (van der Geest et al., 2012).

Tuyen Quang and Bac Kan provinces belong to the northern mountainous region with the majority of ethnic minorities living, collecting vegetables, fruits, bamboo shoots and forest products as a widespread adaptation strategy of ethnic minority households (45%) when their agricultural production fails due to climate change. Meanwhile, only 11% of Kinh households adopt this strategy to diversify their livelihoods because their access to forests is limited (Bui, 2021). Another study conducted on ethnic minority populations also reported that drought affects crops and livestock, lead to a greater risk of hunger in poorer households, and to higher poverty rates. In response to food shortages, many people consume smaller portions and more vegetables are consumed, replacing meat in meals. This means that children are not getting enough nutrients, and as a result, malnutrition in children is inevitable. People mainly eat rice or corn with vegetables, there is no meat in their meals as in the past because the poultry they raise has to be on

sale to buy other foods or household supplies. They simply have to scrimp and save for basic foods, and can't afford to buy or eat meat like before. A poor farmer mentioned a similar circumstance because of drought, "My children do not have the same quality and quantity of food as before. They have no choice but to eat smaller portions, and very little meat. " (Son & Kingsbury, 2020). Research by (Delisle & Turner, 2016) reported the following results: "If it doesn't rain, next year we won't have anything to eat!", in some years the weather is favorable (suitable rainfall and temperature), rice cultivation is enough to feed the family, on the contrary, in other years that the weather is not favorable, so crop production decreases significantly. (Delisle & Turner, 2016). A poor woman in Phu Duc commune, 35 years old, said that her house was deeply flooded in the flood in 2000; clothes are all wet, while there is no rice to eat (Nguyen & James, 2013). Among the Co Tu ethnic minority people, they report that "Once upon a time, twenty-three years ago, we planted enough rice to meet the year's rice demand. Everything has changed now. Our rice production now is only enough for our family to use for three to five months" (Pham et al., 2016). In a paper by Edoka (2013) similar results was reported: weather-affected households tended to reduce consumption of nutrient-rich foods (score - 0.0569 with  $p = 0.0203$ ) and increased consumption of energy-rich foods (score 0.0549 with  $p = 0.0232$ ).



### 3.5. Climate change and nutrition status in Vietnam

**Table 3. 1: Impacts of Climate change and nutritional status in Vietnam**

No	Author and year	Group populations	Sample	Source of database	Type of climate change	Measure of Outcomes	Results
1	(Kien. Le & My. Nguyen, 2022)	Infants	1.961	From the Vietnam Multiple Indicator Cluster Survey (MICS)	Rainfall shocks	Birth weight	In the second trimester, if the mother was exposed to excessive rainfall shocks, the birth weight loss would be 3.4% (0.095), and this would be 3.6% (0.104) kg if the mother is exposed to a lack of rainfall
2	(Le & Nguyen, 2021)	Infants	1.961	From the Vietnam Multiple Indicator Cluster Survey (MICS)	Temperature shocks	Birth weight	During the first trimester, there is an association between increased temperature and birth weight of the baby. Specifically, if the temperature increases by about 0.52 degrees Celsius, the birth weight increases by 0.05kg .
3	(Dornan et al., 2014)	Children under 15 years old	2.391	From the Young Lives Cohort study of childhood poverty	Flooding	Height for age Z score	There was no association between inundation and HAZ score among children
4	(Zamand, 2014)	Children 14 to 16 years old	740	From the Young Lives Cohort study of childhood poverty	Drought and flood	HFA Z-score BFA Z-score	Drought reduced children's HFA and BFA z scores by 0.018 and 0.016 respectively, (statistically significant with $p < 0.05$ )
5	(Tuyet Hanh et al., 2020)	Children under 5 years	N/A	N/A	Climate change and extreme	Underweight; Stunting	Among children living in areas affected by climate change and extreme weather events, 10 -

					weather events		<15% of children under 5 years old are underweight from ; 20 - 30% of children under 5 years old are stunting
6	(Lechtenfeld & Lohmann, 2014)	children and adults	39.863	Survey	Drought	BMI; WFA, weight	No relationship between these indicators and drought among population
7	(G. Pacillo et al., 2022)	Children	N/A	Simple Daily Intensity Index (SDII) and 2015 Nutrition Surveillance	Climate change	Stunting	+ Children over 2 years' old who are ethnic minorities living in highland and lowland areas have a higher rate of stunting than Kinh children living in other areas. + Compared with households living in low and moderate rainfall areas, a greater proportion of households living in high rainfall areas have stunted children.
8	(Thai & Falaris, 2014)	Children under 5 years	4.735	Vietnam Living Standards Survey (VNLSS)	Rainfall shocks	Height for age Zscore	+ There is no relationship between the shock of rainfall in the year and the standard height for age in children at birth + A standard height-for-age prediction would decrease in the second year after birth in the Mekong Delta 0.069, the Red River Delta 0.087, other regions 0.06 when the precipitation relative to the assumed fall from 0 to 0 ,30

9	(Le, 2018)	Children under 5 years	3.678	Vietnam Living Standards Survey (VNLSS) 2016 and MICS4	Flood	Height for age Zscore WHZ score	+ Children living in flood-affected areas usually have a HAZ index 2.38 units lower than children living in non-flood-affected areas and are statistically significant at 5. % + There was no difference in the WAZ between children living in drought or hurricane-prone areas compared with children living in other areas. + The WHZ index of children living in flood- and storm-affected areas is lower than that of children living in non-flood areas, storm difference is 2.34 units and 3.61 units respectively (at 5% significance level)
10	(Edoka, 2013)	Children under 15 years	4.772	From the Vietnam Young Lives Survey (VYLS)	Weather sock	HAZ score	Compared with unexposed children, those exposed to weather shock had approximately 0.15 standard deviations lower HAZ scores (p=0.0439).

Among the studies reporting the climate change impacts on undernutrition in Vietnam, there are 02 studies conducted on infants, 01 study performed on both children and adults, the rest of the studies were conducted on children under 15 years of age. The height for age index was examined mainly in these studies, as the outcome of climate change on the nutritional status of the Vietnamese population.

Most of the studies reported a significant association, under the influence of extreme climate models, the nutritional index decreased significantly, the difference was statistically significant. However, two studies reported no association between the impact of climate change on nutritional index (Lechtenfeld & Lohmann, 2014), (Thai & Falaris, 2014).

Although Thai & Falaris (2014) reported a rainfall shock during the year in utero does not have a significant effect on standardized height-for-age, however this study makes a prediction that in the future if rainfall decreases, height-for-age will decrease in certain areas (table 3.1) (Thai & Falaris, 2014).





**Table 3. 2: Nutritional status distributed by region and population in Vietnam**

By area	Source	Group populations	Type of climate change	Measure of Outcomes
<b>Geographical features</b>				
Coastal	(Zamand, 2014), (Edoka, 2013)	Children	Drought, flood, Weather shocks	BFA, HFA
Delta	(Zamand, 2014), (Edoka, 2013)	Children	Drought, flood Weather shocks	BFA, HFA
Mountainous	(Zamand, 2014) (Edoka, 2013)	Children	Drought, flood Weather shocks	BFA, HFA
<b>Socioeconomic characteristics</b>				
Rural	(Dornan et al., 2014), (Lechtenfeld & Lohmann, 2014); (Thai & Falaris, 2014); (Le, 2018)	Children Adults	Flood Drought Rainfall shocks	HFA, BMI; WfA, WHZ weight
Urban	N/A			
<b>Other (For studies didn't mentioned about the areas as well as socioeconomic characteristics"</b>				
	(Kien. Le & My. Nguyen, 2022) (Le & Nguyen, 2021) (Tuyet Hanh et al., 2020) (G. Pacillo et al., 2022) (United Nations., 2016)	Infants Children Women	Rainfall shocks Temperature shocks Climate change and extreme weather events Drought	Birth weight Underweight; Stunting Malnutrition

Table 4.2 presents the climate change impact on nutritional status in different population groups, in different geographical areas. There are studies in the coastal and mountainous areas to assess the nutritional status and impacts of climate change, however, these studies have only focused on children under 15 years old, no studies have reported on the women population.

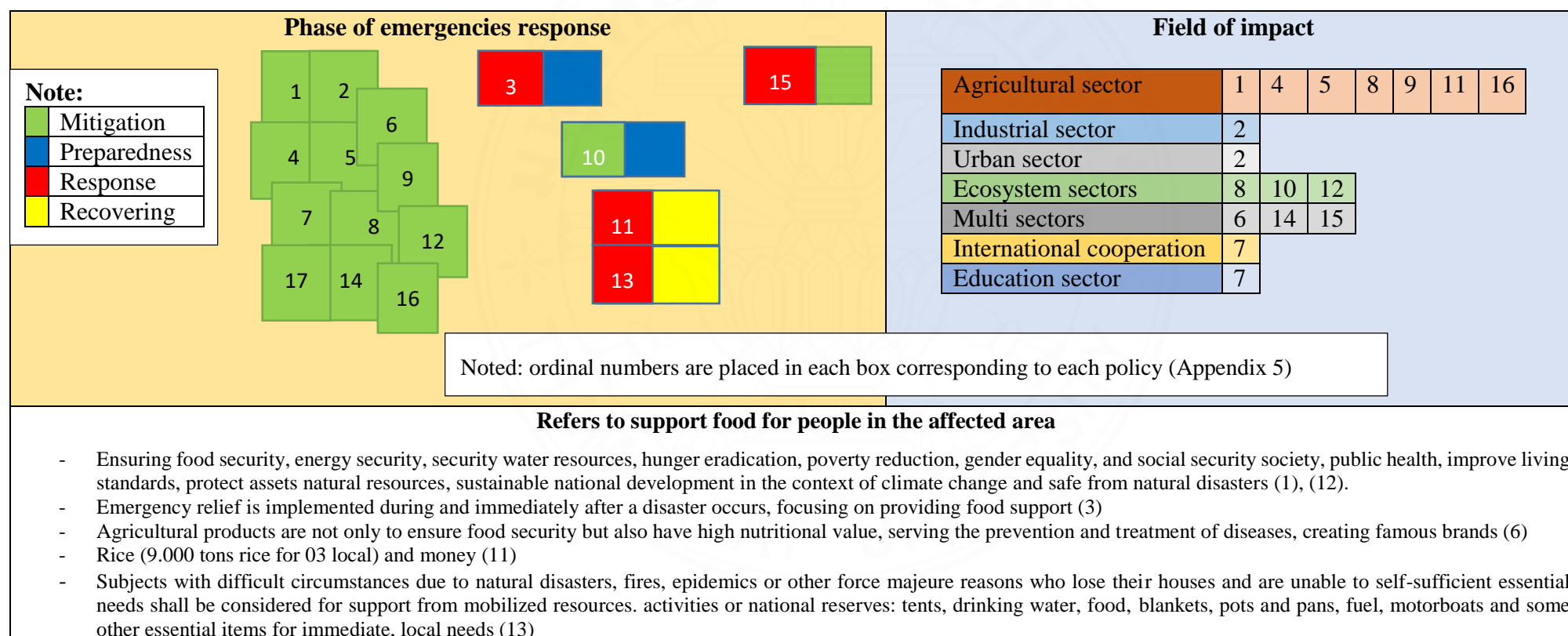
According to socio-economic characteristics, this study collect data in urban and rural areas. The results from Table 3.2 show that most of the current studies focus on rural areas, there are as yet no studies conducted in urban areas examining the impacts of climate change on nutritional status.

### 3.6. The current policy's response related climate change and nutrition in Vietnam.

#### 3.6.1. Statistics of central-level policies in response to climate change and nutritional status of the Vietnamese population

Through a summary of current regulations/policies that the Vietnamese government responds to the impacts of climate change (details in Appendix 5), this study summarizes these regulation/policy by figure 3.3 as follows:

**Figure 3. 3: Statistics of central-level policies in response to climate change and nutritional status of the Vietnamese population**



The top left base (Yellow box) shows the distribution of current policies/regulations in response to climate change events. Each stage of response is represented by a corresponding color. In general, it can be seen that Vietnam's current policies and laws related to climate change mainly focus on adaptation and mitigation.

The top right root (light blue box) represents the main area of focus for the policy/regulation. It can be seen that most of the current policies/regulations focus on the agricultural sector, limiting greenhouse gas emissions, integrating interdisciplinary, towards developing a low-carbon economy to achieve 2030 Sustainable Development Goals, actively working with the international community to protect the Earth's climate system.

The rest of the table (white box) describes the food assistance provided by the Vietnamese government to people in areas affected by the impacts of climate change. Although the issue of ensuring food security for the people has been mentioned in some of the policies listed above, however, this issue is only raised but not really emphasized. There are no highlights on how to ensure food security due to the impacts of climate change, and no specific guidance on food support for people in the affected areas.

### **3.6.2. Vietnamese Government response to climate change impacts that are in practice**

The Vietnamese government provided 5,221 tons of food and distributed disaster relief and support services worth VND 1008 billion (USD 45 million) to people in three drought-affected regions in 2015 (Tum et al., 2016). Most farmers in the Mekong Delta already have enough food and money saved from previous years and receive support from relatives or local authorities (Tran et al., 2021). Many households have received government support for disaster relief (i.e. food and financial assistance) and agricultural subsidies such as climate-resistant rice varieties, funds and technical training to sustainable agricultural development (Tran et al., 2022). (Tran et al., 2021) also reported people receiving more timely help with food or soft drinks from local authorities during difficult times. However, there is a difference in the area of support, for example, the proportion of households in Soc Leo (51,8%) who do not get help when facing difficulties is higher than Nam Chanh (40,5%). Delayed response from local leaders was also reported in the study (Dornan et al., 2014). Although people tried to register to receive timely support, local

authorities responded that support will be implemented in the following years. This makes people think that they are denied help, even they return home without receiving anything.

Notably, ethnic minority households and mountainous farmers in the North of Vietnam seem to be relatively dependent on external support with 13% of them deciding to wait for external financial support, as a response to climate hazards, this rate is higher than that of the Kinh. Ethnic minority groups often receive support in the form of cash or in-kind donations from governments, NGOs and individuals following climate hazards. Quantitative data show that 23% of ethnic minority households receive such financial support while this figure is only seven percent for Kinh people (Bui, 2021).



## Chapter 4: Discussion

### 4.1. Nutritional problems reported in the population of women and children in Vietnam under the impact of climate change

**Climate change is considered a global problem because the effects of climate change are not exclusive to one group of people or one country.** They affect every aspect of life, threatening everyone's quality of life in every nation and worse it puts everyone on this planet at high risk, harming and destroying the lives of the entire human race. Increasing rate of climate change means growing challenges in achieving optimal nutritional status, both directly through affecting food production and indirectly through changing economic and social impacts in human life (Salm et al., 2021). This is a case study in Vietnam, under the challenges of climate change on nutritional outcomes in the population in Vietnam, specifically women and children.

**Women are generally considered to be more vulnerable to the economic, cultural and social effects of climate change (United Nations., 2022 ).** In the time of extreme weather such as droughts and floods, women rise to work significantly to guarantee the livelihoods of their families, but their decision-making power is limited due to the gender inequality involved. In resource-constrained regions, climate change will be a stressor, exacerbating the vulnerability of women, who face domestic violence, sexual intimidation, rape, and including disruption of access to health services (Desai & Zhang, 2021), (Adaawen & de Haas, 2019).

**In addition, nutritional status among women living in climate change-affected areas has also been reported to be an important aspect.** A report from CARE International estimates that 10.2 million people will be affected by the El Niño drought in Ethiopia, of which about 404,000 pregnant and lactating women are at particular risk of malnutrition and pregnancy complications from food shortages such as the impact of drought (CARE International., 2016). In Vietnam, an estimated 27% of mothers with children under 5 years of age have chronic energy deficiency (FAO., 2022). Among women living in 18 drought-affected provinces in Vietnam, this study found that, approximately 39,000 pregnant and lactating women suffer from micronutrient deficiencies (United Nations., 2016). According to the results of the 2019-2020 Nutrition Census in Vietnam, the rate of zinc deficiency in pregnant women decreased to 63.5%, but was still at the level of heavy public health significance as assessed by the World Health Organization (Vietnam Ministry of Health., 2021). Nguyen et al. (2018) reported that most pregnant women did not

respond to RNI for several essential micronutrients, including folate, calcium, iron and zinc in Vietnam.

**Maternal micronutrient deficiencies can severely affect fetal development and maternal health.** For example, leading to adverse outcomes and maternal health complications such as preeclampsia (PE), preterm delivery (PTD), gestational diabetes mellitus (GDM), intrauterine growth restriction (IUGR), small for gestational age (SGA), low birth weight (LBW), stillbirth, perinatal, neonatal and maternal mortality (Walle et al., 2020). Achieving proper nutrition during pregnancy is difficult due to inadequate food availability and access, and this situation is exacerbated by the unpredictable effects of climate change on food security (Iqbal & Ali, 2021), (United Nations., 2022 ). However, the data this study collected on investigating the nutritional status of women living in climate change-affected areas is still limited, and requires future studies to focus on investigate this issue. This may contribute to improving women's health and secure the future of children as well.

**Low birth weight is considered a globally critical public health problem and is associated with a wide variety of consequences, both short and long term, in the future development of children.** WHO estimates that 15% to 20% of all babies born worldwide are low birth weight, accounting for more than 20 million births each year (WHO, 2014). According to a report by the World Bank, in Vietnam the rate of low birth weight children has decreased from 9.2% in 2000 to 8.2% in 2015. This rate is lower than other countries such as Myanmar (12.3%), Thailand (10.5%), Lao PDR (17.3%), Cambodia (12.1%) (The World Bank., 2015). The global nutrition target is to reduce the number of infants born weighing less than 2500gm by 30% by 2025. This would lead to a relative decrease of 3% per year between 2012 and 2025 and drop from around 20 million to around 14 million babies born with low birth weight (WHO, 2014). This requires the efforts of all relevant countries and organizations in strengthening control and prevention of risk factors for birth weight.

**An increasing number of risk factors influence birth weight,** such as those related to air pollution, drinking water pollution, maternal nutrition, and chemical exposure (Chen et al., 2018), (Hannam et al., 2014), (Currie et al., 2013), (Gete et al., 2020), (Govarts et al., 2016), (Woods et al., 2017). In addition, the impact of climate change on birth weight has also been examined by many studies. This study found only two studies reporting birth weight in relation to

precipitation and temperature shocks. Specifically, one study found that exposure to temperature shock during the first trimester reduced birth weight by 0.05 kg (statistically significant result) (Le & Nguyen, 2021). This finding is similar to several other studies examining the effects of exposure to intrauterine temperature on birth weight (Davenport et al., 2020), (Ngo & Horton, 2016), (Andalón et al., 2016). In contrast, another study in Malawi reported that maternal exposure to drought during first three months of pregnancy had no effect on birth outcomes. However, birth weight was reduced by 88.497gm with 95% CI [11,572: 165.422] if the mother suffered from drought during period of the second and third trimesters (Hanjahanja-Phiri, 2018). Besides, this study also found that rainfall has an effect on birth weight (Kien. Le & My. Nguyen, 2022) . This result is similar to another study (Kien. Le & My. Nguyen, 2022) conducted in Bangladesh, with a Z-score reduction of 0.10; 0.11; 0.11 corresponding to the HFA, WFH, WFA index in children with in-utero exposure to droughts. A study of rural households in Malawi reported that a decrease in rainfall at the time of the agricultural season previous to the pregnancy resulted in a 21.8% decrease in mean height for age score (Abiona, 2022). Storms or hurricanes have also been identified with an impact on birth weight (Beuermann & Pecha, 2020), (Currie & Rossin-Slater, 2013). However, this study did not find this relationship in the Vietnamese population.

**Looking at the results above, it can be observed that events under the impact of climate change have led to nutritional deficiencies in utero, and the consequently the birth weight of the fetus (as reported in above) and later forms of undernutrition in children (such as wasting and stunting will be reported in the next section).** This result shows that it is really important and necessary if policies are developed and implemented in the field of nutrition, because it will help support women during pregnancy to be able to address the issues related to maternal nutrition, preventing complications affecting health and reducing maternal mortality. More importantly, by ensuring adequate nutrition for pregnant women in terms of macronutrients and micronutrients, it contributes to protecting the health of fetuses and newborns, thereby promoting sustainable development, and the children's long-term well-being in the future. This result is considered as one of the complementary factors, making an important contribution to the achievement of the Sustainable Development Goals (SDGs) for rural households in developing countries, including Vietnam. Above all, this problem can be addressed through targeted and direct intervention programs from international agencies, non-governmental organizations (NGOs), and

business organizations where local authorities are seen as under-resourced as well as lacking appropriate response mechanisms.

**Due to climate change, 110 million children under 5 years of age will be stunted by 2030 under the poverty scenario, and 83 million children under the no-poverty scenario.** It is estimated that this figure due to climate change will range from 570,000 to 1 million children for low (or non-poverty) and high (or poverty) climate change scenarios respectively. (Lloyd et al., 2018). Vietnam is being assessed at high risk because of the dual impacts of climate change and undernutrition. Vietnam is classified among 34 countries around the world for highest burden of malnutrition, with 1.8 million children under 5 years of age are malnourished and at risk of long-term effects on their physical and mental development, affecting the later quality of life, sometimes irreversible disadvantages, also which affects the quality of the population as well as the development of the country in general (UNICEF., 2022 ). The national percentage of stunting (HFA) of children under the age of five years is 19.6% - <20% - categorized as the medium based on the ranking of the World Health Organization (UNICEF. et al., 2020). Thus, following the miracle of reducing underweight malnutrition among children under the age of five years to 19.9% in 2008 (i.e., Vietnam has reached the finish line 7 years ahead of the target of the Millennium Development Goals - MDGs - set out in 2015), Vietnam is now on track to achieve the Global Nutrition Goal (reducing 40% of stunting rates among children by 2025). However, there are still regional disparities in stunting rates; in rural and mountainous zones, this percentage remains high (Vietnam Ministry of Health., 2021). The Central Highlands, Midlands, and Northern mountainous areas, where many ethnic minorities live, account for the highest proportion of stunted children. In addition, when compared with better-off households, the risk of stunting is three times higher among children from the poorest family. Among various ethnic groups, the Mong have the highest proportion (65%) (UNICEF., 2022 ).

**Considering the effects of climate change, this study also found that stunting rates were higher in areas affected by climate change and extreme weather events** (G. Pacillo et al., 2022), (Tuyet Hanh et al., 2020). This finding is similar to a study conducted on children in India, where vulnerability was positively associated with child malnutrition. Stunted malnutrition increased by 32%, emaciation, low birth weight, and anemia increased by 42%, 45% and 63%, respectively, if children were living in areas classified as highly vulnerable to effect of climate change when compared with others who are classified as very low (Mahapatra et al., 2021). The



study in Khyber Pakhtunkhwa province, Pakistan also reported similar results, with prevalence of chronic malnutrition or stunting of 35.8% in affected children and 27.6% in unaffected children ( $p < 0.041$ ) in relation to flood exposure (Mohsin et al., 2017). In addition, current evidence on the impact of extreme events such as droughts, floods, weather shocks on children's stunting has also been reported in some regions of the world (Cooper et al., 2019), (Tadele et al., 2022), (Dimitrova, 2021), (Jose Manuel. Rodriguez-Llanes et al., 2011), (Mehmood et al., 2021), (Freudenreich et al., 2022). These results contribute to changing perceptions of the public as well as strategic planners about how climate change can negatively impact child undernutrition, from which suitable mitigated-related strategies can be formulated and applicate.

**Adding to the list of evidence above, the results found that HAZ scores were lower in children living in climate change-affected areas than in children living in unaffected areas.**

This result is consistent with other studies (Andalón et al., 2016), (Groppo & Kraehnert, 2016). Specifically, this study found a decrease in HAZ among the number of children under the age of 15 years old living in an area with weather shocks (Edoka, 2013). (Le, 2018) also reported that HAZ among children under the age of 5 years old living in flood-affected areas were 2.38 units lower when compared to children in other regions. Various other studies in Nepal and Pakistan reported similar results, with a higher stunting rate among children living in flood-affected areas than other children living in unaffected regions (Mohsin et al., 2017), (Seeta et al., 2020). Another study also reported HAZ among children living in flooded areas in Vietnam, but the results showed no association (Dornan et al., 2014).

**Other phenomena related to the effects of climate change were also found to have a significant impact on the nutritional status of children.** Drought was reported to reduce HFA and BFA scores by 0.018 and 0.016 respectively ( $p < 0.05$ ) among children aged 14 to 16 years in Vietnam (Zamand, 2014). This result is similar to the Ethiopian study ( $p < 0.001$ ). Furthermore, girls tend to grow worse than boys (Bahru et al., 2019). Although the HAZ was not reported, the study by (Lechtenfeld & Lohmann, 2014) reported no association between BMI, WFA and weight with drought in the population in Vietnam. In terms of the impact of rainfall shocks, a study in rural Vietnam reported that exposure to rainfall shocks in utero had no impact on HAZ in infants. However, this study predicts that if rainfall decreases by 0 to 0.3 points during the second year of life, the HAZ will decrease by 0.069, 0.087 in the Mekong Delta, and the Red River Delta (Thai & Falaris, 2014). Not reporting a decrease in rainfall, a study in Nepal reported that a 0.13 standard

deviation increase in HAZ among children under the age of 5 was associated with a 10% increase in rainfall (Tiwari et al., 2017). In addition, anemia in children living in areas affected by climate change has also been reported. For example, (Gari et al., 2017) estimated the percentage of anemia in the population of children at the age of 6 to 59 months in Adami Tullu district, south-central Ethiopia, a study region facing serious drought and food shortage in 2015. The rate of anemia increased from 2014 to 2015, by 28.2% [95% CI, 26.6–29.8] and 36.8% (95% CI, 35.1–38.5) respectively. Pakistan reported the percentage of micronutrient deficiencies in children in flood affected areas with 90.8% calcium deficiency, 88.3% zinc deficiency, 26.7% iron deficiency, 53.5% vitamin A deficiency and 39.5% iodine deficiency (Haq et al., 2021). Deficiencies in the proper nutrients in the diet can affect a child's development. However, this study did not find relevant data. Another limitation is that this study did not collect data that separates the impacts of climate change events on the sex of children, this study suggest that future studies should supplement this aspect.

**The months in utero and the early postpartum period are recognized to be especially important for the development of health and brain among young children in the future, being seen as the " window of opportunity "** (UNICEF., 2015). Also during this period, nutritional requirements are very high to support rapid growth and development in infancy, and adverse factors are also considered predisposing to developmental delay in (CDC., 2022 ). This distinction can be interpreted by the age group of children in the study as well as the duration of flood exposure. Study subjects in study Le, 2018 are children under 5 years old, while Dorman's study is children under 15 years old. The adverse factor being discussed here is that climate change events have the potential to cause food shortages, nutritional problems and disease outbreaks in the affected areas. These events act in two directions: first, local crops are cut down, livestock are killed, many assets such as houses and vehicles are destroyed, production is affected during and after the adverse event. Second, food prices increased and the purchasing power of affected people decreased due to chronic unemployment and disease burden. Therefore, not providing enough nutrition for pregnant women, the fetus is prone to incomplete brain development leading to stunted after birth. The end result is the nutritional status of the population. Although modern means of transportation and the exchange of information have changed the system of food distribution and consumption, some communities still have to live on crops, fruits and vegetables, products and their indigenous nutritional products, notably the ethnic minorities. At the same time,

vulnerable populations living in disadvantaged areas and remote populations could be severely impacted by flooding in terms of their nutritional needs.

**Although the climate change impacts on nutritional outcomes in the community through a variety of pathways, from factors acting as underlying causes, primary causes or direct causes.** This study provides additional evidence that strengthens the picture between the effects of climate change on nutritional status in the population of interest, through the pathway that food insecurity is seen as a direct cause. If this relationship is extended through the addition of factors related to socio-economic status, education level, medical history, customs and habits ..... then the picture between climate change and nutritional status will be more complex, but will provide a perfect and comprehensive picture of this relationship. Therefore, future undernutrition prevention studies in climate change-affected regions have to be included thoroughly along with comprehensive assessment of the hidden causes of this problem. As well as focusing on gaps related to vulnerable groups, especially nutrition in the first 1000 days, children under 10 years old, adolescent girls and pregnant women.

#### **4.2. The inequity in nutrition security among women and children living in different areas in Vietnam due to the effects of climate change.**

**Most of the world's poor and food-deprived people live in rural areas, where their main source of income is directly or indirectly dependent on agricultural production activities.** In Vietnam, nearly 40% of Vietnam's total land area, with 43% of Vietnam's population working in agriculture, makes Vietnam the 2nd largest exporter of agricultural products in Southeast Asia, and 15th in the world (FAO, 2018), (World Bank Group., 2016). However, agricultural production generates less than a fifth of GDP (18%) for the country (FAO, 2018).

**Climate change-induced events such as floods, rains, and storms all have a negative effect on household calories per capita by affecting crop quality and crop yield** (Le Toan et al., 2021). This study found that the prevalence of food shortages in households living in resource-poor areas ranges from 30 to 50% (Pham et al., 2020), (Pham et al., 2015), (Delisle & Turner, 2016). The reported sensitive period is February to April or before the first crop harvest among ethnic minorities in the northern mountainous areas of Vietnam (Pham et al., 2015), from September to November, especially for the landless in the delta (van der Geest et al., 2012), (Pham et al., 2016) also reported that the current rice production can only meet household consumption

for 3 to 5 months. This result is similar to studies conducted in Bangladesh, Ethiopia (Islam et al., 2022), (Mota et al., 2019). The lack of consistent access to enough food is considered one of the risk factors affecting nutrition security in the world in general, and in Vietnam in particular. However, in this study, the current data collected only reflect and evaluate mainly for agricultural crop products such as rice, it is still necessary to consider whether products from livestock can meet enough quantity for people.

**In addition, climate change will increase drought in many regions of the world, reducing yield, drought reduces nutrient uptake more than growth among crops** (Bista et al., 2018). Drought not only negatively affects the quantity but also the quality of the diets of rural households. Research in rural households in India reported that dry shock had a negative effect on household nutrition (the difference was statistically significant). The study estimates that households spend less than 1% per capita per month on food and consume 1.4% less calories, protein and fat for an average dry shock. In addition, dry shock makes households more dependent on grains and less likely to buy vegetables, fruits, beans and foods of animal origin (Carpena, 2019). Changing consumption patterns during drought in rural Iran, e.g. using cheaper and less nutritious food) is a common strategy reported by families (Keshavarz et al., 2017). This study, also report similar results that the impact of drought on crops and livestock in ethnic minority households, causing them to consume smaller portions and substituting vegetables for meat, this means that children do not have access to all the nutrients they need (Son & Kingsbury, 2020). Similarly, (Bui, 2021) reported that 45% of ethnic minorities choose the solution of harvesting, fruit, bamboo shoots and forest products for consumption when their agricultural production fails due to climate change. In contrast, for household food and non-food expenditures in Fars, Iran reported that food expenditures were not significantly affected by the effects of drought (Khalili et al., 2021). A study conducted among Australian reported that exposure to drought was not associated with lack of meals in both rural and urban areas, although it is reported that 5% of urban residents experiencing 'persistent dryness' most often skip meals, however the difference is not statistically significant (Friel et al., 2014). One possible explanation for this is that drought reduces the adequate yielding of crops, leading to more scarce food and higher food prices. However, the reduced income of households due to the effects of drought is the main reason for the lower consumption of food and nutrients by households during the drought period. Drought is just one of the prime examples of how climate change impacts food security. In addition, if this result is

combined with Figure 1.1, another feedback loop is more clearly seen, although this is a negative loop of reduced food insecurity affecting climate change. While food availability is reduced due to extreme weather events, resulting in reduced incomes among households living in the affected areas, this leads to economic inequalities in these households. In order to restore production, farmers will step up farming through more forest exploitation, the use of growth promoters, as well as more likely in the overuse of antibiotics.....which leads to greenhouse gas emissions, and impacts on climate change. Collectively, these findings suggest that achieving food security under extreme weather events requires a holistic approach to food, not only to survive but also to lead a healthy and active life. This is equally important when looking further into the balance between food security while limiting the factors that cause climate change.

**Along with direct effects on agricultural production, climate change has been shown to impact food nutrient content, an important way but potentially significant pathway for food security and global nutrition** (Giulia et al., 2020). A study conducted in 17 areas of the world to assess the effect of floods found that people worldwide suffering from hunger would increase by about 11 million (range 7.8 million to 13) and the amount of food calories will reduce by 6.6 kcal/person/day (5.3 to 8.6 kcal/person/day) by 2030 (Seki et al., 2020). In Afghanistan, Oskorouchi & Sousa-Poza (2021) reported that flood exposure over a 12-month period reduced the daily calorie intake of the household by about 60 Kcal. Households were more likely to choose lower quality foods, which increased the likelihood of iron deficiency by 11%, and vitamin A and C deficiency by 12 and 27% respectively (Oskorouchi & Sousa-Poza, 2021). Climate change directly affects population health through a direct pathway from nutritional deficiencies, especially among vulnerable populations such as women and children, they are often reported to eat last and eat the least, so they are most affected (M. M. Blakstad & E. R. Smith, 2020). Gabrysch, et al (2018) assessed the food security and diverse diet among women and children in the 2017 flood affected region of Bangladesh. A total of 28% expected rice shortages in 5 months or more was seen compared to a year in households that normally grow rice, which results in rates of food insecurity more than twice as high as those in households that did not lack rice (OR = 2.5, 95% CI 1.8–3.6). Dietary diversity of food groups among women in these families was 0.4 (95% CI 0.1–0.7) lower than in non-deprived families (Gabrysch et al., 2018). Another study conducted in Bangladesh reported that the majority of women (63%) reported that both the quality and quantity of food consumption were impaired, 58% said that the number of their meals per day decreased to

one or two meals, however, it was three meals before any climate change event (Parvin & Ahsan, 2013). Although there were no reports of this problem in Vietnamese women in the included study, however, through qualitative research, a few cases reported that their children's diets were inadequate in both quality and quantity as a result of climate change, the intake of smaller and very little meat is the only option (Son & Kingsbury, 2020). The aspect of access to safe food is important in ensuring nutritional security. In Ethiopia, 60.5% of respondents chose unsafe food under the impact of climate change (Mekonnen et al., 2021). However, this study did not find any documents reporting this issue. This study suggests that future studies should consider enough components of nutrition security under the effect of climate change.

**Vietnam is a country with many ethnic minority groups, they live mainly in the northern mountainous areas, or areas lacking natural resources, so they are more vulnerable to the impacts of climate change.** It can be seen in this study that, when compared with the Kinh ethnic group (who account the majority of Vietnam's population), ethnic minorities are more severely affected in terms of nutritional security. They have nothing to eat during landslides, or cattle die due to high temperatures leading to loss of livelihood. In addition, this is a vulnerable group due to low level of education, heavily influenced by traditional culture, so it is difficult for them to adapt and change to new methods in the field of agriculture. In addition, as they live near the forest, they rely on the forest as their main source of food whenever their food source is affected by climate change. This easily leads them to have access to foods containing natural toxins, a high risk of food poisoning, and even death from eating poisonous foods. Therefore, ethnic minorities should be included when considering food security and nutrition, which may not be incorporated into articles related to nutritional status, but it certainly needs to be considered for long-term nutritional consequences. It takes time to solve these problems, however, continuous efforts are necessary.

**This study found that climate change directly affects crop and livestock productivity, limited household access to food, dietary crisis due to lack of quality food, or limited access to food.** Although this study found evidence of inequalities in nutrition security among women and children, however, the data were not large enough to be conclusive. This study suggest that future studies should consider nutrition security under the effect of climate change among women and children, because of its direct and long-term consequences for the health of the general population.

**Micronutrients are found mainly in fruits and vegetables; they are easier to find because they are present in all food groups.** Thus, it can be seen that it is easier to tolerate macronutrients deficiency in any situation where food supplies are limited, specifically right after a severe weather event. From that, this study suggests that there should be educational programs to help people understand the importance of this issue, as well as improve their diet in a sensitive time due to the impacts of climate change. In addition, food assistance programs for areas affected by climate change should be taken into account. Although beyond the field of the present study, research in the future should examine the stability and availability of food produce against extreme climate events, and how sensitive populations can replace micronutrient-rich foods during the period of extreme climate events to achieve adequate and sufficient caloric intake.

**Evidences on the effects of climate change on food security has been increasingly provided, but evidence on climate change and nutrition security is still limited, especially among vulnerable populations such as women and children. This study has been emphasizing in ensuring food security under the impact of climate change, nutrition security should be considered a priority as the ultimate goal.** As nutrition security extends beyond food security, it is tied to other basic factors such as childcare practices, care based on food availability, access to health care and disease prevention (i.e., vaccinations). Growing up in a good environment (no outdoor defecation, safe air, clean water...) is also considered part of nutritional security. If nutritional security is not guaranteed, for example, if the water environment is polluted or there is a shortage of clean water, the mother of the child needs to travel farther to get fresh water and find food, then she can't spend time taking care of the child. In addition, although food intake may follow principles (to achieve food security), for example, intestinal parasites can reduce nutrient absorption and thus limit nutrient safety. Finally, while noting that nutrition security concerns the individual, there are equally important contributing factors that influence how it is achieved – and the responsibility for taking action stretches across levels of authority in the community, the country, to the world. Vietnam is one of the low-middle-income countries where nutrition security is not assured. Therefore, further efforts and attention to create a nutritionally safe environment should be put in place and can be seen as the responsibility of all sectors to join hands to improve this issue.

### **4.3. The government's current response is about the nutritional problems and impact of climate change among Vietnamese population and proposed solution for Vietnam and other countries or regions in the world.**

Faced with high risks as a results of the impacts of climate change and global warming, Vietnam has been proactive in finding appropriate solutions, actively learning from other countries experiences, and applying advances in science and technology to mitigate the effects of climate change. Vietnam has been demonstrating a strong spirit in global cooperation in combating climate change, as evidenced by the fact that Vietnam has signed a number of commitments to implement global climate change-related goals, such as the Montreal Protocol on substances that deplete the ozone layer, the Paris agreement, the Conference of the Parties (COP), the Sustainable Development Goals (SDGs)...(Viet Nam Meteorological and Hydrological Administration., 2022 ). Not only in terms of international cooperation, but the Vietnamese government also encourages strengthening interdisciplinary and multi-sectoral cooperation in proposing solutions and initiatives related to climate change adaptation and mitigation in Vietnam. Specifically, as shown in Table 4.2, most of the current plans, laws and policies are geared towards adaptation, aimed at reducing vulnerability and risk to the effects of climate change through strengthening the resilience and adaptability of communities, economic sectors and ecosystems; promote the integrating of climate change adaptation into the system of strategic and planning.

**Climate change, rising temperatures, global warming is exacerbating the problem of global economic inequality**, with the gap between the group of countries with the highest and lowest economic output per capita and a study showed about 25% increment in the gap due to climate change. In particular, while the biggest emitters enjoy GDP per capita today about 10% higher on average than they would in a non-warming world, the lowest emitters have been pulled down about 25% (Diffenbaugh & Burke, 2019). The reality is increasingly showing that, despite being responsible for most of today's global emissions, richer nations are lagging behind in addressing climate change-related issues. Many international conferences have been held, but the questions about addressing climate change have not really been answered officially. Meanwhile, in poor countries, which have struggled to keep up with economic growth, they face a vicious cycle of poverty and inequality within their own countries.



**If "mitigation" is largely seen as the responsibility of developed countries, "adaptation" is seen as a requirement for all countries, where the poor in developing countries are most likely to bear the increased risks and are also most vulnerable to the consequences of climate change, and Vietnam is one of those countries.** The mitigation policy focuses on limiting energy consumption, encouraging the use of green energy, promoting reforestation, with the main goal of bringing benefits to the people of Vietnam in particular, and global community at large, slowing climate change through reducing emissions of carbon levels, towards the common goal of improving the living environment, contributing to improving people's quality of life and health. As well as contribute to food security, better livelihoods and safe atmosphere (Climate & clean air coalition., 2022 ). Besides, this could help reduce inequality, as proposed emission reductions would provide the greatest advantage expected to build up to lower-income households, who are more likely to live in low-income areas, the area badly influenced by air pollution and low air quality (Maruyama Rentschler & Leonova, 2022). Most of Vietnam's emission reduction policies are multi-sectoral and multi-stakeholder, which highlights the role of stakeholders. This is similar to countries like Thailand, Indonesia, Colombia, Kenya, while India's policy lacks focus on energy resources (Climate action tracker., 2021).

**With thoroughly designed adaptation strategies, economic policy reforms have led to the greening of economies,** contributing to the creation of 24 million new jobs worldwide by 2030 (ILO., 2018). However, this will be an unequal factor for low-skilled workers who have difficulty accessing new technologies. In terms of usage, green energy can put the poor under financial stress, as many of them use coal, the traditional fuel for cooking and heating. These people lack access to electricity, and the use of new technologies or cleaner fuels seems to be more expensive for them (Zhongming et al., 2018). People living in rural areas are more vulnerable to activities related to renewable energy, and forest management projects because they are at risk of displacement and loss of livelihoods, for a country having 53 ethnic groups like Vietnam, makes people (e.g. forest-dwelling natives) particularly vulnerable. Their traditional life may be affected by these projects, and worst of all, they lose their house and property in case their land use rights are not clearly defined and protected. Although mitigation and adaptation have been determined as necessary components of a climate change response action plan, but are still not sufficient. Implementing commitments on global climate change mitigation is a common trend of the world. However, current evidence shows that Vietnam will face many difficulties and is important for Vietnam to

be clearly aware of its roles and responsibilities and seize opportunities to promote green growth and sustainable development with multi-sectoral and national cooperation.

**In terms of response on the impacts of climate change, the Government of Vietnam has also issued regulations and policies on promoting agricultural production and faster recovery in epidemics-affected zone.** A support system is based on the guidelines where, the cost of plant varieties, livestock, aquatic products or a part of the initial production costs (no compensation for damage); provide timely and direct support in cash or in plant varieties, animals or in kind. Plant varieties, animals and supporting artifacts must ensure quality and be suitable to local ecological and practical conditions; the support must be open, transparent, appropriate and to the right audience (Vietnamese Government., 2021). However, the amount of money people receive to overcome the consequences of climate change impacts is assessed as insufficient (Tran et al., 2021). In addition, the support policies to ensure food security for people in the affected areas are still not really specific for each object, each area, and the requirements on the number of people living in the affected areas. In general, this study found that Vietnam still lacks programs to support people in areas affected by climate change. In other countries, for example India, they have Public distribution system (PDS) cards that refer to the pre flood situation; subsidized cereals supplied through the National Food Security Act (NFSA) may raise the number of food that households eat during the period of a dry shock (Ramakrishna Gollagari., 2014), (Carpena. Fenella., 2019). Although these proposals are assessed as not meeting the needs of the people, they can at least partially support the needs of the people.

**The current aspect of ensuring nutrition for people in areas affected by climate change has not been given due attention.** As evidence, this study did not find any current documents issued by the Ministry of Health or the Government of Vietnam specifying the necessary diets for different groups of patients with different diseases, different age groups living in the affected area. The provision of food support to people in the affected areas is mainly rice and cash from government agencies and local authorities. In addition, food support from donors was observed to be mainly instant noodles, canned goods, prepackaged food, and voluntary, spontaneous provision. These food support packages are the same for all groups of people in the affected areas, without any professional recommendations proposed by the Ministry of Health regarding nutritional needs, consider the age group, or pathology of this target group. On the other hand, due to lack of spontaneity, lack of control, lack of support from authorities in checking the

quality of supporting foods, as well as a lack of assessment of people's health status and food consumption needs leading to a waste of supported food, poses a challenge in providing nutrition-related services such as high consumption of canned foods that can lead to an increased risk of NCD, food that is not tested for quality easily leads to the risk of food poisoning. Although no review provides definitive evidence on this, it is nevertheless recommended that stakeholders consider food support to also ensure the required quality and nutrition, helping people have better health to be able to recover from impacts, as well as prevent diseases related to climate change impacts and lack of essential nutrition. More importantly, future studies should consider this aspect, to provide concrete data and evidence, to help the Government of Vietnam focus more on addressing the dual goal of "climate and nutrition".

With severe impacts on health, quality of life, human development, climate change has been warned to continue to increase and exacerbate threatening problems such as poverty, epidemics and crises. Therefore, many solutions, policies, as well as research have been proposed from international organizations, NGOs to all different countries, with the common goal of addressing the impacts of climate change, towards sustainable development. However, this study finds that there is no "one-size-fits-all" solution when it comes to prediction, monitoring and assessing the impacts of climate change on food insecurity and nutritional outcomes in populations. The consequences of climate change such as droughts, floods, storms, landslides often occur on a certain scale, impact on the community living in that area rather than just affecting a person or a household. Therefore, in combination with Vietnam's current solutions and policies on climate change adaptation and mitigation, this study focus on proposing solutions related to the "resilience" index.

**Resilience is defined as “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt naturally to stress and change”** by IPCC (IPCC., 2007). “Climate resilience” includes related aspects of the ability to prepare for, recover from, and adapt to these impacts (Center for climate and energy solution., 2019). This study use resilience indexes referenced from the RABIT tool, with nine indexes focusing on two aspects of community foundational contributions, and expanding community responsible contributions (Heeks & Ospina, 2016)(*Appendices 4*).

First, this study lists the key factors in each indicator, and use a wheel diagram to summarize these factors (diagram 5.1 below).

Figure 4. 1: Resilience wheel – Resilience activities suggestions



From Figure 4.1: the first circle closest to the center is nine indicators of community sustainability including robustness, diversity, flexibility, equality, scale, rapidity, redundancy, learning, self-organization, each indicator is characterized by a certain color. Next, each of these indicators is composed of three sub-elements, these sub-elements are placed in the second circle, the same color as the main indicator. The circles that follow are suggested actions to contribute to building resilience in the community. This study only considers the current policies of Vietnam,

which does not conduct community resilience assessment for climate change, so when using this toolkit, this study assumes all indicators are equally important in building resilient communities.

From the factors suggested above (figure 4.1), table 4.1, this study proposed specific interventions corresponding to each sustainable living indicator, corresponding intervention level such as household level (H), community – level (C), Municipality – level (M), national – level (N).

Table 4. 1: Priority actions to improve resilience

Resilience Attribute	Resilience Marker	Intervention	Level of involvement			
			H	C	M	N
<b>FOUNDATION ATTRIBUTES OF COMMUNITY RESILIENCE</b>						
<b>ROBUSTNESS</b>	Physical Preparedness	Community campaigns to support building climate change-ready systems, e.g. storing enough water for use during the dry season, clearing and maintaining vulnerable areas risk of flooding. Ensure the food system is sufficient in both quantity and quality, and the emergency response system (manpower and means) to help provide food throughout the time affected by climate change phenomena	x	x		
	Institutional capacity	Ensuring funding for the supply of new plant varieties adapted to the impact of climate change, programs to support people to reproduce in affected areas	x	x	x	
	Mul-ti level Governance & networking	Organize workshops with the participation of local authorities, relevant departments, call for the participation of all members of the community, especially emphasizing the key role of community youth in the goal of building and developing proactive communities in prevention and emergency response to the impacts of climate change.	x	x	x	x
<b>SELF ORGANIZATION</b>	Collaboration/ consensus-building & participation	Highlight the role of the community, voluntary relief organizations, the active participation of all different sectors in supporting and helping the people of the affected area		x	x	

	Social Networks	Strengthen communication through social networks, to call for human, resource and financial support both at home and abroad	x	x	x	
	Local leadership & trust	Improve leadership capacity, accountability, publicity and transparency.		x	x	x
<b>ENABLING ATTRIBUTES OF COMMUNITY RESILIENCE</b>						
<b>LEARNING</b>	Capacity building	Advocating, calling, seeking funding sources for training programs for community members. Develop intervention programs to improve people's awareness and skills to adapt to climate change.				x
	New and traditional knowledge	Increase investment in scientific research, encourage community members to find solutions as well as invent new initiatives that benefit communities in areas affected by climate change. Training programs should allow the community to participate in hands-on experience in responding to any possible climate change-related situations.		x	x	x
	Reflective thinking	Create equal opportunities for individuals, households and communities to access new ideas in agricultural practice improvement, support the community to implement, as well as providing them with an opportunity to respond to the effectiveness or difficulty of experimenting with these innovations, towards sustainable agriculture and climate change adaptation.	x	x	x	
<b>ENABLING ATTRIBUTES OF COMMUNITY RESILIENCE</b>						
<b>REDUNDANCY</b>	Resource Sparseness	The government needs to pay more attention to communities living in resource-limited areas but heavily impacted by climate change. Develop early warning systems and information distribution systems that help predict and prevent disasters. Educating the community to convert agricultural farming models to meet income, crops and livestock to help ensure nutrition	x	x		

	Functional overlaps & interdependency	Government agencies should demonstrate their responsibility in developing response, adaptation and preparedness plans to cope with the worst-case scenarios due to climate change impacts. Combines government and institutional-level approaches with bottom-up approaches rooted in regional, national and local knowledge.	x	x	x	
	Resource substitutability	Central and local budgets need flexibility in identifying risks as a result of climate change and incorporating risk management to provide sufficient flexibility in the face of uncertainty.	x	x		
<b>RAPIDITY</b>	Rapid resource access	Community leaders, stakeholders should support households to access food as quickly as possible in the event of being impacted by climate change, ensuring food availability and timely supply household needs		x	x	
	Rapid resource mobilization	Community leaders should encourage households to support each other in providing available food, especially in the case of food shortages, and aid from different levels of government has not been met in a timely manner. Timely coordination between localities in supporting people in affected areas, timely provision of necessities such as food and health care, the supply should be ensured in time, avoiding interruption in any what situation		x	x	
	Rapid resource Assessment/ Coordination	Need to have an action plan calling for timely assistance when receiving any information or warnings about the impact of extreme weather events. Mobilize resources in terms of human, material and financial resources from local government organizations, domestic and international organizations.		x	x	

<b>SCALE</b>	Multi-level networks	The emergency action plan should fully and comprehensively identify points of contact for individuals in the affected community. Ensure the community receives the full attention of all relevant departments, in which, the Ministry of Health is proactive in providing timely and adequate food and medicine.		x	x		
	Intra/Inter scale Partnerships	Strengthen partnerships with new organizations, support and work on new programs and projects with the aim of improving the quality of life of people in areas affected by the impacts of climate change		x	x		
	Cross-level interactions	Community members should talk and present their views with local authorities and relevant departments in rebuilding infrastructures to adapt to climate change. Government agencies should regularly organize field visits to understand the actual situation in the affected area, understand the needs of the people, listen to feedback.		x	x		
<b>DIVERSITY &amp; FLEXIBILITY</b>	Different courses of action/ Emerging opportunities	Establishing a community network with representatives from different regions, to share ideas on climate-related initiatives. Encourage the participation of women in building and contributing ideas for activities related to the community.	x	x			
	Adaptable Decision- making	Ensure all households have access to new information related to sustainable climate change agricultural practices	x	x			
	Innovation Backbone	Ensure that all households have access to new innovative ideas related to agricultural practices, accepting advances in science and technology while keeping traditional culture	x	x			



<b>EQUALITY</b>	Competency Gap Reduction	Targeted training activities related to and emphasizing agricultural production, sustainable agriculture with climate change, proper food storage towards all members from households to communities, pay special attention to groups of factors such as women, the elderly, young children	x	x	x	
	Inclusiveness	Ensure all members of the community have equal access to education, communication and food distribution activities during extreme weather conditions, ensuring no one is left behind then, towards the goal of a healthy and happy population	x	x		
	Openness and accountability	Make sure the information provided is useful and sufficient for people (long-lived or recently moved) more likely to contact in any case of emergency Ensure the linkage between management levels, avoid extrusion of responsibility in evacuating people, providing food and temporary shelter, adequate medicine.	x	x	x	

The proposed activities in Table 4.1 aim at building resilience communities with climate change. Actions are concretized at different levels, showing the importance of coordination at all levels to tackle climate change. However, this study also suggests that depending on the actual situation, these activities should be prioritized before being applied in practice, to be able to optimize resources to bring the best results for the community.

## Chapter 5: Conclusion and recommendations

A total of 30 studies were selected that met the inclusion and exclusion criteria out of a total of 4577 searched from 3 major databases such as: PubMed, SIENCEDIRECT, SCOPUS. The documentary review gave the following results:

The first objective of this study found that, through available data, climate change has exacerbated nutritional outcomes among children. Stunting and HAZ are most commonly reported, and assessed to be affected by various climate change variables. Our findings add to the existing evidence and contribute to the regulation and promotion of more effective, evidence-based management programs and policies for these crisis events. Although data on nutritional status among women in climate change-affected areas are still limited.

Second, it is clear that climate change has a heavy impact on all aspects of food security, one of the main pathways to nutritional insecurity. Although the evidence this study has found on the effects of climate change on nutrition security is limited, the results do piece together the overall picture between climate change and nutrition security. Qualitative interviews with mothers reported that the quantity and quality of food their children consumed both decreased significantly as a result of the impact of extreme weather events. In comparison to men in the same area, women often have less choice in dealing with extreme weather events, reducing food consumption is the only option that they "must choose", even, they become main breadwinner in the family, when the family's farming activities are affected by extreme events, they have to travel further to find food for their family, face high health risks and become victims of rape.

Finally, this study found that the Government of Vietnam is very aware and emphatic about the challenges it faces and has responded strongly through national, local and sectoral policies and agendas to address vulnerability to climate change and promote the path of low-carbon development and green growth. However, current solutions are only reactive, and intervention policies to mitigate the effects of climate change have led to tough measures, such as rebuilding infrastructure. Very little effort has been made in Vietnam to build climate preparedness and readiness at the household and community levels. Resilience is an essential component of any comprehensive climate action program because climate change is both a global issue and a hyperlocal issue. Pregnant women and their growing fetuses, especially those from less resourced

areas, are particularly vulnerable to its direct and indirect effects. Policy, clinical and research strategies to adapt to or mitigate the effects of climate change are now more important than ever.

## **GAPS**

The research was carried out in Vietnam, but the number of articles in Vietnamese is less (4/30), leading to the lack of specific data for each context. The climate change variable includes a range of different extreme weather events, each with different impacts. However, a few studies did not specifically address climate change variables, leading to a lack of clarity on the extent of impacts and the actual relationship between each phenomenon and nutritional outcomes. In addition, the studies mainly include secondary data from national surveys collected for different purposes, so the results are not likely to establish a cause-and-effect relationship. The path between climate change and nutritional outcomes is considered to be a complex one, with the influence of many different factors, including confounding factors, direct and indirect factors, yet, there are no studies that comprehensively evaluate this issue. Although climate change affects the nutrient content of crops, nevertheless, there are no studies investigating micronutrient deficiencies among children and women living in areas affected by climate change. In addition, there are no studies investigating urban food security in relation to climate change. To capture the full impact of climate change on undernutrition among children and women in Vietnam, both of these areas require further research. Preferably, the surveys should take into account all parameters of malnutrition (including micronutrient deficiencies), in different age groups, between girls and boys. Although the geographical distribution shows that climate change vulnerable areas in Vietnam are studied, the studies are multicenter, integrating many geographically different regions, leading to results that are not truly representative. On the other hand, individual studies in each geographical area (province/city) should be uniformly designed to maintain focus at the micro level but allow the data to be meaningful for meta-analysis in the future.

## **RECOMMENDATIONS**

This study recommends systematic monitoring of children's nutritional status, mothers and especially infants are particularly recommended in environments affected by climate change, with particular emphasis on vulnerable populations living in low-resource areas and rural establishments heavily dependent on subsistence farming, to tailor response policy to these crises in the future. Where possible, preference should be given to longitudinal studies to identify causal

links between individual climate change events such as floods, storms, droughts and undernutrition in children and women. Since infants are affected more often than older children, this study found that jointly assessing the nutritional status of mothers and infants will help to understand the negative impact of climate change and importance of nutritional security. Empirical investigation of variables mediating exposure pathways, the timing of exposure from climate change events to undernutrition is essential as it is crucial to understanding how each event affects nutritional health in order to design intervention's effectiveness and inform prevention policies. Of particular importance, addressing these risks can not only protect people and property, but also generate economic activity that will create jobs in the country and promote prosperity.

Malnutrition occurs not only due to food insecurity but if we look at the bigger picture, it occurs due to nutritional insecurity. For example, if the mother is undernourished since her adolescent days then there are high chances that the baby will be stunted. After analyzing Vietnamese literatures and comparing it with other existing literatures, this study recommends immediate and appropriate interventions to increase food access in affected areas. This results in a more sustainable improvement in nutrition equity for both children and women in climate impacted areas. Government agencies should pre-allocate funds and enhance emergency preparedness to enable impacted communities to ensure all aspects of "nutrition security". Not only food support for the people in the affected areas, but the plan needs to be long-term and sustainable, such as creating more jobs for people in the affected areas, sustainable production models and adaptable to climate change phenomena. Strategies to mitigate the heavy impacts of climate change on people's livelihoods, empowering women to give them greater autonomy in raising their children and other family members.

A successful solution requires close cooperation of cross-sectoral and multi-level agencies including government, community partners, the general public, physicians, industry partners, public health practitioners and researchers. It will take a combined and coordinated effort, to solve this problem. It is important to effectively implement the "dual goal" of both preventing and combating the impacts of climate change and ensuring the nutritional needs of the people before, during and after the impacts of climate change. Building awareness and responses related to climate change in local communities is also equally crucial. A message is to be conveyed to everyone to build a sense of responsibility and address changes in the environment and biodiversity in regards to climate change and nutrition.

Based on the results presented above, glancing at the government agencies and relevant ministries, the study suggests that the Vietnamese government plays a central role in addressing climate change and nutrition issues. In addition, the study proposes that the Ministry of Natural Resources and Environment (MONRE) continues to be the leading agency on climate change, tasked with formulating climate change policies and coordinating the implementation of climate actions among different countries. Industry, local government and MONRE together with the Ministry of Planning and Investment (MPI) and the Ministry of Finance (MOF) undertake the task of reviewing and planning budgets related to climate change. The Ministry of Agriculture and Rural Development (MARD) monitors climate change issues affecting rural development. The Ministry of Industry and Trade coordinates the management and development of Vietnam's most carbon-intensive industries. The Ministry of Construction assists MONRE and respective Ministries in land use planning and coordinates the implementation of the National Program on Urban Development among ministries and provincial governments. Other ministries responsible for climate change activities based on their core functions are: Ministry of Transport (MOT), Ministry of Foreign Affairs, Ministry of Science and Technology (MOST) and Ministry of Education and Training. It is also necessary that the Ministry of Health demonstrate its role in establishing nutrition-related programs in areas where people are affected by climate change, strengthen nutrition monitoring activities of people living in areas affected by climate change for timely interventions. Surveillance should pay special attention to children and pregnant women.

Reduction in negative climate change impacts is one of the key targets of SDGs, which is to be achieved by 2030. Therefore, all ministries and local governments need to strengthen the necessary cooperation - coordination - collaboration measures to realize the importance of achieving SDGs. This emphasis is not only on Vietnam, but on all other countries in the world. National climate policy frameworks should mandate all national ministries to integrate climate change issues into their strategies and plans.

This study demonstrates the importance of climate change impacts on the nutritional status of the population of women and children in Vietnam. However, looking at this relationship in reverse, it can be seen that nutritional status, food insecurity and economic inequalities also have a significant impact on climate change. For example, in ethnic minority areas, due to lack of food supplies, clear forests to find food to feed their families, all of this has led to the loss of ecosystems, increasing the risk of climate change. Looking further, there are many children facing many

diseases related to malnutrition and all of them become weaker and unable to study, cannot work for a living and will not be knowledgeable about climate protection. From here, this study would like to recommend that education programs to raise people's awareness about climate protection should be paid more attention, especially among ethnic minorities, a population that mainly depends on forests.

In summary, climate change is one of the transnational determinants of health, although it is not as powerful as the pandemic, but the consequences it has caused are enough to destroy the global efforts of the past decades. Undernutrition among the population of women and children in Vietnam in climate change-affected areas is one of the examples of health disparities in the country under the impact of climate change, which risk of impacting other transboundary issues. This study wants to emphasize the importance of controlling as well as limiting the risk factors affecting climate change at all levels, from individual, community, national and international levels. Solutions related to prevention - treatment - recovery of diseases related to climate change should be implemented synchronously and effectively at international, national and community levels. Empowering each individual in the community, which focuses on education, awareness raising, and behavior improvement needs to be continued. Besides that, multidisciplinary approaches to malnutrition and climate change need further strengthening and dissemination. As for the global health and climate change picture, climate change should be considered a central concern so that the greatest number of risk factors and consequences of that relationship can be outlined. From there, the responsibilities and obligations of individuals, communities and authorities are recognized, contributing to improving health and health equity for all.

## References

- Abiona, O. (2022). Malnutrition pathway for the impact of in utero drought shock on child growth indicators in rural households. *Environment Development Economics*, 27(1), 20-39.
- Action Against Hunger USA. (2021). *Climate change: A hunger crisis in the making*. Retrieved on May 10, 2022 from <https://reliefweb.int/report/world/climate-change-hunger-crisis-making#:~:text=HUNGER%20AND%20MALNUTRITION%3A%20Climate%20change,particularly%20in%20low%2Dincome%20communities>.
- Adaawen, S., & de Haas, B. (2019). Linkages between climate change and sexual and reproductive health & rights: a demographic perspective. *MT: Bulletin of the Netherlands Society for Tropical Medicine and International Health*, 57(3), 27-28.
- Akresh, R., Verwimp, P., & Bundervoet, T. (2011). Civil war, crop failure, and child stunting in Rwanda. *Economic Development and cultural change*, 59(4), 777-810.
- Alderman, H. (2010). Safety nets can help address the risks to nutrition from increasing climate variability. *The Journal of Nutrition*, 140(1), 148S-152S. <https://doi.org/10.3945/jn.109.110825>
- Allvin, K., Hellstrom, A., Dahlgren, J., & Andersson Gronlund, M. (2014). Birth weight is the most important predictor of abnormal retinal vascularisation in moderately preterm infants. *Acta Paediatr*, 103(6), 594-600. <https://doi.org/10.1111/apa.12599>
- Andalón, M., Azevedo, J. P., Rodríguez-Castelán, C., Sanfelice, V., & Valderrama-González, D. (2016). Weather Shocks and Health at Birth in Colombia. *World Development*, 82, 69-82. <https://doi.org/https://doi.org/10.1016/j.worlddev.2016.01.015>
- Bahru, B. A., Bosch, C., Birner, R., & Zeller, M. (2019). Drought and child undernutrition in Ethiopia: A longitudinal path analysis. *Plos one*, 14(6), e0217821.
- Basu, R., Malig, B., & Ostro, B. (2010). High ambient temperature and the risk of preterm delivery. *American Journal of Epidemiology*, 172(10), 1108-1117.
- Bauer, J. M., & Mburu, S. (2017). Effects of drought on child health in Marsabit District, Northern Kenya. *Economics & Human Biology*, 24, 74-79.
- Beuermann, D. W., & Pecha, C. J. (2020). The effects of weather shocks on early childhood development: Evidence from 25 years of tropical storms in Jamaica. *Econ Hum Biol*, 37, 100851. <https://doi.org/10.1016/j.ehb.2020.100851>
- Bista, D. R., Heckathorn, S. A., Jayawardena, D. M., Mishra, S., & Boldt, J. K. (2018). Effects of Drought on Nutrient Uptake and the Levels of Nutrient-Uptake Proteins in Roots of Drought-Sensitive and -Tolerant Grasses. *Plants (Basel)*, 7(2). <https://doi.org/10.3390/plants7020028>
- Blakstad, M. M., & Smith, E. (2020). Climate change worsens global inequity in maternal nutrition. *The Lancet Planetary Health*, 4(12), e547-e548.
- Blakstad, M. M., & Smith, E. R. (2020). Climate change worsens global inequity in maternal nutrition. *Lancet Planet Health*, 4(12), e547-e548. [https://doi.org/10.1016/S2542-5196\(20\)30246-1](https://doi.org/10.1016/S2542-5196(20)30246-1)

- British Nutrition Foundation. (2021). *Nutrition Requirements*. Retrieved on August 11, 2022 from <https://www.nutrition.org.uk/media/nmmewdug/nutrition-requirements.pdf>
- Bui, T. M. H. (2021). Variations in climate change adaptation among households of different ethnicities in mountainous areas of Vietnam. *Kasetsart Journal of Social Sciences*, 42(2), 331-338.
- Cambridge Dictionary. (2022). *Weather*. Retrieved on May 11, 2022 from <https://dictionary.cambridge.org/dictionary/english/weather>
- CARE International. (2016). *More than 400,000 pregnant women and breastfeeding mothers at risk in Ethiopia, warns CARE*. Retrieved on July 04, 2022 from <https://www.care-international.org/news/more-400000-pregnant-women-and-breastfeeding-mothers-risk-ethiopia-warns-care>
- Carpena, F. (2019). How do droughts impact household food consumption and nutritional intake? A study of rural India. *World Development*, 122, 349-369.
- Carpena, Fenella. (2019). How do droughts impact household food consumption and nutritional intake? A study of rural India. *World Development*, 122, 349-369. <https://doi.org/https://doi.org/10.1016/j.worlddev.2019.06.005>
- Carvalho, F. P. (2017). Pesticides, environment, and food safety. *Food energy security*, 6(2), 48-60.
- CDC. (2021). *Climate Effects on Health*. Retrieved on March 12, 2022 from <https://www.cdc.gov/climateandhealth/effects/default.htm#:~:text=The%20health%20effects%20of%20these,and%20threats%20to%20mental%20health>.
- CDC. (2022 ). *Infant and Toddler Nutrition*. Retrieved on July 23, 2022 from <https://www.cdc.gov/nutrition/infantandtoddlernutrition/index.html#:~:text=Good%20nutrition%20during%20the%20first,children%20develop%20healthy%20dietary%20patterns>.
- Center for climate and energy solution. (2019). *What is Climate Resilience, and Why Does it Matter?* Retrieved on July 15, 2022 from <https://www.c2es.org/document/what-is-climate-resilience-and-why-does-it-matter/>
- Chen, G., Guo, Y., Abramson, M. J., Williams, G., & Li, S. (2018). Exposure to low concentrations of air pollutants and adverse birth outcomes in Brisbane, Australia, 2003-2013. *Sci Total Environ*, 622-623, 721-726. <https://doi.org/10.1016/j.scitotenv.2017.12.050>
- CIA World Factbook. (2022). *Coastline - The World Factbook - CIA*. Retrieved on March 09, 2022 from <https://www.nationsencyclopedia.com/WorldStats/CIA-World-Factbook-Coastline.html>
- Climate & clean air coalition. (2022 ). *The economic case for cutting short-lived climate pollutants*. Retrieved on July 15, 2022 from <https://www.ccacoalition.org/en/content/economic-case-cutting-short-lived-climate-pollutants>
- Climate action tracker. (2021). *Thailand*. Retrieved on July 15, 2021 from <https://climateactiontracker.org/countries/thailand/policies-action/#:~:text=Under%20the%20Climate%20Change%20Master,Resources%20and%20Environment%2C%202015>.



- Climate Change Knowledge Portal. (2022). *Vietnam*. Retrieved on March 09, 2022 from <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability#:~:text=Vietnam%20faces%20high%20disaster%20risk,%2C%20flash%2C%20and%20coastal%20flooding>.
- Cooper, M. W., Brown, M. E., Hochrainer-Stigler, S., Pflug, G., McCallum, I., Fritz, S., . . . Zvoleff, A. (2019). Mapping the effects of drought on child stunting. *Proc Natl Acad Sci U S A*, 116(35), 17219-17224. <https://doi.org/10.1073/pnas.1905228116>
- Currie, J., & Rossin-Slater, M. (2013). Weathering the storm: hurricanes and birth outcomes. *J Health Econ*, 32(3), 487-503. <https://doi.org/10.1016/j.jhealeco.2013.01.004>
- Currie, J., Zivin, J. G., Meckel, K., Neidell, M., & Schlenker, W. (2013). Something in the water: contaminated drinking water and infant health. *Can J Econ*, 46(3), 791-810. <https://doi.org/10.1111/caje.12039>
- Davenport, F., Dorélien, A., & Grace, K. (2020). Investigating the linkages between pregnancy outcomes and climate in sub-Saharan Africa. *Population and Environment*, 41(4), 397-421.
- Delisle, S., & Turner, S. (2016). ‘The weather is like the game we play’: Coping and adaptation strategies for extreme weather events among ethnic minority groups in upland northern Vietnam. *Asia Pacific Viewpoint*, 57(3), 351-364.
- Department of Climate Change - Ministry of Natural Resources and Environment of Vietnam. (2017). *Decision No. 672/QĐ-BTNMT Promulgating action plan to respond to climate change of the Ministry of Natural Resources and Environment for the period 2016-2020*. Retrieved on June 24, 2022 from <http://www.dcc.gov.vn/van-ban-phap-luat/1037/Quyết-dinh-so-672/QĐ-BTNMT-Ban-hanh-ke-hoach-hanh-dong-ung-pho-voi-bien-doi-khi-hau-cua-Bo-Tai-nguyen-va-Moi-truong-giai-doan-2016-2020.html>
- Desai, Z., & Zhang, Y. (2021). Climate Change and Women's Health: A Scoping Review. *Geohealth*, 5(9), e2021GH000386. <https://doi.org/10.1029/2021GH000386>
- Deschênes, O., Greenstone, M., & Guryan, J. (2009). Climate change and birth weight. *American Economic Review*, 99(2), 211-217.
- Diffenbaugh, N. S., & Burke, M. (2019). Global warming has increased global economic inequality. *Proceedings of the National Academy of Sciences*, 116(20), 9808-9813.
- Dimitrova, A. (2021). Seasonal droughts and the risk of childhood undernutrition in Ethiopia. *World Development*, 141, 105417.
- Do, V. Q., Phung, M. L., Truong, D. T., Pham, T. T. T., Dang, V. T., & Nguyen, T. K. (2021). The Impact of Extreme Events and Climate Change on Agricultural and Fishery Enterprises in Central Vietnam. *Sustainability*, 13(13), 7121.
- Dornan, P., Ogando Portela, M. J., & Pells, K. (2014). *Climate Shocks, Food and Nutrition Security: Evidence from the Young Lives cohort study*. Oxfam International.
- Edoka, I. (2013). Weather shocks and nutritional status of disadvantaged children in Vietnam. *Health Econometrics and Data Group*, 13(10).

- FAO. (2003). *Trade reforms and food security: Conceptualizing the Linkages*. Retrieved on May 05, 2022 from <https://www.fao.org/3/y4671e/y4671e00.htm#Contents>
- FAO. (2018). *SMALL FAMILY FARMS COUNTRY FACTSHEET*. Retrieved on July 08, 2022 from <https://www.fao.org/3/I8358EN/i8358en.pdf>
- FAO. (2021). *Hunger and food insecurity*. Retrieved on September 07, 2022 from <https://www.fao.org/hunger/en/>
- FAO. (2022). *Improving nutrition and food security through better farming techniques*. Retrieved on July 03, 2022 from <https://www.fao.org/vietnam/programmes-and-projects/success-stories/nutrition-and-food-security/zh/>
- Freudenreich, H., Aladysheva, A., & Brück, T. (2022). Weather shocks across seasons and child health: Evidence from a panel study in the Kyrgyz Republic. *World Development*, 155, 105801.
- Friel, S., Berry, H., Dinh, H., O'Brien, L., & Walls, H. L. (2014). The impact of drought on the association between food security and mental health in a nationally representative Australian sample. *BMC Public Health*, 14, 1102. <https://doi.org/10.1186/1471-2458-14-1102>
- Gabrysch, S., Waid, J. L., Wendt, A. S., Müller, A. A., Kader, A., & Gosh, U. (2018). Nutritional effects of flooding due to unseasonably early monsoon rainfall in Bangladesh: A cross-sectional study in an ongoing cluster-randomised trial. *The Lancet Planetary Health*, 2, S3.
- Gari, T., Loha, E., Deressa, W., Solomon, T., Atsbeha, H., Assegid, M., . . . Lindtjorn, B. (2017). Anaemia among children in a drought affected community in south-central Ethiopia. *Plos one*, 12(3), e0170898. <https://doi.org/10.1371/journal.pone.0170898>
- Gete, D. G., Waller, M., & Mishra, G. D. (2020). Effects of maternal diets on preterm birth and low birth weight: a systematic review. *Br J Nutr*, 123(4), 446-461. <https://doi.org/10.1017/S0007114519002897>
- Giulia, S., Lea, B.-F., Carol, Z.-C., Lisa, M., Harper, S. L., & Elizabeth, C. (2020). The effect of climatic factors on nutrients in foods: evidence from a systematic map. *Environmental Research Letters*, 15(11), 113002.
- Global climate risk index. (2020). *Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2018 and 1999 to 2018* Retrieved on April 13, 2022 from [https://www.germanwatch.org/sites/default/files/20-2-01e%20Global%20Climate%20Risk%20Index%202020\\_14.pdf](https://www.germanwatch.org/sites/default/files/20-2-01e%20Global%20Climate%20Risk%20Index%202020_14.pdf)
- Govarts, E., Remy, S., Bruckers, L., Den Hond, E., Sioen, I., Nelen, V., . . . Schoeters, G. (2016). Combined Effects of Prenatal Exposures to Environmental Chemicals on Birth Weight. *Int J Environ Res Public Health*, 13(5). <https://doi.org/10.3390/ijerph13050495>
- Government of Vietnam. (2015). *Climate change in Vietnam*. United Nations Framework Convention on Climate Change (UNFCCC). Retrieved on March 09, 2022 from <https://data.vietnam.opendevelopmentmekong.net/en/dataset/dong-gop-do-qu-c-gia-t-quy-t-d-nh-indc-c-a-vi-t-nam>
- Government of Vietnam. (2016). *DECREE 119/2016/ND-CP ON SOME POLICIES FOR MANAGEMENT, PROTECTION AND SUSTAINABLE DEVELOPMENT OF COASTAL*

- FORESTS RESPONDING TO CLIMATE CHANGE*. <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Nghi-dinh-119-2016-ND-CP-quan-ly-bao-ve-phat-trien-ben-vung-rung-ven-bien-bien-doi-khi-hau-2016-320507.aspx>
- Grace, D., Bett, B. K., Lindahl, J. F., & Robinson, T. P. (2015). Climate and livestock disease: assessing the vulnerability of agricultural systems to livestock pests under climate change scenarios. *CCAFS Working Paper*.
- Grosso, V., & Kraehnert, K. (2016). Extreme weather events and child height: evidence from Mongolia. *World Development*, 86, 59-78.
- Hagos, S., Lunde, T., Mariam, D. H., Woldehanna, T., & Lindtjørn, B. (2014). Climate change, crop production and child under nutrition in Ethiopia; a longitudinal panel study. *BMC Public Health*, 14(1), 884. <https://doi.org/10.1186/1471-2458-14-884>
- Hang, L. T. T. (2014). ASSESSMENT OF THE IMPACTS OF STORM AND TIDES ON THE LIVELIHOODS OF THE POOR GROUPS COASTAL AND NORTH ISLAND. *Vietnam Hydrometeorology Magazine*, 9.
- Hanjahanja-Phiri, T. (2018). Intergenerational effects of maternal exposure to drought in utero on newborn size in rural Malawi. *Annals of Nutrition and Metabolism*, 73(1), 74-76.
- Hannam, K., McNamee, R., Baker, P., Sibley, C., & Agius, R. (2014). Air pollution exposure and adverse pregnancy outcomes in a large UK birth cohort: use of a novel spatio-temporal modelling technique. *Scand J Work Environ Health*, 40(5), 518-530. <https://doi.org/10.5271/sjweh.3423>
- Haq, I. U., Mehmood, Z., Mujahid, A. M., Ahmed, B., Shah, J., Khan, N., . . . Chen, X. (2021). Prevalence of Micronutrient Deficiencies among Preschool and School-Going Children in Flood-Hit Areas of Pakistan. *Am J Trop Med Hyg*, 105(6), 1638-1644. <https://doi.org/10.4269/ajtmh.21-0705>
- Heeks, R., & Ospina, A. V. (2016). Measuring and intervening on resilience: The RABIT approach. *Centre for Development Informatics, University of Manchester, UK*.
- Hendrawan, V. S. A., Kim, W., Touge, Y., Ke, S., & Komori, D. (2022). A global-scale relationship between crop yield anomaly and multiscalar drought index based on multiple precipitation data. *Environmental Research Letters*, 17(1), 014037.
- Hossain, S. M., Talat, M., Boyd, E., Chowdhury, S. R., Soofi, S. B., Hussain, I., . . . Bhutta, Z. (2013). Evaluation of Nutrition Surveys in Flood-affected Areas of Pakistan: Seeing the Unseen! *IDS Bulletin*, 44(3), 10-20.
- ILO. (2018). *Greening with jobs*. Retrieved on July 12, 2022 from [https://www.ilo.org/weso-greening/documents/WESO\\_Greening\\_EN\\_web2.pdf](https://www.ilo.org/weso-greening/documents/WESO_Greening_EN_web2.pdf)
- International Maize and Wheat Improvement Center. (2020). *Pests and diseases and climate change: Is there a connection?* Retrieved on June 17, 2022 from <https://www.cimmyt.org/news/pests-and-diseases-and-climate-change-is-there-a-connection/>
- Investopedia. (2021). *Z-Score vs. Standard Deviation: What's the Difference?* Retrieved on September 07, 2022 from <https://www.investopedia.com/ask/answers/021115/what-difference-between-standard-deviation-and-z-score.asp>

- IPCC. (2018a). @Annex I: Glossary. <https://www.ipcc.ch/sr15/chapter/glossary/> ( Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty)
- IPCC. (2018b). *Glossary*. Retrieved on May 05, 2022 from [https://www.ipcc.ch/site/assets/uploads/2018/11/sr15\\_glossary.pdf](https://www.ipcc.ch/site/assets/uploads/2018/11/sr15_glossary.pdf)
- IPCC. (2022a). *Climate change: a threat to human wellbeing and health of the planet. Taking action now can secure our future [EN/AR/RU/ZH]*. Retrieved on March 08, 2022 from <https://reliefweb.int/report/world/climate-change-threat-human-wellbeing-and-health-planet-taking-action-now-can-secure#:~:text=%E2%80%9CThe%20scientific%20evidence%20is%20unequivocal,%E2%80%9D%20said%20Hans%20Otto%20P%3B%20rtner.>
- IPCC. (2022b). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Retrieved on March 08, 2022 from <https://www.ipcc.ch/report/ar6/wg2/>
- IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability*. [https://www.ipcc.ch/site/assets/uploads/2018/03/ar4\\_wg2\\_full\\_report.pdf](https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf)
- IPCC. (2022). *Definition of Terms Used Within the DDC Pages*. Retrieved on August 11, 2022 from [https://www.ipcc-data.org/guidelines/pages/glossary/glossary\\_r.html](https://www.ipcc-data.org/guidelines/pages/glossary/glossary_r.html)
- Iqbal, S., & Ali, I. (2021). Maternal food insecurity in low-income countries: Revisiting its causes and consequences for maternal and neonatal health. *Journal of Agriculture and Food Research*, 3, 100091.
- Islam, M. S., Samreth, S., Islam, A. H. M. S., & Sato, M. (2022). Climate change, climatic extremes, and households' food consumption in Bangladesh: A longitudinal data analysis. *Environmental Challenges*, 7, 100495. <https://doi.org/https://doi.org/10.1016/j.envc.2022.100495>
- Keshavarz, M., Maleksaeidi, H., & Karami, E. (2017). Livelihood vulnerability to drought: A case of rural Iran. *International Journal of Disaster Risk Reduction*, 21, 223-230.
- Khalili, N., Arshad, M., Kächele, H., Farajzadeh, Z., & Müller, K. (2021). Drought shocks and farm household consumption behaviour: Insights from Fars province of Iran. *International Journal of Disaster Risk Reduction*, 66, 102625. <https://doi.org/https://doi.org/10.1016/j.ijdr.2021.102625>
- Knowlton, K., Rotkin-Ellman, M., Geballe, L., Max, W., & Solomon, G. M. (2011). Six climate change-related events in the United States accounted for about \$14 billion in lost lives and health costs. *Health Aff (Millwood)*, 30(11), 2167-2176. <https://doi.org/10.1377/hlthaff.2011.0229>
- Kuehn, L., & McCormick, S. (2017). Heat exposure and maternal health in the face of climate change. *International journal of environmental research and public health*, 14(8), 853.
- Lawlor, D. A., Leon, D. A., & Smith, G. D. (2005). The association of ambient outdoor temperature throughout pregnancy and offspring birthweight: findings from the Aberdeen

- Children of the 1950s cohort. *An International Journal of Obstetrics & Gynaecology*, 112(5), 647-657.
- Le, K., & Nguyen, M. (2021). The impacts of temperature shocks on birth weight in Vietnam. *Population Development Review*, 47(4), 1025-1047.
- Le, K., & Nguyen, M. (2022). Droughts and child health in Bangladesh. *Plos one*, 17(3), e0265617.
- Le, K., & Nguyen, M. (2022). The impacts of rainfall shocks on birth weight in Vietnam. *Journal of Development Effectiveness*, 14(2), 143-159.
- Le, M. K. (2018). *IMPACTS OF NATURALS ON THE HEALTH OF PEOPLE AND CHILDREN IN RURAL AREA OF VIETNAM* [Dr. Vo Tat Thang, UNIVERSITY OF ECONOMY AT HO CHI MINH CITY].
- Le Toan, T., Huu, N., Simioni, M., Phan, H., Arai, H., Mermoz, S., . . . Duong, T. H. (2021). Agriculture in Viet Nam under the impact of climate change. *Climate change in Viet Nam. Impacts and adaptation. A COP26 assessment report of the GEMMES Viet Nam project*.
- Lechtenfeld, T., & Lohmann, S. (2014). *The effect of drought on health outcomes and health expenditures in rural vietnam*.
- Lieber, M., Chin-Hong, P., Kelly, K., Dandu, M., & Weiser, S. (2022). A systematic review and meta-analysis assessing the impact of droughts, flooding, and climate variability on malnutrition. *Global Public Health*, 17(1), 68-82.
- Lloyd, S. J., Bangalore, M., Chalabi, Z., Kovats, R. S., Hallegatte, S., Rozenberg, J., . . . Havlik, P. (2018). A Global-Level Model of the Potential Impacts of Climate Change on Child Stunting via Income and Food Price in 2030. *Environ Health Perspect*, 126(9), 97007. <https://doi.org/10.1289/EHP2916>
- Lloyd, S. J., Kovats, R. S., & Chalabi, Z. (2011). Climate change, crop yields, and undernutrition: development of a model to quantify the impact of climate scenarios on child undernutrition. *Environmental Health Perspectives*, 119(12), 1817-1823. <https://doi.org/10.1289/ehp.1003311>
- Mahapatra, B., Walia, M., Rao, C. A. R., Raju, B. M. K., & Saggurti, N. (2021). Vulnerability of agriculture to climate change increases the risk of child malnutrition: Evidence from a large-scale observational study in India. *PLoS One*, 16(6), e0253637. <https://doi.org/10.1371/journal.pone.0253637>
- Maruyama Rentschler, J. E., & Leonova, N. (2022). *Air Pollution and Poverty: PM2.5 Exposure in 211 Countries and Territories*.
- Mehmood, Z., Afzal, T., Khan, N., Ahmed, B., Ali, L., Khan, A., . . . Zakki, S. A. (2021). Prevalence and determinants of stunting among preschool and school-going children in the flood-affected areas of Pakistan. *Brazilian Journal of Biology*, 82.
- Mekonnen, A., Tessema, A., Ganewo, Z., Haile, A., & Research, F. (2021). Climate change impacts on household food security and farmers adaptation strategies. *Journal of Agriculture and Food Research*, 6, 100197.

- Ministry of natural resources and environment in Vietnam. (2016). *Climate change and sea levels rise scenarios for Vietnam*. Retrieved on April 24, 2022 from <http://www.imh.ac.vn/files/doc/2017/CCS%20final.compressed.pdf>
- Ministry of natural resources and environment in Vietnam. (2022 ). *Circular No: 01/2022/TT-BTNMT, detailing the implementation of the Law on Environmental Protection in response to climate change* Retrieved from <https://www.monre.gov.vn/VanBan/Pages/ChiTietVanBanPhapQuy.aspx?pID=281>
- Ministry of Natural Resources and Environment of Vietnam. (2016). *Summary of climate change and sea level rise scenarios for Vietnam*. Retrieved on June 17, 2022 from [https://vihema.gov.vn/wp-content/uploads/2015/12/03.-Tom-tat-Kich-ban-BDKH-va-NBD-cho-VN\\_2016\\_Tieng-Viet.pdf](https://vihema.gov.vn/wp-content/uploads/2015/12/03.-Tom-tat-Kich-ban-BDKH-va-NBD-cho-VN_2016_Tieng-Viet.pdf)
- Ministry of Natural Resources and Environment of Vietnam. (2017). *DECISION 672/QĐ-BTNMT, ISSUING ACTION PLAN TO RESPOND TO CLIMATE CHANGE OF THE MINISTRY OF RESOURCES AND ENVIRONMENT FOR 2016 - 2020*. Retrieved on June 24, 2022 from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quy-dinh-672-QĐ-BTNMT-2017-Ke-hoach-hanh-dong-ung-pho-voi-bien-doi-khi-hau-375104.aspx>
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group\*, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*, 151(4), 264-269.
- Mohsin, S. N., Fatima, M., Aasim, M., & Ghous, R. (2017). Comparison of nutritional status among, flood affected and unaffected school aged children. *Pakistan Journal of Medical Research*, 56(2), 39-43.
- Mota, A. A., Lachore, S. T., & Handiso, Y. H. (2019). Assessment of food insecurity and its determinants in the rural households in Damot Gale Woreda, Wolaita zone, southern Ethiopia. *Agriculture & Food Security*, 8(1), 1-11.
- Ngo, N. S., & Horton, R. M. (2016). Climate change and fetal health: The impacts of exposure to extreme temperatures in New York City. *Environ Res*, 144(Pt A), 158-164. <https://doi.org/10.1016/j.envres.2015.11.016>
- Nguyen, K. V., & James, H. (2013). Measuring household resilience to floods: a case study in the Vietnamese Mekong River Delta. *Ecology and Society*, 18(3).
- Nguyen, T. V. H. (2022). Welfare impact of climate change on capture fisheries in Vietnam [Article]. *Plos one*, 17(4 April), Article e0264997. <https://doi.org/10.1371/journal.pone.0264997>
- Oskorouchi, H. R., & Sousa-Poza, A. (2021). Floods, food security, and coping strategies: Evidence from Afghanistan. *Agricultural Economics*, 52(1), 123-140.
- Ospina, A. V. (2013). *Climate change adaptation and developing country livelihoods: the role of information and communication technologies*. The University of Manchester (United Kingdom).
- Pacillo, G., Bao-Nam, N.-V., Burra, D. D., Trinh, H. T., Le, T. D., Truong, M. T., . . . Läderach, P. (2022). Disruptive Innovations for Well-Functioning Food Systems: The Data-Driven

“Food and Nutrition Security Under Climate Evolution” Framework. *Frontiers in Sustainable Food Systems*, 525.

- Pacillo, G., Bao-Nam, N. V., Burra, D. D., Trinh, H. T., Le, T. D., Truong, M. T., . . . Läderach, P. (2022). Disruptive Innovations for Well-Functioning Food Systems: The Data-Driven “Food and Nutrition Security Under Climate Evolution” Framework [Article]. *Frontiers in Sustainable Food Systems*, 5, Article 726779. <https://doi.org/10.3389/fsufs.2021.726779>
- Parvin, G. A., & Ahsan, S. M. R. (2013). Impacts of climate change on food security of rural poor women in Bangladesh. *Management of environmental quality: an international journal*.
- Pham, N. T. T., Nong, D., & Garschagen, M. (2019). Farmers’ decisions to adapt to flash floods and landslides in the Northern Mountainous Regions of Vietnam. *Journal of environmental management*, 252, 109672.
- Pham, N. T. T., Nong, D., & Garschagen, M. (2021). Natural hazard's effect and farmers' perception: Perspectives from flash floods and landslides in remotely mountainous regions of Vietnam. *Science of the Total Environment*, 759, 142656. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.142656>
- Pham, N. T. T., Nong, D., Sathyan, A. R., & Garschagen, M. (2020). Vulnerability assessment of households to flash floods and landslides in the poor upland regions of Vietnam. *Climate Risk Management*, 28, 100215.
- Pham, P., Doneys, P., & Doane, D. L. (2016). Changing livelihoods, gender roles and gender hierarchies: The impact of climate, regulatory and socio-economic changes on women and men in a Co Tu community in Vietnam. *Women's Studies International Forum*, 54, 48-56.
- Pham, T., Hieu, D. T., Hoan, L., Quyen, L., San, L., Ferrer, A. J., . . . Sebastian, L. S. (2015). Situation Analysis and Needs Assessment Report for Ma Village and Yan Bai Province, Vietnam.
- Phuong, L. T. H., Biesbroek, G. R., Sen, L. T. H., & Wals, A. E. (2018). Understanding smallholder farmers' capacity to respond to climate change in a coastal community in Central Vietnam. *Climate and Development*, 10(8), 701-716.
- Poblacion, A., Ettinger de Cuba, S., & Cook, J. T. (2022). For 25 Years, Food Security Has Included a Nutrition Domain: Is a New Measure of Nutrition Security Needed? *J Acad Nutr Diet*. <https://doi.org/10.1016/j.jand.2022.04.009>
- Prime Minister of Vietnam. (2011). *DECISION ON APPROVING THE NATIONAL STRATEGY ON CLIMATE CHANGE THE PRIME MINISTER*. Retrieved from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quy-dinh-2139-QD-TTg-phe-duyet-Chien-luoc-quoc-gia-bien-doi-khi-hau-132631.aspx>
- Prime Minister of Vietnam. (2012). *Decision No. 1393/QD-TTG : Approving the National Strategy on Green Growth*. Retrieved from [https://data.vietnam.opendevlopmentmekong.net/vi/laws\\_record/quy-t-d-nh-s-1393-qd-ttg-phe-duy-t-chi-n-lu-c-qu-c-gia-v-tang-tru-ng-xanh/resource/63d2e1b6-b1c3-4ab0-b924-bfc02553c981](https://data.vietnam.opendevlopmentmekong.net/vi/laws_record/quy-t-d-nh-s-1393-qd-ttg-phe-duy-t-chi-n-lu-c-qu-c-gia-v-tang-tru-ng-xanh/resource/63d2e1b6-b1c3-4ab0-b924-bfc02553c981)
- Prime Minister of Vietnam. (2017a). *Decision No. 1670/QD-TTg approving the Target Program to respond to climate change and green growth for the 2016-2020 period*.

- Prime Minister of Vietnam. (2017b). *National program on reducing greenhouse gas emissions through limiting forest loss and degradation; conservation, enhancement of carbon stocks and sustainable management of forest resources (REDD+) to 2030*. Retrieved from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quyiet-dinh-419-QD-TTg-Chuong-trinh-quoc-gia-giam-phat-thai-khi-nha-kinh-qua-han-che-mat-rung-2017-345551.aspx>
- Prime Minister of Vietnam. (2020). *Decree 1913/QD-TTg on financial support for locals for rewarding the effects of storm number 5, 6, 7, 8, 9 and the october 2020 drain in the Central and West Highlands*. Retrieved on July 11, 2022 from <https://thuvienphapluat.vn/van-ban/Tai-chinh-nha-nuoc/Quyiet-dinh-1913-QD-TTg-2020-ho-tro-kinh-phi-khac-phuc-hau-qua-bao-so-5-6-7-8-9-tai-mien-Trung-458269.aspx>
- Prime Minister of Vietnam. (2021a). *National plan to adapt to climate change for the period 2021-2030, with a vision to 2050 (NAP) (Attached to Decision No. 1055/QD-TTg dated July 20, 2020 issued by the Prime Minister)*. Retrieved accessed on June 24, 2022 from <http://vanban.monre.gov.vn/ArticleDetail.aspx?ArticleID=269>
- Prime Minister of Vietnam. (2021b). *No. 553/QD-TTg approving the “Project for community awareness-raising and community-based natural disaster risk management, with a vision toward 2030”* Retrieved on August 11, 2022 from [https://snnptnt.quangnam.gov.vn/webcenter/portal/sonnvptnt/pages\\_tin-tuc/chi-tiet?dDocName=PORTAL191972](https://snnptnt.quangnam.gov.vn/webcenter/portal/sonnvptnt/pages_tin-tuc/chi-tiet?dDocName=PORTAL191972)
- Ramakrishna Gollagari. (2014). IMPACT OF FLOODS ON FOOD SECURITY AND LIVELIHOODS OF IDP TRIBAL HOUSEHOLDS: THE CASE OF KHAMMAM REGION OF INDIA. *International Journal of Development and Economics Sustainability*, 2, 11-24.
- Resourcewatch. (2018). *Italy, Austria And China Top The List Of Countries At High Risk Of Landslides Right Now*. Retrieved on March 26, 2022 from <https://blog.resourcewatch.org/2018/08/27/italy-austria-and-china-top-the-list-of-countries-at-high-risk-of-landslides-right-now/>
- Rodriguez-Llanes, J. M., Ranjan-Dash, S., Degomme, O., Mukhopadhyay, A., & Guha-Sapir, D. (2011). Child malnutrition and recurrent flooding in rural eastern India: a community-based survey. *BMJ open*, 1(2), e000109.
- Rodriguez-Llanes, J. M., Ranjan-Dash, S., Degomme, O., Mukhopadhyay, A., & Guha-Sapir, D. (2011). Child malnutrition and recurrent flooding in rural eastern India: a community-based survey. *BMJ Open*, 1(2), e000109. <https://doi.org/10.1136/bmjopen-2011-000109>
- Romanello, M., McGushin, A., Di Napoli, C., Drummond, P., Hughes, N., Jamart, L., . . . Arnell, N. (2021). The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *The Lancet*, 398(10311), 1619-1662.
- Rust, J. M. (2019). The impact of climate change on extensive and intensive livestock production systems. *Anim Front*, 9(1), 20-25. <https://doi.org/10.1093/af/vfy028>
- Salm, L., Nisbett, N., Cramer, L., Gillespie, S., & Thornton, P. (2021). How climate change interacts with inequity to affect nutrition. *Wiley Interdisciplinary Reviews: Climate Change*, 12(2), e696.



- Seeta, B., Singh, N. B., Bhola, G., & Minato, N. (2020). Malnutrition among under five years children as an impact of flood in Rural Eastern Nepal. *Research Center for Urban Safety and Security, Kobe University*, 24, 204-208.
- Seki, Y., Hasegawa, T., & Fujimori, S. (2020). Global flood impacts on food consumption and risk of hunger through changes in crop yields. *Journal of Japan Society of Civil Engineers, Ser. G (Environmental Research)*, 76(5), I\_89-I\_95.
- Seneviratne, S., Nicholls, N., Easterling, D., Goodess, C., Kanae, S., Kossin, J., . . . Rahimi, M. (2012). Changes in climate extremes and their impacts on the natural physical environment. [https://www.ipcc.ch/site/assets/uploads/2018/03/SREX-Chap3\\_FINAL-1.pdf](https://www.ipcc.ch/site/assets/uploads/2018/03/SREX-Chap3_FINAL-1.pdf)
- Son, H., & Kingsbury, A. (2020). Community adaptation and climate change in the Northern Mountainous Region of Vietnam: A case study of ethnic minority people in Bac Kan Province. *Asian Geographer*, 37(1), 33-51.
- Statistic. (2021). *Drought risk score worldwide 2020, by country\**. Retrieved on March 26, 2022 from <https://www.statista.com/statistics/1099051/drought-risk-by-country/#:~:text=The%20country%20that%20was%20most,effects%20such%20as%20agricultural%20losses.>
- Sustainable Development Goals. (2018). *Vietnam's voluntary national review - key messages* Retrieved on March 26, 2022 from <https://sustainabledevelopment.un.org/memberstates/vietnam>
- Tadele, T. T., Gebremedhin, C. C., Markos, M. U., & Fitsum, E. L. (2022). Stunting and associated factors among 6–23 month old children in drought vulnerable kebeles of Demba Gofa district, southern Ethiopia. *J BMC nutrition*, 8(1), 1-11.
- Thai, T. Q., & Falaris, E. M. (2014). Child schooling, child health, and rainfall shocks: Evidence from rural Vietnam. *Journal of Development Studies*, 50(7), 1025-1037.
- Thành, N. V., Hà, N. T. V., Tuyết, Đ. T., Toàn, T. Q., & Thanh, N. N. (2017). Climate change vulnerability assessment to capture and aquaculture. *Vietnam University Science Journal: Economics and Business*, 33(1), pp 64-73.
- The Borgen Project. (2017). *Countries most affected by hurricanes* Retrieved on March 26, 2022 from <https://borgenproject.org/countries-most-affected-by-hurricanes/>
- The World Bank. (2015). *Low-birthweight babies (% of births)* Retrieved on July 05, 2022 from <https://data.worldbank.org/indicator/SH.STA.BRTW.ZS?locations=VN>
- Tian, M., Reichetzedder, C., Li, J., & Hoher, B. (2019). Low birth weight, a risk factor for diseases in later life, is a surrogate of insulin resistance at birth. *J Hypertens*, 37(11), 2123-2134. <https://doi.org/10.1097/HJH.0000000000002156>
- Tiwari, S., Jacoby, H. G., & Skoufias, E. (2017). Monsoon babies: Rainfall shocks and child nutrition in Nepal. *Economic Development Cultural Change*, 65(2), 167-188.
- Tran, D. D., Dang, M. M., Du Duong, B., Sea, W., & Vo, T. T. (2021). Livelihood vulnerability and adaptability of coastal communities to extreme drought and salinity intrusion in the Vietnamese Mekong Delta. *International Journal of Disaster Risk Reduction*, 57, 102183. <https://doi.org/https://doi.org/10.1016/j.ijdr.2021.102183>

- Tran, P. T., Vu, B. T., Ngo, S. T., Tran, V. D., & Ho, T. D. N. (2022). Climate change and livelihood vulnerability of the rice farmers in the North Central Region of Vietnam: A case study in Nghe An province, Vietnam. *Environmental Challenges*, 7, 100460. <https://doi.org/https://doi.org/10.1016/j.envc.2022.100460>
- Trinh, T. A. (2018). The impact of climate change on agriculture: findings from households in Vietnam. *Environmental and resource economics*, 71(4), 897-921.
- Tum, K., Lai, G., & Lak, D. (2016). The drought crisis in the Central Highlands of Vietnam. In Tuyet Hanh, T. T., Huong, L. T. T., Huong, N. T. L., Linh, T. N. Q., Quyen, N. H., Nhung, N. T. T., . . . Kien, T. M. (2020). Vietnam Climate Change and Health Vulnerability and Adaptation Assessment, 2018. *Environmental Health Insights*, 14, 1178630220924658.
- UNICEF. (2017). *First 1000 days the critical window to ensure that children survive and thrive*. Retrieved on April 12, 2022 from <https://www.unicef.org/southafrica/media/551/file/ZAF-First-1000-days-brief-2017.pdf>
- UNICEF. (2022). *Nutrition*. Retrieved on May 04, 2022 from <https://www.unicef.org/vietnam/nutrition>
- UNICEF. (2015). *The 1,000-day Window of Opportunity*. Retrieved on July 23, 2022 from <https://www.usaid.gov/sites/default/files/documents/1864/1000-days-brief-508-revFeb2017.pdf>
- UNICEF. (2022 ). *UNICEF works to improve the nutritional status of infants and young children in Viet Nam to ensure every child has the best start in life*. Retrieved on July 02, 2022 from <https://www.unicef.org/vietnam/vi/dinh-d%C6%B0%E1%BB%A1ng>
- UNICEF., WHO., & World Bank Group Joint Child Malnutrition Estimates. (2020). *Levels and trends in child malnutrition*. Retrieved on July 06, 2022 from <https://apps.who.int/iris/bitstream/handle/10665/331621/9789240003576-eng.pdf>
- United Nations. (2015). *The 17 Sustainable Development Goals (SDGs)*. Retrieved on April 24, 2022 from <https://sdgs.un.org/goals>
- United Nations. (2016). *RESIDENT / HUMANITARIAN COORDINATOR REPORT ON THE USE OF CERF FUNDS VIET NAM RAPID RESPONSE DROUGHT 2016*. [https://cerf.un.org/sites/default/files/resources/16-RR-VNM-20550-NR01\\_Viet%20Nam\\_RCHC.Report.pdf](https://cerf.un.org/sites/default/files/resources/16-RR-VNM-20550-NR01_Viet%20Nam_RCHC.Report.pdf)
- United Nations. (2022 ). *The World's Food Supply is Made Insecure by Climate Change*. Retrieved on July 02, 2022 from <https://www.un.org/en/academic-impact/worlds-food-supply-made-insecure-climate-change>
- US Environmental Protection. (2021). *Climate Change Indicators: Weather and Climate*. Retrieved on May 11, 2022 from <https://www.epa.gov/climate-indicators/weather-climate#:~:text=Scientific%20studies%20indicate%20that%20extreme,storms%2C%20floods%2C%20and%20droughts.>
- USAID. (2020). *Stunting: Considerations for use as an indicator in nutrition projects*. Retrieved on April 12, 2022 from [https://www.advancingnutrition.org/sites/default/files/2021-10/usaaid\\_an\\_stunting\\_literature\\_review\\_2021.pdf](https://www.advancingnutrition.org/sites/default/files/2021-10/usaaid_an_stunting_literature_review_2021.pdf)

- van der Geest, K., Nguyen, K. V., & Nguyen, T. C. (2012). Internal migration in the upper mekong delta, viet nam: what is the role of climate related stressors? *Asia-Pacific Population Journal*, 25-41.
- Viet Nam Meteorological and Hydrological Administration. (2022 ). *National strategy on climate change for the period to 2050*. Retrieved on July 11, 2022 from <http://vmha.gov.vn/public/index.php/tin-tuc-bdkh-112/chien-luoc-quoc-gia-ve-bien-doi-khi-hau-giai-doan-den-nam-2050-12012.html>
- Vietnam's Ministry of Agriculture and rural development. (2016). *Decree 819/QĐ-BNN-KHCN, approving action plan to respond to climate agriculture and rural development industry for 2016 - 2020, vision 2050 vision* Retrieved on July 11, 2022 from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quy-dinh-819-QĐ-BNN-KHCN-hanh-dong-ung-pho-bien-doi-khi-hau-nganh-nong-nghiep-2016-2020-2050-310923.aspx>
- Vietnam Disaster Management Authority. (2021). *Summary report on disaster prevention and search and rescue 2021*. Retrieved on March 27, 2022 from <https://phongchongthientai.mard.gov.vn/Pages/bao-cao-tong-ket-cong-tac-phong-chong-thien-tai-va-tim-kiem-cuu-nan-2020.aspx>
- Vietnam Ministry of Health. (2021). *The Ministry of Health announced the results of the 2020 Nutrition Census*. Retrieved on July 02, 2022 from [https://moh.gov.vn/tin-noi-bat/-/asset\\_publisher/3Yst7YhbKA5j/content/bo-y-te-cong-bo-ket-qua-tong-ieu-tra-dinh-duong-nam-2019-2020](https://moh.gov.vn/tin-noi-bat/-/asset_publisher/3Yst7YhbKA5j/content/bo-y-te-cong-bo-ket-qua-tong-ieu-tra-dinh-duong-nam-2019-2020)
- Vietnam Ministry of Natural Resources and Environment. (2022). *Circular No: 01/2022/TT-BTNMT, detailing the implementation of the Law on Environmental Protection in response to climate change* Retrieved on July 11, 2022 from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Thong-tu-01-2022-TT-BTNMT-huong-dan-Luat-Bao-ve-moi-truong-500962.aspx>
- Vietnam Ministry of Natural Resources and Environment. (2022 ). *The Ministry of Natural Resources and Environment consults to develop the National Strategy on Climate Change to 2050*. Retrieved on June 20, 2022 from <https://monre.gov.vn/Pages/bo-tn&mt-tham-van-xay-dung-chien-luoc-quoc-gia-ve-bien-doi-khi-hau-den-nam-2050.aspx#:~:text=th%E1%BA%A3i%20n%C4%83ng%20l%C6%B0%E1%BB%A3ng-D%E1%BB%B1%20th%E1%BA%A3o%20Chi%E1%BA%BFn%20l%C6%B0%E1%B B%A3c%20qu%E1%BB%91c%20gia%20v%E1%BB%81%20B%C4%90KH%20giai%20%C4%91o%E1%BA%A1n,h%C3%ACnh%20t%C4%83ng%20tr%C6%B0%E1%BB%9Fng%2C%20n%C3%A2ng%20cao>
- Vietnam National Assembly. (2013). *Law on Natural Disaster Prevention and Control 2013, No. 33/2013/QH13*. Retrieved from <https://luatvietnam.vn/tai-nguyen/luat-phong-chong-thien-tai-2013-79379-d1.html>
- Vietnam National Assembly. (2020). *ENVIRONMENTAL PROTECTION LAW, No.: 72/2020/QH14*. Retrieved from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Luat-so-72-2020-QH14-Bao-ve-moi-truong-2020-431147.aspx>
- Vietnamese Government. (2021). *Decree no: 20/2021/ND-CP Provising social support policies for social protection objects*. Retrieved on July 13, 2022 from

<https://thuvienphapluat.vn/van-ban/Van-hoa-Xa-hoi/Nghi-dinh-20-2021-ND-CP-chinh-sach-tro-giup-xa-hoi-doi-voi-doi-tuong-bao-tro-xa-hoi-467723.aspx#:~:text=Ngh%E1%BB%8B%20%C4%91%E1%BB%8Bnh%20n%C3%A0y%20quy%20%C4%91%E1%BB%8Bnh,s%E1%BB%9F%20tr%E1%BB%A3%20gi%C3%BAp%20x%C3%A3%20h%E1%BB%99i>.

- Vietnamese Government. (2022). *Decree no. 06/2022/ND-CP: Regulations for reducing GHG emissions and protection of the ozone layer* Retrieved from <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Nghi-dinh-06-2022-ND-CP-giam-nhe-phat-thai-khi-nha-kinh-va-bao-ve-tang-o-don-500104.aspx>
- Walle, B. M., Adekunle, A. O., Arowojolu, A. O., Dugul, T. T., & Mebiratie, A. L. (2020). Micronutrients deficiency and their associations with pregnancy outcomes: a review. *Nutrition and Dietary Supplements*, 12, 237.
- WFP. (2021). *Act now on climate crisis or millions more will be pushed into hunger and famine*. Retrieved on May 10, 2022 from <https://www.wfp.org/stories/act-now-climate-crisis-or-millions-more-will-be-pushed-hunger-and-famine>
- WHO. (2014). *Global nutrition targets 2025: low birth weight policy brief*. Retrieved on July 05, 2022 from <https://www.who.int/publications/i/item/WHO-NMH-NHD-14.5>
- WHO. (2015). *Stunting in a nutshell*. Retrieved on April 12, 2022 from <https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell#:~:text=Stunting%20is%20the%20impaired%20growth,WHO%20Child%20Growth%20Standards%20median>
- WHO. (2017a). *Heatwaves*. Retrieved on March 26, 2022 from [https://www.who.int/health-topics/heatwaves#tab=tab\\_1](https://www.who.int/health-topics/heatwaves#tab=tab_1)
- WHO. (2017b). *Landslides*. Retrieved on March 26, 2022 from [https://www.who.int/health-topics/landslides#tab=tab\\_1](https://www.who.int/health-topics/landslides#tab=tab_1)
- WHO. (2021a). *1Malnutrition*. Retrieved on April 24, 2022 from <https://www.who.int/news-room/fact-sheets/detail/malnutrition#:~:text=Malnutrition%2C%20in%20all%20its%20forms,resulting%20diet%2Drelated%20noncommunicable%20diseases>.
- WHO. (2021b). *Climate change and health*. Retrieved on March 08, 2022 from <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>
- WHO. (2021c). *Drought*. Retrieved on March 26, 2022 from [https://www.who.int/health-topics/drought#tab=tab\\_3](https://www.who.int/health-topics/drought#tab=tab_3)
- WHO. (2022a). *1Nutrition Landscape Information System (NLiS)*. Retrieved on April 24, 2022 from <https://apps.who.int/nutrition/landscape/help.aspx?menu=0&helpid=391&lang=EN>
- WHO. (2022b). *Floods*. Retrieved on March 12, 2022 from [https://www.who.int/health-topics/floods#tab=tab\\_2](https://www.who.int/health-topics/floods#tab=tab_2)
- WHO. (2022c). *Tropical Cyclones*. Retrieved on March 26, 2022 from [https://www.who.int/health-topics/tropical-cyclones#tab=tab\\_1](https://www.who.int/health-topics/tropical-cyclones#tab=tab_1)

- WHO. (2009). *Length/height-for-age*. Retrieved on August 11, 2022 from <https://www.who.int/tools/child-growth-standards/standards/length-height-for-age>
- WMO. (2021a). *Weather and climate extremes in Asia killed thousands, displaced millions and cost billions in 2020*. Retrieved on March 08, 2022 from <https://public.wmo.int/en/media/press-release/weather-and-climate-extremes-asia-killed-thousands-displaced-millions-and-cost#:~:text=Sea%20surface%20temperatures%20and%20ocean,during%20the%201982%2D2020%20period.>
- WMO. (2021b). *Weather@ - related disasters increase over past 50 years, causing more damage but fewer deaths*. Retrieved on March 26, 2022 from <https://public.wmo.int/en/media/press-release/weather-related-disasters-increase-over-past-50-years-causing-more-damage-fewer>
- WMO. (2021c). *WMO recognizes new Arctic temperature record of 38°C*. Retrieved on March 26, 2022 from <https://public.wmo.int/en/media/press-release/wmo-recognizes-new-arctic-temperature-record-of-38%E2%81%B0c>
- Woldehanna, T. (2010). *Do pre-natal and post-natal economic shocks have a long-lasting effect on the height of 5-year-old children? Evidence from 20 sentinel sites of rural and urban Ethiopia*. Young Lives.
- Woods, M. M., Lanphear, B. P., Braun, J. M., & McCandless, L. C. (2017). Gestational exposure to endocrine disrupting chemicals in relation to infant birth weight: a Bayesian analysis of the HOME Study. *Environ Health*, 16(1), 115. <https://doi.org/10.1186/s12940-017-0332-3>
- World's Top Exports. (2020). *Rice exports by country*. Retrieved on March 10, 2022 from <https://www.worldstopexports.com/rice-exports-country/>
- World Bank. (2019). *World Bank, UNICEF call for solid steps to address child undernutrition in Vietnam*. Retrieved on March 03, 2022 from <https://www.worldbank.org/en/news/press-release/2019/09/12/world-bank-unicef-call-for-solid-steps-to-address-child-undernutrition-in-vietnam>
- World Bank Blogs. (2020). *1.47 billion people face flood risk worldwide: for over a third, it could be devastating*. Retrieved on March 26, 2022 from <https://blogs.worldbank.org/climatechange/147-billion-people-face-flood-risk-worldwide-over-third-it-could-be-devastating>
- World Bank Group. (2016). *Transforming Vietnamese Agriculture: Gaining More from Less*. Retrieved on July 08, 2022 from [https://data.vietnam.opendevelopmentmekong.net/vi/library\\_record/transforming-vietnamese-agriculture-gaining-more-from-less](https://data.vietnam.opendevelopmentmekong.net/vi/library_record/transforming-vietnamese-agriculture-gaining-more-from-less)
- Zamand, M. (2014). *Impact of Climatic Shocks on Child Human Capital: Evidence from Ethiopia, India, Peru and Vietnam, Using Young Lives Data*.
- Zhongming, Z., Linong, L., Xiaona, Y., Wangqiang, Z., & Wei, L. (2018). *Financial Barriers to Development of Renewable and Green Energy Projects in Asia*.

**Appendices 1: Summary of studies on the effects of climate change on nutritional status of the affected population:**

No	Authors & years	Countries/ Regions	Impacts of climate change	Nutrition indicators were considered	Results
1	(Bauer & Mburu, 2017)	Marsabit district, Kenya	Drought	Malnutrition children	The study showed that the drought index as measured by the Normalized Difference Vegetation Index (NDVI Z-score) when this index increased a 1 SD, the average probability of undernutrition would decrease by 12–16%.
2	(Mahapatra et al., 2021)	India	The level of vulnerability in terms of agricultural aspects as a result of climate change	Malnutrition indicators including stunting, wasting, underweight and anemia	<p>+) Stunting is probably going to be 3% more in exceptionally weak regions than in those with extremely low weakness.</p> <p>+) The locale with exceptionally high weakness is probably going to have an overflow impact of stunting by 0.24 rate point contrasted with extremely low weakness region.</p> <p>+) The blended impact examination observed that the odds of a child suffering from stunting, wasting, underweight and anemia increased by 32%, 42%, 45%, and 63% respectively when assuming the kid had a place with a locale classified as exceptionally weak when contrasted with those sorted as extremely low.</p> <p>+ The macro-level spatial analysis revealed that the proportion of malnourished children in the most vulnerable areas was particularly higher than in low very vulnerable districts by 3–5%</p>
3	(Lloyd et al., 2011)	South Asia and sub-	Climate change	child stunting	By 2050, it is estimated that the average prevalence of stunting is 1 to 29% due to

		Saharan Africa			climate change impacts, increasing from 23% in the SSA region to 62% in South Asia.
4	(Hagos et al., 2014)	Ethiopia	Rainfall and temperature predicting	Stunting and underweight	In certain areas, the standard deviation in mean stunting will increase by 0.242 if there is an increase in the standard deviation of precipitation, and conversely it will decrease by 0.216 if there is an increase in the standard deviation in the amount of stunting. temperature
5	(Basu et al., 2010)	California	Temperature	Preterm delivery	An 8.6% increase in the number of premature births (95% CI = 6.0 - 11.3) was associated with an increase in mean weekly temperature (approximately 10°F (5.6°C))
6	(Lawlor et al., 2005)	Scotland	temperature	Birthweight	Birth weight decreased by 5.4g (95%CI: 2.9 - 7.9) when the mean outdoor temperature increased by 1°C during the middle 10 days of the first trimester, in contrast, this index increased by 1.3 g (95% CI 0.50 - 2.1 g) for a 1°C increase in the middle 10 days of the third trimester
7	(Deschênes et al., 2009)	United States	extreme temperatures	Birth weight	Exposure to hot days was significantly associated with reduced birth weight, ranging from 0.003 % to 0.009 % per such day in all three trimesters.
8	(Akresh et al., 2011)	Rwanda	rainfall	The HAZ (height for age z-scores)	The HAZ (height for age z-scores) among children born in years with higher rainfall (increased rainfall) is higher than 0.427 SD, and this index is higher than 0.272 SD for children born in years with normal rainfall when compared with children born in years with low rainfall (precipitation decline), both of these data are statistically

					significant with $P < 0.01$ and $P < 0.005$ corresponding
9	(Alderman, 2010)	Tanzania	Drought	the median height for age Z-score	Exposure to a dry spell in the initial 5 y of life might add to a decrease in mean height of 1%
10	(Woldehanna, 2010)	Ethiopia	drought	stunting	Height-for-age scores increase by 1.3% and 6.2%, respectively, for children living in rural and urban areas, if reducing area-wide shock such as drought from 7.2 per cent to 2 per cent and from 63 per cent to 10 per cent respectively
11	(J. M. Rodriguez-Llanes et al., 2011)	India	flood	malnutrition in children	The proportion of children in flooded households tends to be 1.6 times more stunted than children in non-flooded households (95% CI 1.05 to 2.44). The prevalence of malnutrition was also 1.86 times higher among children living in flooded communities (95% CI 1.04 to 3.30).



### Appendices 2: Characteristics of selected studies

No	Authors & year	Journal	Research Question/ Objective	Group of study populations	Context	Types of climate change	Outcomes	Summary of relevant results
1	(Kien. Le & My. Nguyen, 2022)	Journal of Development Effectiveness	The effects of intrauterine rainfall shocks on the birth weight of Vietnamese infants are investigated in this research.	Infants	Vietnam	Rainfall Shocks	Nutrition status (Birth weight)	A statistically significant association between exposure to excessive and deficient second-trimester precipitation shocks in utero reduce birth weight, which is not statistically significant in the first and third trimesters
2	(Le & Nguyen, 2021)	Journal of Development Effectiveness	This study looks at how temperature shocks in the womb affect birth weight in Vietnam.	Infants	Vietnam	Temperature Shocks	Nutrition status (Birth weight)	Exposure to temperature shocks in the first trimester had an impact on birth weight, in contrast, no effect was found for the second and third trimesters.
3	(Pham et al., 2020)	Climate risk management	Evaluate the vulnerability level of smallholder farmers under the effect of these hazards.	ethnic minorities in Van Yen district, Yen Bai province	In the Northern Mountainous Regions of Vietnam	Flash floods & landslides	Food security	The study area is particularly vulnerable to FF & LS, with the majority being ethnic minorities, heavily dependent on agriculture for their livelihoods. FF & LS causes people to lose food, affecting food security and livelihoods of people in this area
4	(Pham et al., 2015)	Climate change, Agriculture and Food Security	Understand the broad context of climate change, agriculture, and food security at the provincial, district, and village levels. Identify stakeholder roles, community capacity building	Ethnic minorities Ma village, Vinh Kien commune, Yen Binh district, Yen Bai province	In the Northern Mountainous Regions of Vietnam	droughts, heavy rains, floods, landslides, severe and long, cold spells	Food security	Summary of impacts of climate change on people's lives in Ma village, Yen Bai province. The coordination between organizations is still poor, human and financial resources have not really supported effectively in solving problems in this area.

			needs, as a basis for monitoring and evaluating changes occurring over time in areas affected by climate change					
5	(Dornan et al., 2014)	Oxfam International.	Assess the proportion of food security and environmental shocks affecting households, determining the impact of these events on children's later physical development or family circumstances.	Children (ages 1, 5, 8 years)	Vietnam	Flooding	Nutritional status (Height for age Z score)	Examining the impact of climate change on household, nutritional status of children through cohort studies in Ethiopia, India, Peru and Vietnam
6	(Zamand , 2014)		This study investigates the effects of two climate shocks: drought and flooding on human capital – broken down into education outcomes and health outcomes – for children aged 14 to 16 years, across four countries, Ethiopia, India, Peru and Vietnam.	Children 14 to 16 years old	Northern Uplands Red River Delta Central Coastal Mekong River	Drought & flood	Nutritional status (Body Mass Index for age (BFA))	The study showed a significant negative impact of drought on HFA z-scores in Vietnam and Ethiopia. For the BFA z-score specification, the study found a significant coefficient estimate only in the case of Peru. In addition, drought and flooding are also reported to have an impact on cognitive outcomes, Cloze test scores are subject to variation in individual countries.
7	(Tuyet Hanh et al., 2020)	Environmental Health Insights	to assess the vulnerability and adaptive capacity of	Children under 5 years of age	Vietnam	Extreme weather events	Nutritional status	From 2013 to 2017, the health sector's level of “exposure” to climate change-related hazards was “high” to “very high”, with an

			the health sector in Vietnam in 2018			and climate change hazards	(Height for age (HFA) z)	average score of 3.5 to 4.4 (above 5.0). For "health sensitivities", the score dropped from 3.8 in 2013 to 3.5 in 2017, making the overall rating "high". For "adaptive capacity", a score of 4.0 to 4.1, means that adaptive capacity is "very low." Overall V&A rating in 2013 was "very high risk" (score 4.1) and "high risk" with a score of 3.8 in 2014 and 3.7 in 2015-2017
8	(Lechtenfeld & Lohmann, 2014)		studies the impact of droughts on health outcomes and health expenditures in rural Vietnam.	Ha Tinh, Thua Thien Hue, Dak lak	The rural provinces in Vietnam	Climate change and extreme weather	Nutritional status (Underweight, stunting (low height-for-age))	The results show that rural households affected by drought have significantly lower health conditions and have significantly higher health expenditures. Drought increases disease susceptibility, especially in the working-age population.
9	(Son & Kingsbury, 2020)	Asian Geographer	this study explores how communities in the past adapted to climate pressures and how they were able to increase their adaptive capacity. It focuses on the responses to specific climate shocks in the NMR in order to distill lessons for future adaptation.	Tay, Dao and Hmong ethnic minorities The Nam Mau commune in the Ba Be district of Bac Kan Province	in the Northern Mountainous Region (NRM)	Drought; flood; cold spell	Food security	Climate change has significant impacts on incomes, livelihoods and food in Vietnam's rural NMR communities. Although these communities have diverse ways of responding to and adapting to the impacts of climate risks. However, it is necessary to consider and strengthen the supporting role from relevant authorities to help people in this area adapt sustainably to CC.
10	(Nguyen & James, 2013)	Ecology and Society	to measure households' resilience to floods	"Phu Duc, Thanh My	Mekong River Delta	Flood	Food security	The article assesses the impact of floods on households in 03 areas of the Mekong Delta, the degree of

				Tay, Trung An				vulnerability, how they overcome difficulties during the flood season as well as lessons to help them live with floods and earn income for their families
11	(Pham et al., 2019)	Environment management	explores the decision-making process of rural households in adapting to flash floods and landslides (FF&LS)	Ethnic minority in Van Yen District, Yen Bai province, one of provinces	in the Northern Mountains regions of Vietnam	Flash floods & landslides	Food security	The article evaluates strategies to adapt to FF & LS in the research subjects, the difficulties in dealing with and preventing these events, highlights the need for government support in programs to improve knowledge, skills, and financial support for the people of this region to help them adapt sustainably to the events of the impact of change climate
12	(Pham et al., 2016)	Women's studies international forum	explores the decision-making process of rural households in adapting to flash floods and landslides (FF&LS)	The Co Tu ethnic group living Cady commune in Nam Giang district	A mountainous area in Quang Nam province	dry spells; flash floods	Food security	Changes in climate have made life more difficult for the CO TU community, due to the change from a subsistence economy to a market economy, sell what they grow to earn money to pay for their living. In addition, changes in gender roles due to new regulations make it impossible for men to do the same jobs as before, in return women have to work more to support their families.
13	(van der Geest et al., 2012)	Asia-Pacific Population Journal,	investigated under what circumstances households use migration to cope with	Three communities in Dong Thap Province	in the Upper Mekong Delta in Viet Nam	floods, storms and changes	Food security	The study presents the link between climate-related migration and stressors in the upper Mekong Delta in Vietnam. In addition, the increased need for industrial

			climate variability and food insecurity.			in rainfall patterns,		workers and the desire of young people to adopt a more urban lifestyle, households that are poorer and landless or scarce migrate because of the heavy pressures on their livelihoods and food security.
14	(Delisle & Turner, 2016)	Asia Pacific Viewpoint	explore the degree to which these events impact the livelihood portfolios and food security of ethnic minority farmers, and examine the coping strategies households initiate, based on their ecological knowledge as well as recent market integration initiatives	Ethnic minority farmers	Vietnam's northern uplands.	drought and severe cold spells	Food security	The study shows the impact of drought and extreme cold on the lives of ethnic minorities in the northern mountainous area, although people have adaptation strategies, however, these strategies are still not really effective due to lack of knowledge and skills, influenced by culture, especially lack of support from the government.
15	(Grazia. Pacillo et al., 2022)	Frontiers in Sustainable Food Systems,	"introduces a monitoring approach that uses	N/A	Vietnam	floods, storms and changes in rainfall patterns,	Nutritional status (Stunted children)	The application of the FANSCE method has provided rich data, significantly increasing the understanding of what leads to food and nutritional insecurity under different climatic exposures, vulnerability and assisting policy makers in making informed decisions to increase climate resilience.
16	(Thai & Falaris, 2014)	Journal of Development Studies,	the effect of early life conditions, proxied by rainfall shocks, on schooling and	Children	Vietnam	Rainfall shocks	Height for age Z score	A rainfall shock during the year in utero does not have a significant effect on standardized height-for-age

			height in rural Vietnam.					A rainfall shock in the second year after the birth year has a positive coefficient in the standardized height-for-age equation. A similar change in rainfall during the second year after the birth year increases the standardized height-for-age more in the regions RM than in other regions
17	(Pham et al., 2021)	Science of the total environment	to fill the gap in the existing literature on exploring variables potentially impacting how rural farmers perceive changes in flash floods and landslides by using the Multinomial Logit model	An Binh, An Thinh, Dai Son communes	Van Yen District, Yen Bai province Northern mountainous regions	FF & FS	Food security	It is reported by 93% of all respondents that one of the most observed impacts of these climate-induced hazards is admitted as a critical reason for crop failure and reductions in productivity, which in the long run could lead to food insecurity, causing diseases in livestock and poultry (47%).
18	(Tran et al., 2022)	Environmental Challenges	assessing the livelihoods of rice households in Nghe An province of Vietnam	Quynh Luu, Yen Thanh, Dien Chau district	Nghe An province Delta and coastal	Heat waves; Cold spells; Floods; Drought	Food security	Many households received government supports for disaster relief (i.e. foods and financial support)
19	(Tran et al., 2021)	International Journal of Disaster Risk Reduction	This study aims to assess livelihood vulnerability and adaptation of the coastal people of the VMD under the	Nam Chanh, Soc Leo Hamlets, Tran De district,	Soc Trang province, Mekong Delta	droughts; saltwater intrusion	Food security, Government's response	The People's Committee of Lich Hoi Thuong informed us that food security is not an issue during a disaster event. Most farmers had enough food and money saved from previous years as well as receiving support from their relatives or local

			impacts of drought and saltwater intrusion					authorities. A higher proportion of households not receiving help when facing difficulties in Soc Leo (0.518) than Nam Chanh (0.405) means the former may receive more timely help with food or freshwater from local authorities during the difficult time.
20	(Le Toan et al., 2021)	HAL open science	evolution in crop yields in the past decades, and its predicted evolution in the future.		Vietnam	Climate change	Food security	By increasing the temperature by one degree, rice yields are estimated to decrease by 7.09%, only the occurrence of flooding negatively affects food security as measured by FSI. A similar result is found regarding the impact of flooding on agricultural production. Flood, precipitation and typhoon are found to impact household per capita calorie intake, but not drought and temperature
21	(Phuong et al., 2018)	Climate and Development	to explore smallholder farmers' capacity to respond to climate change in current and future agricultural production.	Thua Thien Hue Province	Coastal community in central Vietnam	Climate change	Food security	The most frequently identified climate impacts on crops are: decrease in crop yield (91 reporters), increase in crop pests and diseases (47 reporters). For livestock, the main impacts are: increase in investment costs for livestock (79 people), increase in the number and frequency of livestock diseases (78 people), decrease in the number of healthy livestock (38 people in ), increasing number of livestock

								deaths due to climate change impacts (34 people)
22	(Do et al., 2021)	Sustainability	The aim of this study is to examine the impact of extreme weather events and climate change on the value-added of agriculture and fishery enterprises in the Central and Central Highlands regions of Vietnam in the period 2000–2018	Nghe An, Thua Thien Hue, Da Nang, Binh Dinh, Gia Lai, Lam Dong, Khanh Hoa, and Binh Thuan	8 provinces of the Central and Central Highlands regions, including:	Storm; drought	Food security	Increase by 1 storm will reduce the added value of agricultural and fishery enterprises in the Central and Central Highlands by 1.44%, this figure is 1.85 if increasing by 1 drought unit index.
23	(Nguyen, 2022)	Plos one	The study aims to identify the welfare changes via a partial equilibrium analysis and supporting methods		Vietnam	sea surface temperature increases	Food security	When sea surface temperature increases by 1°C, the total catches fall 19.61%. If precipitation rises 1%, the output drops 0.44%. An additional typhoon in a year decreases the capture yield by 2.76%. The severity of storms also negatively influences output. When the maximum wind speed of typhoons increases by 1%, the yield reduces by 0.18%
24	(Bui, 2021)	Kasetsart Journal of Social Sciences	assesses differences in climate change adaptation among households of different ethnicities in two mountainous	Tuyen Quang, Bac Kan	mountainous provinces in Northeast Vietnam	Climate change	Nutrition security	The collection of forest fruits, vegetables, bamboo shoots and other products was a wide-spread adaptive strategy of ethnic minority households (45%) when their agricultural production failed due to climate variations.



			provinces in Northeast Vietnam					Meanwhile, only 11 percent of the Kinh households applied this strategy to diversify their livelihoods because of their limited access to forests
25	(Tum et al., 2016)		This assessment and evaluation activity aimed to achieve the following objectives: 1. Conduct a first-hand observation and assessment of the drought crisis in the Central Highlands; 2. Provide science-based recommendations to MARD and local authorities on future actions to cope with drought crisis and prepare for future climate change impacts; 3. Identify potential CSA options that can be integrated in ongoing and future development/donor interventions; and 4. Identify feasible R4D actions of	Kon Tum, Gia Lai, Dak Lak, Dak Nong and Lam Dong.	The Central Highlands, Vietnam	Droughts	Food security	Up to mid-April, nearly 170,000 ha of crops were affected by the drought, of which 7,100 ha were left fallow and more than 95,000 ha were deficient in irrigation. The latest reports showed that the total affected area in Kon Tum was 2,106 ha, including 1,226 ha of rice, 857 ha of industrial crops (mainly coffee and black pepper) and 23 ha of cash crops. The damage was greater in Gia Lai with 21,998 ha of affected area of rice (5,378 ha), cash crops (8,653 ha), coffee (6,317 ha) and black pepper (1,650 ha).
		Report						

			CGIAR centers in the region					
26	(Trinh, 2018)	Environmental and resource economics	examines farm household-level impacts of climate change by examining the relationship between climatic variables and Vietnamese agricultural output.	37 provinces	Vietnam	Climate change	Food security	Dry temperatures can increase up to a point where further increases in temperatures will damage the crop.
27	(Thành, 2017)	Vietnam University Science Journal: Economics and Business	to assess climate change vulnerability to fishing and aquaculture in the Northern region	10 provinces	Vietnam	Climate change	Food security	Thai Binh is the province assessed to have the highest vulnerability index to the impacts of climate change on aquaculture (about 0.6).
28	(Hang, 2014)	Vietnam Hydrometeorology Magazine	Assessing the impact of climate change on the poor group in the Northern region and proposing mitigation solutions	03 provinces: Thai Binh, Hai Phong, Thanh Hoa	Vietnam	Climate change	Food security	42.2% of respondents said that they suffered a lot and a lot of damage due to climate change in the cultivation of food crops, for crops, 38.8% of households suffered severe damage. 4.9% of households suffered complete damage to food crops and 6.4% of households suffered complete damage to crops. For fishing and aquaculture, the extent of damage is only 14% to 19% of the total number of households surveyed.
29	(Le, 2018)	Master's thesis in economics	Analyzing the impact of natural disasters on the health of people	Rural	Vietnam	Climate change	Nutritional status	Children living in flood-affected areas usually have a HAZ index 2.38 units lower than children living in

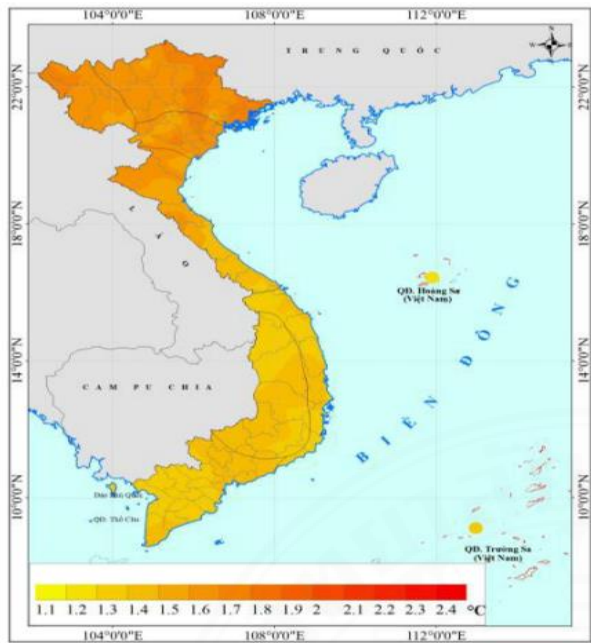
			and children in rural areas of Vietnam					non-flood-affected areas and are statistically significant at 5. %
30	(Edoka, 2013)	The University of York	This study uses the Vietnam Young Lives Survey to investigate the impact of small-scale weather shocks on child nutritional status as well as the mechanism through which weather shocks affect child nutritional status	05 provinces Lao Cai, Hung Yen, Da Nang, Phu Yen, Ben Tre	Vietnam	Weather socks	Nutritional status	Households exposed to weather shocks tended to reduce their consumption of nutrient-rich foods (score - 0.0569 with $p = 0.0203$ ) and increase their consumption of energy-rich foods (score 0.0549 with $p = 0.0232$ )

### **Appendices 3: Summary of climate change scenarios at the end of the century**

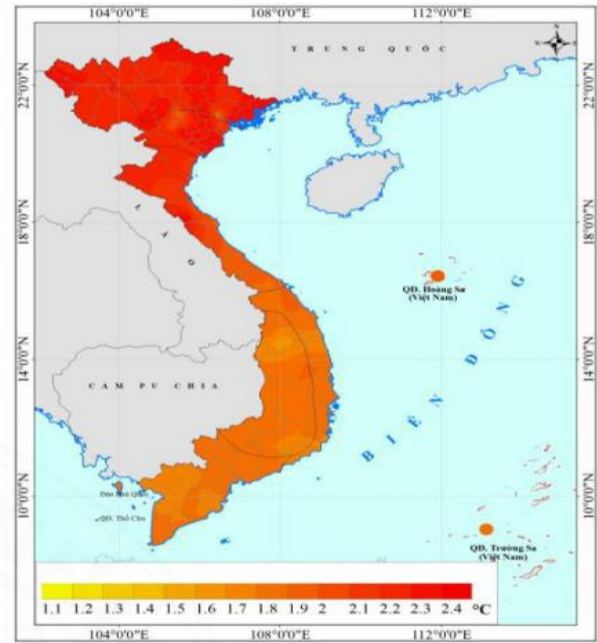
- Temperature: According to the RCP4.5 scenarios, the temperature increases 1.9 - 2.4 0C in the North and 1.7÷1.9oC in the South. According to the RCP8.5 scenarios, the temperature will increase by 3.3 - 4.0°C in the North and 3.0÷3.5oC in the South. Extreme temperatures tend to increase markedly (Ministry of Natural Resources and Environment of Vietnam., 2016)

- Rainfall: According to the RCP4.5 scenarios, the rainfall will increase from 5÷15%. According to the RCP8.5 scenarios, the maximum increase could be over 20% in most of the North, Central Central, part of the South and the Central Highlands. The average value of the maximum daily rainfall tends to increase in the whole territory of Vietnam (10÷70%) compared to the average of the base period (Ministry of Natural Resources and Environment of Vietnam., 2016)



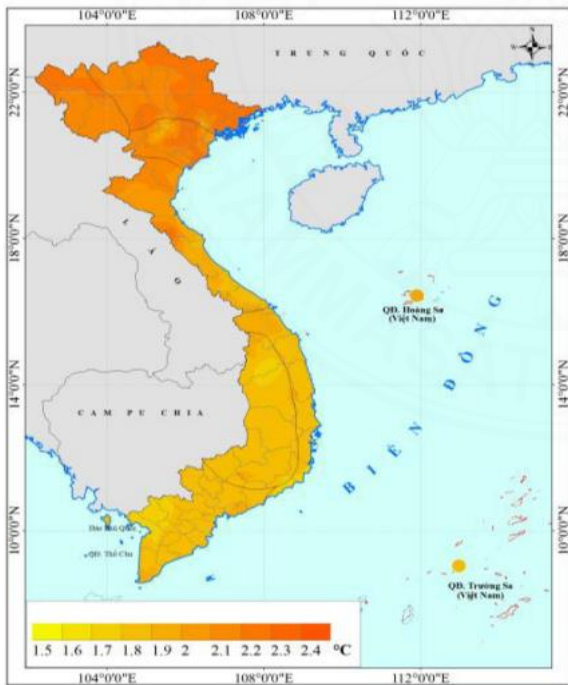


a) In the middle of the 21st century

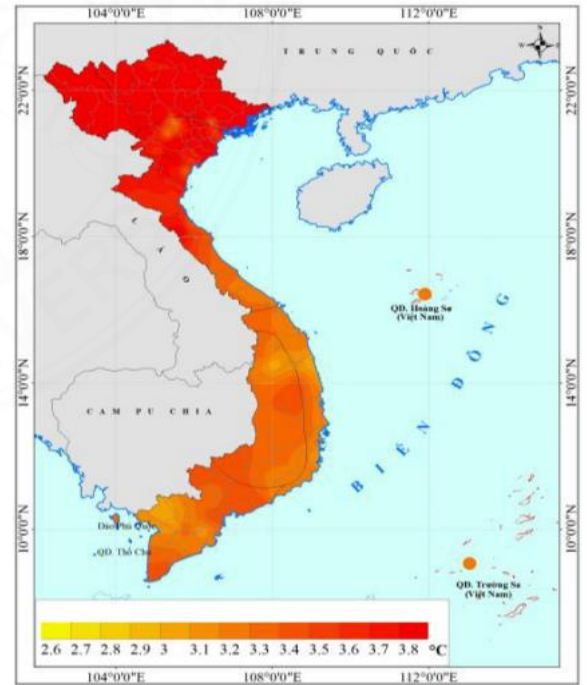


b) at the end of the 21st century

Figure 4. 2: Variation of annual mean temperature (°C) under scenario RCP4.5

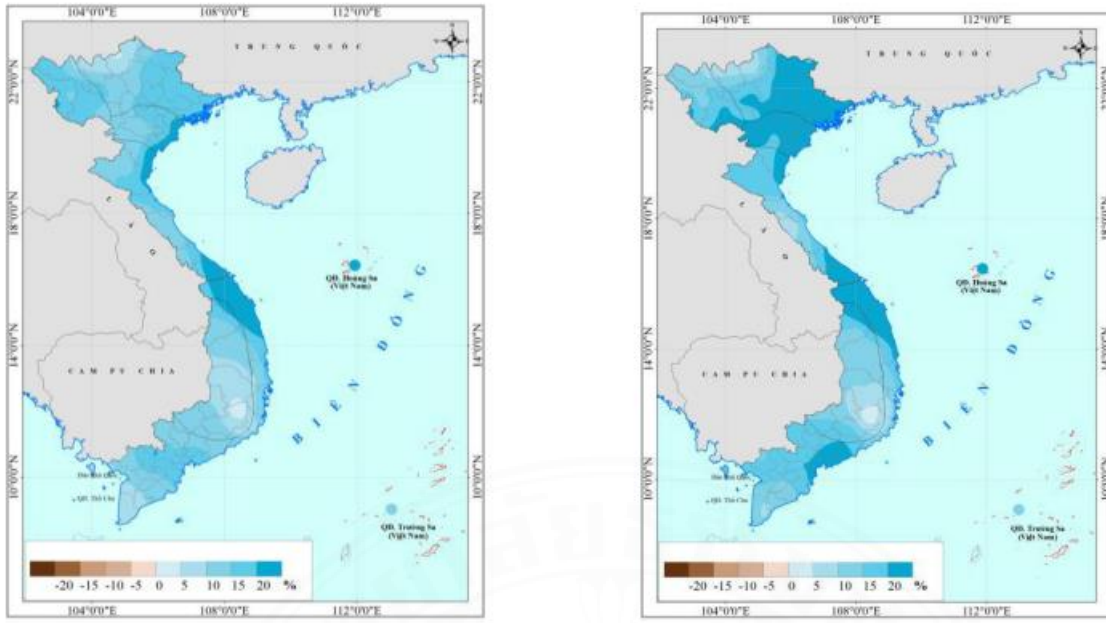


a) in the middle of the 21st century



b) at the end of the 21st century

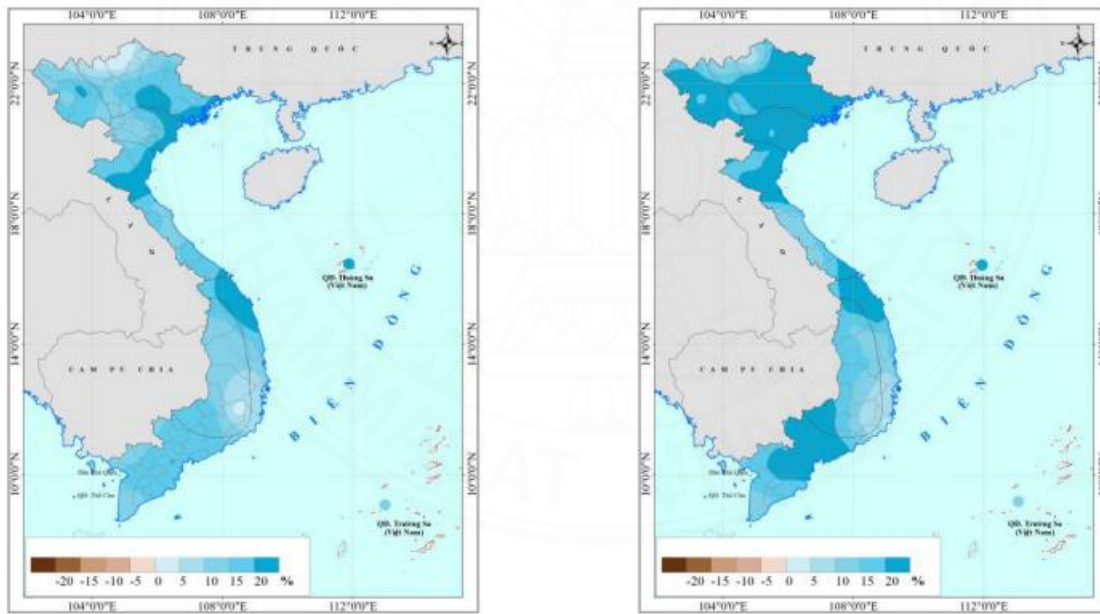
Figure 4. 3: Variation of annual mean temperature (°C) under scenario RCP8.5



b) In the middle of of the 21st

a) At the end of of the 21st century

Figure 4. 4: Variation of five-year rainfall (%) under scenario RCP4.5



a) In the middle of the 21st century

b) At the end of of the 21st century

Figure 4. 5: Variation of five-year rainfall (%) under scenario RCP8.5

**Appendices 4: The RABIT Model of Resilience (Ospina, 2013)**

<b>Resilience Attribute</b>	<b>Definition</b>	<b>Key Markers/ Indicators</b>
<b>FOUNDATIONAL ATTRIBUTES OF COMMUNITY RESILIENCE</b>		
Robustness	Ability of the community to maintain its characteristics and performance in the face of environmental shocks and fluctuations.	<ul style="list-style-type: none"> <li>• Physical Preparedness</li> <li>• Institutional Capacity</li> <li>• Multi-level Governance and Networking</li> </ul>
Self-Organization	Ability of the community to independently rearrange its functions and processes in the face of an external disturbance, without being forced by external influences.	<ul style="list-style-type: none"> <li>• Collaboration/</li> <li>• Consensus-building and Participation</li> <li>• Social Networks</li> <li>• Local Leadership and Trust</li> </ul>
Learning	Capacity of the community to generate feedback with which to gain or create knowledge, and strengthen skills and capacities. Closely linked to the community's ability to experiment, discover and innovate.	<ul style="list-style-type: none"> <li>• Capacity Building</li> <li>• New and Traditional</li> <li>• Knowledge Reflective Thinking</li> </ul>
<b>ENABLING ATTRIBUTES OF COMMUNITY RESILIENCE</b>		
Redundancy	Extent to which community resources and institutions are substitutable; for example, in the event of disruption or degradation.	<ul style="list-style-type: none"> <li>• Resource Spareness</li> <li>• Functional Overlaps and Interdependency</li> <li>• Resource Substitutability</li> </ul>
Rapidity	Speed at which assets can be accessed or mobilised by community	<ul style="list-style-type: none"> <li>• Rapid Resource Access</li> <li>• Rapid Resource Assessment/Coordination</li> <li>• Rapid Resource Mobilisation</li> </ul>

	stakeholders to achieve goals in an efficient manner.	
Scale	Breadth of assets and structures a community can access in order to effectively overcome or bounce back from or adapt to the effects of disturbances	<ul style="list-style-type: none"> <li>• Multi-level Networks</li> <li>• Resource Access and (intra/inter) Partnerships</li> <li>• Cross-level Interactions</li> </ul>
Diversity and Flexibility	Ability of the community to undertake different courses of actions with the resources at its disposal, while enabling them to innovate and utilise the opportunities that may arise from change	<ul style="list-style-type: none"> <li>• Different Courses of Action/Emerging Opportunities Adaptable Decision-making</li> <li>• Innovation Backbone</li> </ul>
Equality	Extent to which the community provides equal access to rights, resources and opportunities to its members	<ul style="list-style-type: none"> <li>• Strengthened Competencies/ Gaps' Reduction</li> <li>• Inclusiveness</li> <li>• Openness and Accountability</li> </ul>



**Appendices 5: Statistics of central-level policies in response to climate change and nutritional status of the Vietnamese population**

<b>Coding</b>	<b>Strategy/Plan</b>	<b>Phase of emergencies response</b>	<b>Field of impact</b>	<b>Refers to support food for people in the affected area</b>	<b>Reference</b>
1	“National strategy on climate change (2011)”	Mitigation	Agricultural sector (low carbon economy)	Ensuring food security, energy security, security water resources, hunger eradication, poverty reduction, gender equality, and social security society, public health, improve living standards, protect assets natural resources in the context of climate change;	((Decision No. 2139 December 5, 2011 of the Prime Minister) (Prime Minister of Vietnam., 2011)
2	“National strategy on green growth for the period 2011-2020 and vision to 2050”	Mitigation	Industrial sector, urban sector	N/A	Decision No. 1393/QD-TTG: (Prime Minister of Vietnam., 2012)
3	“The Law on Natural Disaster Prevention and Control (2013)”	Preparedness & response	N/A	Emergency relief is implemented during and immediately after a disaster occurs, focusing on providing food support.	((Vietnam National Assembly., 2013)
4	“Approving action plan to respond to climate	Mitigation	Agriculture sectors	N/A	“Decree 819/QD-BNN-KHCN”

	agriculture and rural development industry for 2016 - 2020, vision 2050”				(Vietnam's Ministry of Agriculture and rural development., 2016)
5	“Management, protection and sustainable development of coastal forests responding to climate change”	Mitigation	Coastal forest (Agriculture sectors)	N/A	Decree 119/2016/ND-CP (Government of Vietnam., 2016)
6	“Resolution No. 120/NQ-CP On Sustainable Development of the Mekong Delta Adapting to Climate Change”	Mitigation	Multi sectors	Agricultural products are not only to ensure food security but also have high nutritional value, serving the prevention and treatment of diseases, creating famous brands.	(Department of Climate Change - Ministry of Natural Resources and Environment of Vietnam., 2017)
7	“Issuing action plan to respond to climate change of the ministry of resources and environment for 2016 – 2020”	Mitigation	International cooperation on climate change is promoted;	N/A	Decision 672/QD-BTNMT, (Ministry of Natural Resources and Environment of Vietnam., 2017)

			Increased awareness of climate change.		
8	“Approving the Target Program to respond to climate change and green growth for the 2016-2020 period”	Mitigation,	Agricultural sectors, Ecosystem sectors, Reduce energy consumption, use solar energy	N/A	Decision No. 1670/QĐ-TTg, (Prime Minister of Vietnam., 2017a)
9	“National program on reducing greenhouse gas emissions through limiting forest loss and degradation; conservation, enhancement of carbon stocks and sustainable management of forest resources (REDD+) to 2030”	Mitigation	Sustainable forestry development	N/A	(Prime Minister of Vietnam., 2017b)

10	“Regulations on climate change adaptation - Article 90 of the revised” (Vietnam National Assembly., 2020)	Mitigation Preparedness	Community-based and ecosystem-based	N/A	“Law on Environmental Protection 2020” (Vietnam National Assembly., 2020)
11	“Financial support for locals for rewarding the effects of storm number 5, 6, 7, 8, 9 and the october 2020 drain in the Central and West Highlands”	Response and recovering	Forestry sector	Rice (9.000 tons rice for 03 local) Money	Decree 1913/QD-TTg (Prime Minister of Vietnam., 2020)
12	“National plan to adapt to climate change for the period 2021-2030, with a vision to 2050 (NAP)	Mitigation	Natural ecosystems, biodiversity; strengthen the resilience of natural ecosystems and protect and conserve biodiversity	Ensuring food security, energy security, water security, gender equality, social security, community health, protection of natural resources, sustainable national development in the context of climate change and safe from natural disasters.	(Attached to Decision No. 1055/QD-TTg dated July 20, 2020 issued by the Prime Minister)” (Prime Minister of Vietnam., 2021a)

			against the impacts of climate change.		
13	“Providing social support policies for social protection objects”	Response and recovering	N/A	Subjects with difficult circumstances due to natural disasters, fires, epidemics or other force majeure reasons who lose their houses and are unable to self-sufficient essential needs shall be considered for support from mobilized resources. activities or national reserves: tents, drinking water, food, blankets, pots and pans, fuel, motorboats and some other essential items for immediate, local needs.	Decree no: 20/2021/ND-CP (Vietnamese Government., 2021)
14	“Regulations for reducing GHG emissions and protection of the ozone layer	Mitigation	Multi sectors, Ecosystem	N/A	Decree no. 06/2022/ND-CP (Vietnamese Government., 2022)” (Ministry of natural resources and environment in Vietnam., 2022 )
15	“Detailing the implementation of the Law on Environmental	Mitigation, response	Agencies, organizations and individuals	N/A	Circular No: 01/2022/TT-BTNMT, (Vietnam Ministry of Natural Resources and Environment., 2022)

	Protection in response to climate change”		involved in climate change response activities		
16	Draft “National Strategy on Climate Change Up to 2050”	Mitigation	Energy sector; agriculture, forestry, land use; waste; industrial processes and industrial product	N/A	(Vietnam Ministry of Natural Resources and Environment., 2022 )
17	“Project for community awareness-raising and community-based natural disaster risk management, with a vision toward 2030”	Mitigation	N/A	N/A	Decision No. 553/QD-TTg (Prime Minister of Vietnam., 2021b)