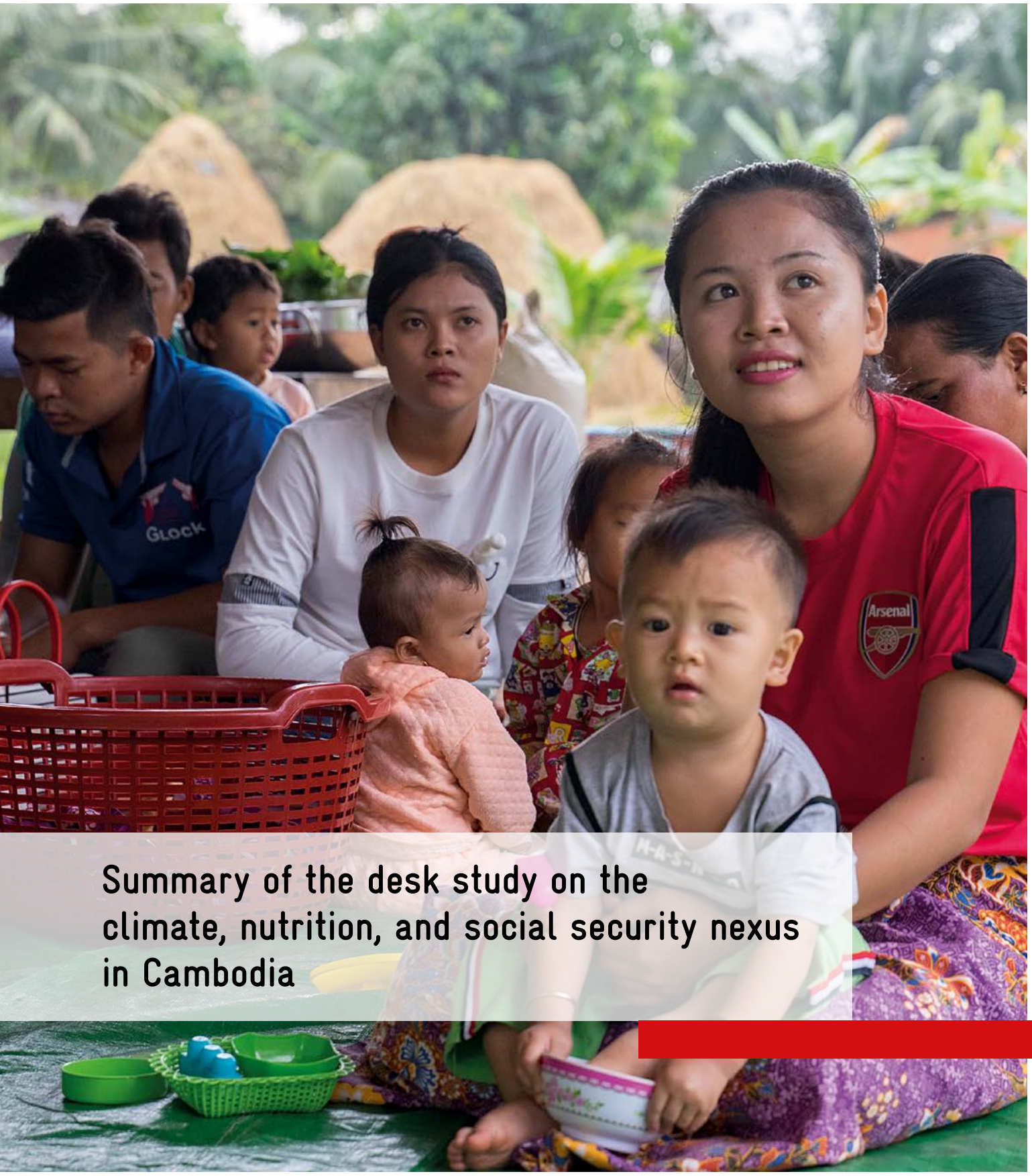

Summary of the desk study on the climate, nutrition, and social security nexus in Cambodia

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Federal Ministry
for Economic Cooperation
and Development

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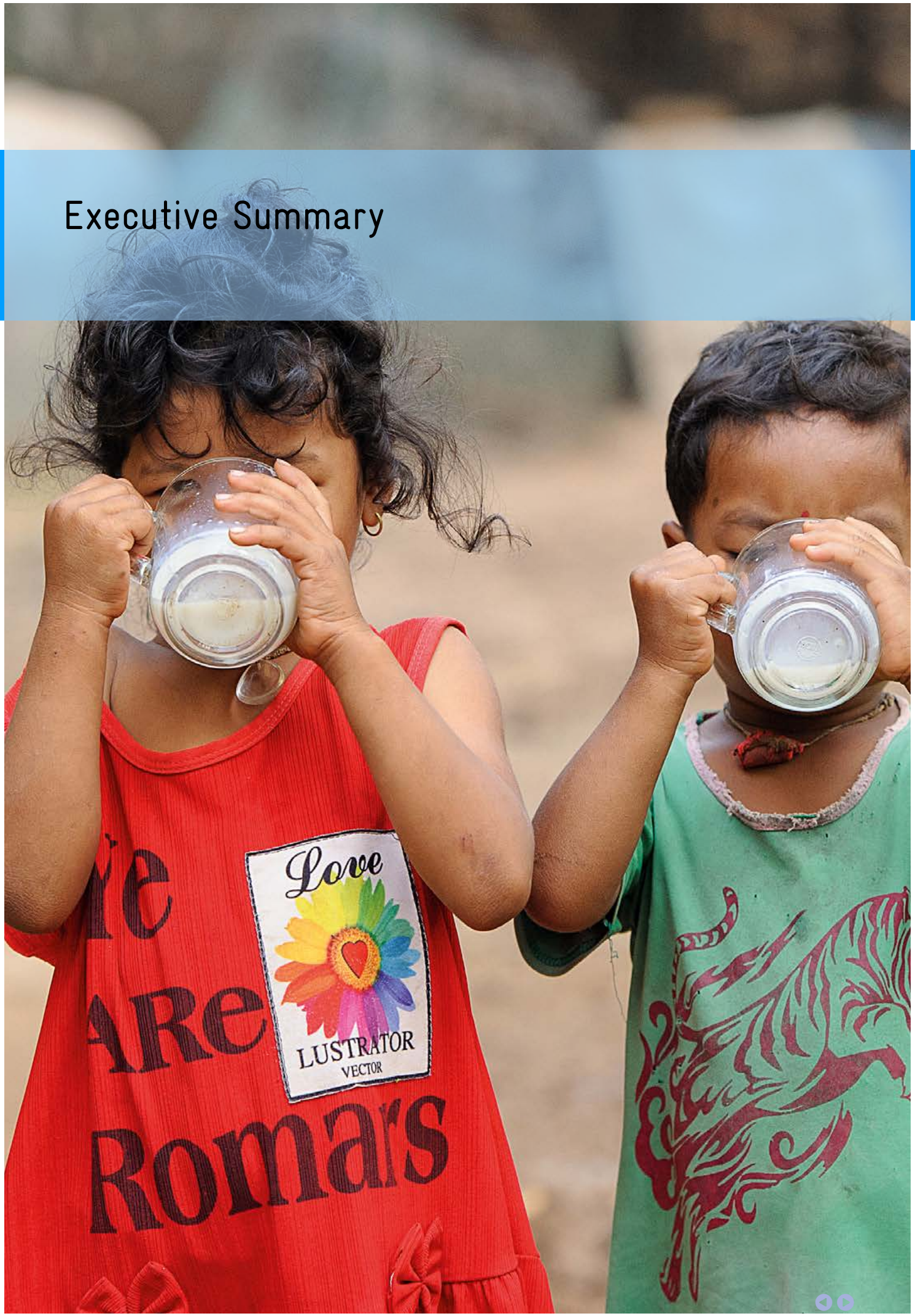
ABBREVIATIONS

ADB	African Development Bank
CA	Conservation agriculture
CAMADAPT	Climate Adaptation and Resilience in Cambodia's Coastal Fishery Dependent Communities
CARD	Council for Agriculture and Rural Development
CCPAP	Climate Change Priorities Action Plan for MAFF
CMIP	Coupled Model Intercomparison Project
CSA	Climate-smart agriculture
FAO	Food and Agriculture Organization
FIES	Food Insecurity Experience Scale
FSN	Food security and nutrition
GAP	Good Agricultural Practices
GBN	Global Business Network (GIZ Programme)
GDP	Gross Domestic Product
GCMs	General Circulation Models
GHI	Global Hunger Index
HEF	Health Equity Fund
ICS	Improved cookstove
IFReDI	Cambodia's Inland Fisheries Research and Development Institute
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated pest management
ISIMIP	Inter-Sectoral Impact Model Intercomparison Project
ISNM	Integrated soil nutrient management
KHR	Cambodian Riel
MAD	Minimum acceptable diet
MAFF	Ministry of Agriculture, Forestry and Fisheries
MDD	Minimum dietary diversity
MDD-W	Minimum dietary diversity for women
MMF	Minimum meal frequency
MoP	Ministry of Planning
MoSVY	Ministry of Social Affairs, Veterans and Youth Rehabilitation
NCDM	National Committee for Disaster Management
NDC	Nationally Determined Contribution
NSPC	National Social Protection Council
NSPPF	National Social Protection Policy Framework
OECD	Organisation for Economic Co-operation and Development
PGS	Participatory guarantee system
PPM	Parts per million
PPP	Purchasing power parity (GDP per capita)
RCP	Representative concentration pathway
RGC	Royal Government of Cambodia
SDG	Sustainable Development Goals
SLR	Sea level rise
SRI	System of Rice Intensification
SRP	Sustainable Rice Platform
SRSP	Shock responsive social protection
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WFP	World Food Programme
WHO	World Health Organization
WRA	Women of reproductive age

Executive Summary



Executive Summary

State of food and nutrition security in Cambodia

- Food availability is not a barrier to consuming a nutritious diet for most Cambodians.
- Physical access to livestock and markets is good throughout the country.
- The majority (75.4 %) of the country's total holdings are small, 3.2 hectares (ha), and contribute only 14 % of total production. The huge productivity gap compared to non-small farms makes them net food purchasers and hampers their access to a nutritious diet.
- Despite economic progress, 9.6 million Cambodians are moderately or severely food insecure[1].
- Only 32 % of breastfed children (aged 6–23 months) reach a minimum acceptable diet (MAD) due to low minimum dietary diversity (MDD) (40 %), while minimum meal frequency (MMF) was reached by over 74 % of children[2].
- Cambodia is facing a nutrition crisis[3], with stunting levels classified as high risk[4] (20.8 %) for children of up to 23 months in 2022. Similarly, wasting levels were at medium risk in both age groups (9.8 % in 0–23 months, 9.5 % in 24–59 months).

Climate change in Cambodia

- Cambodia has been categorised as a country that is "highly vulnerable" to the effects of climate change (12th most impacted country globally).
- Temperature projections for Cambodia to the end of the century see a year-on-year increase of between ~+0.39°C and ~+1.1°C by 2050. Climate risks in Cambodia are largely due to a high 'climate variability' (irregular rainfall, worsening floods, and prolonged, unpredictable droughts) and the impacts these have on important sectors with low adaptive capacity, specifically agriculture, forestry and fisheries, rural infrastructure and health.
- Food production is projected to be negatively impacted by increasing temperatures and the impact of more erratic, unpredictable rainfall patterns and drought events on the agricultural sector. There is also some evidence of a likely reduction in protein and micronutrient concentrations in rice due to higher atmospheric CO_2 levels.

1 FAO, 2014. The food insecurity experience scale: One metric for the world, Voices-Of-The-Hungry@fao.org

2 *Note: The indicators minimum acceptable diet (MAD), minimum dietary diversity (MDD) and minimum meal frequency (MMF) are three of eight core indicators for assessing infant and young child feeding (IYCF), practices developed by the World Health Organization (WHO) and finalised at the WHO global consensus meeting on indicators of IYCF in 2007.*

3 Cambodia Demographic and Health Survey (CDHS) 2014 and CDHS, 2022

4 de Onis, M., et al. (2018). Prevalence thresholds for wasting, overweight and stunting in children under 5 years. Public health nutrition, 22(1), 175–179.

Adaptation options and needs

- Adaptation of food production systems includes the following: use of climate-resilient cultivars and breeds (drought and heat stress resistant); sustainable intensification to increase yields of rice – the dominant staple crop in Cambodia; conservation agriculture (CA) techniques that minimise inputs and reduce environmental impacts such as nutrient leaching; improved water management in rice paddies and home gardens.

- Diversification through the development of mixed systems (rice-duck, rice-fish and agroforestry systems) can generate multiple ecological benefits and buffer climate shocks.

- Diversification of aquaculture species can help minimise economic losses from production shocks.

- In home gardens, root vegetables such as the edible cassava pumpkin should be promoted as they are particularly resilient to climate variability and shocks.

- Agricultural diversification to increase livestock and vegetable production is a key strategy to address both climate risks to food availability and the underutilisation of and lack of access to diverse foods that are essential for a healthy and nutritious diet.

- Implementing conservation agriculture (CA)-, System of Rice Intensification (SRI)- and climate-smart agriculture (CSA)-type farming practices in general can provide the conditions needed to manage water, farmland, and crop production sustainably and productively into the future. Special care should be taken to address inequity, such as unequal power relations in decision-making.

- The Cambodian Government, and the Ministry of Agriculture, Forestry and Fisheries (MAFF) in particular, have developed a set of Priority Adaptation Actions for addressing the impacts of climate change on agricultural productivity. The Ministry of Women's Affairs has also identified Priority Adaptation Actions related to nutrition (Climate Change Priorities Action Plan (CCPAP) 2016 – 2020 & Nationally Determined Contribution, 2020).

Policy recommendations

- The resilience of food production systems in Cambodia and the achievement of sustainable intensification of food production under both current and future climatic conditions depend on the successful promotion and adoption of climate adaptation strategies targeting the following priority areas: 1) water resources, 2) soil health, and 3) crop yields and incomes.

- Implementation through integrated social protection and payment for ecosystem services mechanisms can help target poorer households.

- Increasing the resilience and development of home gardens through the adoption of technologies and conservation practices that improve soil health and water management is a priority. Capacity-building is another priority action.

- Four specific priorities to improve food security and nutritional status of the target group include 1) healthy diets for all (targeting food availability, access and utilisation), 2) empowerment of youth, women and the vulnerable, 3) resilient and sustainable livelihoods, and 4) just, inclusive and participatory governance for a more inclusive food system.

- Cambodia will require a diverse range of agricultural insurance products such as yield guarantees, weather and yield indices, and disaster risk reduction programmes for the national and provincial governments.

Introduction

1

1 Introduction

This desk study aims to provide targeted and systemic information on the effects of climate change on food and nutrition security of selected vulnerable populations in Cambodia, as well as their current adaptive capacity through existing social security programmes and future adaptation needs under projected climate change in the next 30 years up to 2050.

The vulnerable populations targeted in this study (hereafter mentioned as "the target group") consist of

- women of reproductive age (WRA) from 15 to 49 years,
- young children up to the age of two, and
- small-scale farmers.

The main objectives of the study on the climate, nutrition, and social security nexus in Cambodia are:

1. Brief analysis of country **climate information** and early warning systems, including relevant and available data for the target areas (Kampong Thom and Kampot).

2. Analysis of the **effects of climate change** with the perspective until 2050 on the target group in the target areas.

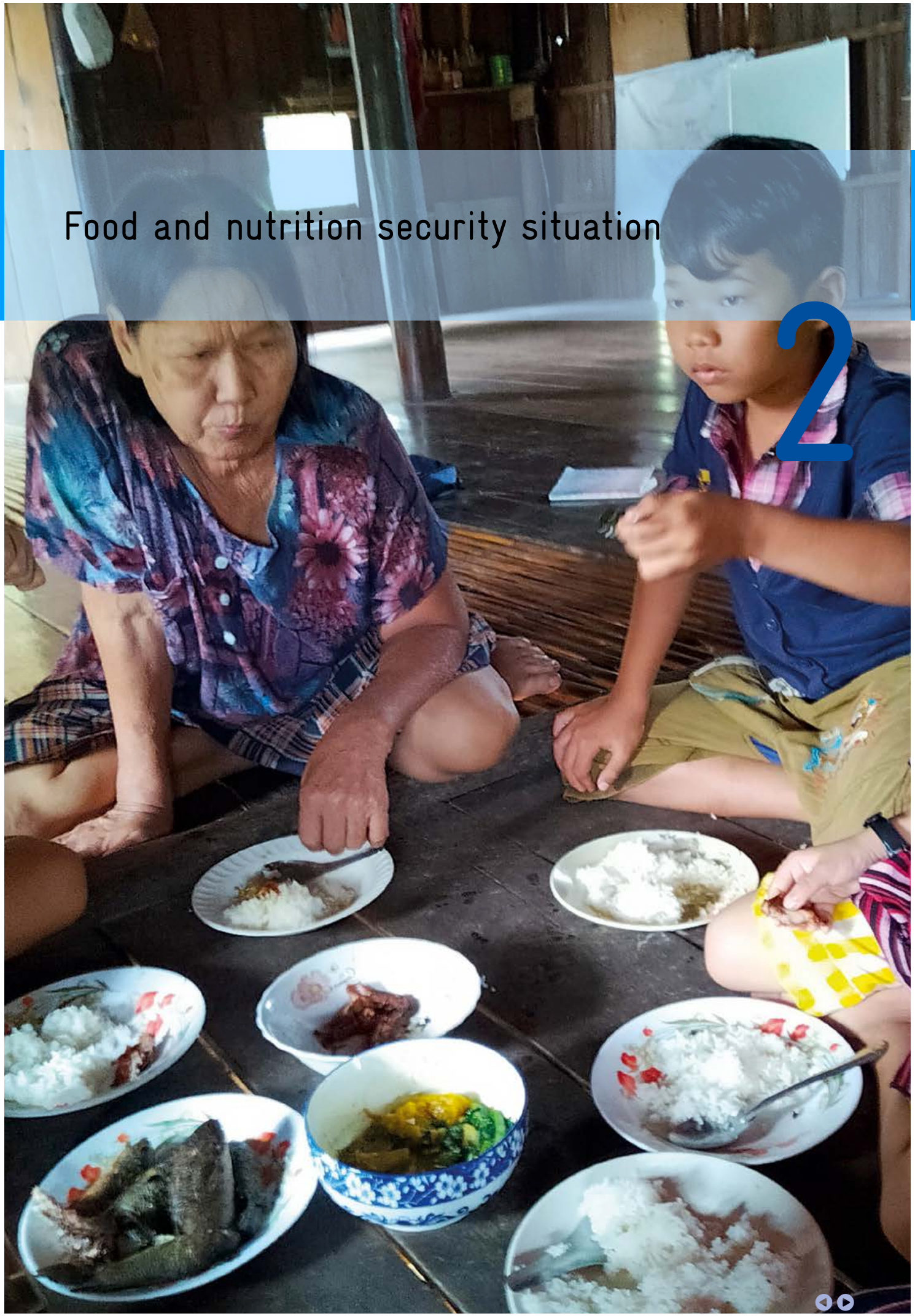
3. An assessment of which **existing measures** are already (1) climate-adaptive in the sense of ensuring sustainable healthy nutrition and (2) corresponding to an adaptive social security system.

4. Recommendations on what **additional measures** need to be considered in the short, medium, and long term to **mitigate the effects** of climate change on the food situation and the adaptive social security systems (e.g., improved seeds, crop varieties and breeds, crop and livestock diversification, sustainable practices and technologies, and reconfiguration of food systems).

The summary of the study report presents a profile for Cambodia regarding the food and nutrition security of the target group (section 2), climate change (section 3), the impact of climate change on food and nutrition security (section 4) and existing social protection systems and vulnerability (section 5). The study then examines adaptation needs and options (section 6) and proposes policy recommendations based on an appraisal of adaptation options targeting food security and nutrition (section 7).

Food and nutrition security situation

2



2 Food and nutrition security situation

This section covers the state of food security and nutrition in Cambodia with a discussion on availability, access, utilisation, and stability, as well as nutritional status of young children and WRA based on available national data of Cambodia.

Properly nourished children have better educational achievements and better potential to delay the onset of non-communicable diseases in adult life, are more productive, and learn better. The foundation is laid in the first thousand days of life, starting from conception to two years of age, when most of the effects of child malnutrition are irreversible[5], especially poor cognitive development, which can reduce school performance and thereby long-term earning potential[6]. Infant and young child feeding practices are essential for an optimal nutritional status in the first thousand days of life.

2.1 Food production systems

Cambodia is endowed with a diverse food system and a rich culinary history. Agriculture in Cambodia is mostly traditional and subsistence-oriented, centred on paddy rice production. Crop yields remain low, relying on low-input and rain-fed production systems.

Supply chains are short due to smaller urban populations, resulting in many local, fragmented markets. Food losses are high due to inadequate storage and distribution infrastructure. Food is mainly sold in informal market outlets, including independently owned small shops, street vendors, and local public markets. Supermarkets and fast food outlets are beginning to grow in number but are mainly seen in more developed localities.

Starchy staples are widely available: the quantity, diversity, and prices of foods available depend on the season. Processed and packaged foods have started to emerge in retail stores.

The Cambodian diet consists largely of staple grains, roots and tubers, legumes, and some seasonal fruits and vegetables, with less access to animal-sourced foods[7].

5 *Note: Studies have shown that children can have a second opportunity to catch up with growth during their teen years.*

6 FHI Solutions LLC., 2022

7 Espino, et al., 2021

2.2 Status of food availability

Food availability is not a barrier to a nutritious diet for most Cambodians. Cambodia's national dietary energy intake was 2,700 kcal / capita / day in 2019 (Figure 1), above the WHO recommendation[8]. However, nearly 60 % of this daily energy supply comes from cereals, chiefly rice (Figure 2). This is considerably higher than the global average[9] and suggests a lack of dietary diversity, especially regarding the consumption of vegetables and fruits: only 144 g of fruit and vegetables are consumed daily, compared to the recommendation of 400 g / capita / day. As fruit and vegetables are key sources of vitamins and fibres, this could suggest a deficit in these areas. Sugar consumption is slightly above the recommendation (11 % instead of 10 %)[10].

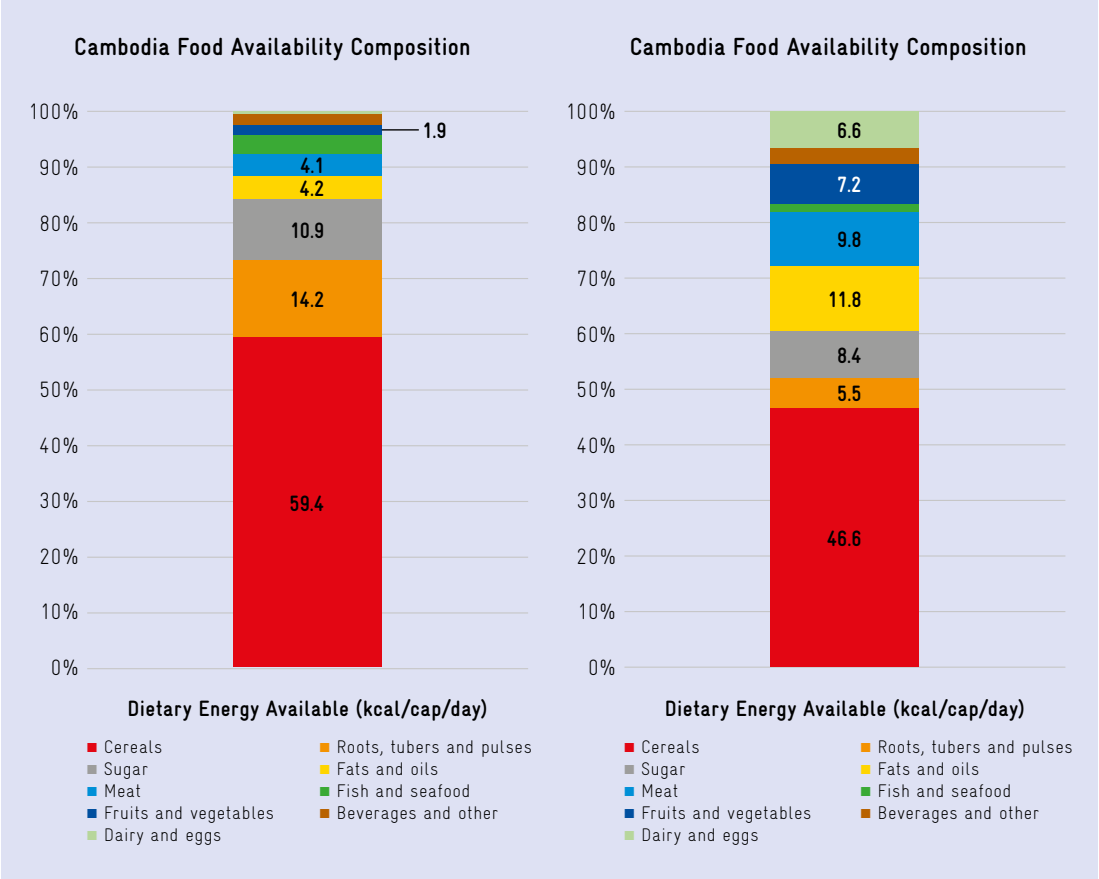
Figure 1: Key food availability indicators in Cambodia[11]

Indicator with units	Supply national level (2010)	Supply national level (2019)	Recommended level
Energy supply (kcal / capita / day)	2,539	2,700	2,000
Share of dietary energy supply from cereals, roots, tubers (%)	71	68	50-60
Total protein supply (g / capita / day)	62	66	50-60[12]
Protein supply from animal origin (g / capita / day)	18	19	14-28
Fat supply (g / capita / day)	35	39	70-90[13]
Legumes supply (g / capita / day)	11	15	65-100
Vegetables (g / capita / day)	96	103	300
Fruits (g / capita / day)	67	41	200
Eggs (g / capita / day)	3	3	100
Milk (g / capita / day)	5	5	250

Fats and oils, which, according to WHO's recommendation,[14] should provide 30 % (70-90 g / capita / day for a total diet of ~2000 kcal / day) of total energy requirements, account for a very small proportion of energy intake in Cambodia ~4 % (less than 40 g / capita / day) (Figure 2). Lack of fat in the diet contributes to poor absorption of vitamin A. In terms of energy supply (Figure 2), roots, tubers and pulses (~14 %) are the second-most important food group for energy needs, whereas globally, fats and oils are the second-most important food group. Meat also contributes much less to Cambodia's energy requirements (4 %) than the global average (10 %). Dairy products and eggs, at less than 1 % of total dietary energy intake, provide almost no energy benefits to Cambodians (Figure 2). In terms of total protein supply (Figure 1), the average Cambodian diet provides adequate protein (66 g / capita / day) with an adequate supply of protein being of animal origin (19 g / capita / day).

8 World Health Organization, 2020
9 Food and Agriculture Organization of the United Nations, 2021
10 Food and Agriculture Organization of the United Nations, 2021
11 Food and Agriculture Organization of the United Nations, 2021
12 *Note: 0.5–1.0 g per kg of body weight, based on 50–60kg reference weight of women and men respectively.*
13 *Note: 10–15 % of recommended energy.*
14 World Health Organization, 2020

Figure 2: Status of food availability (Cambodia vs. global)[15]

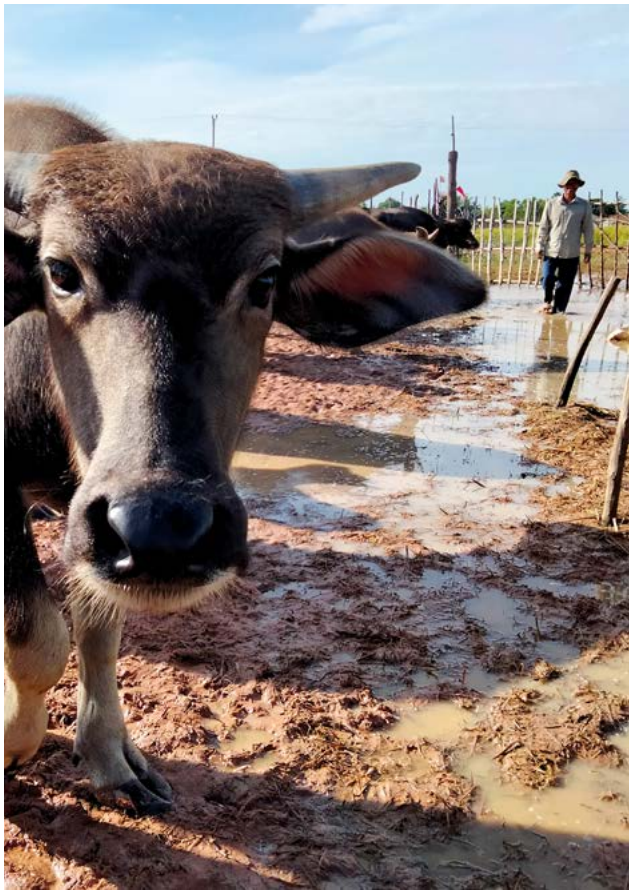


2.3 Status of food access

Economic access

Cambodia's GDP has been rising at 7–8 % per year, and the average GDP per capita / purchasing power parity (PPP) was 4,511.4 USD in 2021[16]. However, the data on inequality in per capita caloric intake measured as the coefficient of variation of the distribution of habitual caloric consumption (real number) is low, suggesting equity in caloric intake (0.24, 2020) with not much (2.9) incidence of habitual caloric losses at the retail distribution level, indicating less food wastage[17]. The productivity gap between small and non-small farms is large. Labour productivity data for smallholders corresponds to a PPP of 13,182 Cambodian Riel (KHR), equivalent to 9.02 USD per labour day, against non-small farms with a PPP of 78,554 KHR, equivalent to 53.8 USD per labour-day[18]. Inequalities exist between the incomes of small and non-small farms, with 22 % having poor access to a healthy diet due to the unaffordability of various dietary components such as fruit, vegetables and milk[19]. In the 2019 agricultural

15 FAOSTAT, 2021
16 International Monetary Fund, 2021
17 Food and Agriculture Organization of the United Nations, 2021
18 Cambodia Inter-Censal Agriculture Survey, 2019
19 Fill the Nutrient Gap Cambodia, March 2017



year, small-scale holders generated only 14 % of the total volume of products produced in the country (3,522,926,998 out of 24,901,492,423 PPP)[20]. These figures reveal a lack of economic access to food for farmers with small-scale holdings throughout the year, leading to widespread food insecurity.

As per Food Insecurity Experience Scale (FIES)[21], the state of food insecurity in Cambodia is very high, with 9.6 million of the population being moderately or severely food insecure. In the 2018–2020 three-year average, 7.4 million (44.8 %) of the population were mildly to moderately food insecure, and 2.2 million (13.4 %) had severe food insecurity[22]. The majority of the food products need to be purchased from the market: fruits (72 %), vegetables (66 %), root crops (58 %), beans and pulses (71 %), fish (75 %) and meat / animal products (82 %)[23].

While the country has exhibited strong economic performance, made great strides towards sustained and broad-based economic development, and poverty has reduced exponentially in the past two decades[24], most agricultural households produce their own rice needs but rely on markets and foraging for access to nutrient-rich foods.

Physical access

Road transport has a modal share of more than 90 % for passenger and freight. The total length of roads in Cambodia is more than 61,000 km. Rail lines density was 0.4 km per 100 km² of land area in 2003[25]; by 2019, the modal share of railways for passenger and freight was negligible[26]. Food access for some population groups living in remote areas is thus poor.

The majority (75.4 %) of the country's total holdings are small-scale, with less than 3.2 ha of land. The Tropical Livestock Unit[27] was lower than 2.85, indicating access to, on average, two types of livestock at the household level. Access to livestock and markets is good throughout the country[28], but some population groups in remote rural areas may struggle to access markets.

20 Cambodia Inter-Censal Agriculture Survey, 2019
21 FAO, 2014. The Food Insecurity Experience Scale: One metric for the world, Voices-Of-The-Hungry@fao.org
22 Food and Agriculture Organization of the United Nations, 2021
23 Fill the Nutrient Gap Cambodia, March 2017
24 Fill the Nutrient Gap Cambodia, March 2017
25 Food and Agriculture Organization of the United Nations, 2021
26 Asian Development Bank, September 2019
27 *Note: Tropical Livestock Units are livestock numbers converted to a common unit. An increased number of animals per adult available to support the household indicates improved food security and household resilience and is a direct indicator of food security risk.*
28 Fill the Nutrient Gap Cambodia, March 2017

2.4 Status of food utilisation

The proper utilisation of food includes the way people physically handle the food with clean water under appropriate sanitary conditions, as well as the knowledge to prepare and consume food. The prevalence of the population whose habitual food consumption is insufficient to provide the dietary energy levels required to maintain a normal, active, and healthy life was low (6.2 %), translating into one million people not consuming sufficient energy. In 2020, less than one-third (27.8 %) of households had access to safely managed drinking water services. The majority of households (65.6 %) used one basic source of water service. Sanitation facilities with no open defecation was 71.2 %[29].

Only 32.9 % of the Cambodian households use a clean fuel stove as a primary source. Two-thirds of households that use a clean fuel stove as their primary stove use it in combination with a biomass stove, and only 11.1 % use it exclusively. An LPG (Liquefied petroleum gas) stove is the most popular (30.9 %) type of clean fuel stove followed by fuel (wood, cow dung, etc.). In Cambodia, 66.7 % of households use a biomass stove as their primary stove. Among them, 35.1 % use an improved cookstove (ICS), 26.8 % use a traditional cookstove, and 4.8 % use a three-stone stove. Nearly 62 % of households with a biomass stove use firewood as their primary cooking fuel; the next most common fuel is charcoal (4.8 %). The share of households using clean fuels has increased consistently, rising by 17 % per year between 1997 and 2014 and just over 20 % per year from 2014–2017[30].

2.5 Status of nutrition security

The Global Hunger Index (GHI), measuring inadequate food supply for population and child undernutrition (stunting and wasting levels), was with a score of 17 at a moderate level of severity in 2021 (rank 69 out of 166 countries)[31].

Stunting levels in children were in the high-risk category for children aged 0-23 months (20.8%) and 24-59 months (21.9%). Similarly, wasting levels were in medium in both age groups, children aged 0–23 months (9.8 %) and 0–59 months (9.5 %)[32]. More than half (55 %) of children aged 6–23 months were reported to be anaemic in 2014 due to micronutrient deficiencies, (Liquefied petroleum gas thalassemia[33], and helminth[34] infections. Micronutrient deficiencies in children were reported in 2014, with the highest prevalence of vitamin D deficiency (33.1 %), followed by vitamin A deficiency (9.2 %) and vitamin B deficiency (8 %). Consequently, only 32 % of breastfed children between the ages of 6–23 months consumed a minimum acceptable diet (MAD), primarily due to 40 % consuming a diet of minimum dietary diversity (MDD) and 74 % having a minimum meal frequency (MMF). Most children are fed watery rice porridge (borbor), and few mothers enrich the porridge with nutrient-dense foods, such as fish, meat, and vegetables[35]. The cost of nutritious foods, time restrictions and women returning to work are

29 Food and Agriculture Organization of the United Nations, 2021

30 Rutu, et al., 2018

31 Grebmer & Bernstein, 2020

32 CDHS, 2022

33 Thalassemias are inherited blood disorders characterised by decreased hemoglobin production.

34 Helminths, also commonly known as parasitic worms, are large multicellular parasites, which can generally be seen with the naked eye when they are mature. They are often referred to as intestinal worms even though not all helminths reside in the intestines.

35 National Institute of Statistics Cambodia, 2015

cited as the main barriers to providing appropriate complementary child feeding[36].

Maternal undernutrition in WRA was 14 %, classified as thinness (body mass index < 18.5), with 30.9 % suffering from vitamin D deficiency, 19.2 % with folic acid deficiency, and 3.2 % with vitamin A deficiency[37]. In contrast, 18 % are overweight or obese, and this trend appears to be increasing steadily[38]. Region-specific studies suggest that MDD for women (MDD-W) is poor, with a low consumption of nutrient-rich foods such as beans, nuts, dairy, eggs and vitamin A-rich fruits and vegetables[39]. Dietary intakes of the population are generally poor as they fail to meet the minimum and maximum targets of each food group that should be included in their diet[40].

2.6 Status of food stability

Production trends of most of the food groups have either remained stable (total meat, milk, eggs) or increased (vegetable oil, raw sugar) from 2000 to 2019, indicating food stability. Similarly, per capita food supply variability was 26 % indicating stability in 2019 concerning food consumption data over time[41]. This indicator uses the data on dietary energy supply to measure annual fluctuations in the per capita food supply (in kcal), represented as the standard deviation over the previous five years' per capita food supply. Food supply variability results from a combination of instability and responses in production, trade, consumption, and storage and changes in government policies such as trade restrictions, taxes and subsidies, stockholding, and public distribution.

Approximately 34 % of agricultural holdings reported experiencing some form of severe shock during the last 12 months, including weather events like typhoons, floods, landslides or droughts and other impactful events, including infestations, crop or livestock disease. The three main issues reported were drought, food insecurity, insect infestation, livestock / poultry disease and their prevalence throughout Cambodia[42].

36 Fill the Nutrient Gap Cambodia, March 2017
37 National Institute of Statistics Cambodia, 2015
38 Greffeuille, et al., 2016
39 MUSEFO Project Report, 2021
40 Trufts University, 2019
41 Food and Agriculture Organization of the United Nations, 2021
42 Ministry of Agriculture, Forestry and Fisheries, 2018

Climate change in Cambodia

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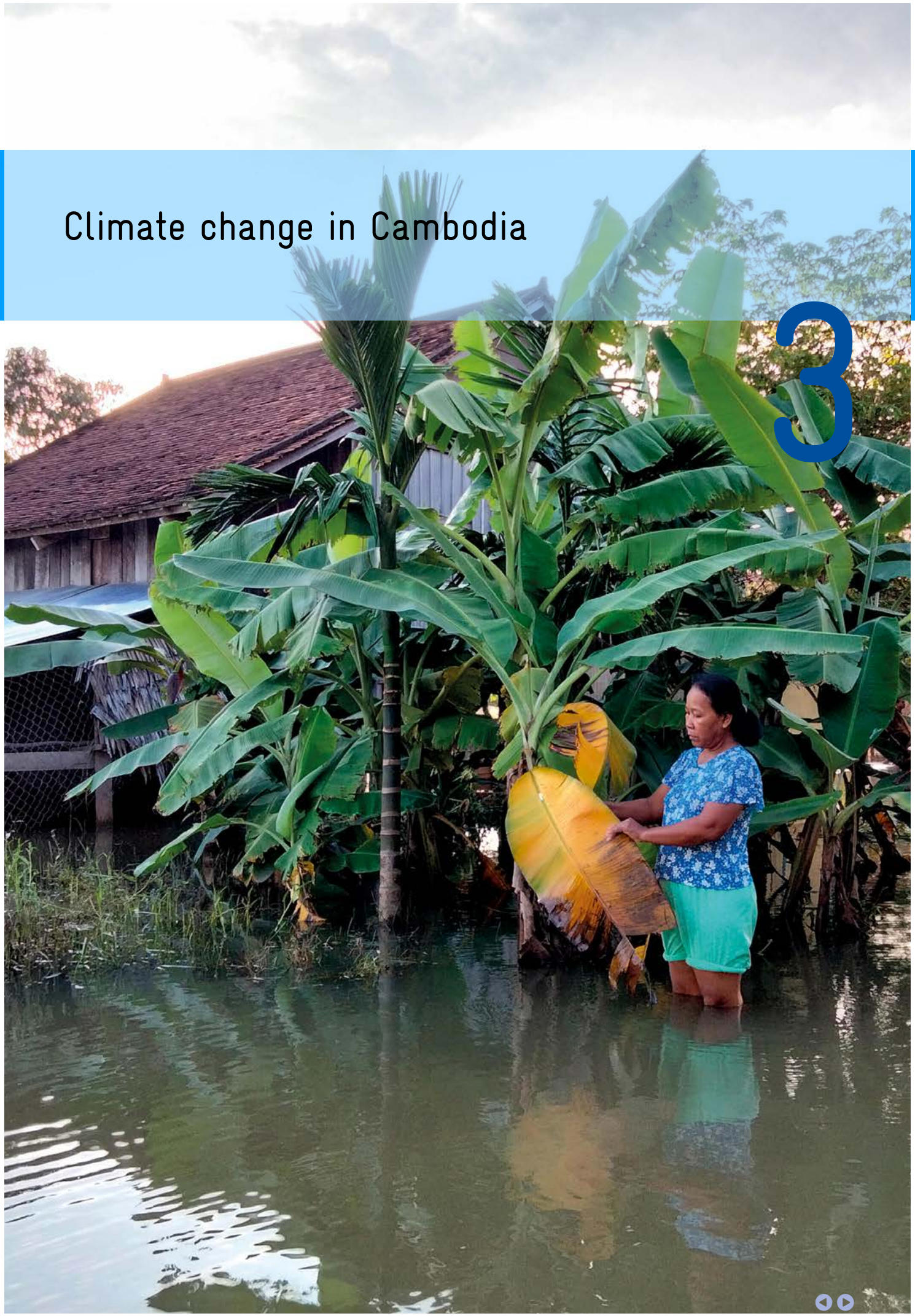


3 Climate change in Cambodia

3.1 Projected climate change up to 2050

Cambodians are noticing changes in the weather and their environment – temperatures are getting hotter, and the intensity of storms is increasing. As a nation, Cambodia is experiencing a shorter, more intense wet season and a long, hotter dry season.

3.1.1 Changes in temperatures

Annual mean temperatures in Cambodia are projected to increase between 0.8 to 1.6°C by 2050, relative to 2005.

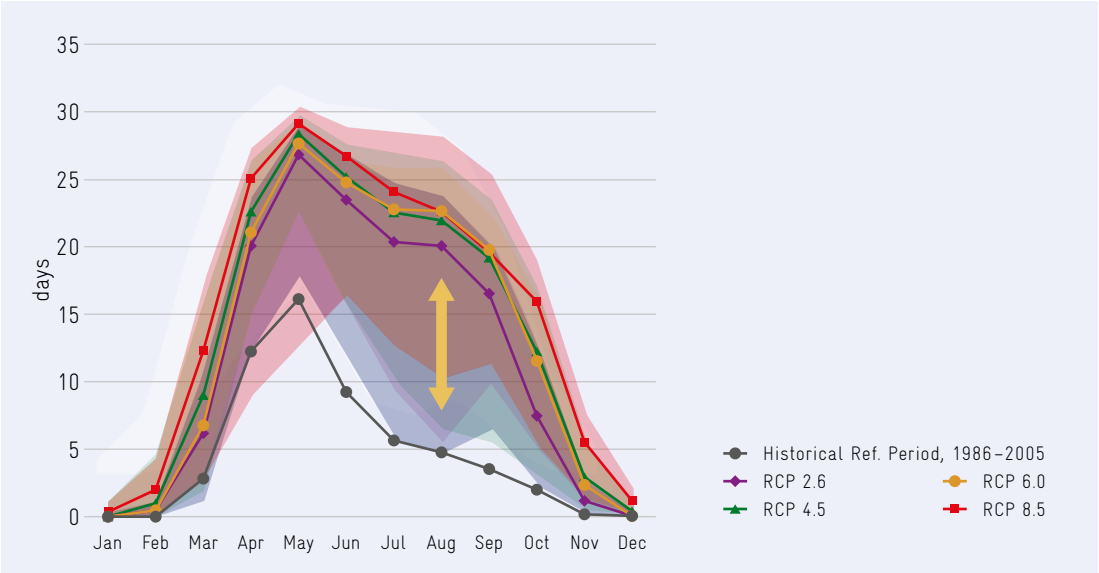
3.1.2 Changes in precipitation

Climate projections show a reduction in precipitation in the season preceding the peak of the rainy period (March–May), which could indicate a delayed start of the rainy season.

Longer periods of drought may be expected across the country, especially during the early rainy season. March and April are the months with the highest increase in the number of consecutive dry days in both locations, with an average of approximately one extra consecutive day without rain during these periods, and a potential of up to 10 extra days under worst-case scenarios[43].

While the extent to which climate change will affect intra-annual precipitation remains unclear, increased variability between years is predicted by several models by 2050. In addition, the on-going precipitation regime projection reveals a trend towards a shorter rainy season, drier conditions in April and May, and wetter conditions in October and November[44], all of which have the strong potential to negatively affect food production and food security.

Figure 3: Projected climatology of days with heat index >35°C for circa 2050



43 https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-projections

44 USAID. 2019. https://www.climatelinks.org/sites/default/files/asset/document/2019_USAID_Cambodia%20CRP.pdf

3.1.3 Sea level rise

Rising sea levels are expected to impact coastal systems through inundation, flood and storm damage, loss of wetlands, erosion, saltwater intrusion, and rising water levels. An analysis of the impact of sea level rise on coastal areas suggests that a total area of about 25,000 ha would be permanently inundated by a sea level rise of one metre, increasing to 38,000 ha for a sea level rise of two meters. Under a high emissions scenario, and without large investments in adaptation, an average of 30,700 people per year are projected to be affected by flooding due to sea level rises between 2070 and 2100[45]. Cambodia also faces inland river flood risks. It is projected that an additional 69,800 people may be at risk of river flooding annually by 2030 as a result of climate change, in addition to the estimated 89,700 people affected annually in 2010.

3.1.4 Changes in extreme weather

The extent to which Cambodia is already affected by floods, droughts, and storms ranks it 14th in the world in terms of the proportion of its population and GDP at risk of climate-related disasters[46].

Extreme rainfall and flooding

Flooding is considered to be the principle natural hazard impacting Cambodia. Flooding is caused by two main processes: (1) the increase in the volume of the Mekong and Tonle Sap Rivers, resulting in overflow and flooding of the surrounding area and (2) flooding caused by from extreme local rainfall[47]. While these processes are essential for the country's agricultural productivity, they also result in significant damage to crops and infrastructure in the floodplain areas throughout the provinces, with losses ranging from 100 to 170 million USD each year[48]. By 2050, more severe floods and droughts are expected to reduce Cambodia's GDP by almost 10 %.

Localised, intense rainfall impacts locations throughout Cambodia (uplands, lowlands and coastal areas) wherever there is insufficient drainage or water intrusion capacity of the recipient landscape (i.e. the capacity of the water to seep into the soils and aquifers or run off efficiently without causing damage); deforestation and poor land management including unsustainable agriculture are major contributors to local flooding and associated damage throughout the Kingdom.

Another, larger, slower and generally more protracted challenge for communities that live along the Mekong and Tonle Sap River basins and floodplains is regional, upstream rainfall and the impact of damming operations along the Mekong. These floods tend to be seasonal but can be unpredictable in intensity and duration due to the large volume of water that affects flood depths and the extensive rainfall catchment areas that influence the downstream water flow and volume.

Increased rainfall intensity during the monsoon seasons could significantly impact flood response management across the Mekong.

Drought

Drought is considered to be the second major hazard in Cambodia. Very large decreases in rice farming productivity (up to 70 %) could be expected without adaptation measures[49].

Although the total amount of rainfall per year is not expected to change significantly by 2050, its distribution throughout the year may alter;

45 From WHO Climate and Health Profile Cambodia 2015: https://apps.who.int/iris/rest/bitstreams/1064308/retrieve

46 According to the Global Climate Risk Index, Cambodia was ranked the 14th most climate risk-prone country globally, https://www.germanwatch.org/en/19777

47 Technical report on V&A assessment in specific sector, Centre for Agricultural and Environmental Studies (CAES) [Not published].

48 Rinbo, 2009. The Expert Group Meeting on Innovative Strategies towards Flood Resilient Cities in Asia-Pacific Cambodia: Mainstreaming Flood and Drought Risk Mitigation in East Mekong Delta and Climate Risk and Adaption profile 2011.

49 GSSD 2017. National Adaptation Plan Process in Cambodia. General Secretariat of National Council for Sustainable Development/ Ministry of Environment, Kingdom of Cambodia, Phnom Penh.

Cambodia as a whole may experience an additional six to nine days of continuous drought each year under the worst-case scenario. Additionally, various reports, including the Nationally Determined Contribution (NDC) Update 2020, state for example that "most of Cambodia's agricultural areas will be exposed to higher risks of drought" by 2050, and that under high emission scenarios, the likelihood of drought conditions would increase, with concomitant reductions in the length of growing periods.

Heatwaves

Heatwaves[50] are increasing in frequency and intensity, although projections are calculated for the region as a whole rather than specifically for Cambodia.

What is known specifically for Cambodia is that the total number of days per year (non-consecutive) with extreme temperatures (above 35°C) is expected to increase significantly towards 2050. The number of recorded days per year above 35°C was 65 days in 2013 and will increase to between 115 and 179 days by 2050, almost doubling the number of hot days, even under the most conservative projections. The number of tropical nights above 26°C (at ~30 in 2013) is also projected to increase dramatically under all scenarios in the CMIP6 model ensemble. The World Bank stated that "[T]here is sufficient existing data to infer that Cambodia also faces a transition to a state of permanent heat stress as a result of temperatures which regularly surpass levels safe for humans and biodiversity"[51].

The growing number of hot days with temperatures above 35°C poses a threat to the ability of

50 A heatwave is defined as a period of three or more days where the temperature is above the long-term 95th percentile.

51 Climate Risk Profile: Cambodia (2021): The World Bank Group and Asian Development Bank.

labourers, both in rural and urban locations, to work safely and effectively[52]. In addition, high temperatures over several days can negatively impact crop growth.

Compound events

The major compound events impacting food production, livelihoods and health are high temperatures/heatwaves and drought.

It is clear that where high temperature events lead to increased evapotranspiration rates in plants and increased drinking water requirements in livestock, the repercussions (of a concurrent deficit in water availability) can be disastrous in terms of increased mortality, crop losses, and lower yields. These events are likely to be felt more acutely by farming families with limited access to pumped water, meaning that the more remote and poorer households will feel the greatest impact of the combined effects of drought and high temperatures.

Increased water scarcity and higher temperatures may have important implications for dry season production of fruits and vegetables, the increased consumption of which is an important target for improving dietary diversity and nutritional deficits.

The resulting impact of compounded drought and heatwaves on rice productivity is projected to be highly deleterious. Insufficient water and high temperatures can impact rice plant germination, sewing success, vegetative phases and grain filling. More frequent pest infestations due to higher temperatures, compounded by higher susceptibility due to the physiological stress that a lack of water places on plants, are likely to increase disease prevalence where drought and heatwaves coincide.

Droughts and heatwaves are also strongly associated with forest fires, which can affect the productivity of agroforestry crops, such as cashew, and the ability of forests to provide ecosystem services such as surface water flow rate reduction and increased infiltration into groundwater once the rains return. Droughts and heatwaves also lead to increased weed proliferation as hardy, unwanted plant species thrive at the expense of crops (removing even more soil moisture), increasing costs and diverting labour away from more productive activities. Similarly, pest infestations are also associated with the high stress conditions brought about by simultaneous episodes of drought and high temperatures[53].

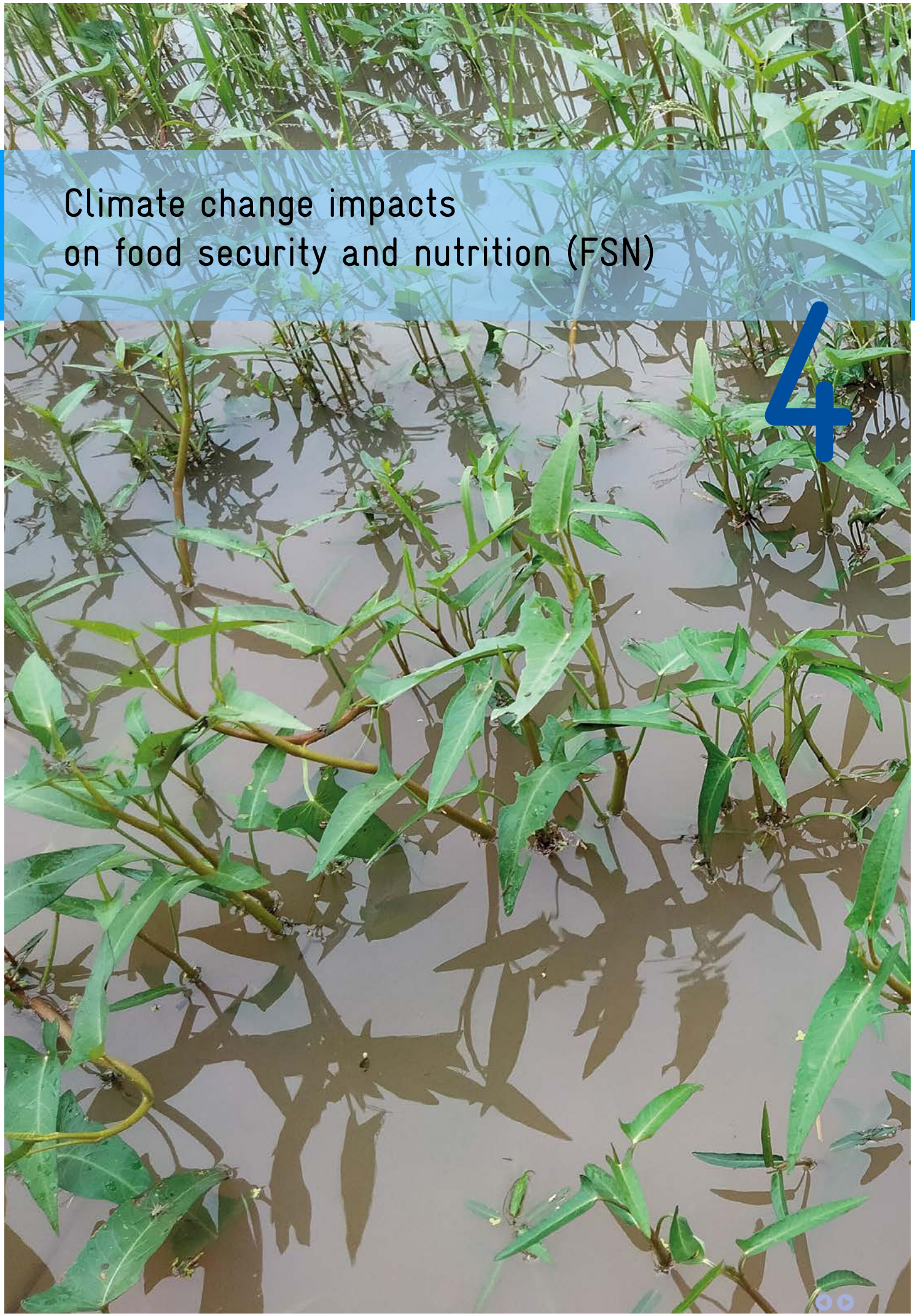
Higher temperatures have an impact on soil health and fertility. Soil carbon decomposition is accelerated as temperatures increase, and in Cambodia, where sandy soils predominate and fertility is often low, any increase in soil deterioration is problematic. Intense rainfall, flooding, and drought are compounding factors in reducing soil health, especially where land is tilled or denuded through deforestation.

52 World Bank/ADB 2021. Climate Risk Country Profile Cambodia. https://www.adb.org/publications/climate-risk-country-profile-cambodia

53 CIAT FAO 2021. Climate Smart Agriculture Country Profile, Cambodia.

Climate change impacts on food security and nutrition (FSN)

4



4 Climate change impacts on food security and nutrition (FSN)

4.1 Climate change impacts on food availability

Crop production

Approximately 98 % of rice, meat and pulses consumed in Cambodia are produced within the Kingdom[54]. Therefore, the sustainability of domestic food production is of high importance. Furthermore, as nearly 60 % of Cambodian dietary energy supply comes from cereals, chiefly rice, its production is especially critical to national food security. Where climate change and atmospheric CO_2 concentrations impact the production, availability or nutritional value of rice and other essential crops and livestock, implications for food security may be severe.

Figure 4: Climate change impacts on crops cultivated in Cambodia.

Rice	› By 2050, rice yields may decrease by ~10 %, while incomes in the agricultural sector could drop by 17 %[55]. › Under higher atmospheric CO_2 conditions, rice harvests are likely to be improved by a CO_2 fertilisation effect, but this improvement is contingent on overcoming negative factors such as reduced access to water, declining soil health, increased impact of diseases and negative impacts of higher temperatures.
Soybean	› The increase in the number of hot days is likely to reduce yields by affecting both germination and growth. › Drought during the growing period impacts soybean plant establishment and survival and ultimately affects yields.
Cassava	› Issues related to cassava farming, including soil disturbance, erosion, and nutrient leaching, are likely to become more acute as extreme climate events such as more intense rainstorms and droughts become more common. › Research suggests that while higher cassava yields and a more efficient water use can be expected as atmospheric CO_2 increases over the coming decades, these benefits are likely to be offset by deleterious conditions such as increased droughts and floods, declining soil health and greater spread of diseases exacerbated by climate change.[56, 57, 58]
Cashew nut	› Unseasonal rains and heavy dew during the flowering and fruiting periods affect the yield and quality of cashew nuts. › Cloudy conditions, high relative humidity, and heavy dew create favourable conditions for outbreaks of insect pests and diseases. › Drought conditions drastically reduce cashew nut production.
Lemon tree	Lemon farmers experience reductions in their yields due to the interplay of: › Decreasing soil fertility because of unclosed nutrient circles, › High nutrient competition among plants, › Low water retention capacities, › Mono-cropping practices negatively impact lemon production, › Increased pest, disease, and fungus infections.

54 FAOSTAT 2021

55 Ministry of Economy and Finance and GSSD. 2019. Addressing Climate Change Impacts on Economic Growth in Cambodia. Phnom Penh, Cambodia.

56 Ruiz-Vera et al. 2021. High sink strength prevents photosynthetic down-regulation in cassava grown at elevated CO_2 concentration. Journal of Experimental Botany, Volume 72, Issue 2, 2 February 2021, Pages 542–560, https://academic.oup.com/jxb/article/72/2/542/5921141?login=false

57 Gleadow et al. 2009. Growth and nutritive value of cassava (Manihot esculenta Cranz.) are reduced when grown in elevated CO. Plant Biol (Stuttg) . 2009 Nov;11 Suppl 1:76–82. doi: 10.1111/j.1438–8677.2009.00238.x

58 Jarvis, A., Ramirez-Villegas, J., Herrera Campo, B.V. et al. Is Cassava the Answer to African Climate Change Adaptation?. Tropical Plant Biol. 5, 9 –29 (2012). https://doi.org/10.1007/s12042-012-9096-7

Home gardens

While there is little to no specific information available on the impacts of climate change on specific home garden crops (except for soybean), negative impacts from heat and drought can be expected on the yield and quality of above-ground vegetables (e.g., leafy greens and cucumber varieties), which are especially vulnerable to heat and drought stress during pollination and fruit set. Warming and climate variability have altered the rate of tuber development (root types). Root crops are more sensitive to drought than cereals, as they require large amounts of water over long periods and are highly sensitive to drought and heat events during tuber initiation.

Aquaculture and fisheries

Changes in Cambodia's climate have the potential to impact access to and availability of fish and seafood in the diet by disrupting the productivity of natural and farmed stocks and by disrupting their capture and farming, i.e., infrastructure and fishing activities.

According to the Ministry of Agriculture, Forestry and Fisheries (MAFF)'s 2016 Climate Change Priority Action Plan, delayed onset of the flood season, droughts and longer drier dry seasons, shorter wetter rainy seasons and sea level rise are the main threats to capture fisheries.

A study of aquaculture in Cambodia[59] projected that:

- Increases in temperature and changes in rainfall patterns are likely to affect aquaculture as it becomes more difficult to prevent stock loss from flash floods.
- Longer dry seasons may affect freshwater availability, especially if there is increased competition from other users, thereby constraining fish production.
- Storm intensity and frequency could affect coastal and reservoir aquaculture infrastructure and inland aquaculture farm flood security.
- Rising sea levels are likely to reduce the area available for aquaculture due to increased inland flooding[60].

Figure 5: Climate change impacts on fisheries in Cambodia by season[61]

Delayed onset of flood season	› Changes the triggering effect of the flood season, with unknown response to fish migrations.
Longer, drier dry seasons	Some species can survive the dry season as long as there are some viable fish refuges. It is not known how well they will be able to survive for longer, drier and potentially hotter periods. › Reduces key habitats – for example, flooded forests. › Exposes dry-season brood stock more to fishing.
Shorter, wetter rainy seasons	› Affects migration triggers. › Reduces season for breeding and spawning, as well as feeding. › Reduces opportunity for juveniles to reach suitable size and maturity to continue migration and life cycle.
Sea level rise (SLR)	› Even a modest SLR of 20 cm would cause contour lines of water level in the Mekong Delta to shift 25 km inland during the flood season and saltwater to move further upstream during the dry season. › Alters the fish species composition of fisheries but may not be detrimental to overall fisheries' yield.[62]

59 ICEM/DAI, 2013.
60 MAFF Climate Change Priority Action Plan 2016–2022.
61 MAFF CCPAP, 2016.
62 ADB 2009.

Livestock

MAFF expects that small and medium commercial livestock operations (with limited capacity to adapt to climate change) will be most strongly affected but that high-performance breeds in high-density systems will also be negatively affected.

Threats to the livestock sector include:

- Higher temperatures, and especially heatwaves, have a strong impact on livestock mortality. Furthermore, higher temperatures increase the susceptibility of livestock to disease, leading to increased morbidity.
- Cambodian livestock farmers depend on rainwater for livestock grazing requirements (grass and feedstock) and drinking needs. Where precipitation is reduced in the long term or during years of extended or unseasonal drought, reduced productivity and increased mortality and morbidity can be expected.
- Extreme rainfall events and high winds / storms are responsible for increased mortality in all livestock. Flooding can also impact feedstock and grazing requirements.

Climate impacts on feed crops such as maize and cassava will have knock-on effects on livestock operations and production costs[63]. Where farmers are unable to grow or purchase sufficient feed for their herds, herd sizes will decline along with productivity. The availability and affordability of local meat products may be negatively impacted, with implications for FSN.

Climate change impacts on food storage and preservation

Food (and grain) storage and preservation in rural communities in Cambodia often relies on traditional methods that utilise clay or, increasingly, plastic containers placed on wooden platforms and covered by palm thatch or corrugated zinc roofs. The conditions within these traditional setups are generally not ideal and lead to heat damage (grain) and insect / pest infestations. Hotter and / or more humid conditions are likely to increase the likelihood of pest damage. Drying of grain prior to storage is important to prevent fungal attacks, and erratic rainfall may impact this process. However, as innovation and technology adoption advance towards 2050, these issues should be relatively easy to overcome.

Insect production

Little is documented on insect farming in Cambodia. A 2018 paper[64] describing insect trapping – rather than farming – mentions some activity in Kampong Thom. Insect trapping is highly impacted by the seasonality of insect numbers, with significant declines during the hot, dry periods before the start of the wet season in May (80 kg per night in the rainy season reduces to 3 kg in the dry season before increasing again with the onset of the rains). With longer, drier, and hotter dry seasons predicted towards 2050, insect farming is likely to be negatively affected by climate change. However, as the practice requires little or no land ownership and is relatively risk-free in terms of infrastructure / crop damage from floods and droughts, insect collection may be considered an interesting, lucrative and, nutritious alternative to traditional farming.

63 ICEM: http://dss.icem.com.au/CambodiaDSS/.

64 https://www.researchgate.net/publication/323402703_An_explorative_study_of_the_practice_of_light_trapping_and_the_informal_ma r-ket_for_crickets_in_Cambodia

Forests

Forests are essential providers of ecosystem services, supplying many of the prerequisites for agriculture and fisheries, including water replenishment, storage and flood regulation, soil health, and climate stability. In terms of food availability, access and use in Cambodia, they are an important direct provision of food, especially in emergency contexts or when access to other foods is low (during drought or the while waiting for harvests).

Climate change is expected to negatively impact forests in a number of ways, but mainly through increased temperatures and dry periods leading to more frequent forest fires. Additional climate change-driven pressures on agriculture (soil erosion, accelerated soil degradation, disease and reduced water availability) will increase the pressure on forests to provide alternative sources of income, including land-use change from forest to tree plantations and the opening of new land for crops such as cassava, as previous plots become less productive more rapidly.

Cross-cutting impacts on food productivity

Soil health and erosion

- Warmer temperatures are likely to increase the decomposition rate of organic matter in soils, meaning that soil carbon levels and, hence, soil health will decline more rapidly under conditions projected for Cambodia in 2050.
- Erratic rainfall that manifests as dry periods followed by more intense rainfall events has an increased capacity to wash away soil matter and nutrients in soils.

Irrigation

- Reduced or delayed rainfall at crucial times, especially at the beginning of the rainy season (when rice crops require inundation and other crops need a consistent supply of water to establish young plants) can delay planting and severely affect resulting yields.
- Flooding damages irrigation channels and water storage infrastructure such as in-stream check dams. More frequent or more extreme flooding is likely to threaten major infrastructure and increase the need to repair already damaged infrastructure. Continued need to repair infrastructure in high-risk areas combined with lower returns on labour and capital investment due to drought, disease, etc. may lead to abandonment of irrigation practices and potentially agriculture altogether.

Salinity

- As sea levels rise, saltwater intrudes into coastal aquifers. Cropping near coastlines is very likely to be affected by rising salt concentrations.
- Where saline groundwater is pumped for irrigation, the build-up of salt in soils can strongly impact the agricultural viability of an area.

Insect pests

- Pests and disease are already a major issue in Cambodia. The high proliferation of weeds is also well recognised throughout the Kingdom as one of the major drivers of land-use change and deforestation – as the labour / financial costs of managing weed proliferation become untenable after just a few years of cropping, the opening up of new land for agriculture through swidden-type agriculture results in heavy losses of forest cover, and has done so for many years.

4.2 Climate change impacts on food access

In total, agriculture (food and non-food production) contributes approximately 21 % to national GDP[65]. Approximately 80 % of Cambodia's territory is located within the Mekong and Tonle Sap basins, which, according to the climate change projections highlighted above, is likely to be increasingly impacted by higher temperatures and unpredictable rainfall. These worsening threats are likely to have an increasingly negative impact on food production, especially for small-scale, family farmers, who rely almost exclusively on rainfed agriculture for their food access and livelihoods.

Rainfed agriculture contributes significantly to Cambodia's national economy, and more so for the rural majority of the population; impacts due to climate change are estimated to cost between 100 and 170 million USD each year due to lack of adaptation capacity[66].

It is possible that climate change could exacerbate access to markets in some areas as flooding and storm damage intensify, which impact on ability to transport agricultural products efficiently to the markets.

4.3 Climate change impacts on food stability

Focusing specifically on Cambodia, food stability is impacted by the seasonal nature of the dominant activity of rice farming. Due to the highly cyclical nature of rice farming, at certain times of the year, i.e., the lean season (August to November before the rice harvest), families may run out of money to purchase food while food production at the household level is commonly in short supply. During this time, households and communities that depend heavily on rice tend to rely on coping mechanisms such as formal or informal loans and off-farm activities, which may require seasonal rural–urban migration. In addition to farmers generally having less money at this time, the cost of rice is also highest. "The price of rice is highest immediately before the main wet season harvest which typically starts in November. The price drops when the main wet season harvest commences as rice supply increases, and gradually rises throughout the year"[67].

Seasonal flooding and untimely and prolonged droughts are responsible for Cambodia's inherent vulnerability to food instability, as yields and the timing of expected harvests are negatively impacted by adverse climate conditions.

Climate change is projected to increase the intensity of flooding events affecting the timing of the onset of the rainy season and increase the likelihood and intensity of unseasonal droughts and extreme rainfall events (i.e., during harvest time). As a result, food production and the ability of farmers to sell and purchase food are likely to become more precarious, especially for communities dependent on rainfed rice production.

Food instability associated with purchased, imported food can also be affected by climate change. Where climate change impacts production in one country, the knock-on effects can be an increase in cost or a reduction in the availability in another purchasing country. In Cambodia, nutritionally important products include meat, fruits and vegetables; these may be affected by various climate impacts that can reduce their availability or increase their price, thereby affecting food stability for consumers.

65 MAFF.2019. Agriculture Sector Development Plan 2019–2023. Phnom Penh, Cambodia.

66 UNDRR (2019). Disaster Risk Reduction in Cambodia: Status Report 2019. Bangkok, Thailand, United Nations Office for Disaster Risk Reduction (UNDRR), Regional Office for Asia and the Pacific.

67 WFP 2010 Cambodia Food Market Analysis and Survey Report.

Impacts on rice production, while potentially significant, are unlikely to affect national rice availability due to the quantities available and the political importance of ensuring rice is available to all citizens. However, more severe shock events towards 2050 could lead to temporary emergencies requiring stronger social protection systems to ensure that emergency rice is distributed effectively.

As most of the fruits and vegetables consumed in Cambodia are produced domestically and rely on rainfed production, any impact on horticulture activities due to changes in precipitation regimes (longer, drier dry season, shorter wet season) could affect the availability of these products in the long term. Fruit trees are likely to be less vulnerable due to their perennial nature, deeper roots, and drought tolerance. However, yields may decrease if conditions during pollination and flowering become less favourable.

4.4 Climate change impacts on food utilisation and nutrition

Elevated atmospheric CO_2 concentrations

CO_2 interactions with crops can be summarised as a) a positive impact on the plant's ability to photosynthesise due to the CO_2 fertilisation effect, and b) a reduction in stomatal conductance, i.e. lower evapotranspiration potential (and a resulting lower water requirement), which could increase drought tolerance in crops[68]. These processes are key factors in model-based projections showing yield increases of between 5.4 % (RCP26) and 9 % (RCP85) towards 2050[69]. Improvements in evapotranspiration of C3 crops, including rice, due to changes in stomatal conductance have been calculated to be ~5 % globally[70].

However, apart from improved carbohydrate concentrations, the nutritional quality of the produce will likely be reduced due to carbohydrate dilution. A 2007 study of protein reduction under CO_2 (540–958ppm) for wheat, barley and rice found that the reduction in grain protein concentration was ~10–15 % of the value at ambient CO_2[71]. Analyses on rice cultivars in China and Japan have shown that Fe (Iron) and Zn (Zinc) concentrations also decreased (by 8 % and 5 %, respectively), as did vitamins including B1 (-17 %), B2 (-17 %), B5 (-13 %), and B9 (-30 %), while vitamin E increased[72]. In Cambodia, this could impact the dietary consumption profile of the entire population under the higher-end CO_2 emission scenarios projected for 2050. Research to develop cultivars adapted to elevated CO_2 concentrations and dietary diversification are two adaptation strategies to address these impacts.

Drinking water

Sustained periods of low rainfall can lead to freshwater scarcity and drought, leading in turn to shortages of drinking water and safe water for food preparation / cooking.

68 Toreti, A., Deryng, D., Tubiello, F.N. et al. Narrowing uncertainties in the effects of elevated CO_2 on crops. Nat Food 1, 775–782 (2020). https://doi.org/10.1038/s43016-020-00195-4

69 https://climate-impact-explorer.climateanalytics.org/impacts/?region=KHM&indicator=yield_rice_co2&scenario=rcp26&subregion=KH.KT&warmingLevel=3.0&temporalAveraging=annual&spatialWeighting=area&compareDimension=warmingLevel&compareVal- ues=3.0%2C1.5&compareYear=2030&compareScenario=h_cpol

70 Deryng, D., Elliott, J., Folberth, C., Mueller, C., Pugh, T., Boote, K., Conway, D., Ruane, A., Gerten, D., Jones, J., Khabarov, N., Olin, S., Schaphoff, S., Schmid, E., Yang, H., & Rosenzweig, C. (2016). Regional Disparities in the Beneficial Effects of Rising CO_2 Concentrations on Crop Water Productiv- ity. Nature Climate Change, 6, 786–790. https://doi.org/10.1038/nclimate2995

71 Taub, Daniel & MILLER, BRIAN & ALLEN, HOLLY. (2008). Effects of elevated CO_2 on the protein concentration of food crops: a meta-analysis. Global Change Biology. 14. 565 - 575. 10.1111/j.1365-2486.2007.01511.x

72 Narrowing uncertainties in the effects of elevated CO_2 on crops

Social security situation and climate vulnerability

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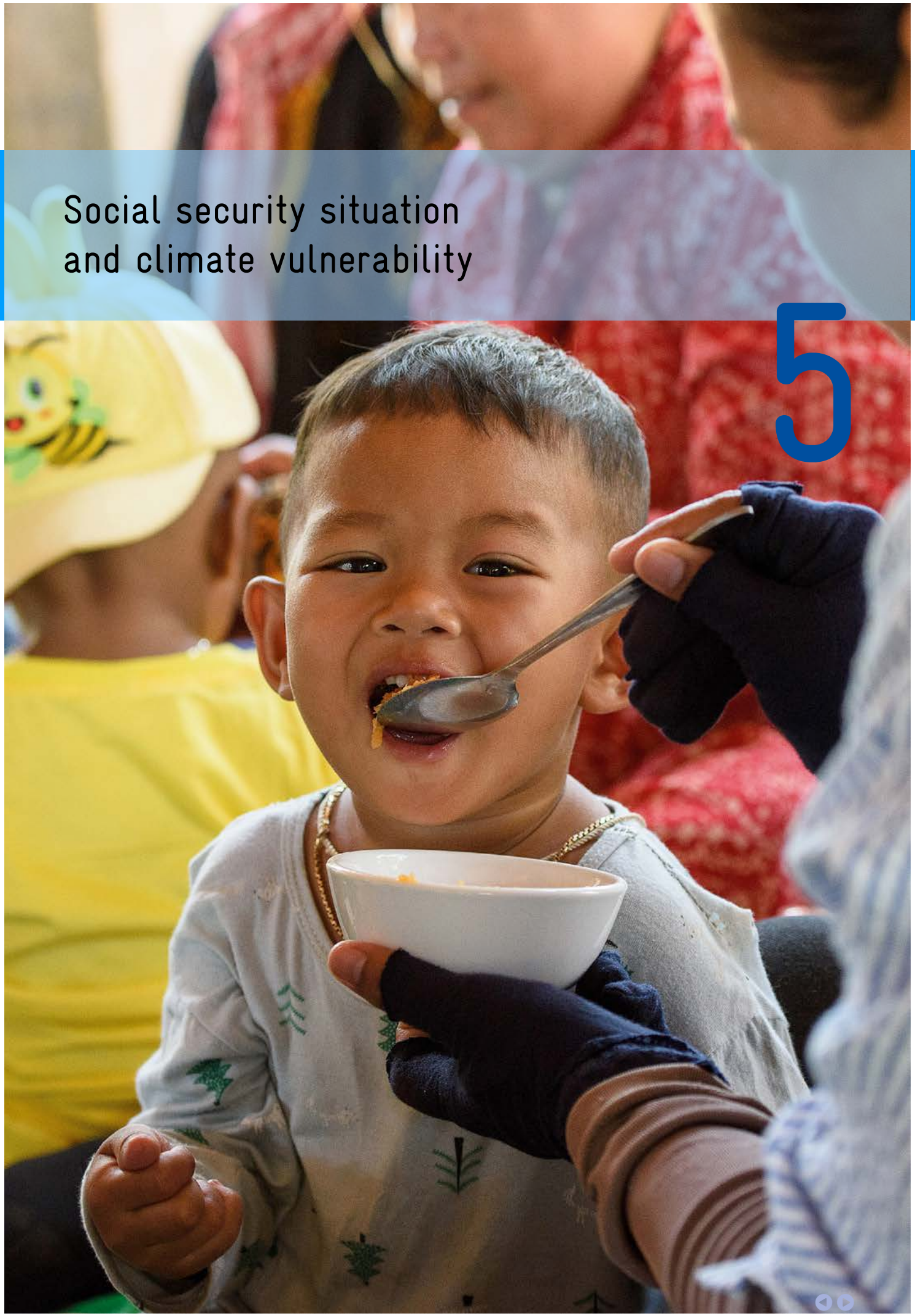


5 Social security situation and climate vulnerability

5.1 Social security situation

Cambodia's economy has averaged 7.7 % real GDP growth over the last two decades, driven mainly by construction, tourism, and manufacturing for export sectors (garments, textiles and footwear) and domestic demand. This robust growth has translated into a higher incomes for the population, resulting in a reduction in poverty rates from 53 % in 2004 to 13.5 % in 2014, and 12.9 % in 2018[73,74]. However, as a result of the COVID-19 pandemic, poverty has increased to an estimated rate of 17.8 % in the population since 2020[75]. As a Least Developed Country, Cambodia has been eligible for graduation from LDC status since 2021[76].

This economic performance has allowed the government to initiate extensive policy reforms in the area of social protection, aimed at reducing inequalities and better protecting people against various forms of risk. Consequently, a comprehensive National Social Protection Policy Framework (NSPPF) has been elaborated for the decade 2016–2025.

Within the NSPPF, the social assistance policy is based on four types of interventions, each of which targets a specific domain:

1. Emergency responses,
2. Human capital development,
3. Vocational training,
4. Social welfare of vulnerable people (i.e., family package).

In addition to the above programmes, the social assistance component includes two more mechanisms: The Health Equity Fund (HEF), respectively the Food Reserve Programme.

Figure 6: List of social assistance policies.

Emergency response	› Food security programme
Human capital development	› Supporting programmes for pregnant women and children under the age of two, › School feeding programme, › Scholarships for primary and secondary education.
Vocational training	› Short training organised for basic skills, › Introduction of e a cash transfer for technical training levels 1-3 for poor people and women in priority sectors (envisaged).
Welfare for vulnerable persons	› Cash transfer programme for people with disability, › Support programme for elderly people.

73 Where have all the poor gone? Cambodia Poverty Assessment 2013, April 2014
74 Organisation for Economic Co-operation and Development, November 2017
75 Asian Development Bank, 2022
76 United Nations Department of Economic and Social Affairs, 2021

5.2 Vulnerability

According to several international climate change indices, Cambodia is one of the most vulnerable countries to the adverse impacts of climate change. The Global Climate Risk Index (1999–2018) ranked Cambodia as the 12th most vulnerable country globally. The World Risk Index (2019), calculated as the product of exposure and vulnerability, ranked Cambodia among those countries with a 'very high' risk. According to a series of vulnerability assessments carried out in 2016, 17.5 % of Cambodia's communes were 'highly' vulnerable (i.e. 288 communes) and 27.28 % (449 communes) were 'quite' vulnerable to multiple climate change hazards.

These climate events can have a direct impact on households' incomes, livelihoods, and, by extension, their food security and access to basic services. Furthermore, the actions taken by households to cope with shocks, such as reducing food consumption, withdrawing children from school, or selling productive assets, ultimately increase their vulnerability. This further undermines hard-won development gains and contributes to the transmission of poverty from one generation to the next.

5.2.1 Vulnerability of the food system

Vulnerability of the fisheries sector

A 2012 World Fish Center study, titled "Assessing vulnerability to climate change and building adaptive capacity in Cambodia's fisheries sector"[77] found among other things, that:

- Saline water intrusion up the Mekong River Delta has increased from approximately 20 km inland to 50 km inland since the end of the last century (~1 km per year).
- Temperature increases are projected to impact fish metabolism, growth and distribution, while lower trophic levels could affect the food web[78].
- Climate change could generate anoxic conditions in the bottom layers of rivers and lakes while breeding cycles could be disrupted, affecting fertility and extending the spawning season[79].
- These ecological impacts could change production and yield, species distribution, species diversity, migration patterns and fish disease incidence.
- Changing flood pulses could reduce key fish habitats such as flooded forests[80].
- The degradation of forests and wetland ecosystems could make agriculture and fisheries more vulnerable to climatic variation.
- More than 80 % of the fish traders and processors in the Lower Mekong Basin are women.

77 World Fish Center 2012. Assessing vulnerability to climate change and building adaptive capacity in Cambodia's fisheries sector. A report prepared for the Fisheries Administration project, "Building Capacity for Integrating Climate Change Adaptation in Fisheries Sector in Cambodia" Kaitlin Almack,

78 Johnston, R., Hoanh, C. T., Lacombe, G., Noble, A., Smakhtin, V., Suhardiman, D., Kam, S.P., and Choo P.S. (2009). Scoping Study on Natural Resources and Climate Change in Southeast Asia with a Focus on Agriculture. International Water Management Institute, Colombo, Sri Lanka, and The WorldFish Center, Penang, Malaysia

79 V. Beznosov, A. Suzdaleva. Potential Changes in Aquatic Biota in the Period of Global Climate Warming. 2004. Environmental Science Water Resources.

80 Ministry of Environment and UNDP. (2011). Building Resilience: The future of rural livelihoods in the face of climate change. Cambodia Human Development Report. UNDP, Phnom Penh, Cambodia.

A study undertaken by IFREDI in 2013 identified a potential 30 % reduction in fish yield by 2030, partly due to damming[81]. The report suggests that when population growth is factored in, the resulting reduction in fish and fish products would amount to 34 % less availability than the baseline. This is likely to have severe negative impacts on the nutrition (especially of children and pregnant women) and income of the rural populations. In general, it can be concluded that capture fisheries and aquaculture are highly vulnerable to climate change. This includes vulnerability to higher temperatures, changes in rainfall patterns, changes in hydrological regimes (water levels, duration of floods, timing of floods and damming activities), changes in runoff or sediment load / movement; and increased instances of extreme weather events (storms, floods and droughts)[82].

Vulnerability of the livestock sector

Livestock-associated climate vulnerability arises from:

- Increased disease risk due to heat stress or changes in the range of pathogens (temperature / precipitation driven),
- Changes in fodder and forage availability and costs (as cereals and other fodder crop production is affected by climate change, i.e., flooding, unseasonal dry spells and drought and becomes less available and more expensive),
- Drinking water availability during prolonged drought and hot spells,
- Livestock mortality due to flooding, high temperatures and drought.

Vulnerability of tree crop farming systems

Tree crops, such as lemon are considered to be highly beneficial crops across Cambodia. They are primarily seen as a market crop to provide additional household income, but can also contribute to important dietary diversity requirements, especially in terms of vitamins and micronutrients.

From an ecological perspective, fruit trees provide benefits in terms of soil moisture and soil erosion, and, if properly planned in an agroforestry system, can increase the productivity of other crops, including rice, as well as mitigate the impacts of flooding by providing benefits in terms of soil stability.

As tree crops in Cambodia are almost always planted in a monocropping system, the risk profile of farmers dependent on tree monocropping systems is twofold: 1) low profit due to low yields associated with monocrop-driven ecological factors and 2) higher vulnerability to economic shocks due to a lack of diversification.

5.2.2 Vulnerability of the target group

Cambodia's vulnerability is characterised by frequent flooding and irregular rainfall, coupled with an agrarian-based economy, limited human and financial resources, inadequate physical infrastructure, and limited access to technology. Socio-economic status, location, access to resources and technology, all influence Cambodia's ability to manage the impact of climate change. Different social groups experience climate vulnerability differently, and women, children, the disabled, the elderly, and other socially marginalised groups often feel the impacts of climate change disproportionately.

81 Food And Nutrition Security Vulnerability To Mainstream Hydropower Dam Development In Cambodia INLAND FISHERIES RESEARCH AND DEVELOPMENT INSTITUTE (IFREDI), Fisheries Administration, Ministry Of Agriculture, Forestry And Fisheries, November 2012

82 Hap Navy, Truong Hoang Minh, and Robert Pomeroy. 2016. Impacts of Climate Change on Snakehead Fish Value Chains in the Lower Mekong Basin of Cambodia and Vietnam Marketing, Economic Risk Assessment, and Trade/Study/13MER03UC

Climate change disproportionately affects gender minorities, including women and girls. The areas in which women play a central role – food security, nutrition, energy, livelihoods, health, natural resource management, among others – are those most directly impacted by climate change. By exacerbating gender inequality, climate change also reinforces a structural root cause of violence against women and girls[83]. Women's main vulnerabilities to climate change are: limited voice in decision-making, limited capacity to diversify agricultural resources, few options to cope with disasters and extreme weather, loss of income, workload and health problems, post-disaster shocks, etc. Climate change spending that addresses gender issues or has a gender focus in climate change-related programmes is 11 % in 2018 and increased to 15 % in 2019[84].

Projected heatwaves will negatively impact the most vulnerable populations, especially children and the elderly[85]. Higher temperatures and variable precipitation accelerate microbial growth, transmission and virulence, and can lead to changes in the seasonal and geographic distribution of vector- and water-borne diseases[86]. The spatial pattern of malaria risk in Cambodia has been found to change as rainfall and temperature change in the future. The transmission risk tends to increase until 2050, and then decreases again in 2080[87]. High temperature and precipitation changes can also result in lower food production in the tropics and heat-related diseases.

The negative impacts of climate change on agricultural production can lead to the collapse of food systems, and vulnerable groups risk further deterioration into food and nutrition crises when exposed to extreme climate events. Adaptation strategies, such as additional time spent in sourcing water or pasture, can particularly affect women's labour allocation, which, in turn, affects the time available for childcare and feeding (e.g., breastfeeding exclusively, preparing healthy meals). Further increases in the workload of women and climate change-related stress during pregnancy could contribute to low birth weight, leading to higher risks of undernutrition and non-communicable diseases[88].

More than four million ha of lowland forests, especially in the north-east and south-west, which currently experience a water deficit of four to six months, will experience a water deficit period of six to eight months or more. In turn, a reduction in forest cover may have a negative impact on the population, especially children, through micronutrient deficiencies. Moreover, reduced forest cover, whether due to climate change or deforestation, increases the risk of landslides[89].

83 Gender, Climate change, Health WHO: https://www.who.int/globalchange/GenderClimateChangeHealthfinal.pdf?ua=1

84 The NGO forum on Cambodia: Cambodia's Citizens Climate Budget for 2018-2019

85 WHO Climate and Health Profile Cambodia 2015: https://apps.who.int/iris/rest/bitstreams/1064308/retrieve

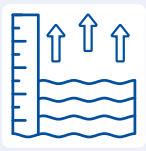
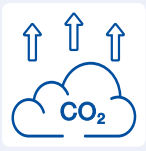
86 Children's Environment and Health in East Asia and the Pacific: https://www.unicef.org/eap/reports/childrens-environment-and-health-east- asia-and-pacific

87 NCSD (2016)

88 Gender, Climate change, Health WHO: https://www.who.int/globalchange/GenderClimateChangeHealthfinal.pdf?ua=1; Gender statistics for key sectors in Cambodia: https://www.jica.go.jp/project/cambodia/011/news/general/ku57pq00001xwvts-att/20150308_01.pdf; Gender statistics for key sectors in Cambodia: https://www.jica.go.jp/project/cambodia/011/news/general/ku57pq00001xwvts-att/20150308_01.pdf; 12 Impacts of forests on children's diet in rural areas across 27 developing countries: https://advances.sciencemag.org/con- tent/4/8/eaat2853?utm_source=TrendMD&utm_medium=cpc&utm_campaign=T rendMD_1

89 Deforestation Effects on Rainfall-Induced Shallow Landslides: Remote Sensing and Physically-Based Modelling https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019WR025233

Figure 7: Climate Risk and Vulnerability Assessment Synthesis

Climate hazards and exposure	Impacts	Vulnerability	Key risks to FSN of target group	Climate risks and vulnerability hotspots
› Floods  › Droughts  › Wind storms  › Compound heatwaves & droughts  › Sea level rise  › Rising CO_2 concentrations 	› Rice yield decline due to higher temperatures. › Increased water stress for crops and livestock due to higher temperatures and droughts. › Less predictable onset of seasons, impacting traditional rice production systems. › Increased risks of pathogens, pests, and diseases. › Crop yield stimulated by elevated CO_2, but decrease in nutrient quality (strong evidence for rice). › Higher CO_2 increases competition with weeds, which are also stimulated. › Reduction of coastal crop areas due to sea level rise. › Higher temperatures reduce soil fertility, which is already low in Cambodia. › Increased nitrate leaching due to higher temperatures and alternating heavy rain and drought events.	› **Society:** Lack of food because of flooding and difficult-to-get healthcare. Worry about children getting sick or drowning. Some families migrate to earn money. Potential for conflict over lack of water during drought periods. People travel long distances for water. › **Food production:** higher temperatures and erratic water availability impact all crops, including rice and vegetable production of small-scale farmers. Changes in the duration and timing of the wet season impact traditional cropping practices using traditional varieties and technologies. Desertification and soil degradation impact yields in general. Expansion of agricultural land due to poor soils and unsustainable agricultural practices (and the resulting need to open new lands) drives deforestation and affects biodiversity. › **Health:** People suffer from fever, coughs, diarrhoea, dengue, and malaria during floods. Increased itchiness and skin infections during droughts. › **Economy:** People have to spend money on food, healthcare (accessing healthcare and medicines), agriculture and feeding animals. Animals, rice, cassava, and charcoal are destroyed by floods. › **Most vulnerable:** Children are the most vulnerable, as are elders and pregnant women. As there is little work when there is flooding, more loans must be taken out. There is a shortage of drinking water. Migration continues to be a coping strategy.	› Drought/flood/pests/desertification/soil degradation, etc. impact food productivity and thus farmers' livelihoods. Decline in food production affects food access/availability. › Access to sufficient, clean water may impact water, sanitation and hygiene and thus food utilisation. › Decline in nutritional quality of crops, particularly protein and micronutrients. › Decline in nutritional quality of seafood[90]. › Increased food and nutrition insecurity due to decreased physical/economic access. › Decreased dietary intake of women due to the tradition of women eating last and least. › Poorer nutritional status of children under two years due to sub-optimal infant and young children feeding practices and poor care practices as mothers spend more time fetching water during droughts and more time coping with droughts or floods. › Impaired access to health services during floods/droughts increasing the likelihood of illness due to lack of immunisation, infections (especially in floods), and poor management of illnesses leading to an infection–malnutrition cycle in children. › Hampered access to safe water and sanitation facilities.	› Increase risks of damaging floods (flash floods) in Tonle Sap and Mekong River basins, floodplains, and upland areas (inc. Kampong Thom). › Loss of cropland areas in coastal areas and the Mekong Delta (cl. Kampot). › Fishing communities in inland and coastal areas are impacted by changing conditions (flood pulses, temperatures, degradation of mangroves and wetlands).

90 Note scientific evidence remains limited.

Adaptation needs and options appraisal

6

6 Adaptation needs and options appraisal

6.1 Adaptation options targeting food availability

In terms of adaptation to climate change in agricultural systems, improved water access and use efficiency, improved soil health and nutrient content, increased yields and incomes, and the provision of locally suited seeds and breeds have been identified as climate-smart-agriculture (CSA).

According to the IPCC AR6, CSA is an approach that aims to increase agricultural productivity, improve food security, adapt to climate change and, where possible, reduce greenhouse gas emissions. Yet, the IPCC also warns that CSA may not benefit women unless carefully designed participatory approaches are used to promote the adoption of gender-sensitive CSA technologies and practices. These include, for example, direct seeding, green manuring and laser land levelling, which can have a significant role in reducing the gender gap in women's labour burden in agriculture[91].

The most promising interventions include[92]:

- Access to improved climate-resilient and high-yielding cultivars;
- Conservation agriculture (CA) and diversified farming practices – crop rotation, cover cropping;
- Agroforestry;
- Investment in irrigation infrastructure and water-saving technologies.

Therefore, short-season, locally suited cultivars, irrigation technologies and other agronomic interventions will need to be developed and deployed to enable farmers to capitalise on the slightly wetter but shorter wet season, and adapt to a longer, drier dry season.

Climate-resilient cultivars

The availability and use of improved and traditional cultivars proven to cope with inter-annual variability should be supported. Selecting heat-tolerant varieties from the hundreds of local cultivars accepted and trusted by farmers could encourage better adoption of climate-resilient varieties.

Higher temperatures, especially during crucial life stages of plants, and particularly if they coincide with drought spells, are likely to affect yields. Hardier, more resilient or short-duration cultivars that can be planted earlier or later to avoid these shocks will be required to cope with climate change. Availability of these cultivars, effective and timely information and early warning systems, as well as knowledge of which cultivars to choose in each location and year will be important to enable farmers to make the right decisions, and then implement them.

91 IPCC AR6 2022, Chapter 5: Food, fiber and other ecosystem products

92 Savelli, A., Giles, J., Atieno, M., Leyte, J., Grosjean, G. 2020. Climate-Smart Agriculture in Cambodia. CSA Country Profiles for Asia Series. The Alliance Bioversity International and CIAT (The Alliance); Food and Agriculture Organisation of the United Nations (FAO), FAO, Rome, 54p.

6.1.1 Focus on rice production systems

Being by far the most dominant and important crop for consumption and market, and with the largest footprint in terms of climate and environmental impacts, climate-smart rice production should be given particular attention in terms of climate-proofing food production towards 2050.

Cambodia's "Updated NDC 2020" highlights interventions for climate-proofing rice production. They aim to increase rice yield, reduce loss during post-harvesting, and improve rice quality and safety through:

- Stress-tolerant varieties,
- Climate-smart agriculture (CSA),
- Sustainable Rice Platform (SRP),
- Good Agricultural Practices (GAP),
- Organic agriculture,
- Integrated soil nutrient management (ISNM),
- Integrated pest management (IPM),
- Water saving techniques,
- System of Rice Intensification (SRI),
- Complex Rice System[93],
- Agroforestry,
- On-farm seed conservation and selection techniques and post-harvest technologies;
- Sustainable landscape management (land levelling, integrated micro-watershed management).

As mentioned above, promoting the adoption of gender-sensitive CSA technologies and practices, including CA, should be strongly considered by any policy maker or manager of agricultural production. CA already has a foothold in Cambodia.

In addition, integrated approaches such as rice-livestock systems, rice-fish systems and agro-forestry provide agro-ecological benefits, diversify food sources and strengthen farmers' resilience to climate-related shocks.

6.1.2 Focus on cassava and other root vegetables

Cassava and other root vegetables are inherently climate-resilient due to their ability to remain in the ground once mature, regardless of weather conditions, and await harvest until the farmer is ready to collect them or the market is ready to receive them. However, they are also associated with highly soil-disruptive harvesting practices, and commonly extract high quantities of nutrients from the soil without replenishment, leading to nutrient leaching and reduced soil health.

Cassava in particular is also highly susceptible to the cassava mosaic virus disease, which has decimated the crop in Cambodia and across the region for over a decade.

According to the NDC, promoting cassava production systems and practices that are more resilient to climate change includes:

- Introducing a variety improvement programme for cassava mosaic virus disease;
- Preventing soil erosion and soil nutrient leaching;
- Introducing appropriate waste management for post-harvest processing of cassava.

93 For example, mixed duck-rice system, a traditional mixed farming system in Asia, which is a low cost, environmentally friendly and labour-saving farming system and very suitable for small-scale and poor farmers. This system attracts interest for its agroecological benefits (e.g., organic fertiliser and pest control).

6.1.3 Focus on fisheries and aquaculture

According to the NDC, promoting aquaculture production systems and practices that are more adaptive to climate change includes

- Domesticating and producing both indigenous and exotic species that are more adaptable to climate change;
- Promoting aquaculture in plastic and composite ponds;
- Promoting cage and pen culture in man-made reservoirs;
- Increasing adaptation, strengthening livelihoods and safeguarding food and nutrition security of small-scale fishermen.

Adaptation options identified by CAMADAPT include

- Selecting species that are resilient in the context of climate change;
- Integrating fish farming / small-scale aquaculture into irrigation production systems, i.e., rice-field fisheries, to improve water productivity;
- Switching to aquaculture systems when areas are no longer suitable for cultivation by small-scale producers;
- Improving the capability of brackish water aquaculture with proper infrastructure design as well as land and water use policies;
- Diversifying aquaculture by finding and growing species that are more climate-adaptable;
- Reviving indigenous techniques of fish aggregation and floating beds;
- Using indigenous species and improving culture technology to prevent overfishing and overfeeding;
- Screening species, resulting in the selection of better-adapted species or the development of strains that are physiologically more tolerant to the changing environment;
- Introducing feeding practices that are more ecologically efficient and less polluting;
- Introducing disease treatment and prevention measures;
- Avoiding overfeeding and overstocking fish by aquaculture producers and monitoring water temperature;
- Adapting technologies to suit the capability of diverse groups of people, including the poor.

Post-harvest adaptation options for fisheries

- Insurance schemes could be introduced;
- Investment in better infrastructure could be increased, and a disaster response plan developed;
- Traditional post-harvest methods that are more resilient could be promoted; i.e., local materials, traditional smoking of fish.

6.1.4 Focus on livestock

According to the NDC, promoting livestock production systems and practices that are more adaptive to climate change includes

Promoting animal production and animal health

- Improving animal breeding technology through artificial insemination, which can adapt to climate change;
- Promoting animal production and animal health improvement through animal breeding technologies, which can adapt to climate change;
- Improving animal health by feed fodder, cooling systems and deworming and vaccination programmes.

Stengthening research capacities on animal genetics, breeding, and feeds to adapt to climate change

- Strengthening research skills and improving breeding technologies;
- Improving vaccinations;
- Improving animal breeding and feeding (animal improvement technique, fodder programme);
- Using cooling systems, deworming and vaccine programmes;
- Improving animal disease surveillance.

6.1.5 Adaptation in home gardens

A number of suitable crops for improving home gardens' capacity to adapt to climate change have been identified for Cambodia:

- Kangkong is noted as being particularly resilient to inundation and, therefore, flooding, as well as requiring little watering, i.e., it is drought resistant.
- Sweet potato, sesbania grandifolia and sauropus androgynous are also considered drought-resistant.
- Due to their ability to remain on the stalk, pumpkin, bottle and wax gourd can be harvested over a long period of time, which provides a degree of resilience to adverse weather conditions that can impact other more harvest-time specific fruits and vegetables.
- Growing edible cassava, sweet potatos and other root vegetables has the advantage that their harvest time is far more flexible / less affected by seasonal or unseasonal weather conditions. They can remain in the ground until required, providing an emergency supply of carbohydrates during or after stress events.

As described above, each of these crops has nutritional value as well as characteristics that make it appropriate for cultivation under future, likely harsher conditions.

However, access to sufficient water throughout the growing period is a common challenge for home gardens – and often a barrier to taking up horticultural activities. As temperatures increase and droughts become longer, more frequent or untimely (more severe drought spells during the wet season, for example), households will find it more difficult to store sufficient water to ensure home gardens remain productive.

This stress on vegetable production can lead to reduced adoption rates and even abandonment as production viability drops. Ensuring that farmers have both access to resilient crops and exposure to an enabling environment that ensures the availability of innovative and affordable water solutions will be paramount to successful home garden productivity into the future.

As climate change is likely to bring longer, drier dry seasons, production during this period will become more difficult. Dry season vegetable growing is often used to limit disease, weed and pest burdens, but the trade-off of having limited water for irrigation is already high and may become unfeasible under future scenarios.

Access to markets, knowledge of market dynamics and growers' business skills are all major additional barriers for households that are already practising or wishing to start home gardening, and is an area that needs to be strongly focused on in conjunction with any activities that increase agricultural productivity. In addition to selecting specific crops that are less vulnerable to climate change, choosing cropping methods and systems that are more resilient to high temperatures, inundation, storms, drought, and disease is key.

Mixed cropping, cover cropping, polyculture, agroforestry and permaculture have strong bio-physical, nutritional and economic attributes that make them particularly important for small-scale farming for FSN in the future. For medium- to large-scale farming, CA, which is already being researched and adopted in Cambodia, is one of the most promising future and current climate-smart methods for increasing productivity while simultaneously integrating climate adaptation and mitigation into its production system.

6.1.6 Focus on vegetable production

The Cambodian diet currently includes just 1/3 of the recommended 300–400 g of vegetables per day, so there is an important and urgent need to increase production, availability and, ultimately, consumption.

Cambodia's "Updated NDC 2020" highlights horticulture as a priority sector for adaptation and provides a number of adaptation options for consideration:

Development of horticulture and other food crops to increase production, improve quality safety, harvesting and post-harvesting techniques and agrobusiness enhancement, thereby increasing profit in horticulture production value chains.

Promotion of local chemical-free vegetable value chains by improving sustainable water management practices, promoting diversification to increase food security, access to healthy food and diversified income opportunities resilient to climate change.

Specific measures include:

- Stress-tolerant varieties
- Climate-smart agriculture (CSA)
- Conservation agriculture (CA)
- Good Agricultural Practices (GAP)
- Integrated soil nutrient management (ISNM)
- Integrated pest management (IPM)
- Participatory guarantee system (PGS)
- Organic agriculture
- Water saving techniques
- Post-harvest technologies
- Stress-tolerant species and varieties
- Intercropping
- Agroforestry
- Crop rotation, mixed cropping/ companion planting
- Integrated farming system approach

6.2 Adaptation options targeting food utilisation and nutrition

Future climate conditions and changes in atmospheric CO_2 will impact food utilisation and nutrition in Cambodia. In terms of adaptation to climate change in the agricultural sector, water availability and water use efficiency, improved soil health, increased yields and improved income opportunities, and the provision of locally suited seeds and breeds have been identified as CSA-related areas where farmers feel they need the most support. Access to improved climate-resilient and high-yielding crop varieties, diversified farming practices, such as crop rotation, cover cropping, conservation agriculture, and investments in irrigation infrastructure and water-saving technologies have been singled out as the most promising interventions[94].

A stronger focus on diversifying food production away from the prevailing dominant cultivation of rice is likely to be a positive step towards increasing access to a diverse diet and building food and nutrition security in Cambodia. Encouraging the cultivation of alternative crops, such as legumes within mixed cropping modalities that provide both human and soil health benefits should be strongly considered.

Where substitution / reduction of rice production and consumption with more nutritious foods **is not a viable option**, identifying and making available rice cultivars that are higher in protein and other nutrients, and that thrive at higher CO_2 levels and in warmer, shorter wet season conditions, will be paramount to ensuring nutrient security towards 2050.

94 Savelli, A., Giles, J., Atieno, M., Leyte, J., Grosjean, G. 2020. Climate-Smart Agriculture in Cambodia. CSA Country Profiles for Asia Series. The Alliance Bioversity International and CIAT (The Alliance); Food and Agriculture Organisation of the United Nations (FAO), FAO, Rome, 54p.

Where substitution / reduction of rice production and consumption **is a viable option** (which may be difficult given the ingrained position of rice in Cambodia's social and political culture) consumption of more nutritious alternatives should be encouraged. With reference to Cambodia's shortfalls in terms of dietary diversity identified in Section 2, increasing fruit, vegetable and legume consumption should be a particular priority. Cambodia already imports significant quantities of fruits and vegetables to meet demand (despite consumption being low). To satisfy this demand domestically, and to take advantage of the projected future increased demand for more nutritious food vegetables, increased attention to diversified food production in home gardens, at the smallholder level and at medium- to large-scale should be prioritised by agriculture policy makers and support agencies. CSA methods and technologies that promote mixed farming, rotation cropping, cover cropping and other forms of polyculture with edible legumes should be given specific attention.

As described above, higher atmospheric concentrations of CO_2 are expected to be felt most strongly in terms of higher yields and increases in carbohydrate production (CO_2 fertilisation) but are likely to result in reduced protein concentrations in food rice for consumption (the carbohydrate dilution effect). A 10 % reduction in protein concentration per gramme of rice can be expected. Currently, Cambodian's derive approximately 32 g, or nearly half of their daily protein intake from the consumption of rice, meaning a 10 % reduction in rice protein concentration due to elevated CO_2 could result in a 3 g (or almost 5 %) reduction in total daily protein intake for the average Cambodian consumer, under business and usual conditions.

However, with appropriate planning (see paragraph below), overall rice yields are likely to increase under the higher atmospheric CO_2 concentrations projected for 2050. This means that more rice may be available for consumption or sale. If rice farmers are then able to sell higher quantities of rice (due to increased yields from CO_2 fertilisation) and purchase more higher-protein foods, the reduction may also be averted for this demographic, but rice purchasers may not be able to do so. If the increased availability (and / or lower cost / kg) of rice results in more rice being consumed (10 % more rice per day) without a reduction in the intake of other nutritious foods (i.e., people eat more overall) the problem of reduced protein concentration may be averted, although the increase in associated carbohydrate intake would be likely to create other problems, for example increased rates of obesity. Specific attention will need to be paid to the impact of less nutritious, cheaper rice on low-income / poor households, who are likely to increase their rice intake at the expense of more nutritious dietary items.

In order to capitalise on higher yield opportunities under elevated CO_2 conditions, sufficient soil nutrients and water are required during crop growing periods. While C3 plants such as rice will become more water efficient under higher CO_2 concentrations, higher temperatures, longer droughts, and reduced water infiltration due to climate change may make water less available. In general, soils are likely to become less healthy (as higher temperatures increase rates of soil carbon decomposition and increased flooding and heavy rain events increase erosion and runoff), and soil nutrient availability may decrease. To adapt to these changes, rice farming will need to adopt better soil and water management practices. As described previously, implementing CA, SRI, and CSA-type farming practices in general can provide the conditions needed to manage water, farmland and crop production sustainably and productively into the future. Special care should be taken to address inequities, such as unequal power relations in decision-making at the household level, to ensure that WRAs fully benefit from the implementation of these techniques and practices, and that they effectively reduce labour burdens and increase purchasing power.

6.3 Adaptation options targeting social resilience to climate risks

A substantial proportion of Cambodia's population is highly vulnerable to climate-induced shocks. Climate shocks have a direct impact on household incomes, livelihoods, food security and access to social services in Cambodia[95]. Poor households are among the most vulnerable, and shocks can push these households further into poverty. Meanwhile a large proportion of the population lives close to the poverty line (the second and third quintiles of the population have an average income of only 20 USD / month / capita), and shocks are shown to regularly push these 'near poor and vulnerable' households back into poverty[96]. Without the means to cope effectively, actions taken by households in the face of these shocks (such as reducing food consumption, withdrawing children from school, or selling productive assets) undermine their future prospects and ultimately increase their vulnerability. The impact of recurrent shocks presents a threat to Cambodia's sustainable development and to national efforts to reduce poverty. Increasing efforts to build resilience to these shocks and mitigate their impact on the most vulnerable is a priority for the Royal Government of Cambodia (RGC).

The social protection sector in Cambodia is highly dynamic and rapidly evolving, with significant changes in the past few years that are building an enabling environment for resilience to shock responses. This includes developing the National Social Protection Policy Framework (NSPPF) 2016–25, establishing the institutional framework, rolling out cash-based social assistance, expanding the Identification of Poor Households (IDPoor) Program, and transitioning to digital cash delivery systems. The COVID-19 crisis highlighted the critical importance of social protection, particularly cash transfers, in helping people to cope with shocks. The experience of the National Social Protection Council's (NSPC) in implementing the national Cash Transfer Program for Poor and Vulnerable Households during COVID-19 (CT-COVID) clearly demonstrated that the social protection system in the country, although still in its early years of growth and expansion, does indeed offer great potential as a system through which the needs of those affected by shocks can be met, providing a valuable mechanism that complements existing government efforts for disaster response. Going forward, the use of social protection systems for shock response can help to facilitate more harmonised and unified ways of working between government social protection actors, such as NSPC, MoSVY, MoP, etc., government disaster management actors such as the National Committee for Disaster Management (NCDM), and partner organisations leading on emergency response in times of shock. Social protection that reaches those in need and that can be scaled up rapidly to mitigate the impact of shocks as they occur has the potential to contribute to significant savings for the RGC over time, as it cushions the impact of shocks on vulnerable people and builds resilience. SRSP is an important complement to wider RGC efforts to reduce vulnerability and enhance the long-term resilience of households for sustainable development and poverty reduction.

95 For example, in the NCDM/HRF Rapid Assessment to flash floods in October 2020, the two main concerns of affected households were lack of food and loss of livelihoods

96 Studies highlight that a shock contributing to a reduction in average household income by just 20% would nearly double the national poverty rate (OECD (2017) Social Protection System Review of Cambodia, OECD Development Pathways). As many as two million people were estimated to have fallen below the poverty line owing to the 2008–09 food and fuel crises (Jalilian et al (2009) Global Financial Crisis Discussion Series Paper 4: Cambodia, ODI)

Policy recommendations

7

7 Policy recommendations

7.1 Priority for improving the resilience of food production systems and fostering sustainable intensification

The resilience of food production systems in Cambodia and the achievement of sustainable intensification of food production under both current and future climate conditions depend on the successful promotion and adoption of climate adaptation strategies targeting the following priority areas: 1) water resources, 2) soil health, and 3) crop yields and incomes.

Prioritise agricultural water needs in a hotter, less predictable climate with a shorter wet season and a longer, drier dry season:

- Improve water use efficiency and storage at the individual, smallholder production and home garden level;
- Integrate water storage and irrigation infrastructure with aquaculture production;
- Improve water infiltration capacity at the community / landscape level (protecting and expanding natural resources that provide ecosystem services, such as forests and responsible agricultural landscapes) and create infrastructure such as check dams;
- Identify and adopt nutrient-rich, drought-resilient / short-season crop cultivars and breeds appropriate to local conditions and market preferences.

Prioritise addressing soil health deterioration under increasing climatic pressure (higher temperatures, more intense droughts and extreme rain events):

- Use cover crops and similar mixed cropping techniques, including agroforestry, which increase organic nutrient availability to soils while simultaneously providing soil protection by physically shielding the soil from direct sunlight and rain damage;
- Implement no-till or minimal-till production techniques for major crops, including rice, maize and cassava;
- Increase the usage of organic fertilisers, including nitrogen-fixing legume species and mulching to ensure soil carbon and water content is maintained at a level beneficial to sustained cropping – reduce the need for opening new lands and resulting deforestation;
- Strengthen protection of ecosystem service providers, such as forests and wetlands, with a particular focus on reducing encroachment by farmers, deforestation and the opening of new lands / land-use change from natural forests to farmland.

Prioritise addressing declining yields and incomes due to increased changing climate trends (higher temperatures, longer dry season, shorter wetter wet season) and climate variability (less predictable):

- Identify and develop an enabling environment for the adoption of higher-yielding, more nutrient-dense and future climate-resilient seeds and breeds;
- Strengthen early warning systems to enable farmers to make informed cropping decisions on when and what to plant, how much to invest, and whether to prioritise off-farm activities to generate additional income;
- Increase investments in agriculture extension, training and technologies to help farmers to understand and adopt CSA methods.

These interventions can potentially be implemented under integrated social protection and payment for ecosystem services mechanisms where vulnerable households and communities benefit from both the construction and the output of the activities.

7.2 Priority for the integration of social protection into resilient food production schemes

A comprehensive Inter-Agency Social Protection Assessment on Food Security and Nutrition (ISPA-FSN) has been conducted by CARD and NSPC. The study will be available by 01 January 2024 at the latest.

7.3 Priority for improving food security and nutrition status of the target group

Stakeholders at national, sub-national and community levels and across sectors must work together to create a multiplier effect to reduce poverty, end malnutrition and hunger, and protect our environment. Most importantly, engaging and including the voices of consumers and producers, as well as the most vulnerable, including youth, women, indigenous peoples and ethnic minorities, will be key to shaping the food system of tomorrow, for a healthier population, planet, equitable economy and prosperity. Four specific priorities for improving food security and nutritional status include the following:

Healthy diets for all

- Make healthy diets more available and accessible through enhanced agricultural productivity and diversification, agroindustry, research and development, food safety, food fortification, value addition, wider commercialisation, and infrastructure improvements in local markets;
- Make food more accessible through the expansion of social assistance to vulnerable individuals and households, including its cash transfer, home-grown school feeding, and the use of fortified foods for in-kind distribution schemes;
- Implement the expansion of 1,000 days of health counselling and services for mothers and children under two years of age, with a focus on promoting exclusive breastfeeding and improving infant and young child feeding and maternal dietary diversity;
- Operationalise the National Roadmap for Prevention and Treatment of Child Wasting;
- Ensure access to clean drinking water, sanitation and good hygiene practices;
- Create a food environment in which consumers can make healthy food choices by regulating food marketing (including breastmilk substitutes) and promoting national dietary guidelines and standards.

Empowerment of youth, women and the vulnerable

- Engage youth, particularly young women, in leadership roles and provide opportunities for youth, women and the vulnerable to be routinely engaged in policy dialogue and decision-making;
- Promote digitalisation, research and development, innovation, and support for the vulnerable, youth and women's SMEs; and
- Strengthen vocational training programmes, formal and non-formal education, and youth and women associations to meet the demands of a developing food system and the country's development.

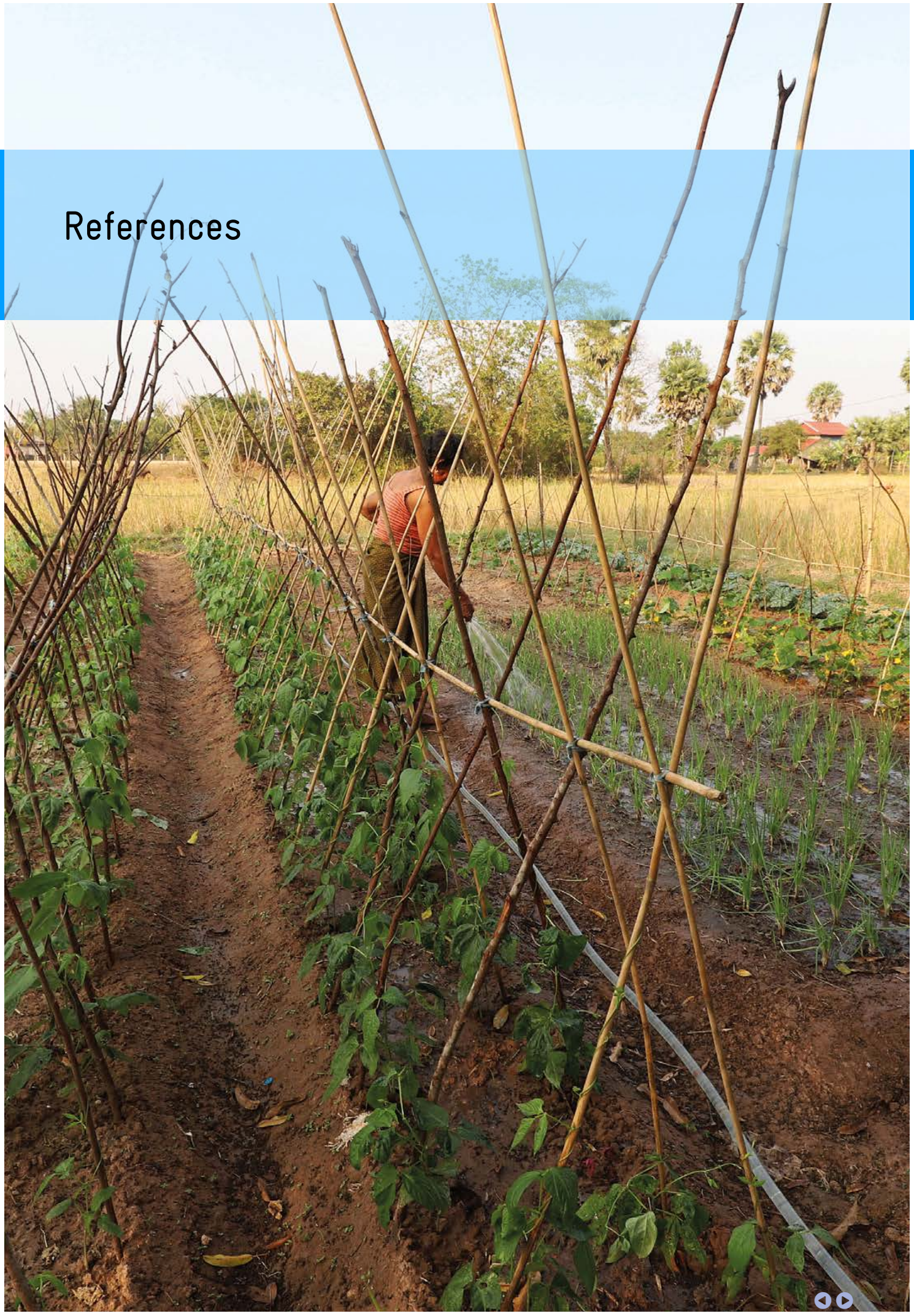
Resilient and sustainable livelihoods

- Expand shock-responsive social protection to include vulnerable families, and build resilience and maintain food reserves;
- Apply One-Health principles, including traceability along the value chain; and
- Steer food systems development towards green growth by enabling the potential of the private sector in digitalisation, green finance, agro-ecological transformations, gender-sensitive implementation of CSA, resource efficiency, reduction of waste and food losses, use of renewable energy and improvement of green infrastructure including irrigation and rural roads.

Just, inclusive and participative governance for a more inclusive food system

- Open the door for multi-stakeholder and multi-sectoral dialogue, coordination, and collaboration to make planning and implementation processes more just, inclusive and participatory. These processes will be promoted at national, sub-national and community levels, and include collaboration between the RGC, development partners, the private sector, academia, and civil society.

References



References

World Bank and Asian Development. (2021). *Open Knowledge Repository: Climate Risk Country Profile: Cambodia.* Retrieved April 2022, from https://openknowledge.worldbank.org/handle/10986/36380?show=full

FHI Solutions LLC. (2022). *1,000 Days.* Retrieved April 2022, from https://thousanddays.org/

World Health Organization. (2020, April 29). *Healthy Diet.* Retrieved April 2022, from https://www.who.int/news-room/fact-sheets/detail/healthy-diet

International Monetary Fund. (2021, October). *World Economic Outlook Databases.* Retrieved May 2022, from https://www.imf.org/en/Publications/SPROLLs/world-economic-outlook-databases#sort=%40imfdate%20descending

(March 2017). *Fill the Nutrient Gap Cambodia.* Council for Agricultural and Rural Development, Ministry of Agriculture, Forestry and Fisheries, and World Food Programme.

Food and Agriculture Organization of the United Nations. (2021). *FAOSTAT.* Retrieved April 2022, from https://www.fao.org/faostat/en

(2019). *Cambodia Inter-Censal Agriculture Survey.* Cambodia: National Institute of Statistics, Ministry of Planning and Ministry of Agriculture, Forestry and Fisheries.

Asian Development Bank. (September 2019). *Cambodia: Transport Sector Assessment, Strategy, and Road Map.* Institutional Document. Retrieved from http://dx.doi.org/10.22617/TCS190449-2

National Institute of Statistics Cambodia. (2015). Retrieved May 2022, from http://nis.gov.kh/index.php/km/

Rutu, Keller, Koo, Fleurantin, Portale, & Rysankova. (2018). *Cambodia – Beyond Connections : Energy Access Diagnostic Report Based on the Multi-Tier Framework.* Washington DC: World Bank. Retrieved from http://hdl.handle.net/10986/29512

Greffeuille, Sophonneary, Laillou, Gauthier, Hong, Hong, . . . Berger. (2016). Inequalities in nutrition between Cambodian women over the last 15 years (2000–2014). *Nutrients 8, no. 4,* p. 224. Retrieved from https://doi.org/10.3390/nu8040224

Grebmer, & Bernstein. (2020). *Global Hunger Index 2020 One Decade to Zero Hunger – Linking Health and Sustainable Food Systems.* Bonn, Germany / Dublin Ireland: Deutsche Welthungerhilfe e. V. and Concern Worldwide.

Trufts University. (2019). *Global Dietary Database.* Retrieved May 2022, from https://www.globaldietarydatabase.org/data-download

(2021). *MUSEFO Project Report.* Bonn, Germany: GIZ.

Ministry of Agriculture, Forestry and Fisheries. (2018). Retrieved April 2022, from https://web.maff.gov.kh/?lang=en

(April 2014). *Where have all the poor gone? Cambodia Poverty Assessment 2013.* Washington, D.C.: The World Bank.

Organisation for Economic Cooperation and Development. (November 2017). *Social Protection System Review of Cambodia, Chapter 1: Forward-looking assessment of social protection needs in Cambodia.* Paris, France: OECD Development Pathways, OECD Publishing. Retrieved from https://doi.org/10.1787/9789264282285-en

Asian Development Bank. (2022, April). *Poverty Data: Cambodia.* Retrieved 2022 April, from https://www.adb.org/countries/cambodia/poverty#:~:text=Poverty%20Data%3A%20Cambodia&text=In%20Cambodia%2C%2017.8%25%20of%20the,Cambodia%20is%200.3%25%20in%202020

United Nations Department of Economic and Social Affairs. (2021). *Least Developed Country Category: Cambodia Profile.* Retrieved April 2022, from https://www.un.org/development/desa/dpad/least- developed-country-category-cambodia.html

Eckstein, Künzel, & Schäfer. (2021). *Global Climate Risk Index 2021.* Bonn, Germany: Germanwatch e.V. Retrieved from https://www.germanwatch.org/en/19777

Thoeun, H. C. (2015, February 17). Observed and projected changes in temperature and rainfall in Cambodia. *Weather and Climate Extremes, Vol 7,* pp. 61–71. Retrieved from https://doi.org/10.1016/j.wace.2015.02.001

Rinbo. (2009). *The Expert Group Meeting on Innovative Strategies towards Flood Resilient Cities in Asia-Pacific Cambodia: Mainstreaming Flood and Drought Risk Mitigation in East Mekong Delta and Climate Risk and Adaption profile 2011.*

(July 2019). *Disaster Risk Reduction in Cambodia Status Report.* Bangkok, Thailand and Regional Office for Asia and the Pacific: Asian Disaster Preparedness Center and United Nations Office for Disaster Risk Reduction.

Centre for Agricultural and Environmental Studies. (2020). *Technical report on VandA assessment in specific sector.* Unpublished Report.

Savelli, Giles, Atieno, Leyte, & Grosjean. (2020). *Climate-Smart Agriculture in Cambodia: Country Profiles for Asia Series.* Rome, Italy: The Alliance Biodiversity International and CIAT and Food and Agriculture Organisation of the United Nations.

(2019). *Addressing Climate Change Impacts on Economic Growth in Cambodia.* Phnom Penh, Cambodia: Ministry of Economy and Finance and General Secretariat of National Council for Sustainable Development. Retrieved from https://www.undp.org/cambodia/publications/addressing-climate-change-impacts-economic-growth-cambodia

(March 2013). *Food and nutrition security vulnerability to mainstream hydropower dam development in Cambodia.* Phnom Penh, Cambodia: Inland Fisheries Research and Development Institute, Fisheries Administration and Ministry of Agriculture, Forestry and Fisheries.

(n.d.). *Climate Adaptation and Resilience in Cambodia's Coastal Fishery Dependent Communities.* FAO and GEF.

(2012). *Food and nutrition security vulnerability to mainstream hydropower dam development in Cambodia.* Cambodia: Inland Fisheries Research and Development Institute and Ministry of Agriculture, Forestry and Fisheries.

Espino, Monville-Oro, Barbon, Ruba, Gummadi, & Gonsalves. (2021). *Local Food Systems in Cambodia, Myanmar, and the Philippines: Perspective from the Local Communities.* Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security.

El-Noush. (2010). *Cambodia Food Market Analysis and Survey Report.* Cambodia: World Food Programme

(2016). *Cambodia Socio-Economic Survey 2015,* Phnom Penh, Cambodia: National Institute of Statistics, Ministry of Planning.

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