WFP World Food Programme

THE CLIMATE-MALNUTRITION EQUATION:

Insights and Actions for Asia-Pacific

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ABBREVIATIONS:

AA	Anticipatory Action
CGIAR	Consultative Group on International Agricultural Research
CLEAR	Consolidated Livelihood Exercise for Analyzing Resilience
CotD	Cost of the Diet
DIA	Diet Impact Assessment
FAO	Food and Agriculture Organization
FSCI	Food Systems Countdown Initiative
GDR	Global Dietary Recommendations
GHC	Greenhouse Gas
LMICs	Low- and Middle-Income Countries
LSFF	Large-Scale Food Fortification
NCDs	Noncommunicable Diseases
SBC	Social and Behavior Change
RCP	Representative Concentration Pathway
RHoMIS	Rural Household Multiple Indicator Survey
UN	United Nations
UNICEF	United Nations Children's Fund
WFP	World Food Programme
WHO	World Health Organization

Executive summary

BACKGROUND

Climate change has been called a "profound existential threat" for the Asia-Pacific region (UNDP, 2024). Indeed, those living in the region are six times more likely to be affected by climate hazards and disasters than those living elsewhere (EM-DAT, 2024), while climate-related shocks cause more damage in the region than the rest of the world, with average annual losses amounting to $924 billion (USD), or 2.9% of GDP (UN-ESCAP, 2023). At the same time, the region has amongst the highest prevalence of all forms of malnutrition in the world, with persistently high levels of undernutrition and a rapid, alarming rise in overweight, obesity, and non-communicable diseases (NCDs). In fact, more the majority of the world's stunted children (52%), more than 70% of children affected by wasting, and nearly half of children under five who are overweight call the region home (UNICEF, WHO, and the World Bank, 2023).

AIM AND METHODS

The overall aim of this report was to investigate and assess the direct and indirect effects of climate change on all forms of malnutrition in the Asia-Pacific region, with a particular focus on vulnerable populations, to inform the integration of nutrition-focused strategies into the World Food Programme's (WFP) climate response system in countries most at risk. This aim was achieved by conducting a literature review, ten key informant interviews, and data mapping.

FINDINGS

Without mitigation strategies, climate change will dramatically increase the prevalence of all forms of malnutrition in Asia-Pacific

Available predictions paint a stark picture in Asia-Pacific:

- The percentage of the population which is undernourished will nearly double by 2050.
- An additional 11.2 million children will become undernourished.
- An additional 2 million children will be stunted.
- More than 400,000 will die climate-related deaths.
- 44 million disability-adjusted life years (DALYs) will be lost due to nutritional deficiencies.[1]

In short, this report highlights a stark increase in malnutrition outcomes in the region, including stunting, wasting, and micronutrient deficiencies, as well as likely obesity and NCD outcomes, necessitating urgent mitigation strategies.

[1] The disability-adjusted life year (DALY) is a measure of population health which accounts for both mortality and nonfatal health consequences to illuminate the full burden of disease. One DALY represents the loss of the equivalent of one year of full health, either through premature death or time lived with illness and disability. DALYs can be used to calculate how diseases and medical conditions affect both the length and quality of life for a given population, and measure the health benefits and cost-effectiveness ratios of different health interventions (WHO, 2024).

The pathways from climate change to all forms of malnutrition go through multiple systems

Multi-directional pathways between climate change and malnutrition emerge across four systems – agri-food, health, water, and social protection. Each system interacts with the others, highlighting the interconnectedness of the pathways, and stressing the need for comprehensive strategies to mitigate impacts.

Agri-food system: Climate change affects food availability and access through a range of factors, including reduced crop production, food price increases, and loss of livelihoods. Furthermore, food safety risks and food waste are increasing under climate change, while rising CO2 levels reduce the micronutrient content of crops.

Health system: Climate variability and extreme weather events are driving an increase in chronic diseases, while negatively affecting birth and pregnancy outcomes, and leading to negative mental health consequences, Furthermore, increased temperatures and frequent climate-related shocks are likely to reduce physical activity levels and contribute to more obesity. Together, these factors will lead to increased stress on already fragile health systems which are facing damage and disruption from climate change.

Water system: Climate change will result in mounting water scarcity, impacting the availability and accessibility of water for households, and negatively affecting agricultural productivity and food security, as well as all livelihoods reliant on water. Furthermore, climate change induced water contamination will increase water-borne diseases and diarrhea, again contributing to undernutrition.

Anticipatory Action and Social Protection system: Anticipatory Action (AA) and social protection programs can enhance nutrition resilience by supporting livelihoods and ensuring access to essential services. In their absence, households often resort to harmful coping strategies, like reducing food intake, which lowers resilience. Additionally, certain climate mitigation strategies may unintentionally worsen malnutrition, underscoring the need for integrated approaches that address both climate change and nutrition.

Equity: Throughout each of these systems, gender disparities and the inequity experienced by vulnerable populations provide disproportionate impacts on women, children, and marginalized groups.

Profiling climate change risks on malnutrition in the region

Countries	Matrix Score
Afghanistan	14
Lao PDR	13
Kiribati	13
Timor-Leste	12
Vanuatu	12
India	11
Myanmar	11
Indonesia	11
Solomon Islands	11
Nepal	10
Bangladesh	10
Marshall Islands	10
Pakistan	9
Sri Lanka	9
Cambodia	9
Fiji	9
Samoa	9
Bhutan	8
Philippines	8
Federated States of Micronesia	8
Tuvalu	8
Nauru	7
Palau	7
Tajikistan	6
Kyrgyz Republic	4
Tonga	4
DPR Korea	3
Niue	3
Cook Islands	2
Tokelau	2

Matrix score developed for this report:[2]

This score reflects each Asia-Pacific country's standing within the region, considering various climate, nutrition, health, WASH, agri-food system and resilience indicators. Higher scores, like those of Afghanistan and Lao PDR, indicate greater challenges in the metrics considered. Pacific countries have lower scores, in part due to a lack of data.

[2] See Annex 2

Synergizing nutrition and climate change: Strategies for integration

Opportunities exist for the integration of climate change and nutrition in adaptation strategies and interventions. These opportunities emerge across a continuum of responses, beginning with immediate reactions to shocks, progressing through strategies that build resilience and the promotion of nutrition and health, and culminating with the overarching principles which must run through every response.

➢ Immediate reaction to climate shocks

Anticipatory Action

- Anticipatory Action (AA) enables the implementation and financing of actions before extreme climate events occur, allowing governments and communities to act days, weeks, even months or years in advance to mitigate the impact of shocks. AA has been shown to protect crops and livestock, improve household food consumption and dietary diversity, and reduce the use of coping strategies, particularly when directed towards vulnerable populations.

➢ Strategies that build resilience

Anticipatory Action and Social Protection System

- Anticipatory action and social protection programs are shown to make people and communities more resilient to shocks, promoting livelihoods and preventing the use of negative coping strategies which reduce future resilience. Importantly, social protection can be directed specifically towards addressing malnutrition by providing access to nutritious foods, removing barriers to accessing health services, and promoting sustainable food systems, each of which is shown to be particularly beneficial for at-risk groups such as pregnant and breastfeeding women, children under five, agricultural workers who depend on food systems for livelihoods, and displaced populations.

Livelihood diversification

- Livelihood diversification is an important strategy to build resilience and reduce vulnerability to the impacts of climate change on malnutrition, particularly in rural areas where households rely on climate-sensitive food production for their livelihoods. Diversifying sources of income either by moving into new sectors of expanding diversity within an existing sector is shown to reduce poverty, lower food insecurity, and improve dietary diversity.

Underutilized and indigenous crops

- Supporting the production of underutilized and indigenous crops can promote nutrition by improving nutrient intake and reducing the cost of a nutritious diet, while at the same time enhancing the resilience of food systems to climate impacts and lowering the environmental impacts of food production.

Food fortification

- Large-scale food fortification (LSFF) and biofortification are cost effective approaches to addressing micronutrient deficiencies, reducing the cost of a nutritious diet while mitigating the negative impact of increased atmosphere CO2 on crop micronutrient levels.

Reduce production and consumption of red meat in certain contexts

- Reducing the production and consumption of red meat and encouraging a shift towards plant-based diets and novel meat alternatives can have a double benefit for NCD outcomes and environmental sustainability in certain contexts. Where an increase in red meat could be beneficial for nutrition outcomes, more sustainable production should be pursued.

Innovation to reduce Food Loss and Waste

- Addressing post-harvest losses and waste is critical for improving food availability and reducing environmental impact. Moreover, since nutritious foods are often the worst affected, reducing their loss and waste can promote nutrition.

Water Security

- Strengthening water systems is essential for ensuring the availability, accessibility, and safety of water, as well as for sustaining food production, health, livelihoods, and food security under climate stress.

➢ Promotion of nutrition and health

Create an enabling environment through policy, regulation and fiscal measures

- Achieving long-term climate and nutrition resilience cannot be achieved without creating an enabling environment through policy and regulatory measures and fiscal tools across a range of sectors, including regulatory measures to reduce the consumption of unhealthy foods such as bans or strict regulations on marketing of unhealthy foods, especially to children, taxation on unhealthy products, and mandatory front-of-pack labelling which contains warnings for high sugar, salt, or fat content.

Promote, support and protect breastfeeding

- Not only does breastfeeding protect against undernutrition and NCDs later in life, this "first food system" is also "the first anticipatory action" as it protects infants from waterborne disease and undernutrition in time of climate shocks such as floods, while reducing the cost of a nutritious diet even when the nutritional needs of lactating mothers are met.

➢ Overarching principles and measures to ensure impact of every response

Make interventions equity-sensitive

- Recognize marginalized groups and the disproportionate climate change impacts they face, and ensure they are represented in designing solutions, and provided with access to resources and opportunities.

Conclusion

This report quantifies the impacts of climate change on malnutrition in Asia-Pacific, examines the pathways which lead from one to the other, and provides insights into actions for change. In doing so, this report provides a roadmap for policymakers, practitioners, and researchers to develop integrated, sustainable solutions across a continuum of responses. Through these efforts, the report can inform the integration of nutrition-focused strategies into the climate response systems in countries most at risk, building more resilient and nutrition-sensitive systems across the Asia-Pacific region.

Introduction

Climate change stands as one of the gravest threats to global health and nutrition, particularly in the Asia-Pacific region. This report delves into the complex interplay between climate change and all forms of malnutrition in the region, uncovering the multifaceted impacts, identifying gaps in literature and knowledge, and exploring strategies for mitigating these challenges. Through a comprehensive examination of the impact of climate change on all forms of malnutrition, this document aims to shed light on the broader consequences of environmental changes on the nutritional status of populations in this diverse and dynamic region.

Section 1 provides an in-depth analysis of the varied impacts of climate change on all forms of malnutrition, pinpointing critical literature gaps that hinder a full understanding of this nexus. It highlights the pressing need for targeted research and data collection to better address undernutrition, micronutrient deficiency, and the rising tide of overweight, obesity, and diet-related noncommunicable diseases (NCDs) exacerbated by changing environmental conditions.

In Section 2, we introduce a tool kit designed to identify and assess the risk from climate change to all forms of malnutrition in the Asia-Pacific context.

Constructed using 14 existing methodologies which explore different aspects of the multi-faceted threats from climate change to nutrition, the tool kit allows for a holistic understanding of vulnerability to be built. This section not only outlines the components of the tool kit but also demonstrates its application through a detailed country snapshot of Pakistan, offering insights into localized risks and responses.

Section 3 delves into the pathways through which climate change drives malnutrition, presenting frameworks that articulate these connections.

By unpacking these pathways, the report aims to elucidate the direct and indirect effects of environmental changes on nutritional outcomes, thereby informing more effective intervention strategies.

Finally, Section 4 explores the integration of climate change considerations into nutrition interventions.

From immediate reactions to climate shocks to long-term strategies that build resilience and promote nutrition and health, this section provides a roadmap for policymakers, practitioners, and researchers to develop integrated, sustainable solutions to the twin challenges of climate change and malnutrition in the Asia-Pacific region.

Climate change in Asia-Pacific

Climate change has been called a “profound existential threat” for the Asia-Pacific region (UNDP, 2024). Indeed, those living in the region are six times more likely to be affected by climate hazards and disasters than those living outside the region (EM-DAT, 2024). Research shows that climate-related disasters cause more damage, as a percentage of GDP, in the region than the rest of the world, with average annual losses amounting to $924 billion (USD), or 2.9% of regional GDP (UN-ESCAP, 2023), while more than two million people have lost their lives to these same disasters since 1970 (UNDP, 2023).

The complexity of the problem is heightened by Asia-Pacific’s notable geographical diversity, with the region encompassing all climate zones, from tropical to high mountains, and thus facing a full spectrum of climate change threats (IPCC, 2014). This includes monsoons and heavy rainfall events across South and Southeast Asia, as well as cyclones in Southeast Asia and the Pacific. It includes rising mean temperatures across the region, highlighted by the occurrence of severe heat waves, as well as increasing droughts, particularly in South Asia. It includes melting glaciers in high mountain areas, and rising sea levels which threaten many of the region’s most populous cities, such as Mumbai, Bangkok, Jakarta, and Dhaka, as well as Pacific Island countries. It includes the increasing prevalence of infectious diseases and pests across the region, particularly in temperate areas which have not traditionally faced such threats.

In short, the region faces a wide-ranging and diverse cacophony of climate change risks, making it critical to examine the full spectrum of impacts.

Malnutrition in Asia-Pacific

According to the latest available statistics, nearly 400 million people in the Asia-Pacific region are undernourished (FAO, 2023c). Moreover, nearly one-quarter of children under five are stunted (23.4%), and 13.6% of children are affected by wasting. According to the prevalence thresholds established by the WHO-UNICEF Technical Advisory Group of Nutrition Monitoring, both stunting and wasting are considered “High” in the region (UNICEF, 2023b).
In fact, more than 80 million children are affected by stunting in Asia and the Pacific, a number which represents more than half (52%) of all children who are stunted globally, while the region is home to more than 70% of the world’s children affected by wasting (31.7 million), and more than three-quarters of those affected by severe wasting (10.6 million) (UNICEF, WHO, and the World Bank, 2023). Notably, the prevalence of wasting is twice the global average (FAO, 2023c).

Additionally, micronutrient deficiencies are also prevalent in the region. This is particularly true among children, where one of every two children under five have at least one micronutrient deficiency (UNICEF, 2024b), and women, where the prevalence of anemia among women aged 15-49 years sits at 32.7% (FAO, 2023c).

Figure 1 shows the prevalence of stunting and wasting among children under 5 years of age, and the prevalence of anemia among women of reproductive age in the Asia-Pacific region. While some improvements have been seen in the past decade for stunting and wasting, the prevalence of anemia remains stagnant or on the rise. Concerningly, wasting is on the rise in some countries.

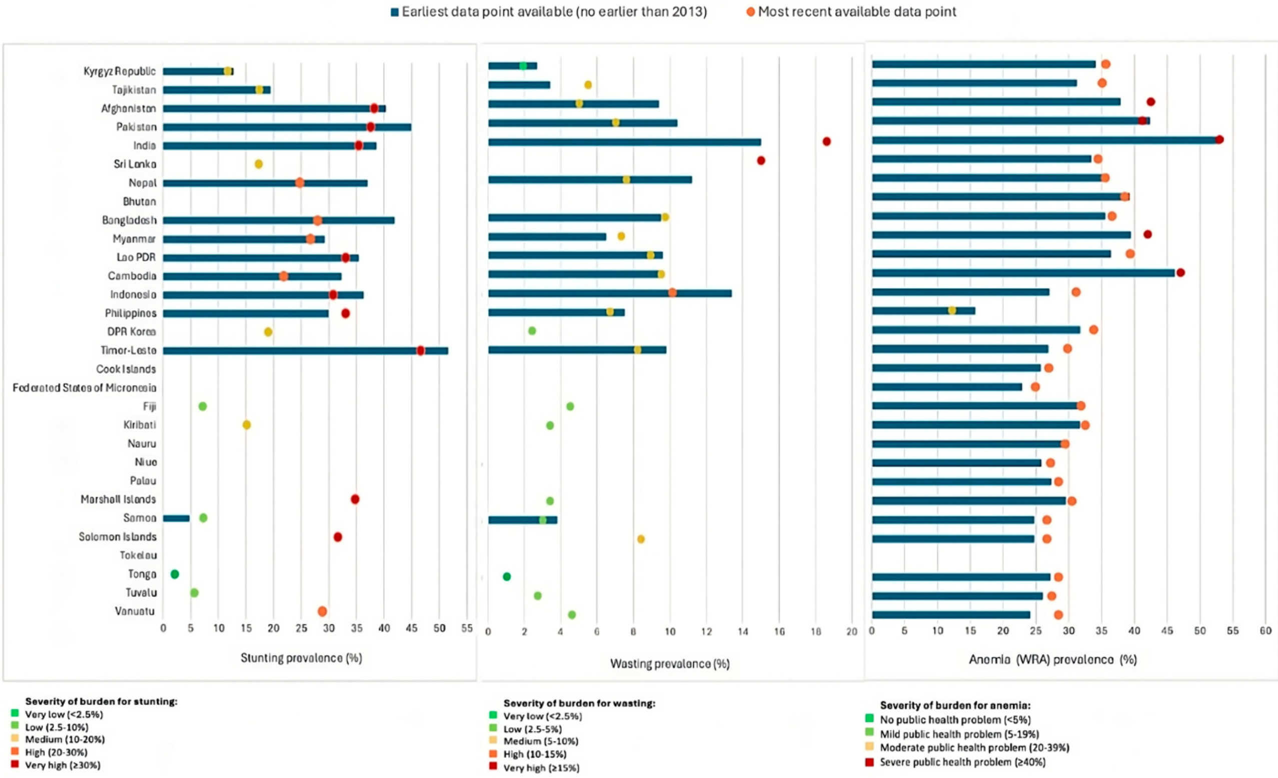

Figure 1: Prevalence of stunting and wasting in children under 5 years of age (Source: UNICEF-WHO-WB) and anemia among women of reproductive age (Source: WHO) in the WFP Asia-Pacific region by country.

Notes: This figure was produced in April 2024 with data extracted from UNICEF-WHO-WB and WHO. The blue bars represent the earliest available data point for each country on stunting and wasting prevalence and for anemia in women of reproductive age, with data no earlier than 2013. The dots indicate the most recent available data point for each country..

WRA: women of reproductive age.

In parallel with the persistently high burden of undernutrition, the percentage of the population which is overweight or obese is rapidly increasing, with numbers projected to more than double by 2035 (World Obesity Federation, 2023). Notably, nearly half of all children under five on earth who are affected by overweight live in the region, a total which now exceeds 18 million (UNICEF, WHO, and the World Bank, 2023).

Figure 2 clearly shows that the prevalence of overweight and obesity has increased in all parts of the Asia-Pacific region in the past 10 years, and that, alarmingly, near 60 and 80% of the adult population in Central Asia and the Pacific, respectively are overweight.

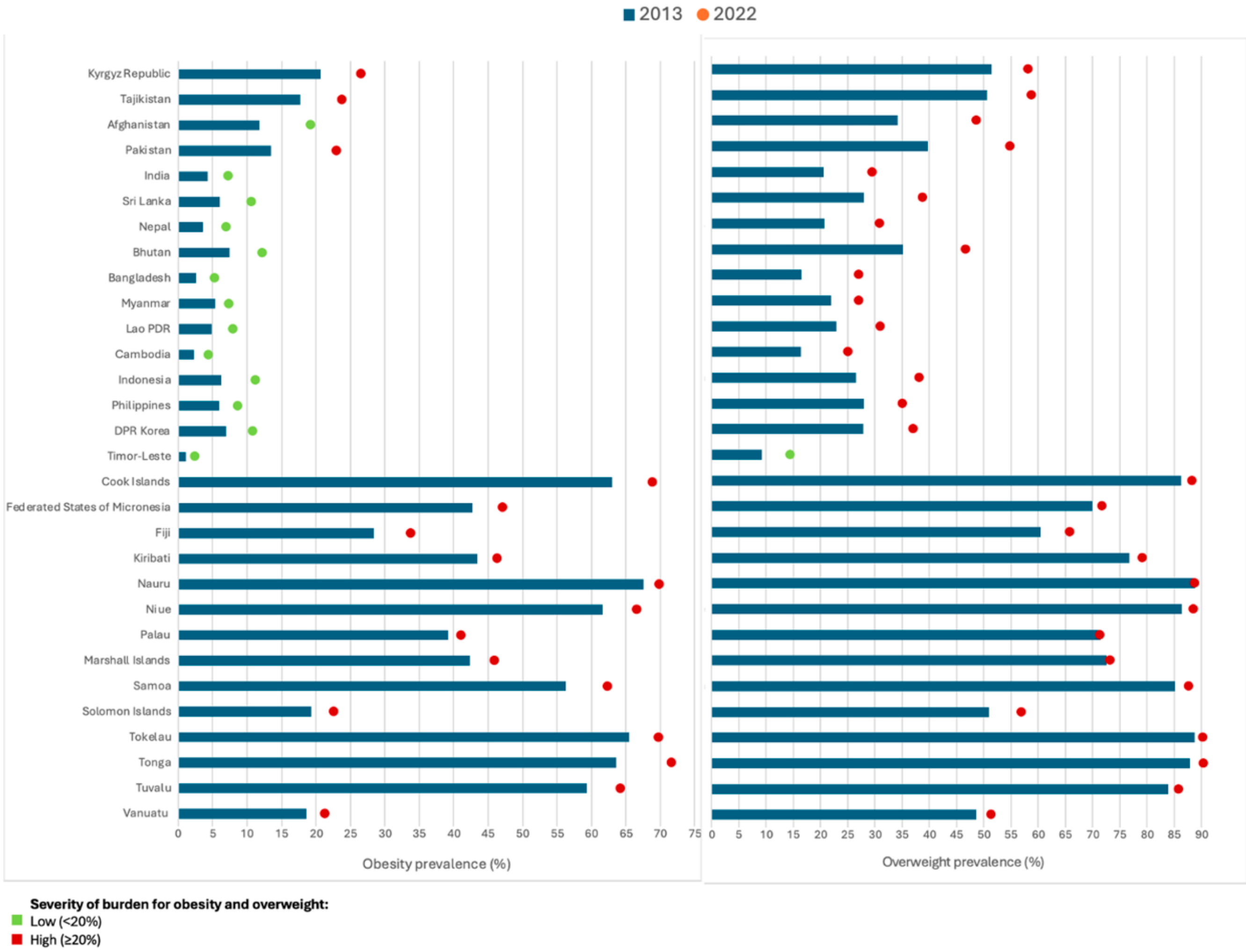

Figure 2: Prevalence of overweight and obesity among adults (Source: WHO) in the WFP Asia-Pacific region by country.)

Notes: This figure was produced in April 2024 with data extracted from WHO. The blue bars represent data on obesity and overweight for the year 2013, the dots indicate data for year 2022 for each country.

Together, undernutrition, micronutrient deficiencies, and overweight and obesity make up a well-established 'triple burden' of malnutrition in the region. Addressing malnutrition in Asia-Pacific means addressing each of these forms of malnutrition.

Key food systems sustainability challenges in the Asia-Pacific region

When examining the impacts of climate change on all forms of malnutrition in Asia-Pacific, three key food system features which impact susceptibility and outcomes can be mentioned.[3]

1. Reliance on imports

First, many countries in the Asia-Pacific region are net food importers, meaning they rely on imports for much of their food supply (ESCAP, 2022). Looking specifically at staple foods, the region as a whole produces a surplus of rice, though concentration of production in certain areas means that many countries stand as net rice importers (Sundram, 2023; Teng, 2022). Meanwhile, Asia-Pacific fails to produce enough wheat, maize, or soybeans to satisfy its needs, leaving most countries in the region reliant on imports of these staple products from elsewhere in the world (Teng, 2022).

Moving beyond staple foods, the region is a net importer of fruits, vegetables, and legumes (Springmann et al., 2023), positioning Asia-Pacific countries as dependent on imports from the rest of the world for these fundamental components of a nutritious diet.

Together, this reliance on imports leaves Asia-Pacific countries highly susceptible to climate events which disrupt global food supply chains and reduce the availability and accessibility of food imports.

2. Rapid urbanization

Second, rapid and unprecedented urbanization is currently taking place in the Asia-Pacific region, with nearly 55% of the region's population expected to live in urban areas by 2030 (UNICEF, 2023). This is changing the urban-rural nexus within food security and nutrition.

Within the context of climate change, this projection may not fully capture the scope of the transition taking place in the region. Research shows that climate-induced migration is increasing rapidly in Asia-Pacific, driven by long-term changes in weather patterns, degrading environmental conditions, and extreme weather events (UN-IOM, 2024; Asian Development Bank, 2011). While this migration may occur both within and between countries, it is most often driven by rural dwellers moving to cities as a result of climate-related failures in agricultural production in rural areas (UN-IOM, 2024; Asia-Pacific Foundation of Canada, 2013). This is projected to further increase urbanization in Asia-Pacific, with some sources suggesting as many as two-thirds of the region's population may live in urban areas by 2050 (UN-ESCAP, 2023b).

In many cases, cities are not equipped to handle these massive population influxes, meaning that urban growth is and will be accompanied by a rapid expansion of informal settlements and slums (Tacoli, 2017). This has particularly concerning implications for food security and nutrition. In urban settings, markets and income mediate access to food (Roy et al., 2023). When these things are disrupted by climate shocks which impact supply chains and subsequently reduce incomes and increase food prices, the availability and accessibility of food in urban areas can be seriously hindered, particularly for low-income households residing in slums and informal settlements (Tacoli, 2017).

Research shows that low-income households in slums and informal settlements spend a disproportionately large percentage of their income on food (Tacoli, 2017), while their budgets are further stressed by inadequate access to health and financial resources, essential services, and transportation systems (Roy et al., 2023). Moreover, research shows that food prices are often higher in low-income areas such as slums and informal settlements than in more affluent areas (Tacoli, 2017).

Together, these factors are driving food insecurity and malnutrition during rapid urbanization in Asia-Pacific. Accordingly, while traditionally it has been understood that urban areas have food security and nutrition advantages when compared to rural areas, rapid urbanization in an era of climate change means that this is no longer necessarily the case in Asia-Pacific. At once, cities are concentrating poverty in slums and informal settlements, where food security and nutrition outcomes are often worse than rural areas, while at the same time, urban areas are almost entirely reliant on food imports from rural areas, both within individual countries and globally, making them highly susceptible to climate change events which disrupt rural agriculture and supply chains.

[3] Food systems are conceptualized using the Innocenti Framework presented by UNICEF and GAIN (2019). This will be discussed in further detail later in the report.

At the same time, it can be mentioned that some research suggests more positive food systems opportunities which are arising from rapid urbanization in Asia-Pacific. For example, growing urban markets and rising demand for more diverse food products can provide new income opportunities for farmers, processors, and sellers, particularly those located close to urban markets, who research has shown receive higher returns on agricultural products (de Bruin et al., 2021).

For those still residing in rural areas, particularly those employed in agriculture, urbanization can provide opportunities for off-farm employment, diversifying streams of income, and thus increasing purchasing power and expanding options to access healthy diets (FAO, 2023c). Furthermore, as rural areas become more connected to urban areas, rural producers can gain access to better agricultural inputs and services which improve productivity and again increase income levels and access to nutritious foods (FAO, 2023c).

More broadly, the shifting food systems landscape resulting from rapid urbanization in Asia-Pacific provides opportunities to develop more sustainable production systems and supply chains (Knorr et al., 2017). This could include directing efforts towards more nutrient dense crops, adopting innovative water conservation techniques, and developing urban and peri-urban production methods such as rooftop gardens or small-land farming. It could also include an overarching focus on building new food systems which are more equitable, inclusive, and sustainable for all (HLPE, 2024).

Taken together, rapid urbanization in Asia-Pacific presents both tremendous challenges and potential opportunities. Simply, rapid urbanization means that an examination of the impacts of climate change on all forms of malnutrition in the Asia-Pacific region is rapidly transforming around an evolving urban/rural nexus, making up-to-date research more critical than ever.

3. Nutrition transition

Third, a nutrition transition is currently taking place in the region away from traditional diets and towards diets featuring unhealthy, processed foods high in salt, sugar, and fat. Contributing to this transition, imports of unhealthy, processed foods and sugar-sweetened beverages are rising across the region, increasing the availability and accessibility of unhealthy diets (Farrell et al., 2021). At the same time, climate events are reducing the availability and accessibility of nutritious foods, both by disrupting local production and by disrupting global supply chains for things like fruits and vegetables. Simply, with a nutrition transition already underway, Asia-Pacific is facing the increased availability and accessibility of unhealthy diets at the same time as the availability and accessibility of nutritious diets are declining (Farrell et al., 2021).

While the linkages between climate change and a higher consumption of ultra-processed food is still an emerging field of study, research suggests that climate change can directly contribute to an increased dependence on less nutritious imported foods (Savage et al., 2021; Boxer et al., 2023; Schubert et al., 2017). In an Asia-Pacific region already in the midst of a nutrition transition, this portends concerning impacts on nutrition.

Overall aim of the project

The overall aim of this report is to investigate and assess the direct and indirect effects of climate change on all forms of malnutrition in the Asia-Pacific region, with a particular focus on vulnerable populations. This involves analyzing how climate change impacts all forms of malnutrition, understanding the pathways that link climate change to nutrition, exploring methodologies to identify high-risk countries and groups, and examining opportunities for integration of climate change and nutrition in interventions. Taken together, the project will inform the integration of nutrition-focused strategies into the World Food Programme's (WFP) climate response system in countries most at risk, while providing support to government sectors in countries across Asia-Pacific to prepare and respond to climate shocks affecting the nutritional status of the least vulnerable.

Methods

The methods undertaken by this report incorporate three separate approaches which together provide a comprehensive compilation of findings.

Literature Review

In order to identify relevant literature on the impacts of climate change on nutrition in Asia-Pacific, searches were conducted in numerous databases and grey literature repositories, including PubMed, EBSCO, EBSCO GreenFILE, CORE, and ReliefWeb, as well as through ENN, IFPRI, and Google Scholar.

Search terms were influenced and directed by the FAO's ***Climate Action and Nutrition Pathways to Impact*** brief, as well as GAIN's 2023 framework for nutrition-sensitive, climate-smart food systems, each of which was highlighted at COP28. Together, these sources emphasize the diverse pathways through which climate change impacts nutrition.

Utilized search terms combined climate change with nutrition, child nutrition, women's nutrition, diets, dietary diversity, food consumption, stunting, wasting, obesity, urban nutrition, livelihoods, coping strategies, food safety, food loss, food availability, water safety, water access, access to markets, pests, illness, and disease.

Relevant literature chosen for this review included only studies or prediction models focused specifically on Asia-Pacific or countries within, and only those which explicitly tied climate change to malnutrition outcomes. Moreover, only literature published since 2014 was considered for inclusion, as this has been noted as the year in which research linking climate change to all forms of malnutrition began to accelerate (Headey and Venkat, 2024).

Findings were categorized based on the extent and maturity of the evidence they were supported by. This classification was inspired by methodologies used in other literature reviews (ECF, 2024; Tom et al., 2023), which helps in systematically assessing and interpreting the existing body of completed and recorded work. The classification aimed to highlight the reliability of the findings and the generalizability of the evidence across different contexts. The criteria for this classification were as follows:

- **Established Evidence**: This category includes findings supported by multiple studies, including randomized controlled trials (RCTs) and before-after studies, conducted in more than six countries. These studies must have consistently demonstrated an impact (or lack thereof) on climate change and nutrition outcomes. The breadth of evidence across diverse contexts underlines the robustness of the conclusions drawn, indicating a high level of confidence in the findings.
- **Emerging Evidence**: This classification applies to evidence derived from multiple studies or reports, but limited to one or two countries. These studies have identified an impact (or lack thereof) on climate change and nutrition outcomes. Although the evidence suggests a certain level of impact, the limited geographic scope means the findings may not be as widely applicable or established as those in the first category.
- **Limited Evidence**: This lowest category is for evidence from a single study conducted in only one country, showing an impact (or lack thereof) on climate change on nutrition outcomes. Due to the singular nature of the evidence, the findings are considered preliminary and may not be generalizable across different settings or populations.

Limitations

The review by Headey and Venkat (2024) critically assesses the literature regarding the impacts of climate change on nutrition, revealing significant limitations in existing studies. These include a wide diversity in data and methods, insufficient attention to measurement error and statistical power, questions about external validity, concerns about publication bias, and a lack of depth in exploring mechanisms linking climate change to nutrition outcomes. To improve research quality, they recommend a set of best practices and emphasize the need for new data types and interdisciplinary approaches to better understand mechanisms and test interventions. However, the review also highlights that few studies currently meet these high-quality evidence criteria, indicating a general lack of robust analysis in the field and suggesting a need for caution in interpreting existing findings.

Our findings are subject to similar limitations, as the studies we included may not fulfill all the criteria outlined in Headey and Venkat (2024) (refer to Annex 1). Consequently, although we have applied a quality of evidence assessment across the body of evidence, the epidemiological and scientific robustness of individual studies may vary.

Key Informant Interviews

In conjunction with the literature review, ten key informant interviews were conducted between February and April 2024. Experts in climate change and nutrition were engaged to provide insights and uncover relevant impacts, pathways, and practices within the Asia-Pacific region. Key informants were identified through recommendations and the Asia-Pacific United Nations (UN) network, as well as by reviewing speakers and organizers of relevant COP28 events.

Interviews followed a structured topic guide aligned with the research questions and lasted approximately one hour each. Themes and findings from the KIIs were integrated into the review, enriching the narrative and enhancing understanding. The methodology used for the KIIs can be found in Annex 1.

Data Mapping

Finally, a data mapping activity aimed to identify and assess datasets relevant to nutrition and climate indicators across the Asia-Pacific region. It involved exploring various sources such as United Nations Children's Fund (UNICEF), the World Health Organization (WHO), Demographic Health Surveys (DHS), the World Bank, and others, as well as platforms like the Climate Change Dashboard and NASA's Global Climate Change Website. The data analysis spanned a decade, covering a 10-year period to facilitate a comprehensive trend analysis. The figures present both the most recent and oldest data points within this timeframe, providing a clear view of developments and changes over time.

To assess the performance of countries within the region and identify those most at risk, we developed a matrix using conditional ranking for each indicator with the most recent data. Each indicator was ranked based on its relative performance compared to other countries in the region. This conditional ranking system allowed for a comparative analysis of each country's standing across a variety of metrics.

Furthermore, each indicator was classified as either high or low, depending on its type and direction. For example, a high rate of malnutrition would be scored as high, indicating greater risk. Conversely, for indicators like Household Dietary Diversity Score (HDDS), a high rate would be scored low, indicating lower risk. This categorization helped to provide a comprehensive risk profile for each country. The number of high scores per dimension were compiled and added up, providing an overall ranking for each country within the region.

Key limitations of this method include the variable data availability between countries, with some countries having limited or no data availability. In such cases, these countries were still scored, though the reality on the ground might differ significantly, as seen in the Pacific region where data is lacking.

Country Selection

The desk review and data mapping process focused on a diverse range of countries across different sub-regions in Asia and the Pacific. **In the Pacific region**, the countries considered included the Cook Islands, the Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, the Marshall Islands, Samoa, the Solomon Islands, Tokelau, Tonga, Tuvalu, and Vanuatu. Moving to **South-Eastern Asia**, the countries included Lao PDR, Cambodia, Indonesia, Myanmar, the Philippines, Timor-Leste, and DPR Korea. **In Southern Asia**, the countries covered were Afghanistan, Pakistan, India, Sri Lanka, Nepal, and Bhutan. Finally, **in Central Asia**, the review included the Kyrgyz Republic and Tajikistan. This comprehensive review aimed to map out a broad range of data across these regions, ensuring a nuanced understanding of each country's specific contexts and characteristics.

SECTION 1: Impacts of Climate Change on All Forms of Malnutrition in Asia-Pacific

Understanding the impacts of climate change on all forms of malnutrition is critical for mitigating its effects. Accordingly, the following section presents the results of a literature review exploring the measured and projected impacts of climate change on all forms of malnutrition in Asia-Pacific.

While extensive literature reviews into the subject have been conducted in the past (see Richardson et al., 2024; Headey and Venkat, 2024; Owino et al., 2022; Fanzo et al., 2021), few have focused specifically on the Asia-Pacific region. Since it is well-established that the impacts of climate change on all forms of malnutrition differ according to region and context (Fanzo et al., 2021), an examination of Asia-Pacific specific literature stands as vital to addressing both issues in the region.

Key findings

Undernutrition

- Both extreme climate events and climate variability were associated with child undernutrition in Asia-Pacific.
- One study highlighted zinc deficiency in soil as a key driver of child stunting.
- Only two studies examined the impacts of climate change in adults, and only one looked specifically at maternal undernutrition. This will be discussed in the literature gaps below.

Micronutrient deficiency

- Four studies and one prediction model linked climate change to an increase in micronutrient deficiencies.
- Drivers of increased prevalence of deficiency included flooding, drought, zinc deficiency in soil, and rising CO2 emissions.
- Rising prevalence of anemia was noted in three studies as an impact of climate change.

Overweight and obesity

- No studies were found directly linking climate change to obesity in Asia-Pacific. This is particularly notable given global research in the area seen in the EAT Lancet report, and will be discussed in the literature gaps below.

Diet-related NCDs

- Two studies and one prediction model tied climate change to an increase in NCDs.
- Reduced availability of nutritious foods resulting from climate events was noted as a driver of increased risk of NCDs.

Literature gaps

- **Obesity** – No studies looked explicitly at the impacts of climate change on obesity in Asia-Pacific, leaving a growing form of malnutrition unexplored in the context of climate change. Some studies linked climate change to a shift to unhealthy diets, without making an explicit connection to obesity.
- **Gender and maternal malnutrition** – Only one study explicitly examined the impacts of climate change on women's or maternal malnutrition in Asia-Pacific.
- **Equity** – The studies identified by this review did not examine the impacts of climate change on malnutrition specifically for different marginalized groups and vulnerable populations.
- **The urban/rural nexus** – No studies looked at the impact of climate change on any form of malnutrition specifically in urban areas, and no studies considered the interplay and interconnection between rural and urban areas.

Table 1 presents a summary of evidence from studies investigating the impacts of climate change on various malnutrition outcomes, based on the number of studies reviewed, their total sample size, key findings, the impact on nutrition outcomes, and the quality of evidence. The table highlights the diverse impacts of climate change on nutrition, emphasizing the need for further research in underexplored areas. Key insights include:

- **Undernutrition**
    1. Stunting: studies indicate that extreme climate events like flooding and drought are associated with increases in stunting. Two prediction models project significant increases in stunting due to climate change by 2050. The quality of evidence is established.
    2. Wasting: studies find that flooding and climate variability are associated with wasting, with established evidence quality.
    3. Underweight: studies show that community vulnerability to climate events is linked to underweight children, with established evidence quality.
- **Micronutrient Deficiencies:** studies suggest drought and climate change could lead to increased micronutrient deficiencies, with emerging evidence quality.
- For overweight and obesity, no studies were found, indicating a gap in the literature.
- NCDs (Non-Communicable Diseases): studies link climate events to an increased risk of NCDs, with emerging evidence quality.

Table 1: Summary of evidence from studies on malnutrition outcomes

Malnutrition Outcomes		Number of Studies Reviewed (total sample size)	Key Findings	Impact on nutrition outcomes	Quality of Evidence
	Undernutrition				
STUNTING	Stunting (prevalence %)	12 (n=244,924)	• Extreme climate events such as flooding (4 studies: Gaire et al., 2016, Tiwari et al., 2022, Hossain et al., 2020, Rodriguez-Llanes et al., 2016) and drought (2 studies: Shaw et al., 2020; Freudenreich et al., 2022) were associated with stunting increases. • Climate variability was associated with stunting increases, including wet conditions (2 studies: Muttarak and Dimitrova, 2019; Freudenreich et al., 2022), extreme temperatures (1 study: Tiwari et al., 2022), and unusually cold temperatures (Freudenreich et al., 2022) • The vulnerability of a community to climate events was associated with stunting in one studies (Mahapatra et al., 2021) • One study (Bevis et al., 2023) noted zinc deficiency in soils as a driver of stunting. • Two prediction models (Lloyd et al., 2011, IPCC 2014) projected a significant increase in stunting due to climate change by 2050.	Increased stunting	Established evidence
	Length for gestational age z-score (LGAZ)	2 (n=459)	• High temperatures were associated with decreased LGAZ in one study (Shankar et al., 2023).	Increased stunting at birth	Emerging evidence
	Height-for-age z-score (HAZ)	2 (n=234,843)	• Precipitation extremes and delays in monsoon season were associated with decreased HAZ in one study each (Thiede and Gray, 2020, McMahon and Gray, 2021)	Increased stunting	Emerging evidence

Malnutrition Outcomes		Number of Studies Reviewed (total sample size)	Key Findings	Impact on nutrition outcomes	Quality of Evidence
	Undernutrition				
WASTING	Wasting (prevalence %)	6 (n=227,709)	• Flooding was associated with increased wasting in three studies (Tiwari et al., 2022, Islam et al., 2014, Rodriguez-Llanes et al., 2016) • Climate variability, including extreme temperatures and rainfall, was associated with wasting in one study (Tiwari et al., 2022). • The vulnerability of a community to climate events was associated with wasting in two studies (Mahapatra et al., 2021, Mahapatra et al., 2023).	Increased wasting	Established evidence
	Weight-for-height z-score (WHZ)	2 (n=164,441)	• Climate variability, including extreme temperatures and rainfall, was associated with lower WHZ in one study (Tiwari et al., 2022), while drought was associated with lower WHZ in one study (Kumar et al., 2014).	Increased wasting	Emerging evidence
	Mid-upper arm circumference (MUAC) – ***Children and their mothers.***	2 (n=19,954)	• High temperatures during a child's birth month were negatively associated with MUAC in one study (Hanifi et al., 2021). • Children who were exposed to cyclone in utero or during infancy along with their mothers had significantly lower MUAC in one study (Nowak-Szczepanska et al., 2021).	Increase wasting	Emerging evidence
UNDERWEIGHT	Underweight (prevalence %)	3 (n=233,803)	• The vulnerability of a community to climate events was associated with underweight children in three studies (Mahapatra et al., 2021, Mahapatra et al., 2023; Hossain et al., 2022).	Increase underweight	Established evidence
	Body mass index (BMI) – ***Children and adults.***	2 (n=102)	• Flooding reduced BMI for children and adults in one study (Starkweather et al., 2022). • Children who were exposed to cyclone in utero or during infancy along with their mothers had significantly lower BMI in one study (Mahapatra et al., 2023).	Increase underweight among adults	Emerging evidence
OTHER ANTHROPOMETRY	Head-circumference-for-age z-score (HCGAZ)[4]	1 (n=459)	• High temperatures during the first trimester of pregnancy was associated with decreased in HCGAZ in one study (Shankar et al., 2023)	Impaired cognitive function / Impaired cognitive development	Limited evidence

[4] A lower than normal HCAZ can indicate potential issues with brain development, which may be due to a variety of factors, including malnutrition, genetic conditions, or other health issues

Malnutrition Outcomes		Number of Studies Reviewed (total sample size)	Key Findings	Impact on nutrition outcomes	Quality of Evidence
	Undernutrition				
BIRTH OUTCOMES	Preterm birth	1 (n=126,273)	• High temperatures during the first trimester of pregnancy was associated with preterm birth in one study (Shankar et al., 2023b).	Increase poor birth outcomes that are all forms of intergenerational malnutrition	Limited evidence
	Stillbirth	1 (n=126,273)	• High temperatures during the first trimester of pregnancy was associated with stillbirth in one study (Shankar et al., 2023b).	Increase poor birth outcomes that are all forms of intergenerational malnutrition	Limited evidence
	Low birth weight	1 (n=1,961)	• Extreme variable rainfall was associated with low birth weight in one study (Le and Nguyen, 2021).	Increase poor birth outcomes that are all forms of intergenerational malnutrition	Limited evidence
	Micronutrient deficiencies				
	Anemia	3 (n=202,702)	• Flooding was associated with increased probability of anemia in women in one study (Oskorouchi et al. 2018). • Vulnerability of a community to climate events was associated with increased anemia in children in one study (Mahapatra et al., 2021). • One study noted zinc deficiency in soil as a driver of anemia (Bevis et al, 2019).	Increase anemia	Emerging evidence
	Micronutrient deficiencies	2 (n=3,657)	• Drought was associated with child Vitamin A deficiency in one study (Tiwari et al., 2022). • One prediction model project increased micronutrient deficiencies (zinc and iron) and a subsequent spike of DALYs due to falling micronutrient concentrations in food resulting from climate change in 2050 (Weyant et al., 2018).	Increase micronutrient deficiencies	Emerging evidence
	Overweight / Obesity				
	Obesity	0	N/A		No evidence
	Overweight	0	N/A		No evidence
	NCDs				
	NCDs	3 (n=5,347)	• Two studies linked climate events to an increased risk of NCDs (Talukder et al., 2021, Savage et al., 2021). • A rise in the number of deaths attributable to NCDs like heart disease, stroke, and cancer was projected in 2050 by one prediction model (Springmann et al., 2016).	Increase NCDs	Emerging evidence

1.1 Undernutrition

- **Climate change was associated with increased child undernutrition across Asia-Pacific.**
- **The impact of climate change on undernutrition was documented for both extreme climate events like floods, droughts, and cyclones, as well as climate variability, such as higher average temperatures, variable rainfall, and delays in monsoon season.**
- **The domains of child undernutrition affected were linear growth and stunting (indicated by reductions in height-for-age z-score (HAZ) and HAZ <-2 SD, respectively), ponderal growth and wasting (indicated by reductions in weight-for-height (WHZ) z-scores, and WHZ <-2 SD and mid upper arm circumference (MUAC), respectively), head circumference, birth length, and body mass index (BMI).**
- **One study highlighted zinc deficiency in soil caused as a driver of child stunting.**
- **Notably, only two studies examined the impacts of climate change on undernutrition in adults, and only one looked specifically at maternal undernutrition.**

Findings

Impact of flooding and wet conditions on undernutrition

- **Floods increased stunting in Nepal (Gaire et al., 2016)**

Building upon a sample of children aged 6-59 months from the 2011 Nepal Demographic and Health Survey, researchers found floods increased both moderate and severe child stunting. Notably, children from rural households were more likely to be severely stunted compared to children from urban households.

- **Stunting and wasting were more prevalent in flooded communities in India (Rodriguez-Llanes et al., 2016)**

Combining a survey of children aged 6-59 months inhabiting flooded and non-flooded communities in Odisha, India with anthropometric measurements and face-to-face interviews one year after large floods in 2008, researchers found an increased prevalence of stunting and wasting in flooded communities compared to non-flooded. The prevalence of wasting among children in areas flooded in 2006 and 2008 was 51.6%, and for those flooded only in 2008 it was 41.4%, while in non-flooded communities it was 21.2%. Moreover, children in communities flooded in 2006 and 2008 were 3.37 times more likely to suffer severe wasting than those in non-flooded areas, while those in communities flooded only in 2008 were nearly twice as likely to be severely wasted.

- **Flooding was associated with child wasting in rural India (Islam et al., 2014)**

A community-based cross-sectional study conducted in riverine areas of Assam, India, found flooding was associated with child wasting. The prevalence of wasting in flood affected areas was 21.6%, compared to 13.7% in non-flooded areas.

- **Flooding reduced BMI for adults and children in Bangladesh (Starkweather et al., 2022)**

Using anthropometric and economic data, researchers modeled the effects of 2017 flooding on nutrition in fishing families in Bangladesh. They found that the combination of declining fishing income and high food inflation during the flooding resulted in a reduced BMI-for-age for children and reduced BMI for adults, with an average decrease of 0.36 z-scores among children and 0.32 BMI units among adults.

- **Wet conditions were associated with stunting in India (Muttarak and Dimitrova, 2019)**

Using Demographic and Health Survey data in 2015-2016, researchers found that abnormally wet conditions increased the likelihood of stunting for children under five in Kerala, India. Accumulative exposure to abnormally wet conditions over a child's lifetime up to age five increased the odds of stunting by 18% for those living in the southern region, and 7% for those living in the Central and Eastern regions.

- **Precipitation extremes decreased HAZ z-score in South Asia (McMahon and Gray, 2021)**

Combining temperature and precipitation data with household survey data, researchers found that precipitation extremes in the first year of life significantly decreased children's height-for-age z-score (HAZ) in South Asia. A one unit increase in the precipitation anomaly during the first year of life increased HAZ by 2.4% and increased the odds of stunting and severe stunting by 3.1% and 2.4% respectively. Notably, children of rural households displayed an 8.4% lower HAZ and were 9.6% more likely to be stunted than urban children.

Impact of extreme temperature on undernutrition

- **Extreme temperature and rainfall were associated with child undernutrition in South Asia (Tiwari et al., 2022)**

A comprehensive literature review encompassing 42 studies between 2010 and 2020 found a positive association between extreme temperature and rainfall and childhood undernutrition in South Asia, including stunting, wasting, and birth length and weight.

- **High temperatures impacted birth length and head circumference in Pakistan (Shankar et al., 2023)**

Using maternal and neonatal anthropometry data from Thatta, Pakistan, researchers showed a negative association between daily maximal temperatures in the first trimester and birth length and head circumference. For each 5°C increase in maximum temperature during the first trimester, length for gestational age (LGAZ) decreased by 0.19 Z-scores, while head-circumference-for-age (HCGAZ) decreased by 0.14 Z-scores.

- **High temperature negatively impacted child nutrition in rural coastal Bangladesh (Hanifi et al., 2021)**

Using weather data from the last half century and household data from rural coastal Bangladesh, researchers found that temperatures exceeding 25°C in the month of birth have negative effects on children's nutrition status as measured by mid upper arm circumference (MUAC). Results indicated that children born in monthly temperatures between 22°C and 23°C measured 1mm smaller than those born at monthly temperatures between 20°C and 21°C, while those born at between 30°C and 31°C saw an almost 3mm decline in child MUAC.

- **High temperatures were associated with preterm birth and low birthweight in India and Pakistan (Shankar et al., 2023b)**

Combining data from a multi-country maternal and child heath registry with meteorological data from between 2014 and 2020, researchers found high temperatures were associated with preterm birth and low birthweight in three regions in India and Pakistan. A 5°C increase in the trimester average daily maximum temperature during the second and third trimesters meant a relative risk of stillbirth of 1.06 and 1.07 respectively, while a 5°C increase in average daily maximum temperature in the second trimester meant a relative risk of pre-term birth of 1.05.

Impact of multiple climate events and other climate-related exposures on undernutrition

- **Children from districts at high risk of extreme climate events were more likely to be underweight and stunted in Bangladesh (Hossain et al., 2022)**

Using data for children under five in 2019 in Bangladesh, researchers found that children from districts with a high multi-hazard risk score – indicating risk four major hazards: tornados, cyclones, earthquakes, and floods – were 19% more likely to be stunted and 23% more likely to be underweight than those in low-risk districts.

- **Vulnerability of agriculture to climate change was associated with child malnutrition in India (Mahapatra et al., 2021)**

A large-scale observational study in India found that the degree of a region's vulnerability of agriculture to climate change was associated with child malnutrition. Children in regions with a high degree of vulnerability were shown to be 32% more likely to suffer from stunting than those from a low vulnerability area, as well as 42% more likely to suffer from wasting, 45% more likely to be underweight.

- **Vulnerability to climate change was associated children's health in India (Mahapatra et al., 2023)**

Linking district-specific climate change vulnerability to National Family Health Survey data in India, researchers found that levels of children's health indicators were lower in districts with high vulnerability than those with a low vulnerability, including wasting and underweight proportions. For example, 35% of children from high vulnerability districts were underweight, compared to 25% from low vulnerability districts. Moreover, every 1% increase in the vulnerability index increased wasting by 0.07% and underweight by 0.10%.

- **Monsoon delays negatively impacted child nutrition in Indonesia (Thiede and Gray, 2020)**

Using four models constructed from five rounds of the Indonesian Family Life Survey implemented between 1993 and 2015, researchers found that delays in monsoon season during the prenatal period were associated with reduced child height among children 2-4 years old, and reduced weight of young children under two. Each day that the monsoon season was delayed translated into a 0.003-point reduction in height-for-age z-score (HAZ), and a 0.007-point reduction in weight for height Z-score (WHZ). Notably, data revealed that the adverse effects were more significant for girls, with each day translating into a 0.0087-point decline in WHZ.

- **Cyclone in India reduced BMI and MUAC of mothers and children in India (Nowak‐Szczepanska et al., 2021)**

Assessing the impacts of cyclone Aila in India, researchers found that both children who were exposed in utero or during infancy along with their mothers had significantly lower values of both BMI and MUAC. Notably, this was shown to be continuing several years after the event.

- **Extreme variable rainfall was associated with low birth weight in Vietnam (Le and Nguyen, 2021)**

Researchers found exposure to both excessive and deficient rainfall shocks in the second trimester of pregnancy reduced a child's birth weight by 3.5% and 3.1% respectively in Vietnam. Notably, children born to poor, rural, and low-educated mothers were shown to be especially vulnerable.

- **Drought was associated with child stunting in India (Shaw et al., 2020)**

Combining remote sensing and National Family Health Survey data, researchers found that agricultural drought was substantially associated with child stunting in India.

- **Drought was associated with low weight-for-age scores in India (Kumar et al., 2014)**

Combining monthly rainfall data with cross-sectional child level data, researchers found that in-utero exposure to drought, as well as exposure to drought in the year of birth, reduce weight-for-age scores in children. Drought exposure in the year before birth reduces weight-for-age score by 0.12, while drought exposure in the year of birth reduces it by 0.10. Moreover, children exposed to drought in-utero are 2.1 percentage points more likely to be severely underweight. Critically, low caste children are 2.6 percentage points more likely to be severely underweight if exposed to drought in-utero, while poor children are 1.8 percentage points more likely to be underweight.

- **Exposure to weather shocks in early life increases risk of stunting in children in the Kyrgyz Republic (Freudenreich et al., 2022)**

Combining a three-wave representative panel dataset with fixed effects regression models, researchers found that each of excessive rainfall, drought, and unusual cold increase the risk of stunting in the Kyrgyz Republic. Experiencing an additional month of excessive rainfall in the first 19 months of life increased the probability of stunting by 6% for boys and 2.8% for girls, while drought during the same time period increased the risk of stunting by 5% for boys and 2.5% for girls, and unusually cold temperatures increased the probability by 7% for boys and 6% for girls.

Predictions

- **IPCC 5th Assessment**

The IPCC 5th Assessment (2014) predicted the number of undernourished children in the 'South Asia' and 'East Asia/Pacific' regions in 2050 scenarios with and without climate change compared with a baseline in 2000.

The methodology behind this prediction was undisclosed, however, it predicted that an additional 4.4 million children will be undernourished in the 'East Asia & Pacific' region in 2050 under a climate change scenario compared with no climate change, and an additional 6.8 million children will be undernourished in the 'South Asia' region. Moreover, it predicted an additional two million children in the 'Asia, south' region will suffer from climate change-attributable stunting in 2030 – 1.1 million moderate and 900,000 severe stunting – and 2.7 million more children in 2050 (1.8 million, 900,000).

- **Lloyd et al.**

Lloyd et al. (2011) developed a model which accounts for both food and socioeconomic causes linked to regional scenario data in order to estimate future undernutrition and child stunting in the 'South Asia' region in 2050 under two climate change scenarios when compared to a scenario with no climate change. The first climate change scenario was derived from the NCAR model, representing increases to maximum temperature and precipitation of 1.9°C and 10%, while the second climate change scenario was derived from the CSIRO model, representing a 1.2°C temperature increase and 2% precipitation increase. Each scenario is forced by a medium-high emissions scenario.

The model predicts that the percent of the population which is undernourished in 2050 will be nearly double (+97%) under climate change compared with a no climate change scenario in the 'South Asia' region. Researchers define undernourishment as the proportion of people "whose dietary energy consumption is continuously below a minimum dietary energy requirement for maintaining a healthy life and carrying out light physical activity with an acceptable minimum body-weight for attained-height." Moreover, the model predicts moderate stunting will be 29% higher with climate change than without, while severe stunting will be 61% higher in 2050.

1.2 Micronutrient deficiency

- **Four studies and two prediction models linked climate change to an increase in micronutrient deficiencies.**
- **Drivers of these deficiency increases included flooding, drought, zinc deficiency in soil, and rising CO2 emissions.**
- **Rising prevalence of anemia was noted in three studies as an impact of climate change.**

Findings

- **Flooding in Afghanistan increased the probability of anemia in women (Oskorouchi et al., 2018)**

Combining data from the 2013 National Nutrition Survey and satellite precipitation data, researchers found that floods significantly increased the probability of anemia in women of reproductive age (15-49) in Afghanistan. An extra millimeter per day of population density-adjusted flooding increased anemia probability by 0.039-0.054.

- **Zinc deficiency in soil is associated with child stunting and anaemia in Nepal (Bevis et al., 2019; Bevis et al., 2023)**

A comprehensive literature review examined the impact of increasing zinc deficiency in soils on human health in Nepal, finding that zinc deficiency in soil has a casual impact on child stunting, a proxy indicator for human zinc deficiency, and increased prevalence of anaemia across the country, particularly in the more isolated western regions. A one part-per-million increase in plant-available soil zinc would decrease child stunting by 14% and severe stunting by 20%, and decreases the likelihood of anemia by nine percentage points.

- **Vulnerability of agriculture to climate change was associated with anemia in India (Mahapatra et al., 2021)**

A large-scale observational study in India found that the degree of a region's vulnerability of agriculture to climate change was associated with child malnutrition. Children in regions with a high degree of vulnerability were shown to be 64% more likely to suffer from anemia.

- **Drought was associated with child Vitamin A deficiency in South Asia (Tiwari et al., 2022)**

A comprehensive literature review encompassing 42 studies between 2010 and 2020 found that drought had an association with negative nutrition outcomes in children in South Asia, including on a reduced Vitamin A status in preschool children.

Predictions

- **Weyant et al.**

Weyant et al. (2018) created a microsimulation model incorporating estimates of climate change, crop nutrient concentrations, dietary patterns, and disease risk in order to predict the extent to which CO2 concentrations will increase nutritional deficiencies, and the impacts of these deficiencies. The model predicts that in the presence of increasing CO2 concentrations, decreasing zinc and iron concentrations would induce an additional 44 million DALYs in the South-East Asia region between 2015 and 2050.

1.3 Overweight and obesity

- **No studies were found directly linking climate change to obesity in Asia-Pacific. This will be discussed below in the gaps in literature.**

1.4 Diet-related NCDs

- **While research was lacking on obesity, two studies and one prediction model tied climate change to an increase in NCDs.**
- **Reduced availability of nutritious foods resulting from climate events was noted as a driver of increased risk of NCDs.**

Findings

- **Extreme weather events exacerbated the incidence of NCDs in India and Bangladesh (Talukder et al., 2021)**

Using a literature review supported by field observations and informal interviews with key informants in three countries, including India and Bangladesh, researchers found that extreme weather events such as cyclones, flooding, and droughts can exacerbate the incidence of some NCDs including cardiovascular disease, cancers, and respiratory issues among smallholder farmers. Heat-triggered chronic kidney disease associated with recurrent dehydration was also noted in India.

- **Climate change impacts increased the risk of NCDs in Vanuatu (Savage et al., 2021)**

Combining semi-structured interviews with community fieldwork in two villages in Vanuatu, researchers found climate impacts – including both extreme events such as cyclones and extreme variability such as more frequent dry or wet periods – were perceived by participants to lead to an increased risk of NCDs through a reduced availability of nutritious local crops like fruits and vegetables, and an increased dependence on imported, less nutritious foods.

Predictions

Springmann et al.

Springmann et al. (2016) link IMPACT's predictions for production and consumption to a comparative risk assessment for changes in fruit and vegetable consumption, red meat consumption, and food availability in order to predict the number of deaths attributable heart disease, stroke, cancer, and other climate-related causes under a combination of four potential emissions pathways. The multi-step methodology follows a path from the impacts of climate change on agricultural yields, which is expected to reduce global food production and consumption, to subsequent changes in dietary and weight-related risk factors and associated increases in NCDs and mortality.

Data is provided for two relevant regions – 'low- and middle-income countries of South-East Asia' and 'low- and middle-income countries of the Western Pacific.' In both regions, fruit and vegetable consumption, red meat consumption, and food availability are each projected to be negatively impacted by climate change, resulting in an additional 164,000 climate-related deaths by 2050 in the 'South-East Asia' region, and 264,000 additional deaths in the Western Pacific.

(For an estimate of fruit and vegetable consumption, red meat consumption, and food availability, please see Table 2, Table 3, and Table 4 in Appendix 1. For per capita climate-related deaths in different countries, see Figure 3 in Appendix 1.)

1.5 Literature gaps

Most of the available literature identified by this review was focused on the impacts of climate change on undernutrition, specifically for children, while some literature tied climate change to micronutrient deficiencies and an increased risk of NCDs. While these findings have notable value, significant gaps in the literature were identified. In each case, future research is urgently needed in order to better understand the Asia-Pacific-specific impacts of climate change on all forms of malnutrition.

Obesity

While numerous studies examined undernutrition, and relatively fewer looked at micronutrient deficiencies or NCDs, no studies looked explicitly at the impacts of climate change on obesity in Asia-Pacific, leaving a growing form of malnutrition unexplored in the context of climate change in the region.

This is a critical gap, particularly as obesity has been noted as a pillar of a "Global Syndemic," alongside undernutrition and climate change, in the seminal EAT Lancet report (Swinburn et al., 2019). In the report, it is noted that the negative impacts of climate change on fruit and vegetable production will make those products more expensive and may contribute to a shift towards more unhealthy diets highlighted by processed foods that are high in fat, sugar, and salt. Moreover, increasing ambient temperatures could contribute to obesity through reductions in physical activity. Further, the report notes that undernutrition early in life is a predictor for later obesity, suggesting an increase in negative obesity outcomes when considered in the context of the studies related to climate change and undernutrition discussed above.

Notably, some studies identified by this literature review link climate change to a cause of obesity, unhealthy diets, though the direct connection is not tangibly made. For example:

- **Climate change impacts led to unhealthy diets in Vanuatu (Savage et al., 2021)**

  Combining semi-structured interviews with community fieldwork in two villages in Vanuatu, researchers found climate impacts – including both extreme events such as cyclones and extreme variability such as more frequent dry or wet periods – led to a decreased availability of local crops, mainly fruits and vegetables, and an increased dependence on imported, store-bought foods, leading to a lower-quality diet.

- **Climate change impacts increased reliance on unhealthy foods in Fiji (Boxer et al., 2023)**

  A literature review of 22 studies revealed that rising heat and inconsistent rainfall, as well as climate-related disasters, were affecting the food supply chain in Fiji, leading to an increased reliance on processed, packaged foods.

- **Climate change contributed to a shift to unhealthy diets in Pacific Island countries (Schubert et al., 2017)**

  A comprehensive review of literature from Pacific Island countries found that climate change impacted food and nutrition security through changes in local food production and transition from traditional diets to dependence on less nutritious imported foods.

The Lancet report recommends comprehensive actions to address obesity within the context of a Global Syndemic which also includes climate change and undernutrition. Thus, a lack of literature directly linking climate change to obesity in Asia-Pacific stands as a significant gap in the literature.

To address this gap, future research should first construct projections on obesity in the region under climate change and non-climate change scenarios in the future, as well as examine how the pathways between climate change and obesity overlap with the pathways between climate change and undernutrition in order to identify opportunities for each to addressed together.

Moreover, where the Lancet report notes that undernutrition in early life is a predictor of later obesity, future research can examine the interaction between the two in Asia-Pacific, and the potential implications of the substantial and world-leading existence of stunting and wasting in the region discussed above.

Furthermore, the Lancet report indicates a global gap in literature related to how sociocultural factors contribute to obesity, indicating a need for the examination of the specific sociocultural factors which may or may not be contributing to the rising obesity in Asia-Pacific.

Gender and maternal malnutrition

While it is well-established in the literature that women face disproportionate malnutrition outcomes due to gender inequality, particularly in times of crisis (FAO, 2024), only one study identified by this literature review explicitly examined the impacts of climate change on women's malnutrition in Asia-Pacific.

Globally, however, research has now established that the impacts of climate change on nutrition-related outcomes are gendered, disproportionately impacting women (Richardson et al., 2024; Bakker et al., 2021; Committee on World Food Security, 2023). This arises due to systemic inequalities such as women having less access to resources, including those designed to mitigate climate change, less control over land and assets, and less power and input in decision making, which combine to make women less resilient and adaptive to the impacts of climate shocks on malnutrition.

Additionally, the impacts of climate change on malnutrition have been shown to be worse for pregnant and lactating women, along with their children (Fanzo et al. 2021; Richardson et al., 2024; Fanzo et al., 2018), indicating that the effects of climate change have the potential to worsen the intergenerational cycle of malnutrition.

Accordingly, data examining the gendered effects of climate change on all forms of malnutrition in Asia-Pacific are notably lacking, and urgently required.

Equity

Expanding upon literature gaps related to gender, research has shown that rates of malnutrition are often not distributed equally between different population groups within countries around the world (Nisbett et al., 2022). In addition to gender, variations in nutrition outcomes have been noted in different contexts based on factors such as household income, education level, religious affiliation, ethnicity, sexuality, and disability, with socially marginalized groups often suffering from disproportionate negative outcomes.

This extends specifically to the context of climate change, where global research shows that an individual's capacity to adapt to climate change is influenced by factors such as access to resources and existing social capital, factors directly impacted by inequality and marginalization (Hill and Hiwasaki, 2019).

However, the studies identified by this review did not examine the impacts of climate change on malnutrition specifically for different marginalized groups and vulnerable populations in Asia-Pacific, representing a significant gap in the literature for the region. As such, additional research is urgently needed into the impacts of climate change on the malnutrition of specific marginalized groups.

Such research could be built around the concepts and pathways illuminated in the Nutrition Equity Framework (Nisbett et al., 2022), which brings together existing frameworks to illustrate how social and political processes related to unfairness, injustice, and exclusion structure the food and health environments which are critical to nutrition, acting as "the engine of nutrition inequity across place, time, and generations, ultimately influencing both nutritional status and people's space to act" (Nisbett et al., 2022). Indeed, Nesbitt et al. (2022) assert that the Nutrition Equity Framework appropriately illustrates how action on the socio-political determinants of nutrition "is the most fundamental and sustainable way of improving nutrition equity for everyone, everywhere, through equity-sensitive nutrition," allowing it to be effectively used to identify priorities for nutrition research and action.

Following the Framework, future research could provide insights into how social and political processes and norms impact food and health environments central to nutrition, as well as how injustice and exclusion influence nutritional status in the context of climate change. It could assist in understanding how living conditions related to wealth, labor, housing, and access to essential services influence everyday experiences and choices around food and nutrition and thus nutritional status. Doing so would all for the construction of an understanding of where impacts are worst, and how, and thus provide a framework for including the promotion of equity within policies and interventions.

The urban/rural nexus

Rapid and unprecedented urbanization is currently taking place in Asia-Pacific, described as the "defining megatrend" in the region by the UN (UN-Habitat, 2023). Yet, despite this, most studies identified by this literature review were focused on either rural areas, or on countries and regions more broadly. Not one study looked at the impact of climate change on any form of malnutrition specifically in urban areas, and not one study considered the interplay and interconnection between rural and urban areas.

This is a notable gap within the literature, particularly considering that it has been established globally that rapid urbanization is changing the urban-rural nexus within food security and nutrition, particularly in the context of climate change (Richardson et al., 2024).

Notably, studies conducted before 2014, and thus outside the scope of this literature review, do suggest a connection between climate change and urban malnutrition in Asia-Pacific. For example, Goudet et al. (2011) identified flooding as a major cause of malnutrition among infants and young children in urban slums of Bangladesh. Goudet et al. (2011b) indicated that breastfeeding and complementary feeding practices for infants and young children were negatively impacted by flooding, leading mothers to decrease their personal food intake.

Updated research is needed into how malnutrition is impacted by climate change in urban areas across Asia-Pacific, particularly in slums and informal settlements where food security has been shown to be worse than rural areas in many cases. Moreover, the connectivity between urban, peri-urban, and rural areas, how they interact with each other, and how this interaction impacts malnutrition, are also an important point of interest for future research.

Section 2:
Tool kit to identify and assess risk from climate change to malnutrition

As global efforts to combat the impacts of climate change have increased in recent years, a debate has arisen over how to define vulnerable countries and communities in order to best, and most fairly, direct mitigation and adaptation initiatives. This debate formed a significant backdrop to both the COP27 and COP28 proceedings. Accordingly, this section explores existing methodologies used to identify and assess countries and the subsets within them most at risk due to the impacts of climate change on malnutrition.

It highlights nine methodologies which explore different aspects of the multi-faceted threats from climate change to nutrition, allowing for a holistic understanding of vulnerability to be built. Further, it provides six additional tools which can be used to assess risk in greater detail within vulnerable countries and communities. Together, these methodologies and tools represent a tool kit which can be applied in Asia-Pacific or around the world to ascertain who is at risk, and how this risk emerges and functions. The section provides just such an application of this tool kit, presenting a six country snapshots in which a country shown to be at risk is analyzed in greater detail using the full scope of available tools.

Finally, the section builds upon the tool kit by presenting a comparative risk ranking for various countries in the region based upon a proprietary matrix score reflecting various socio-economic and health related indicators.

Key findings

Tool Kit and Climate Change Risks to Nutrition in Asia-Pacific

The tool kit for assessing the impact of climate change on nutrition includes models and indexes that identify vulnerabilities and predict food security challenges. Tools like the ND-GAIN Country Index evaluate overall vulnerability, while models like IMPACT forecast changes in food consumption and hunger risks. Additionally, specific models assess nutrient availability and the impact of CO_2 on protein and micronutrient levels. The tool kit also addresses gender inequality and child nutrition vulnerabilities, offering a comprehensive view of how climate change affects nutrition globally, with a focus on the Asia-Pacific region.

2.1 The tool kit

Overall vulnerability

- **ND-GAIN**

The ND-GAIN Country Index shows the vulnerability to climate disruptions of 185 countries through the use of more than 40 core indicators designed to measure a country's exposure, sensitivity, and ability to adapt to the negative impacts of climate change. While it is not food or nutrition specific, many of its indicators are related to nutrition. Critically, each country can be examined individually, with a score provided for each vulnerability indicator, including areas like child malnutrition, agricultural capacity, food import dependency, deaths from climate change induced diseases, and so on. From this, specific risks can be identified and assessed.

Figure 4 shows the country index for Asia-Pacific countries, comparing scores in 2013 with 2021 scores.

While scores for the majority of countries have improves somewhat in the past decade, all countries are in the "yellow" to "red" zones in terms of their combination of vulnerability and readiness, and scores have decreased in four of the most populous countries (India, Pakistan, Bangladesh and Indonesia).

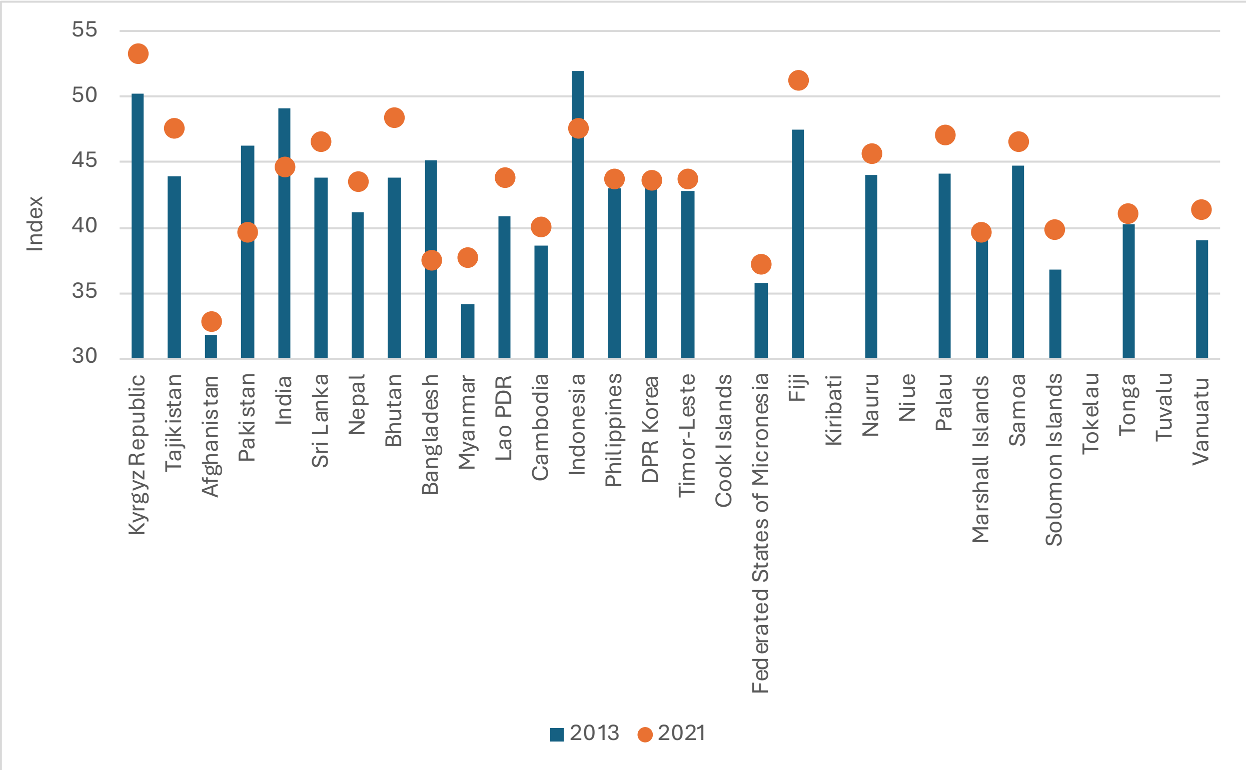

Figure 3: The ND-GAIN Country Index for WFP Asia-Pacific countries (Source: Notre Dame Global Adaption Initiative; Interpretation: Higher scores are better)

Looking at the data differently, the ND-GAIN Country Index also allows for assessing the countries in a matrix of exposure to climate impacts plotted against readiness to implement adaptation strategies (Figure 4). The 11 countries in the upper left quadrant are of particular concern because they display both high vulnerability and a low level of readiness, emphasizing the urgency of investment.

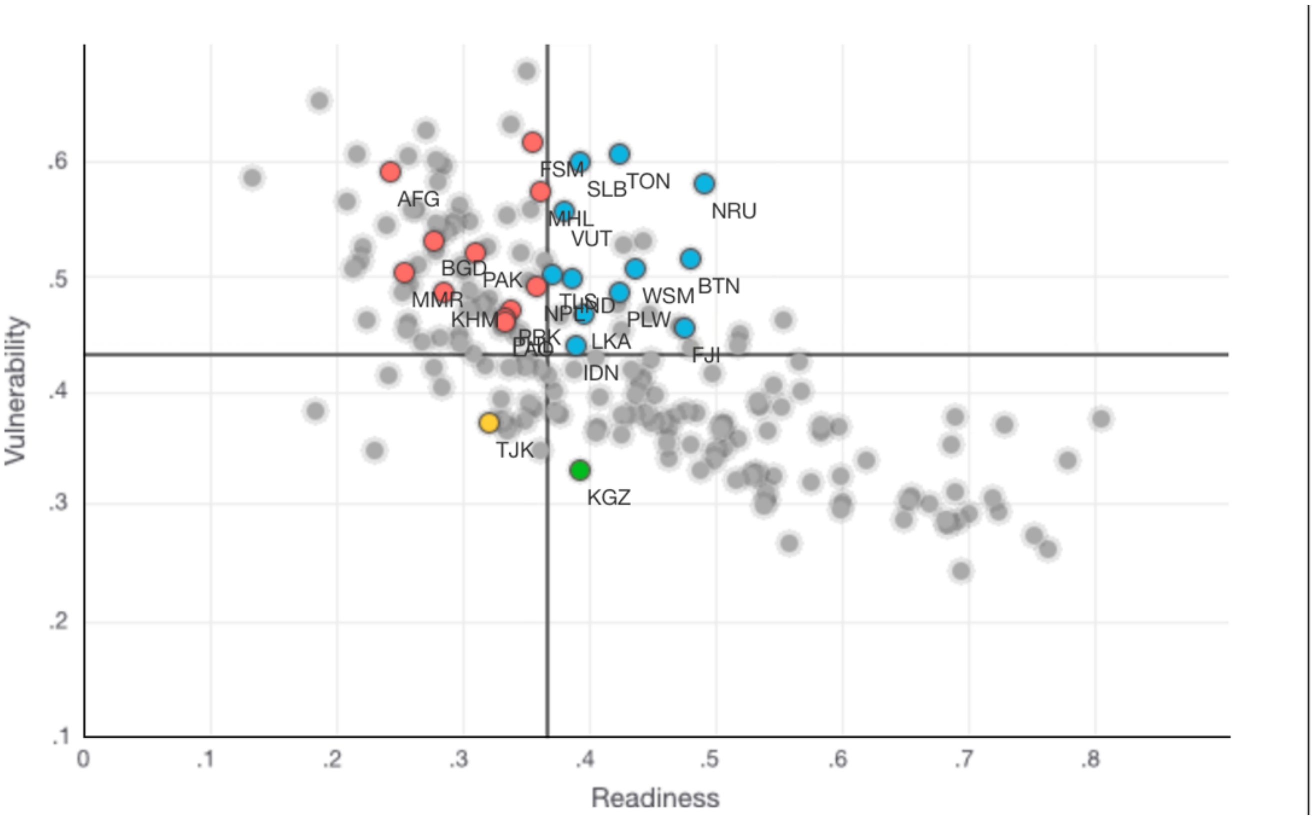

Figure 4: Vulnerability to climate change and readiness matrix to mitigate climate change among WFP Asia-Pacific countries

- **INFER**

Utilizing 95 indicators which build upon the UN's disaster risk management literature and the INFORM Risk Model, INFER allows for tracking and comparison of risk from climate change within and across countries in Asia and the Pacific, based on three outcomes – human health and nutrition, ecosystem health and sustainability, and shared prosperity – across six dimensions of food security – availability, access, utilization, stability, agency, and sustainability. With this model, an overall risk score for each country is provided, as well as an individual score for risk to the three food system outcomes, and an assessment of which countries face the fastest growing risk. Critically, INFER can be used to construct individual risk profiles for specific countries which show risk trends and drivers.

Food production systems

- **Cottrell et al. – Food production shock hotspots**

Cottrell et al. (2019) developed a model to assess the occurrence of shocks in global food production systems. Combining global production data from crop, livestock, aquaculture, and fisheries sectors over 53 years with models identifying shocks, their drivers, and their recovery time, specific shock hotspots are identified and mapped for each food production system in regions around the world. Figure 5 shows food production shock frequency in crop, livestock, fisheries sectors.

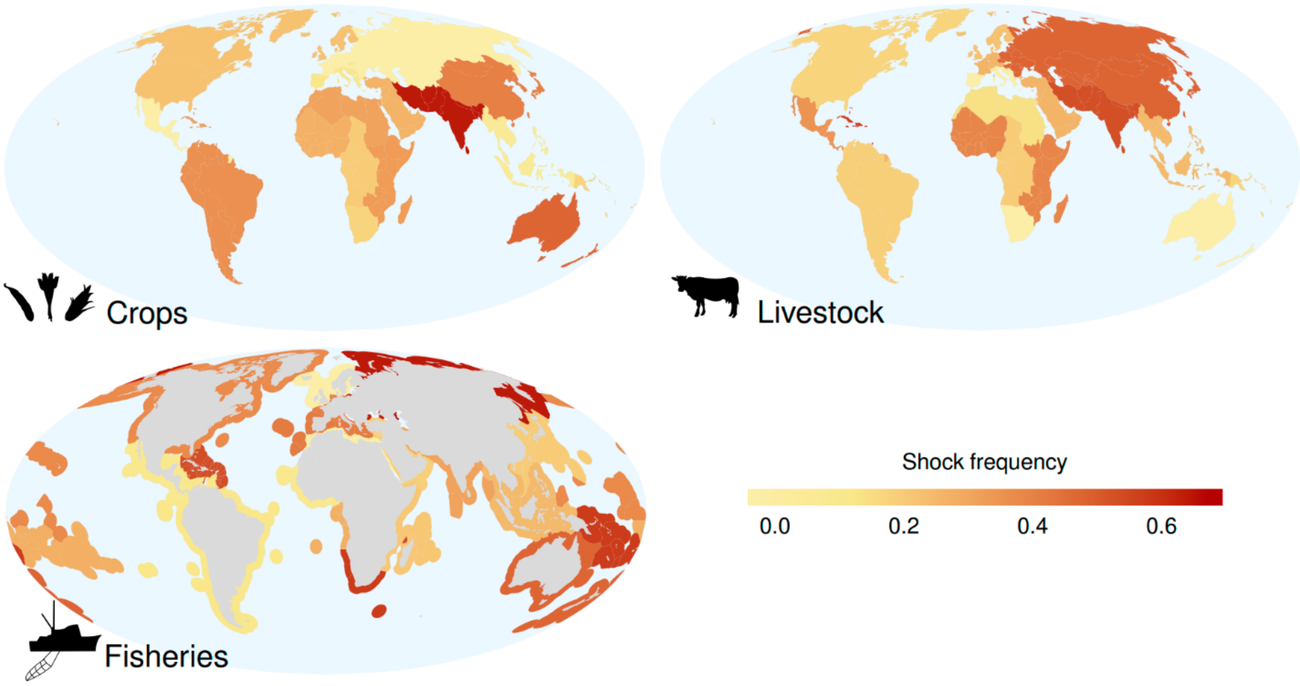

Figure 5: Shock hotspots for crops, livestock, and fisheries (Cottrell et al. 2019).

Consumption and hunger

- **IMPACT**

The IFPRI's IMPACT model provides predictions regarding food production, food consumption, and the population at risk of hunger in 159 countries under climate change scenarios in 2030 and 2050. The model can be used as a methodology to identify and assess countries most at risk from the impacts of climate change on malnutrition by examining data on countries predicted to face the most significant declines in food consumption and most significant increases in hunger.

(For regional and country specific IMPACT data on food production, food consumption, and hunger predictions, please see Tables 3-12 in Appendix 1.)

- **Hunger and Climate Vulnerability Index**

The WFP's Hunger and Climate Vulnerability Index (HCVI) (Krishnamurthy et al., 2014) enables country-level assessments of vulnerability to food insecurity and hunger under different climate change scenarios by aggregating available global datasets for different socioeconomic and environmental indicators. It defines vulnerability as a function of how households or regions are affected by adverse consequences of shocks, and how they cope with this exposure. The model has been used in numerous studies to assess the vulnerability of different countries under different temperature increases, precipitation patterns, and emissions outputs (Figure 6).

(For examples of country-specific vulnerability under different climate change scenarios, please see Figure 18 and Figure 19 in Appendix 1.)

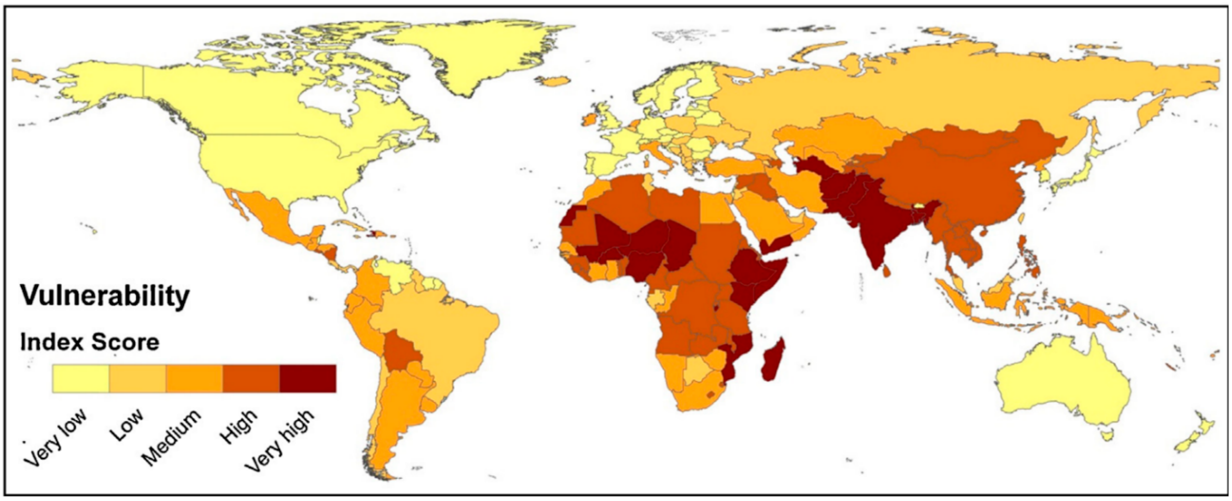

Figure 6: Map of current vulnerability of country food security to climate risk (Krishnamurthy et al. 2014)

Nutrient availability, deficiency

- **Beach et al. – Nutrient availability**

Beach et al. (2019) combine IMPACT with the Global Expanded Nutrient Supply (GENuS) model and use climate-related projections from the high-emissions Representative Concentration Pathway (RCP) 8.5 climate scenario, alongside nutrient projections from two datasets (Loladze, 2014 and Myers et al., 2014) to predict the effect of increased atmospheric CO_2 on per capita availability of protein, iron, and zinc in 2050 (Figure 7 and Figure 8).

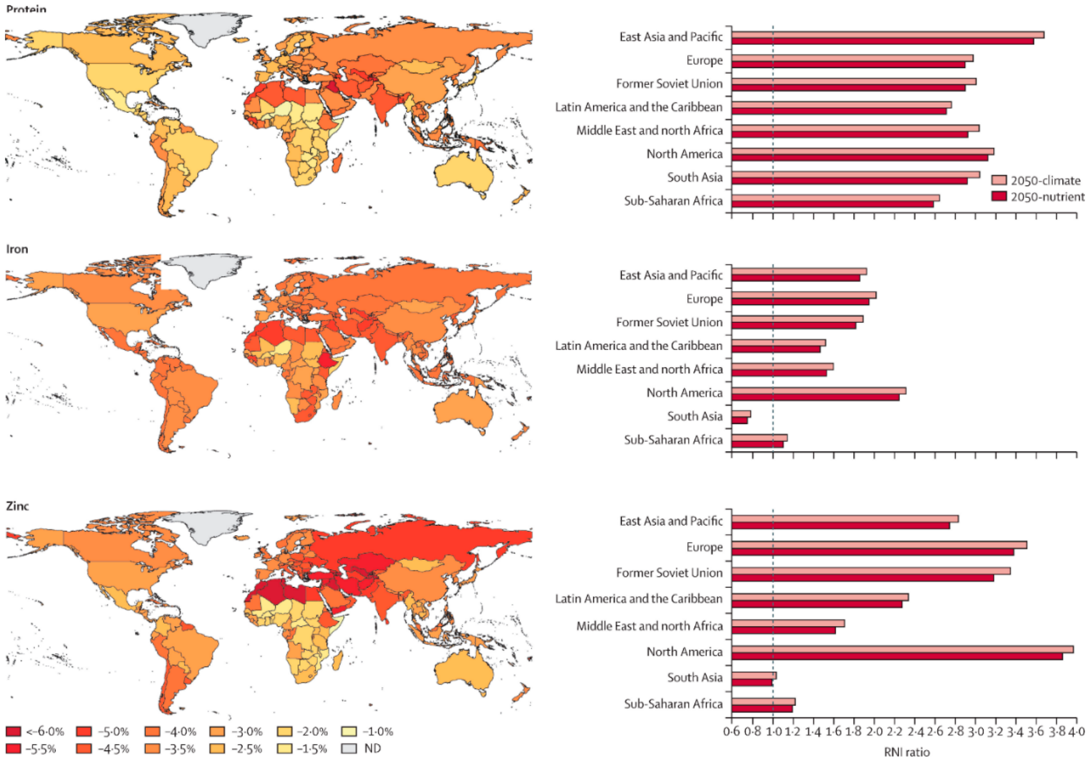

Figure 7: Net effects of increasing atmospheric CO2 on nutrient availability by country in Loladze (2014) dataset (Beach et al. 2019).

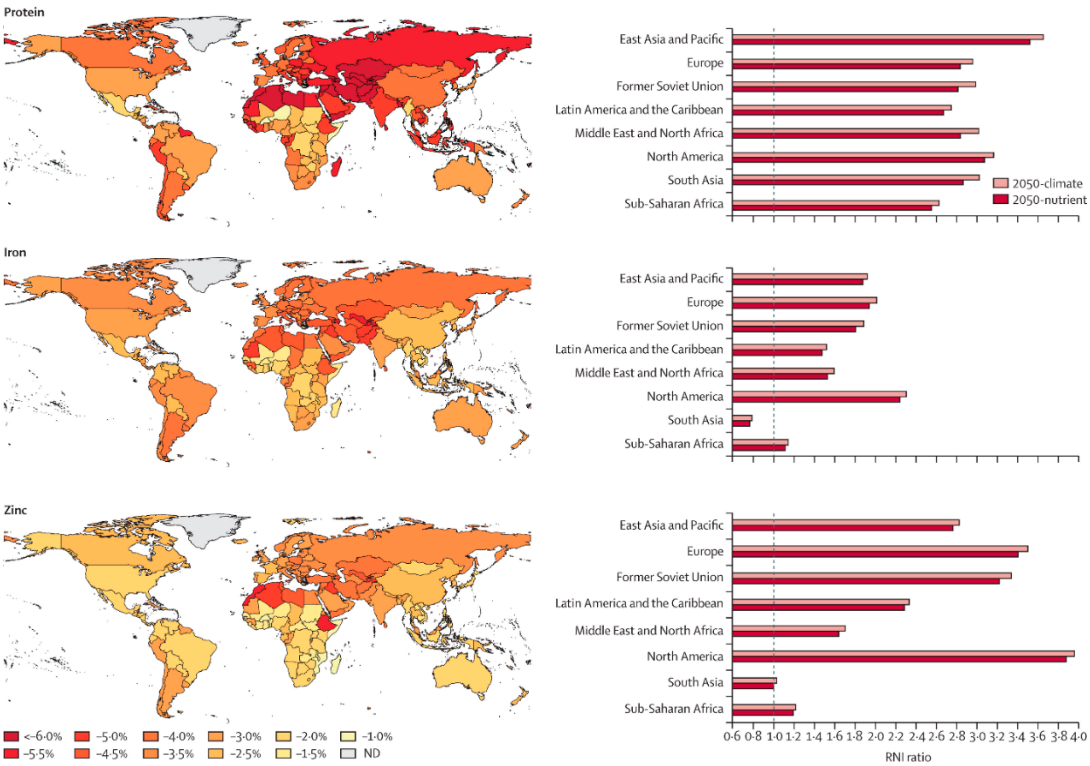

Figure 8: Net effects of increasing atmospheric CO2 on nutrient availability by country in Myers et al. (2014) dataset (Beach et al. 2019).

Vulnerable populations

- **CGIAR – Climate-Agriculture-Gender Inequality Hotspots**

CGIAR (Koo et al., 2022) provides a methodology to identify climate-agriculture-gender inequality hotspots, defined as areas where high levels of climate hazards converge with high levels of women's labor participation in agriculture and food systems, and high levels of women's vulnerability due to prevailing gender inequalities (Figure 9). The methodology allows for a specific assessment of risk to the food security and nutrition of women. Moreover, researchers note that the methodology can be applied to identify subnational hotspots within countries.

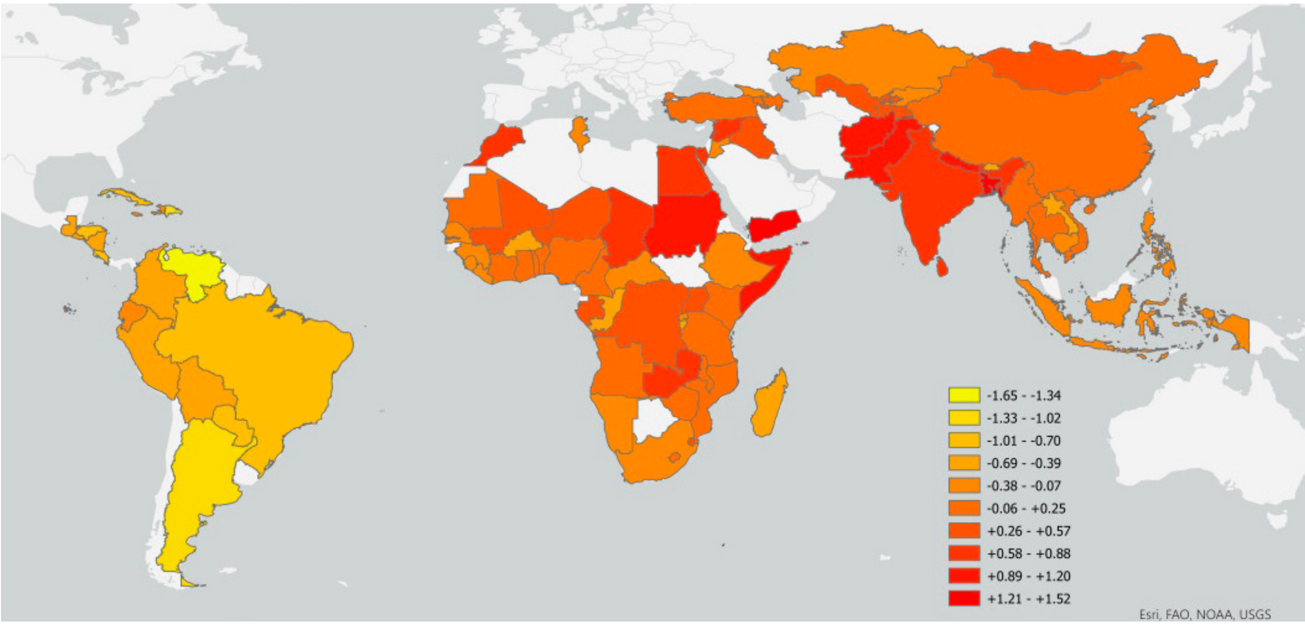

Figure 9: Map of global climate-agriculture-gender inequality hotspots (Koo et al. 2022).

- ## Cooper et al. – Vulnerability of child stunting under drought

Cooper et al. (2019) provide a model which specifically examines vulnerability to child stunting under drought based on historical observations of drought, geographic conditions, and nutrition outcomes, and predicts where child stunting would be expected to increase under drought conditions (Figure 10).

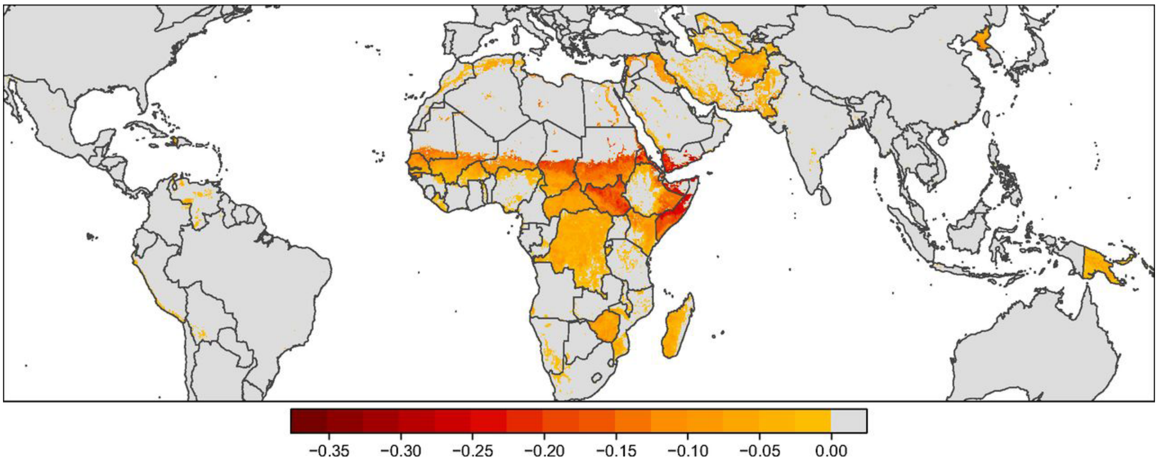

Figure 10: Expected decrease in mean child height-for-age scores during drought conditions (Cooper et al. 2019).

- ## Smith et al. – Anemia in women and children

Combining the GENuS model with FAO food data and estimates, and data from the Global Dietary Database, Smith et al. (2017) construct a model to estimate the risk of anemia in 152 countries due to loss of dietary iron resulting from anthropogenic CO2 emissions between now and 2050. Specifically, the model as used to examine risk in children (1-5 years) and women of childbearing age (15-49 years). The most at-risk countries were those in which the current prevalence of anemia exceeds 20% and the modeled loss of dietary iron would be most severe (Figure 11).

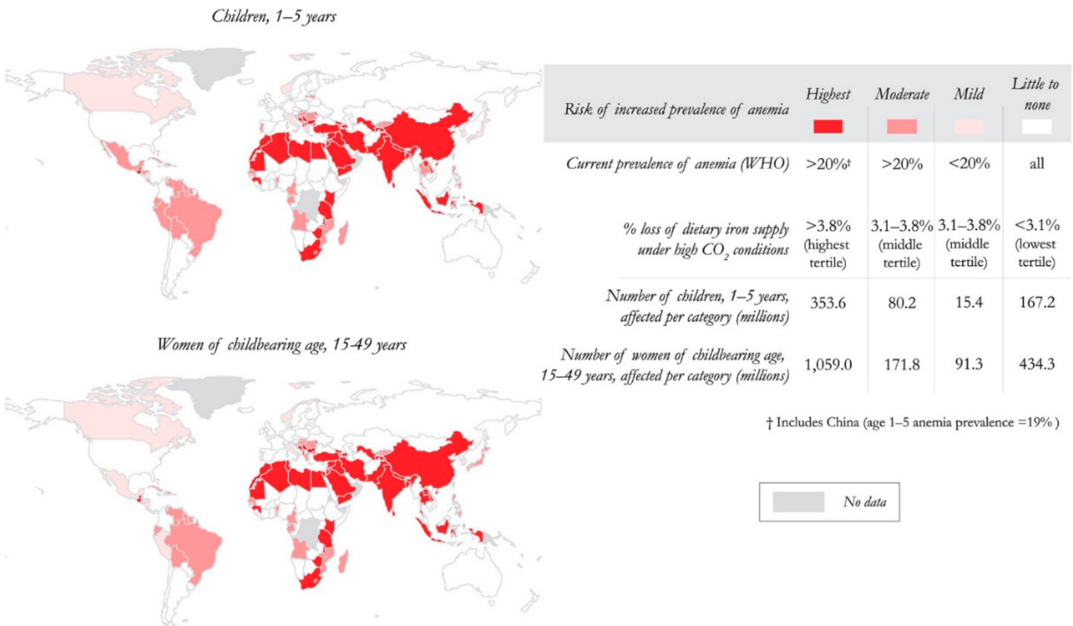

Figure 11: Risk of increased prevalence of anemia in children and women of childbearing age (Smith et al. 2017).

Additional tools

- **CGIAR Gender Toolbox**

CGIAR has developed a Gender Toolbox (Ferdous et al., 2014) which aides assessment of the differences in vulnerability of men and women to climate change within regions and countries. Specifically, it allows for an examination of the relationship of gender to factors such as climate, labor, wealth, empowerment, and changing farming practices, while facilitating the construction of data on gendered differences in each. The toolbox has been used for analysis of proposed climate interventions and the integration of gender issues within, including the risk of women under different intervention strategies in different countries.

- **The Rural Household Multiple Indicator Survey (RHoMIS)**

The Rural Household Multiple Indicator Survey (RHoMIS) is a tool which uses rural household surveys to generate quantitative information on 17 different indicators covering the whole food system, including food availability, dietary diversity, nutrition, agricultural production, poverty. Notably, new indicators of interest can be easily added to individual assessments. The tool can be used to assess how farming strategies generate and interact with food security and nutritional status, as well as which types of climate change risk are most relevant to different regions and communities.

- **IFRC Framework for Climate Action**

The IFRC (2021) has developed a framework to analyze the climate-health-livelihoods nexus in specific countries in order to build community knowledge and awareness on the region-specific impacts of climate change, and support climate change adaptation practices and policies. The framework includes compilation of existing government and NGO reports, as well as peer-reviewed literature, while primary data is collected through informant interviews with experts working in each region. Through this, a broad picture of specific climate change threats and vulnerabilities is constructed. The framework has been applied to relevant Asia-Pacific countries, including Afghanistan, Fiji, Maldives, Myanmar, Nepal, and Pakistan.

- **CLEAR**

The WFP's (2016) Consolidated Livelihood Exercise for Analyzing Resilience (CLEAR) is a tool for better understanding how food security and livelihoods are impacted by climate change within specific countries. By combining data from secondary sources such as topography and agro-ecological maps, poverty and food security surveys, and meteorological agencies, with government and community consultations at the field level, CLEAR enables a mapping of livelihood zones within countries and a ranking of the resilience of different livelihoods to climate risks, which together facilitate the assessment of the impacts of future climate risks on livelihoods and food security. With these risks identified, CLEAR can be used to inform the design of climate change mitigation and adaptation initiatives in a way which takes into account the relationship between resilience, livelihoods, and climate risks.

- **WHO Vulnerability and Adaptation (V&A) Assessment**

The WHO's (2013) Vulnerability and Adaptation (V&A) assessment framework provides flexible guidance to assess which populations and geographical areas within countries are most vulnerable to different types of health impacts resulting from climate change, as well as the capacity of health systems to manage these impacts. Using a participatory process which varies in structure and content depending on local context, including socioeconomic conditions, legal and regulatory frameworks, and other factors, V&A assessments enable evaluation of who, what, and where are most vulnerable to climate change, and the identification of strengths, weaknesses, and capacities in health systems to manage climate risks to health. With this information, V&A assessments can be a useful tool to identify specific interventions to respond, and indeed they have been used in more than 50 countries to date to strengthen health systems in areas designated as high priority within countries.

- **3PA**

The key informant interviews highlighted ongoing work within WFP on including nutrition data in Integrated Context Analysis aimed at highlighting areas within countries that are both highly exposed to shocks and at high risk of malnutrition. For overall resilience building, the WFP's Three-Pronged Approach (3PA) is relevant as it provides information that feeds into related activity design, especially seasonal livelihoods planning. The 3PA is comprised of three processes at three levels:

Integrated Context Analysis (ICA) at the national level. A collaborative tool used to identify the most appropriate programmatic strategies in specific geographical areas between the government and its partners, based on areas of convergence of historical trends of food security, natural shocks, and land degradation (as an aggravating factor that heightens the risk and impact of shocks).

Seasonal Livelihood Programming (SLP) at the sub-national level. A consultative process that brings together communities, government and partners to design multi-year, multi-sectorial operational plans using seasonal and gender lenses.

Community-Based Participatory Planning (CBPP) at the local level. A "from the bottom up" tool that ensures communities have a strong voice and will lead in setting priorities. It is used to develop multi-sectorial plans tailored to local priorities, ensuring prioritization and ownership by communities.

2.2 Gaps in existing tools

While the tool kit above provides a robust framework to assess how climate change impacts malnutrition in Asia-Pacific, critical gaps in its assessment capacities can be noted.

First, no tool explicitly examines the impacts of climate change on malnutrition for vulnerable and marginalized groups beyond gender. As such, the tool kit is unable to assess risk based on factors such as ethnicity, religious affiliation, sexuality, education level, and so on, hindering its ability to provide insights into unique vulnerabilities, and construct knowledge which would facilitate the inclusion of equity in climate change and nutrition initiatives.

Second, while elements of undernutrition and micronutrient deficiencies are well-assessed, no tool explicitly examines obesity. This leaves a glaring hole in the assessment of the triple burden of malnutrition in the Asia-Pacific region.

Third, while one tool enables risk to be unpacked in rural areas, no tool explicitly looks at urban areas. This is a notable gap in the context of the rapid urbanization taking place in Asia-Pacific, and subsequent shift in the urban/rural nexus within a discussion of nutrition and climate change.

Finally, while the additional tools provided as part of the tool kit allow for the assessment of specific subsets within vulnerable countries, each has yet to be applied to most Asia-Pacific countries, including those highlighted below as particularly vulnerable. This means that a critical lack of nuanced data for country-, region-, and community-specific vulnerability as yet exists.

2.3 Country snapshot – *Pakistan*

Here, the toolbox will be applied specifically to Pakistan in order to illustrate how it can be used to both identify and further assess risk from climate change to malnutrition.

To begin, Pakistan is identified as one of the most at-risk countries to climate change in the world by both the **ND-GAIN** model, where its vulnerability score ranks 150th of 180 available countries, and the **INFER** model, which shows Pakistan to have the second high risk from climate change in Asia and the Pacific. Notably, utilizing the various components of the INFER model, Pakistan is shown to be among those countries with both high and rapidly increasing risk, while ranking second in risk from hazard and exposure, and third in risk to human health and nutrition.

A significant driver of this risk is revealed by the model of **Cottrell et al**., where Pakistan is identified as a hotspot for climate shocks to both crop and livestock production systems.

Expanding upon this, the **IMPACT** model identifies Pakistan as one of the most at-risk countries to hunger due to climate change in Asia-Pacific, with an additional 1.9 million people projected to face hunger due to climate change in 2030, and 3.6 million additional people in 2050, while the **HCVI model** seems to confirm this, placing Pakistan among the worst in the world with a "very high" vulnerability to hunger and food insecurity under climate change.

Additionally, the model of **Beach et al.** shows Pakistan to be at a high risk of reduced nutrient availability due to increasing atmospheric CO2, including protein, iron, and zinc, while the model of **Medek et al.** adds to this by projecting Pakistan to have between four and five million additional people facing protein deficiency in 2050 due to elevated CO2.

Looking specifically at vulnerable populations, the model of **Smith et al.** identifies Pakistan as among the worst in the world for risk of iron deficiency under elevated CO2 for both women and children. At the same time, the **CGIAR model** identifies Pakistan as a climate-agriculture-gender hotpot, the fourth worst in the world, while the model of **Brown et al.** places Pakistan among the most vulnerable countries outside of Africa to child stunting under drought.

Taken together, the toolbox definitively identifies Pakistan as one of the most at-risk countries in the world to the impacts of climate change on malnutrition. With this established, additional tools can be used to assess this risk more deeply.

First, examining the country profile provided for Pakistan by ND-GAIN reveals that Pakistan has both a notably high vulnerability score (35th most vulnerable), and a notably low readiness score (146th most ready). Simply, the country is projected to face a high number of shocks which it has low preparedness to deal with.

Furthermore, within vulnerability, Pakistan has among the worst scores in the world in agricultural capacity, dam capacity, and medical staff, while in readiness, it has among the worst scores in control of corruption, education, and innovation.

From there, two country-specific profiles constructed by the **INFER model** (ESCAP, 2024) and **IFRC Framework for Climate Action** (IFRC, 2021b) can be utilized to obtain more detailed insights into the specific risks faced by Pakistan.

To begin, INFER shows Pakistan's overall risk to be rapidly increasing over the past five years, most notably in the risk of hazard and exposure, and the risk to vulnerability. Looking deeper, this growing risk can be unpacked.

The IFPRI assessment details the projected growth in both the frequency and intensity of climate events in the country, including heatwaves and droughts, heavy rainfall, floods, and cyclones, as well as significant increases in average temperatures. Notably, by 2100, Pakistan's mean temperature is projected to rise 3-6°C depending on various climate emission scenarios – higher than the global average – while the northern mountainous region is projected to show an increase in mean temperature of up to 10-12°C.

Further, the IFPRI assessment notes that the staple crops and the land it is grown on are both relied upon for food security and livelihoods, and "highly climate sensitive." Unsurprisingly, climate change is thus projected to negatively impact livelihoods, with "huge consequences" on people's health and nutrition.

Adding to this, the IFPRI assessment notes Pakistani households already spend over 50% of their monthly on food, making them particularly vulnerable to price shocks which emerge when food systems are disrupted by climate change, with or without related impacts to livelihoods.

Moreover, INFER notes that wheat provides some 50% of the daily caloric intake for Pakistani's, a lack of dietary diversity which both increases the risk of climate shocks to nutrition, and increases the risk of micronutrient deficiency.

The IFPRI assessment notes three specific groups who are particularly vulnerable to the impacts of climate change.

First, women, and particularly pregnant women and lactating mothers, who are projected to face disproportionate food insecurity and resulting malnutrition due to climate events, alongside their children, who are expected to face impacts which are "especially severe and potentially lifelong."

Second, farmers, and particularly smallholder farmers, who are projected to face severe challenges to livelihoods as a result of the impacts of climate events on agriculture, livestock, and food production systems, and subsequent negative impacts on health and nutrition.

Finally, people living in urban slums are noted as being at particular risk to climate events, which will threaten their livelihoods, health, and nutrition, and push those already disadvantaged further into poverty, a situation exacerbated by inadequate housing facilities and poor sanitation.

Within this growing risk and its projected impacts on vulnerable populations, a critical factor is identified by the IFPRI assessment – the lack of capacity at a policy and intervention level to address and mitigate the impact of climate events on food security, health, and nutrition. Notably, this includes a lack of focus on climate impacts on health and nutrition within government policy and initiatives, and the limited implementation of policies which do exist due to a lack of financing and the need for more robust data.

Adding to the finding of the ND-GAIN model, which showed Pakistan to have among the worst scores in the world for medical staff, the assessment notes that the country faces vulnerability to health and nutrition outcomes due to limited government health facilities with qualified health professionals.

In addition, the assessment notes underdeveloped early warning and forecasting systems to be a particularly pressing vulnerability which leads to negative impacts on livelihoods, health, and nutrition.

2.4 Country snapshot – *Bangladesh*

Here, the tool kit will be applied to Bangladesh in order to identify and assess risk from climate change to malnutrition in the country.

Most fundamentally, Bangladesh is identified as one of the most at-risk countries to climate change in the world by both the **ND-GAIN** and **INFER** models. According to ND-GAIN, Bangladesh ranks 163rd out of 185 available countries, standing as the 30th most vulnerable country to climate change, and the 167th most ready country. Similarly, INFER shows Bangladesh to have the 8th highest risk from climate change in Asia and the Pacific.

A significant driver of this risk is revealed by the model of **Cottrell et al.** (2019), which identifies Bangladesh as a hotspot for climate shocks to both crop and livestock production systems.

Expanding upon this, the **IMPACT** model projects Bangladesh to be among the most at-risk countries in the region to reductions in food production under climate change scenarios in both 2030 and 2050. Furthermore, with food production at risk, IMPACT also projects Bangladesh to suffer from significant decreases in per capita food consumption and increases in hunger under climate scenarios in 2030 and 2050. In the case of the latter, IMPACT shows an additional 3.7 million people projected to face hunger in 2030 in Bangladesh under climate change, and an additional 1.8 million people in 2050. The **HCVI** model further supports this point, identifying Bangladesh as among the worst in the world with a "very high" vulnerability to hunger and food insecurity under climate change.

Vulnerability to climate change is shown to go beyond consumption through the model of **Beach et al.** (2019), which identifies Bangladesh as at high risk of reduced nutrient availability due to increasing atmospheric CO2 under climate change in 2050, including protein, iron, and zinc.

Looking specifically at vulnerable populations, the model of **Smith et al.** (2017) identifies Bangladesh as among the worst in the world for risk of anemia under elevated CO2 for both women and children, while the **CGIAR** model shows Bangladesh to be among the worst climate-agriculture-gender hotspots.

Taken together, these elements of the tool kit definitively identify Bangladesh as one of the most at-risk countries in the world to the impacts of climate change on malnutrition. With this established, additional tools can be used to assess and unpack the specific risks faced by Bangladesh in more detail. Relevant tools applied to Bangladesh include an INFER country risk profile (ESCAP, 2024), an IFRC country assessment (IFRC, 2024), and a WHO V&A assessment done in concert with the Government of Bangladesh (WHO and MoHFW, 2021).

To begin, both the IFRC and WHO V&A assessments highlight rapidly changing weather patterns in Bangladesh. This includes mean temperature, which is projected to rise by 1.1-4.0 °C between 2030-2100 (IFRC, 2024) and contribute to a five-fold increase in heat waves (WHO and MoHFW, 2021). Furthermore, it includes an increase in the country's annual rainfall, highlighted most critically by a significant increase in variability, with the country's four months of monsoon season getting wetter, and the remaining eight months getting drier, meaning an increase in floods during monsoon season, and more severe droughts during dry season (WHO and MoHFW, 2021).

Adding to temperature and rainfall changes, Bangladesh is noted as one of the most disaster-prone countries in the world, facing high numbers of cyclones, floods, landslides, and other hazards which are becoming more prevalent and more intense (IFRC, 2024).

As a result of these changes in weather patterns, food production in the country is under significant threat, with vulnerability from risk to "sustainable production" at a high level and rising significantly (ESCAP, 2024). Indeed, the INFER country risk profile notes that vulnerabilities related to environmental pressures on food production are "much more significant risk drivers in Bangladesh than the average for LMICs." Furthermore, examination of the components of Bangladesh's ND-GAIN ranking reveals that the country is among the worst in the world for vulnerability to projected change of cereal yields.

Going further, the INFER country risk profile indicates stability as a significant risk to food security in Bangladesh. A closer examination of relevant tools reveals different components which contribute to this growing instability.

First, socio-political conflict and social unrest are shown to be significant risk drivers in Bangladesh (ESCAP, 2024; WHO and MoHFW, 2021), while ND-GAIN indicates Bangladesh to be among the worst in the world at vulnerability due to control of corruption. Furthermore, INFER notes high inflation and depreciating local currency as "important threats" which contribute to instability.

Adding to these risks, the IFRC country assessment indicates significant costs due to infrastructure damage resulting from climate change, which has the potential to substantially harm the country's economic health and further contribute to instability. For example, in 2021, climate-related disasters caused approximately $11.3 billion (USD) in damages, accounting for 2.5% of GDP (IFRC, 2024).

Following the theme of instability further, it can be noted that climate change is leading to a significant spike of internal migration and displacement within Bangladesh (IFRC, 2024). For example, riverbank erosion displaces approximately 25,000 people per year (IFRC, 2024), while in 2020, heavy rains displaced more than 1.5 million people (IFRC, 2024).

Displacement is shown to be a particularly significant issue for those working in Bangladesh's agriculture sector, who make up approximately 46% of the labor force (ESCAP, 2024). Agriculture-dependent communities are experiencing crop failures due to climate changes and extreme climate events (IFRC, 2024).

As a result of this, many farmers are moving into urban areas in search of alternative income opportunities, often into informal settlements where food security and malnutrition are worst (IFRC, 2024). Alternatively, many farmers are shifting professions in response to climate change towards vocations, such as shrimp farming, which may provide short-term returns, but produce unintended consequences and negative long-term impacts on land fertility and social inequalities (IFRC, 2024).

One final, and vital, thing which warrants mention when examining Bangladesh's risk from climate change on malnutrition is the stunning lack of progress which has been made over the last decade in addressing this risk. An examination of the INFER country risk profile indicates that Bangladesh is among the worst in Asia and the Pacific in all seven measured risk indicators, including overall risk, hazard and exposure, vulnerability, lack of adaptive capacity, risk to human health and nutrition, risk ecosystem health and sustainability, and risk to shared prosperity. Critically, however, Bangladesh is ranked among the lowest in each of these indicators for fastest growing risk since 2014, demonstrating that where the risks are significant, they have not improved over the past decade.

With this in mind, the IFRC country assessment identifies various components which must be improved in order to reverse this trend. First, many communities, particularly those in rural areas, lack awareness of the impacts of climate change and relevant adaptive measures, lowering their ability to prepare for changing climate. Relatedly, many communities lack access to timely and accurate climate information, including early warning systems, reducing their ability to make informed decisions regarding livelihoods, resource management, and disaster preparedness. Furthermore, limited financial resources and competing government and NGO priorities impede critical adaptation projects, leaving communities exposed to the impacts of climate change and exacerbating existing vulnerabilities.

These can be seen as a starting point to begin reversing the risk faced by Bangladesh to the impacts of climate change on malnutrition.

2.5 Country snapshot – *Nepal*

Here, the tool kit will be applied to Nepal in order to identify and assess risk from climate change to malnutrition.

Most fundamentally, Nepal is identified as a country with high risk to climate change by both the **ND-GAIN** and **INFER** models. According to ND-GAIN, Nepal ranks 125th out of 185 available countries, standing as the 51st most vulnerable country to climate change, and the 116th most ready, while INFER shows Nepal to have the 20th highest overall risk from climate change in Asia and the Pacific.

The model of **Cottrell et al.** (2019) reveals a significant driver of this risk, identifying Nepal as a hotspot for climate shocks to both crop and livestock production systems.

The **IMPACT** model adds to this by showing Nepal to be one of the most at-risk countries in the Asia-Pacific region to a decline in per capita food consumption and an increase in hunger under climate change in 2030 and 2050. The **HCVI** model further supports this point, identifying Nepal as among the worst in the world with a "very high" vulnerability to hunger and food insecurity under climate change.

Moving beyond hunger, the model of **Beach et al.** (2019) shows Nepal to be at a high risk of reduced nutrient availability due to increasing atmospheric CO2 under climate change in 2050, including for protein, iron, and zinc.

Looking more specifically at vulnerable populations, the model of **Smith et al.** (2017) identifies Nepal as among the worst in the world for risk of anemia under elevated CO2 for both women and children, while the **CGIAR** model shows the country to be among the worst climate-agriculture-gender hotspots.

Taken together, these elements of the tool kit identify Nepal as facing significant risk from the impacts of climate change on malnutrition. With this established, additional tools can be used to assess and unpack this risk more deeply. Relevant tools applied to Nepal include an IFRC country assessment (IFRC, 2021c), a CLEAR assessment (WFP, 2014), a WHO V&A assessment (MoHP, 2022), and an application of the RHoMIS tool conducted in three regions (Giles and Tariq, 2023).

To begin, Nepal is facing significant changes in climate, including temperature increases, more erratic precipitation patterns, and an increase in extreme weather events such as floods, droughts, landslides, and avalanches (IFRC, 2021c; WFP, 2014). Indeed, the IFRC country assessment notes that Nepal experiences approximately 500 weather disaster events annually, which have been increasing in frequency and intensity, positioning Nepal as one of the most disaster-prone countries in the world. Supporting this, the INFER model notes a rapidly rising vulnerability to risk from hazards and exposure in the country.

When examining the changing climate in Nepal, perhaps the most critical factor to recognize is that the country is made up of three distinct agro-ecological zones – the floodplains, the mid-hills, and the mountain regions – each of which has its own distinct climatic conditions and climate change projections (Giles and Tariq, 2023).

For example, while rapid warming has been taking place across mountain regions, in the floodplains, there has been a cooling trend. Similarly, while the western regions of the country have experienced a decrease in precipitation, the eastern and central regions have experienced an increase in precipitation, meaning that the former is experience a heightened risk of drought, while the latter is experiencing increased incidences of flash floods (WFP, 2014).

Across regions, however, the tools indicate that changes in climate pose significant risks to the production of food. At once, regions facing droughts and higher temperatures are facing lower water availability, while at the same time, regions with increased precipitation are experiencing flooding and soil erosion, each of which harm food production (IFRC, 2021c). Moreover, in the floodplains and mid-hills regions, shifts in monsoon seasons are affecting crop cycles, while in the mountain regions, glacial melt resulting from higher temperatures is triggering landslides and flash floods which destroy crops (IFRC, 2021c). Supporting the risks posed by climate change on food production in Nepal, ND-GAIN identifies Nepal as among the worst in the world in vulnerability from a risk to agricultural capacity.

Disruptions to food production are noted as a particular problem in a country where 70% of the population is employed in agriculture (IFRC, 2021c), presenting the potential to substantially reduce farming livelihoods (WFP, 2014). This is particularly concerning in a country already ranked among the world's thirty poorest nations, in which one-third of the population are already experiencing multidimensional poverty (IFRC, 2021c). Unsurprisingly, the INFER model highlights Nepal as facing a high and rapidly growing risk of poverty and inequality.

The concern is further amplified by the CLEAR assessment, which indicates that Nepal's households already spend an average of two-thirds of their income on food. As such, any reduction in income could seriously impact the accessibility of nutritious diets for households.

Another element which threatens the accessibility of a nutritious diet in Nepal is the country's reliance on markets for a significant portion of food supply. In all regions, households rely on the market for almost 50% of their food needs, leaving them highly vulnerable to food price volatility (WFP, 2014). The INFER model supports this, indicating a high and rapidly growing risk from the stability of markets and food price increases.

Going further, the IFRC country assessment notes that climate change is exacerbating risk to human health, including through the proliferation of vector-borne and waterborne diseases, climate-induced mental health issues, and a rise in NCDs. Most notably, the WHO V&A assessment indicates that certain vector-borne diseases are appearing in locations they had not previously (MoHP, 2022). This indicates a shift in the regional variation which is so critical to understanding risk in Nepal.

Finally, with the importance of recognizing the regional variation within Nepal in mind, it can be noted that the tools indicate the mountain regions face disproportionately high risks. First, the mountain regions are projected to experience the highest temperature increases of all regions (IFRC, 2021c). This is expected to have significant impacts on food production, as warmer temperatures dry up water sources, increase the frequency of glacial melt which triggers landslides and flash floods, and turn snowfall into rain, harming winter crops (IFRC, 2021c; WFP, 2014). Additionally, livestock production is projected to be impacted by rising temperatures and increased rainfall intensity, resulting in reduced weight of animals, lower feed conversion, lower milk production, and lower reproduction (IFRC, 2021c).

Notably, the mountain regions already suffer from the highest rates of poverty in the country and spend the highest proportion of their income on food (78%), making them particularly vulnerable to climate-induced reductions in food production (WFP, 2014). This also makes the mountain regions particularly vulnerable to food price volatility, a factor which is further exacerbated by climate-related disruptions to the transportation of food to remote mountain locations, as well increasing problems with food storage due to rising temperatures (IFRC, 2021c; WFP, 2014).

Simply, where this snapshot has shown significant risks from climate change to malnutrition across Nepal, the risks faced in the mountain regions are highest.

With the notable risks from climate change to malnutrition in Nepal discussed above, the CLEAR assessment provides critical avenues for interventions and improvements to reduce these risks. First, water systems must be improved in order to adapt to drought in some regions and increased precipitation in others. Second, with the high vulnerability of livelihoods and an increasing risk of food price volatility, support can be given to income diversification, as well as to ensuring food market stabilization during shocks. Finally, early warning systems should be improved and expanded in order to enhance adaptation planning, particularly as it pertains to communities that may be unreachable during extreme weather events.

2.6 Country snapshot – *Vanuatu*

A snapshot focusing on Vanuatu must begin with a recognition that data is lacking in the country. This is an issue in the Pacific Island countries more broadly, with very few tools which make up our tool kit being actively applied in the region.

With that said, it is possible to begin to build a snapshot of risk from the few tools and methodologies which have been applied to Vanuatu. Most broadly, the **ND-GAIN** model ranks Vanuatu 139th out of 185 available countries in climate change risk, standing as the 22nd most vulnerable country, and the 105th most ready. Adding to this, the **INFER** model shows Vanuatu to have the 24th highest overall risk from climate change in Asia and the Pacific. Together, these models indicate Vanuatu to be at a high risk from the impacts of climate change on malnutrition.

The most significant recorded driver of this risk is provided by the model of **Cottrell et al.** (2019), which identifies Vanuatu as a hotspot for shocks to food production from fisheries.

Expanding upon this, the **IMPACT** model projects a significant decline in both aggregate food production and per capita food consumption in Vanuatu under climate change scenarios in both 2030 and 2050. While IMPACT does not provide projections for how these declines may impact hunger in the country, the model of **Beach et al.** (2019) does indicate that Vanuatu is projected to see a decline in nutrient availability under climate change scenarios in 2050 which are similar to or exceed global and regional averages for each of protein, iron, and zinc.

However, beyond these models, none of the other nine main methodologies provided by our tool kit have been applied to Vanuatu, while, more critically, neither have any of the six additional tools, resulting in an inability to assess risk more deeply, particularly for vulnerable populations.

Here, there are two available options to more thoroughly assess risk from climate change to malnutrition in Vanuatu which can be applied. First, different components of the ND-GAIN and INFER models can be examined more closely in order to obtain more targeted insights. From there, three reports can be utilized which, while not explicitly included in our tool kit, can each be tied to tools which were.

First, the IFRC conducted an assessment of Vanuatu in 2013, well before the release of their model included in the tool kit, which assessed community resilience in the face of climate change and variability in the country (IFRC, 2013). Second, and more recently, the IFRC released an operational update for Vanuatu in response to Tropical Cyclone Lola (IFRC, 2024b). Finally, the WHO produced a health and climate change assessment for the Vanuatu in 2020 as part of their Special Initiative on Climate Change and Health in Small Island Developing States (WHO and UNFCCC, 2020). With these three reports, supplemented by ND-GAIN and INFER, a snapshot for Vanuatu can be constructed which overcomes an overarching lack of data.

To begin, the 2013 IFRC assessment highlights a rapidly changing climate in Vanuatu, including higher temperatures, increased ocean acidification, and rising sea levels, as well as an increased frequency and intensity of extreme climate events.

Importantly, the WHO assessment shows that climate changes are projected to accelerate, including rising mean annual temperature, which is expected to increase by about 2.7 °C by 2100, as well as significant rises in sea levels, which will pose a threat to low-lying areas on Vanuatu's islands. Moreover, a rise in extreme weather events is projected, including an increasing prevalence of both floods and droughts, as well as rising frequency and intensity of cyclones. The increasing risk of changing climate and extreme weather events is highlighted by the INFER model, which indicates that risk to hazard and exposure as well as vulnerability are rising rapidly in Vanuatu.

Changes in climate are projected to have significant potential impacts on food production in Vanuatu. Adding to Vanuatu's position as a hotspot for shocks to food production from fisheries noted above, ND-GAIN identifies Vanuatu as among the most vulnerable in the world to risk of projected change in cereal yields.

These risks can be seen as serious problems in a country where two-thirds of the population works in small-scale agriculture, with food production failures asserted to be "potentially catastrophic" to livelihoods (WHO and UNFCCC, 2020). Unsurprisingly, the INFER model shows a spiking risk of poverty and inequality in the country.

Adding to this, the INFER model shows Vanuatu faces a high and rapidly increasing risk from market instability and food price inflation. Combined with a risk of lowered food production, what emerges is a high and rapidly growing risk to food availability and access, as well as food system sustainability. Indeed, the INFER model shows that each of these dimensions has seen rapidly spiking risk in recent years.

Looking further into the rankings provided by the INFER model, it can be noted that Vanuatu is identified as having the 6th highest risk to human health and nutrition. Expanding upon this, the WHO assessment notes that Vanuatu faces an exacerbation of climate-sensitive diseases, including vector-borne, waterborne, and foodborne diseases, as well as heat-related medical conditions, while the INFER model indicates obesity to be a high and rapidly growing risk in Vanuatu.

Two specific characteristics are noted as significant contributors to an increase in these risks. First, Vanuatu faces a fragile water supply at risk of contamination from saltwater resulting from rising sea levels and extreme weather events, putting access to safe water at risk, and potentially increasing the spread of disease and infections (IFRC, 2024b). Second, the functioning of health care services is also fragile, at risk of damage from extreme weather events, as well as overburden from rising prevalence of health problems (WHO and UNFCCC, 2020). Adding to this, ND-GAIN shows Vanuatu as having among the worst vulnerability in the world to risk from a lack of medical staff and a dependency on external resources for health services.

Finally, one additional factor which increases Vanuatu's risk from climate change to malnutrition must be mentioned. Made up of more than 80 islands in the Pacific Ocean, the remote nature of large parts of Vanuatu's population provides unique challenges to food security and nutrition.

The first problem is logistics. The costs of air and sea transport as well as low available capacity restricts the availability of assistance to all communities, both to adapt to climate change and recover from extreme events (IFRC, 2024b). Second, communication with all impacted communities can be difficult, requiring satellite phones and radio networks, and making collaboration on problem solving more complex than in many other countries (IFRC, 2024b).

Despite notable challenges, there is at least one significant positive identified by the available tools. The INFER model shows that risk from adaptive capacity is declining rapidly in Vanuatu over the past five years. Indeed, Vanuatu is ranked 49th out of 49 in fastest rising risk for lack of adaptive capacity, indicating the country is making strides to enhance its adaptive capacity.

Notably, the WHO assessment highlights how adaptive capacity can be further improved by strengthening monitoring systems that assess risk and respond to climate shocks, as well as building climate-resilient heath care facilities, particularly to service more remote communities.

2.7 Country snapshot – *Lao PDR*

Here, the tool kit will be applied to Lao PDR in order to identify and assess risk from climate change to malnutrition.

Most fundamentally, Lao PDR is identified as a country with high risk from climate change by both the **ND-GAIN** and **INFER** models. According to ND-GAIN, Lao PDR ranks 121st out of 185 available countries, standing as the 69th most vulnerable country to climate change and the 136th most ready to deal with its impacts, while INFER identifies Lao PDR as having the 10th highest overall risk from climate change in Asia and the Pacific, alongside the 10th fastest growing risk over the past five years.

The **IMPACT** model begins to provide context for this growing risk. Within the Southeast Asia region, IMPACT projects aggregate food production to actually increase slightly under climate change scenarios in 2030 and 2050. However, contrary to the region as a whole, Lao PDR is projected to see a decline in food production under climate scenarios in both 2030 and 2050.

Relatedly, IMPACT projects Lao PDR to face a decline in per capita food consumption and an increase in hunger under climate scenarios in both 2030 and 2050. The **HCVI** model further supports this, identifying Lao PDR as having a "high" vulnerability to hunger and food insecurity under climate change.

Moving beyond hunger, the model of **Beach et al.** (2019) shows Lao PDR to be facing a reduced availability of protein, iron, and zinc due to increasing atmospheric CO2 under climate change in 2050.

Looking more specifically at vulnerable populations, the model of **Smith et al.** (2017) identifies Lao PDR as among the worst in the world for risk of anemia under elevated CO2 for both women and children, while the **CGIAR** model shows the country to be a climate-agriculture-gender inequality hotspot.

Taken together, these elements of the tool kit begin to establish Lao PDR as facing significant risk from the impacts of climate change on malnutrition. However, a closer look into the specific components of the INFER model indicates just how all-encompassing this risk may be. There, Lao PDR appears in the top third of countries within Asia and the Pacific for highest risk from six of the model's seven components, including overall food system risk, hazard and exposure, vulnerability, lack of adaptive capacity, risk to human health and nutrition, and risk to shared prosperity.

This indicates that additional tools must be used to assess the risk faced by Lao PDR more thoroughly. Relevant tools applied to Lao PDR include an INFER country profile (ESCAP, 2024), a CLEAR assessment (WFP, 2023), and the use of the RHoMIS tool (Ritzema et al., 2019).

To begin, Lao PDR is facing significant changes in climate, including dramatically shifting rainfall variability, rising temperatures, shifts in the onset of seasons, and a rise in extreme weather events such as floods, droughts, and storms (WFP, 2023). Supporting this, the INFER model indicates that the vulnerability of Lao PDR to risk from hazard and exposure to natural disasters is rising more than three times faster than the average in Asia and the Pacific.

Within this rapidly changing climate, significant regional differences exist. For example, while overall, the country is projected to experience increasing rainfall, in the northernmost provinces, rainfall is projected to decrease by 15% (WFP, 2023). This indicates that while the southern and central regions of the country will see increased flood risk, the northern region will face more intense and longer droughts. Moreover, while most parts of the country are facing earlier onsets of season, the eastern parts of the country are facing later onsets (WFP, 2023).

Across regions, however, the CLEAR assessment indicates that changes in climate pose a significant threat to the production of food.

Concerningly, rice, which accounts for over three-quarters of agricultural production in the country, is highlighted as facing particular risk. Where increasing rainfall may be favorable for paddy production in a broad sense, it will exacerbate flood risk, which can destroy crops and increase the prevalence of waterlogging and fungal diseases. At the same time, where regions face decreased rainfall alongside rising temperatures, the increasing prevalence of droughts may negatively impact the overall feasibility of paddy production. Unsurprisingly, the ND-GAIN model notes Lao PDR to be among the most vulnerable in the world to a risk from the projected change of cereal yields.

In addition to rice, the CLEAR assessment indicates that climate changes will also harm the production of other foods, including cassava, bananas and other fruits, and coffee.

A reduction of crop production stands as a potentially significant problem for a country in which more than 80% of the population works in agriculture (ESCAP, 2024). Indeed, the CLEAR assessment indicates that the impacts of climate change on agricultural production have substantial detrimental effects on livelihoods in the country.

Notably, livelihoods dependent on paddy production are least resilient due to the high climate sensitivity of the practice, a reliance on rainfed agriculture, and a lower livelihood diversity amongst practitioners (WFP, 2023). This is notable since paddy production provides income for over 700,000 households in the country (WFP, 2023). Moreover, poverty levels are already highest among paddy producing households (WFP, 2023), indicating that those whose livelihoods are most at risk are those whose incomes are already lowest.

Adding another component of risk to the loss of livelihoods, the INFER country profile highlights substantial food system instability in Lao PDR. First, the profile notes high vulnerability to risks from food price inflation and market disruptions, each of which have spiked dramatically over the last decade. Compounding this, the INFER country profile indicates Lao PDR faces a significant risk to financial system stability which has grown substantially over the past decade and is now higher than the average for LMICs.

Taken together, reduced food production and the subsequent impacts on livelihoods, alongside risks of food price inflation, the instability of markets, and financial system instability, have dramatically increased the risk to availability and accessibility of food in Lao PDR, while at the same time, spiking the risk of poverty and inequality in the country (ESCAP, 2024).

With these risks established, the tools identify two potential avenues which can begin to address vulnerabilities.

First, it is noted that where much of Laotian food production is reliant on rainfed agricultural systems, agricultural intensification strategies can provide substantial benefits (WFP, 2023; Ritzema et al., 2019). For example, the RHoMIS tool shows that irrigation expansion is “the most significant driver” of improved household dietary diversity in the Greater Mekong Subregion.

Second, where many communities experience a lower resilience due to a reliance on a single crop (paddy), the CLEAR assessment indicates that livelihood diversification enhances resilience (WFP, 2023). The RHoMIS tool adds to this, noting that when off-farm income becomes available for agricultural workers, it provides a “dramatic effect” on dietary diversity (Ritzema et al., 2019).

Livelihood diversification can include engaging in the production of cash crops such as cassava, fruits, or coffee, or acquiring work in a rapidly expanding mining industry (WFP, 2023). However, it must be mentioned that while increasing shifts in land usage towards cash crops or mining may financially benefit communities, it can also lower the availability of land for production of staple crops, potentially lowering the availability and accessibility of foods (WFP, 2023). Moreover, recall that cash crops are not beyond the impacts of climate change on production, indicating that even a diversification into these fields does not guarantee success (WFP, 2023).

2.8 Country snapshot – *Philippines*

Here, the tool kit will be applied to the Philippines in order to identify and assess risk from climate change to malnutrition.

Most fundamentally, the Philippines is identified as a country with high risk to climate change by both the **ND-GAIN** and **INFER** models. According to ND-GAIN, the Philippines ranks 122nd out of 185 available countries, standing as the 65th most vulnerable country to climate change, and the 135th most ready to deal with its impacts, while INFER shows the Philippines to have the 19th highest overall risk from climate change in Asia and the Pacific.

The **IMPACT** model begins to provide context for this risk. Within the Southeast Asia region, IMPACT projects aggregate food production to actually increase slightly under climate change scenarios in 2030 and 2050. However, contrary to the region as a whole, the Philippines is projected to see a decline in food production under climate scenarios in both 2030 and 2050. The model of **Cottrell et al.** (2019) provides support for this, showing the Philippines to be a hotspot for climate shocks to food production from fisheries, particularly in the southwest region of the country.

Returning to IMPACT, the model projects a decline in per capita food consumption in the Philippines under climate scenarios in both 2030 and 2050, as well as a substantial rise in hunger, with one million additional people projected to face hunger under climate change in 2030, and 2.1 million more in 2050. The **HCVI** model further supports this point, identifying the Philippines as having a "high" vulnerability to hunger and food insecurity under climate change.

Moving beyond hunger, the model of **Beach et al.** (2019) shows the Philippines to be facing a reduced availability of protein, iron, and zinc due to increasing atmospheric CO_2 under climate change in 2050.

Looking more specifically at vulnerable populations, the model of **Smith et al.** (2017) identifies the Philippines as facing risk of anemia under elevated CO_2 for both women and children, particularly in the northern and southern regions, while the **CGIAR** model shows the country to be a climate-agriculture-gender inequality hotspot.

Taken together, these elements of the tool kit begin to establish the Philippines as facing significant risk from the impacts of climate change on malnutrition. However, additional tools can be used to assess this risk more thoroughly. Relevant tools applied to the Philippines include a CLEAR assessment (WFP, 2021b) and an IFRC country assessment (IFRC, 2024c).

To begin, the tools indicate that the Philippines is facing significant changes in climate, including a dramatic increase in rainfall variability highlighted by more frequent and intense rainfall events in some regions alongside prolonged dry periods and droughts in others, as well as rising temperatures, and an increase in sea-based hazards such as sea-level rise and saltwater intrusion (IFRC, 2024c; WFP, 2021b).

Moreover, it includes an increase in the frequency and severity of extreme weather-related events such as floods, droughts, cyclones, and tsunamis (IFRC, 2024c; WFP, 2021b). Indeed, the IFRC specifies that 60% of land area in the country and 74% of the population face exposure to extreme climate hazards. Adding to this, the INFER model shows the Philippines to face a high risk from vulnerability to natural disasters which has spiked dramatically over the past decade.

The tools indicate that changes in climate present a significant risk to the production of food in the Philippines (IFRC, 2024c; WFP, 2021b). In fact, it has been estimated that 85.2% of food production sources are at risk from climate-related disasters in the country (IFRC, 2024c).

The CLEAR assessment shows that climate-related hazards such as rainfall variability, flooding, and droughts may result in rice production being "among the hardest hit by climate-related changes." ND-GAIN supports this, indicating that the Philippines has among the worst vulnerability in the world to risk of projected change of cereal yields.

Moreover, the CLEAR assessment notes that sea level rise and saltwater intrusion are projected to threaten the productivity of fisheries, while additional climate changes are expected to have significant negative impacts on the livestock production (WFP, 2021b).

An increasing prevalence and severity of crop diseases are also highlighted as a climate-related threat to food production in the Philippines (WFP, 2021b), including those which are spreading to regions they were not previously found, and those becoming more resilient to disease control measures.

Critically, the CLEAR assessment indicates that the impacts of climate change on food production will have differing impacts on different regions in the Philippines. For example, while rice production may increase in some northern and central regions, as well as in the southwest, it is projected to decline substantially in the southeast.

Decreases in food production become particularly concerning when considering the demand for food in the Philippines is projected to increase considerably in the coming decades, including for staple foods and meat protein, which will be accompanied by a related rise in the demand for animal feed (WFP, 2021b).

Furthermore, decreases in food production hold significant implications for livelihoods in the Philippines, which are "inextricably linked" to the production of food (WFP, 2021b). Rural communities, in which large percentages of the population work in agriculture or fishing, are noted as particularly vulnerable to a loss of livelihoods under a changing climate (WFP, 2021b).

Combining with and exacerbating livelihood losses, the tools indicate that the Philippines is highly vulnerable to food price inflation and volatility (WFP, 2021b). Indeed, the INFER model highlights a high vulnerability to risks from both food price inflation and market disruptions which has risen substantially over the past decade.

Importantly, the CLEAR assessment highlights how a vulnerability to food price inflation and market disruptions impact urban and rural areas differently in the Philippines. In rural areas, climate-related food price inflation combines with the loss of income to create a situation where, as food becomes more expensive, households have less income to spend on it. Meanwhile, in urban areas, where most food is purchased from markets, food price inflation and the disruption of markets can significantly reduce the availability and accessibility of food.

Vulnerabilities to food price inflation and market disruptions are particularly concerning when considering that in both rural and urban areas, large percentages of households already cannot afford critical components of a nutritious diet (WFP, 2021b), and already spend more than half of their incomes on food (IFRC, 2024c). Moreover, the use of coping strategies to deal with food insecurity is already prevalent in both rural and urban areas, including decreasing the quantity and quality of food intake, borrowing money and taking loans, and selling valuable assets (WFP, 2021b).

One final thing which is rigorously highlighted by the tools is the impacts of climate change on human health in the Philippines, including through increases in vector-borne and waterborne diseases, more prevalent heat-related illnesses, and rising instances of respiratory issues (IFRC, 2024c; WFP, 2021b).

The CLEAR assessment notes that increasing health risks resulting from climate change will impact urban populations in particular. Moreover, the tools indicate that rising risks to human health in urban areas are exacerbated by climate-related population displacement, most often from rural to urban areas. Sudden displacement from rural to urban areas can result in overcrowding, which negatively impacts water supply and sanitation, as well as access to health services (WFP, 2021b). Access to health services is a particular problem in a country in which the healthcare system is already strained by multiple burdens (IFRC, 2024c).

Taken together, this snapshot not only shows rapidly increasing risk from the impacts of climate change on malnutrition in the Philippines, but indicates distinct variabilities between regions, including between rural and urban areas, which suggest that interventions must be specifically targeted towards specific communities and populations.

2.4 Risk ranking

Building upon the tool kit above, we developed a matrix to assess the performance of Asia-Pacific countries and identify those most at risk. Table 2 provides a comparative ranking for various countries in the region based on their derived matrix score.

The provided scores reflect each country's standing within the region, considering various climate, nutrition, health, WASH, agri-food system, and resilience indicators (see Annex 3). Higher scores, like those of Afghanistan and Lao PDR, indicate greater challenges in the metrics considered. The number of high scores per dimension were compiled and added up, providing an overall ranking of risk for each country within the region.

The Country Selection column indicates whether a country has been selected for further analysis. The rationale for selection was based on country office capacities, AA portfolio, context (e.g. river deltas, land locked), VAM data availability, and climate change prioritization.

Notably, the table highlights a lack of data for some Pacific countries, contributing to potentially lower scores. For instance, countries such as Kiribati, Vanuatu, and Solomon Islands have lower scores, potentially reflecting this data gap.

Table 2: Ranking of risk for countries in the Asia-Pacific region

Countries	Matrix Score	Countries Selected for Phase 2
Afghanistan	14	No
Lao PDR	13	Yes
Kiribati	13	No
Timor-Leste	12	No
Vanuatu	12	Yes
India	11	No
Myanmar	11	No
Indonesia	11	No
Solomon Islands	11	No
Nepal	10	No
Bangladesh	10	Yes
Marshall Islands	10	No
Pakistan	9	No
Sri Lanka	9	Yes
Cambodia	9	No
Fiji	9	No
Samoa	9	No
Bhutan	8	No
Philippines	8	Yes
Federated States of Micronesia	8	No
Tuvalu	8	No
Nauru	7	No
Palau	7	No
Tajikistan	6	No
Kyrgyz Republic	4	No
Tonga	4	No
DPR Korea	3	No
Niue	3	No
Cook Islands	2	No
Tokelau	2	No

Section 3: Pathways from climate change to malnutrition

A key message of COP28 was the need to broaden the scope of understanding on the connection between climate change and malnutrition, ensuring a focus which considers all actors, activities, and potential impact pathways. While the most direct and well-studied pathway between climate change and malnutrition is through reduced crop production, which in turn reduces food availability (WFP, 2022), an examination of the available literature reveals that the links between climate change and malnutrition are more diverse and nuanced, encompassing complex, multidirectional pathways that connect drivers, actions, and outcomes, and do not always follow a linear progression.

The following section endeavors to delve deeper into these multifaceted pathways in order to unpack the mechanisms at play. It begins by introducing five prominent frameworks which illustrate the nuanced and multidirectional pathways between climate change and malnutrition. From there, the section closely examines specific pathways detailed in the literature within four systems – Food, Health, Water, and Social Protection – supplemented by key informant interviews which highlight the uniqueness of the Asia-Pacific context within each system, building a further understanding of the processes that connect climate impacts, food systems, and other system dynamics to nutrition outcomes. Finally, the section concludes with a proprietary framework which builds upon the literature to illustrate the pathways between climate change and malnutrition in an Asia-Pacific context.

In doing so, this section will lay the foundation for identifying critical opportunities to integrate nutrition within climate response systems.

Key findings

WHAT ARE THE FRAMEWORKS ARTICULATING THE PATHWAYS BETWEEN CLIMATE CHANGE AND NUTRITION?

The frameworks by **IFPRI, Fanzo et al., Macheka et al., and Owino et al.** provide insights into the pathways by which climate change affects malnutrition.

- The IFPRI model links climate change to malnutrition through impacts on health behaviours and environmental conditions.
- Fanzo et al. focus on how environmental changes affect food systems, influencing food availability and consumption, thereby impacting nutrition.
- Macheka et al. discuss the impact of climate adaptation strategies on nutrition, highlighting the agri-food system's central role.
- Owino et al. consider a broad range of factors, including climate events, food loss, and nutrient availability, aiming for sustainable nourishment solutions.
- Finally, the ADP-WFP framework conceptualizes how agriculture, food, productivity, and health form a vicious cycle exacerbated by the impacts of climate change.

These frameworks collectively underscore the need for integrated approaches to mitigate climate change's effects on all forms of malnutrition.

Unpacking the pathways

AGRI-FOOD SYSTEM:

Food production: Climate change negatively impacts food production, leading to reduced availability and accessibility of foods, particularly nutritious foods like fruits and vegetables.

Food prices: Climate change can cause increases in food prices and price instability, making nutritious diets less accessible and pushing households towards cheaper, less healthy food options.

Food safety: Climate change affects food safety through the proliferation of pests and pathogens. Aflatoxins are of particular concern.

Food waste: Climate change increases food waste, especially of highly perishable nutritious foods, impacting food availability and nutrition while contributing to increased GHG emissions.

Impact on diets: Climate change leads to reduced food consumption and/or shifts towards unhealthy diets due to extreme weather events and climate variability. It can lead to household hunger and encourage less nutritious food choices.

Nutrient availability: Elevated CO2 levels may reduce the nutrient content in plants, affecting the availability of essential nutrients like iron and zinc, thus leading to micronutrient deficiencies.

Livelihoods: Extreme climate events and variability negatively impact livelihoods, especially those reliant on agriculture. This reduces food accessibility and contributes to malnutrition.

HEALTH SYSTEM:

Illness and disease: Climate change is associated with increases in disease and illness, some potentially exacerbating malnutrition through a vicious cycle where malnutrition increases disease vulnerability, and disease further impacts nutritional status.

Mental health: Climate change can negatively affect mental health, including increasing stress, anxiety, and depression, as well as resulting in PTSD, each of which can have a negative impact on physical health and nutrition.

Pregnancy complications: Increases in physically demanding work for women during pregnancy resulting from climate change, as well as extreme heat events, can lead to an increase in pregnancy complications such as miscarriage, preterm birth, and low birth weight.

Fragile health systems under strain: Increases in illness and disease, mental health issues, and pregnancy complications can put a strain on already fragile health systems which are suffering damage and disruption from climate shocks, negatively impacting their ability to provide adequate care.

Physical activity: The impacts of climate change, both increasing ambient temperatures and extreme weather events, are likely to reduce physical activity, particularly for children, contributing to higher prevalence of obesity and exacerbating health issues for those who are already obese.

WATER SYSTEM:

Water availability and accessibility: Climate change negatively impacts water systems, reducing availability and accessibility, and negatively affecting food production.

Water contamination and waterborne disease: Climate change can negatively impact water quality, increasing the risk of contamination and waterborne diseases.

Water-based livelihoods: Climate change negatively impacts water systems which are crucial for livelihoods, including in food production and tourism, contributing to malnutrition through a reduction in livelihoods and household income.

AA AND SOCIAL PROTECTION SYSTEM:

Anticipatory Action (AA) and social protection programs boost nutrition resilience by supporting livelihoods and ensuring access to nutrition and health services. Without them, households may adopt negative coping strategies, and some climate mitigation efforts can unintentionally worsen malnutrition and increase vulnerability.

Coping Strategies: Households may resort to negative coping strategies in response to climate-induced shocks, such as reducing food intake, which can lower resilience and increase vulnerability to future shocks.

Mitigation Strategies: Some climate change adaptation and mitigation strategies may inadvertently exacerbate malnutrition, highlighting the need for integrated approaches that consider the complex interplay between climate change and nutrition.

OVERARCHING PRINCIPLES:

Gender Disparities: The impacts of climate change on nutrition are gendered, disproportionately affecting women and girls due to systemic inequalities, increasing their vulnerability to malnutrition.

Equity: Similarly, the impacts of climate change on nutrition are felt disproportionately by marginalized groups, including racial and ethnic minorities, indigenous communities, migrants, the elderly, disabled individuals, and economically disadvantaged populations, while inequity contributes to high GHG emissions.

3.1 Frameworks articulating the pathways between climate change and malnutrition

- **IFPRI**

Building on UNICEF's conceptual model of undernutrition with a consideration of malnutrition in all its forms and the impacts of climate drivers on nutrition through various feedback loops, the IFPRI (2015) present a framework which illuminates how climate-related shocks impact different pathways that then impact malnutrition in all its forms.

The framework illustrates how climate change affects the enabling environment for malnutrition reduction, which leads to impacts in the food, health, living, and work/social environments. Together, these pathways lead to disrupted health behaviors and biological status, including changes in diet composition and consumption, livelihoods, and land and water use, each of which impact climate mitigation. Finally, diminished climate adaptation and mitigation strategies further harm the enabling environment for malnutrition reduction.

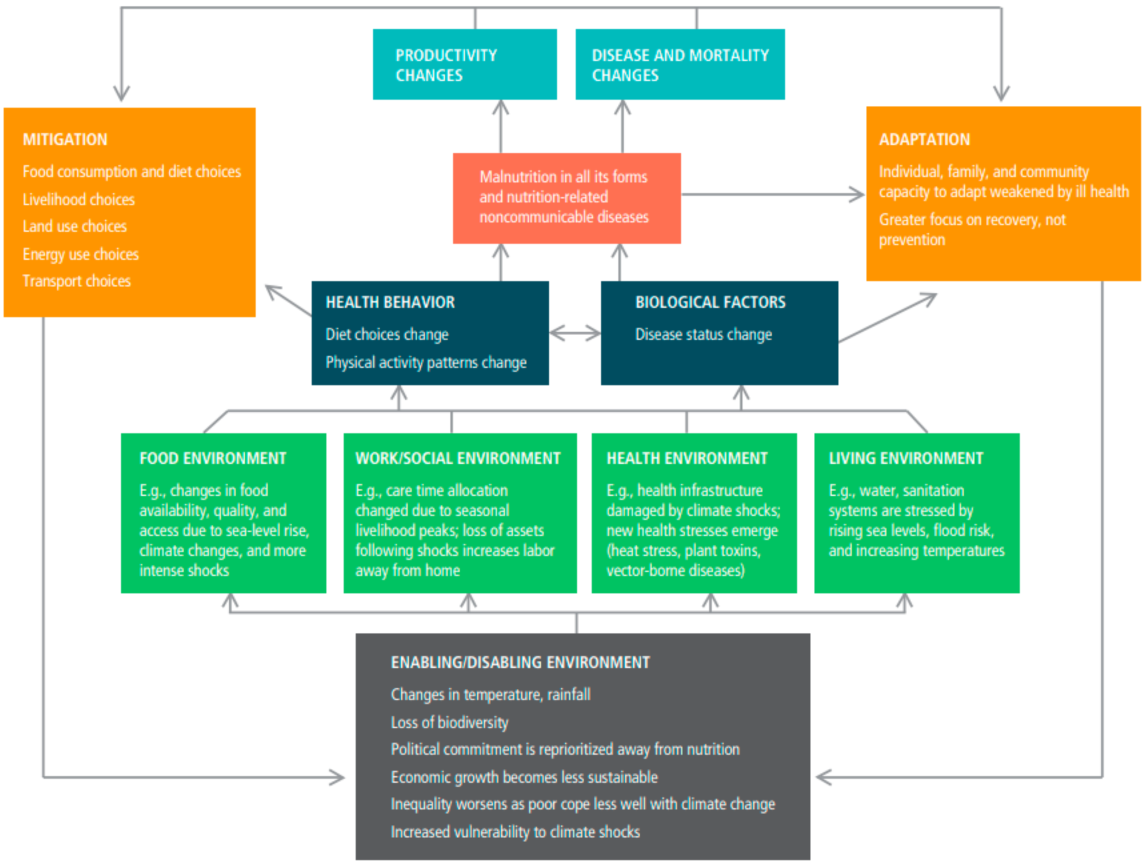

Figure 12: IFPRI framework

- **Fanzo et al.**

Focusing their conceptualization of pathways around food systems, Fanzo et al. (2021) present a framework which illustrates environmental changes as both a driver and outcome of food systems. Environmental inputs such as weather patterns, soil and water quality, and temperature influence food systems through impacts on production, storage, and transportation, which in turn affect food environments and consumer behavior through the availability, affordability, quality, and safety of food. Proximal outcomes of food systems then include diet quality, food safety exposures, and food loss and waste, which together affect both human and environmental health outcomes.

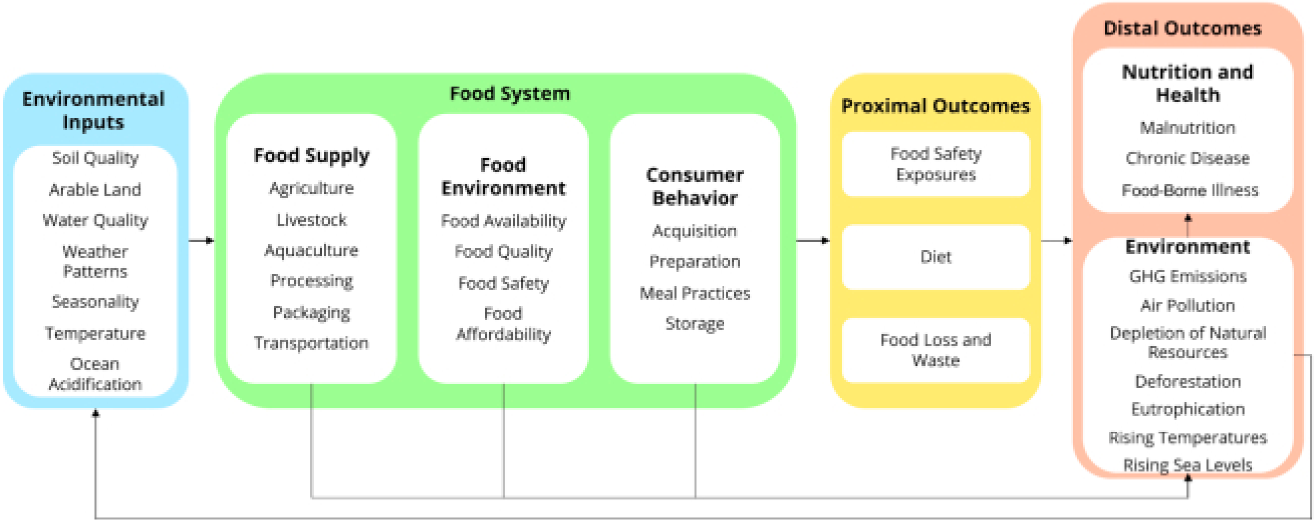

Figure 13: Fanzo et al. framework

- **Macheka et al.**

Drawing upon elements of existing frameworks, Macheka et al. (2022) add consideration of how climate change adaptation strategies impact nutrition outcomes to provide a framework which allows for a deeper understanding of the pathways between climate change and malnutrition. The framework is composed of five key pillars – the agro-food system as the anchor, with climate shocks and stresses, adaptation strategies, context characteristics, and nutrition outcomes linked to this anchor.

It illustrates how the activities which facilitate availability, access, utilization, and stability within the agro-food system are impacted by climate shocks and stresses, while the effectiveness of adaptation strategies in responses to these shocks and stresses are influenced by the context in which the strategies are being implemented. Each pillar works together to provide nutritional outcomes, allowing for a holistic assessment of the pathways between climate change and nutrition. The framework can be used to evaluate climate adaptation strategies and their impact on nutrition outcomes, allowing for the identification of more suitable strategies based on context and shocks.

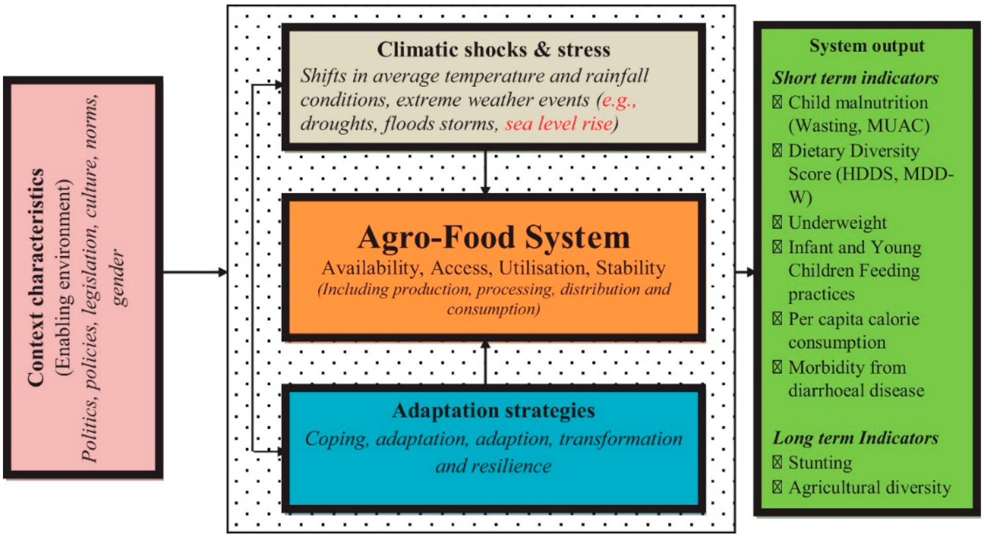

Figure 14: Macheka et al. framework

- **Owino et al.**

Owino et al. (2022) provide a framework for the pathways between climate change and nutrition which takes into account climate events and variability, food loss and waste, stresses on livelihoods, nutrient availability and health, as well as interventions to improve diets. It can be used to identify opportunities for interventions related to soil, water, and seed biodiversity, as well as food production, nutrient retention, and nutrition and health outcomes, building multi-faceted solutions which provide adequate nutrition without environmental tradeoffs.

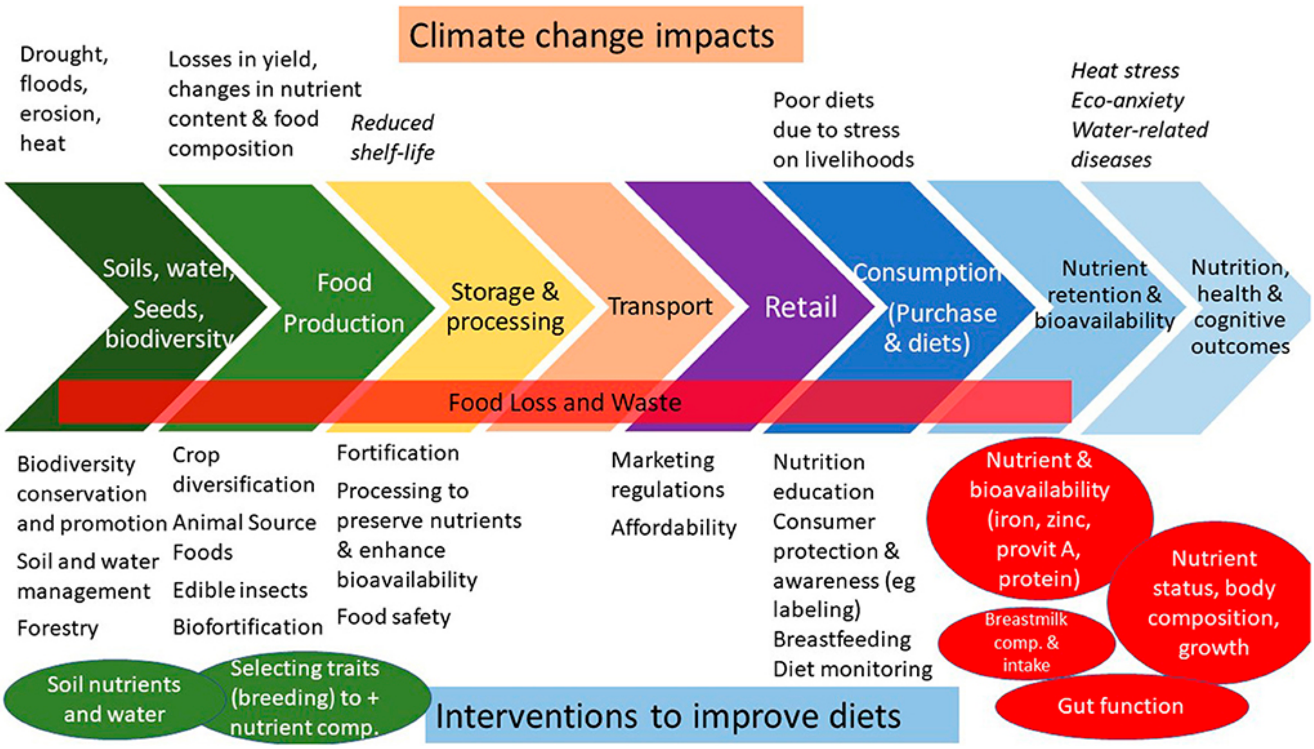

Figure 15: Owino et al. framework

- **ADB-WFP**

The WFP and the Asian Development Bank provide a framework which conceptualizes agricultural production, human productivity, food availability and quality, and human health as a "vicious cycle" exacerbated by the impacts of climate change. It presents three ways in which the impacts of climate change can manifest, from short-term impacts through increased climate shocks to shifts in seasonality patterns, to long-term impacts on the terrestrial environment such as sea level and atmospheric CO2. The framework provides a foundation for identifying multisectoral interventions which can disrupt the cycle at many points, allowing for targeted actions to be selected and applied at the point which they will have the greatest impact

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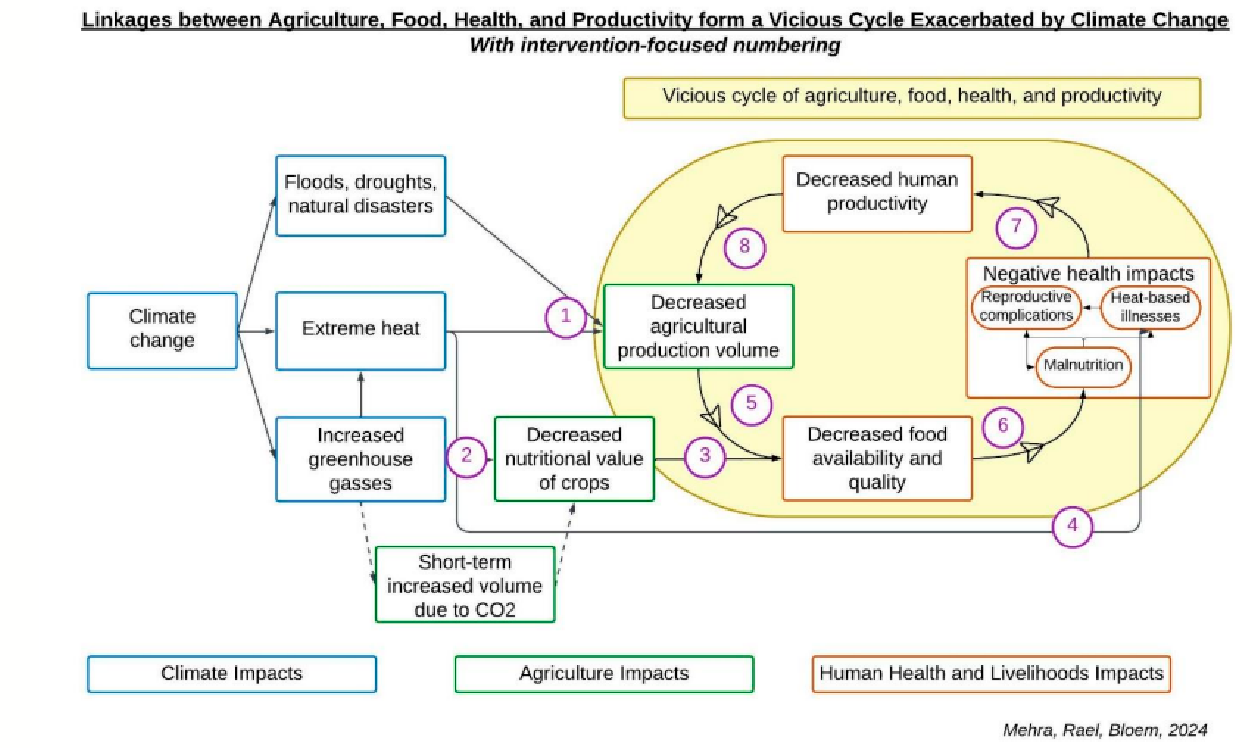

Figure 16: ADP-WFP framework

3.2 Unpacking the pathways – *Food system*

To begin, food systems can be conceptualized through the lens of the Innocenti Framework presented by UNICEF and GAIN (2019), which builds upon an HLPE report on nutrition and food systems to describe the direct and underlying actors and dynamics which affect food, nutrition, and the environment. The framework is comprised of five drivers and four determinants which together influence diets.

Drivers are the underlying structural factors which impact the functionality of food systems. They include demographic drivers such as urbanization, population growth, and migration; political and economic drivers, such as policies, trade, and commerce; innovation and technological drivers, reflecting technological and infrastructural developments; biophysical and environmental drivers, reflecting climate change and natural resource management; and social and cultural drivers, reflecting the underlying social dynamics in different contexts.

Determinants are the processes and conditions existing across a food system from production to consumption which are necessary to secure diets. These determinants include food supply chains, which encompass the actors and activities involved in food production, storage, distribution, processing, packaging, and waste disposal; external food environments, which incorporate the markets and vendors where consumers interact with food, as well as factors such as availability, price, and advertising; personal food environments, comprised of individual- and household-level factors such as purchasing power, access, convenience, and desirability; and finally, behaviors which represent the procurement, preparation, and eating practices of consumers and their caregivers.

Each of these determinants interact with and positively or negatively reinforce one another, combining with the drivers to culminate in the quantity, frequency, and quality of diets that consumers consumer, which then feed back into the system by influencing and reinforcing behaviors.

Food Production

As stated above, the most direct and well-studied pathway between climate change and malnutrition is through reduced food production which in turn reduces food availability and accessibility (WFP, 2022). Indeed, research shows that crop yields have been and will be negatively affected by climate changes in many regions, including through extreme weather events which damage crops and affect growth periods, seasonal changes and climate variability which alter growing seasons, and a reduction in water resources used for food production due to changing precipitation rates, ground water levels, and heat (IPCC, 2014).

The key informant interviews add specific nuance to this research, noting that shifts in monsoon arrival in South Asia has narrowed the window for growing vegetables between cereal harvests, negatively impacting dietary diversity and micronutrient intakes in these populations. Moreover. droughts and desertification of pasture already at risk of overgrazing and mining threatens livestock production in Mongolia, Northern China, and some Central Asian countries, with more frequent extreme winters (dzud) already resulting in substantial livestock losses in Mongolia.

Notably, Garnett et al. (2016) use a prediction model linking IMPACT to a comparative risk assessment to show that food availability is projected to decline 4.1% in 2050 in 'low- and middle-income countries of South-East Asia' due to climate change, and 3.8% in 'low- and middle-income countries of the Western Pacific.'

Critically, research suggests that fruit and vegetable production in particular is highly vulnerable to climate change (IPCC, 2014). An important and representative example of how this can take place emerged recently in India, where a delay in monsoon season negatively impacted the production of vegetables such as tomatoes, eggplant, capsicum, and spinach, as well as pulses, leading to record high prices (Jadhav, 2023).

The interviews highlight an additional factor which may combine with lowered fruit and vegetable production to contribute to a shift towards unhealthy diets, noting policy biases in the region which favor the production of cereals rather than more nutritious foods.

Food prices

Research shows that climate change increases food prices as well as price instability through its impacts on food production and the reduction of yields (FAO, 2023). Increased prices and price instability can make nutritious diets less accessible for many, particularly the most vulnerable, negatively impacting the food consumption and dietary diversity of households (Fanzo et al., 2021; Fanzo et al., 2018). As but one example, IPCC modeling projects that climate change will cause a 7.6% increase in cereal prices by 2050 (Stronger Foundations, 2023).

The key informant interviews note that heavy reliance on imports in many Asia-Pacific countries makes them more vulnerable to macroeconomic price volatility, a factor which is highly prevalent in the small island developing states (SIDS) of the region.

Moreover, research suggests that the effect of climate change on fruit and vegetable production in particular may make these products more expensive, encouraging a shift towards unhealthy diets and food products which are high in fat, sugar, and salt (Swinburn et al., 2019). The interviews support this, emphasizing increased food prices exacerbating a lack of access to nutritious food, resulting in higher consumption of cheaper, processed food. Notably, climate change is projected to increase the cost of a nutritious food basket by 10% by 2030 and 20% by 2050 (WFP et al., 2023).

This pathway becomes particularly concerning when considering the results of a recent study into the impacts of food price increases on child nutrition in 44 low- and middle-income countries, which found that a 5% increase in food price was associated with a 9% higher risk of wasting, and a 14% higher risk of severe wasting (Headey and Ruel, 2023). Moreover, children from rural and asset-poor households were even more vulnerable, with a 5% increase in food prices increasing risk of wasting by 15% in asset poor households, 19% in poor households with farms, and 26% in poor households without farms. In this way, the rising price of a nutritious diet in the region resulting from climate change can be seen as a pre-existing condition for children in the region.

Food safety

Research shows that climate change has negative impacts on food safety. For example, projections indicate temperature increases will result in the proliferation of pests and pathogens which harm both food production and human health, leading to the increased occurrence of food safety hazards at various stages of the food supply chain (Owino et al., 2022; Fanzo et al., 2021).

Of particular note is the projected rise in crops contaminated by aflatoxins, a point highlighted in both the literature and the key informant interviews. Aflatoxins are carcinogenic to humans, and their consumption has been linked in the literature with stunting and being underweight (PACA, 2021). The growth of these aflatoxins is facilitated by climate change-related increases in temperature, heavy rainfalls, and droughts, and can appear in cereals such as rice, maize, and wheat, as well as fruits and vegetables, which are susceptible during both pre- and post-harvest. Concerningly, while aflatoxins have traditionally been more prevalent in tropical and subtropical regions with high temperatures and high humidity, research shows that they are becoming more prevalent in countries with temperate climates (Valencia-Quintana et al., 2020).

Furthermore, increased prevalence of pests can result in increased pesticide application trends, which can lead to soil degradation, water quality deterioration, and biodiversity reduction, further exacerbating and contributing to climate change (FAO, 2020).

Moreover, high temperatures can put pressure on refrigeration and cold chains through the supply chain, including in consumers' homes, again contributing to food safety risks, while water shortages from droughts negatively affect sanitation and hygiene, increasing the risk of food-borne disease in processing, transport, retail, and home preparation (FAO, 2023).

Food waste

Research shows that every year, approximately 1.3 billion metric tons of food produced for human consumption are lost or wasted without being eaten, one-third of the total produced globally (Bakker et al., 2021). Critically, this includes more than 50% of all fruits and vegetables and 20–30% of meat. This can pose a significant problem for nutrition outcomes, reducing food availability and accessibility, particularly for nutritious foods.

Furthermore, research suggests that climate shocks and variability are likely to result in higher food losses, particularly of perishable items like fruits and vegetables, meat and fish, and eggs (WFP et al., 2023; Stronger Foundations, 2023). The key informant interviews support this, highlighting significant food wastage in the region which limits food accessibility, especially of nutritious foods. In rural areas in particular, where infrastructure is limited and access to cold storage is lacking, temperature increases can lead to even further food spoilage and waste (Fanzo et al., 2018).

Taken together, food loss and waste not only reduce the availability and accessibility of nutritious foods, but undermine the sustainability of food systems, wasting not just the food which is lost, but all of the resources which went into producing it, including water, land, labor, and capital, thus depleting available food system resources which are critical to nutrition (UN, 2024).

At the same time, food loss is a significant contributor to climate change, with 8-10% of global GHG emissions attributable to it (Stronger Foundations, 2023).

Diets

Research shows that one of the most prominent pathways between climate change and malnutrition centers around diets. This emerges in two ways.

First, studies from Asia-Pacific show that both extreme weather events and climate variability are associated with reduced food consumption and household hunger (Cooper, 2018; Grote et al., 2020; Islam et al., 2022). ***(For the results of these specific studies, see Appendix 2)***

Multiple prediction models build upon this connection. For example, the most recent predictions generated by the IFPRI (2022) using the IMPACT model show food consumption and hunger negatively impacted under climate scenarios in both 2030 and 2050 in each of the 'East Asia & Pacific,' 'South Asia,' and 'Southeast Asia' regions. Per capita food consumption is projected to decline in each region due to climate change, while the number of people at risk of hunger increases in the South Asia region by 22.7 million in 2030 and 6.8 million in 2050, in the Southeast Asia region by 7.6 million (2030) and 13.1 million (2050), and in the East Asia & Pacific region by 400,000 (2030) and 700,000 (2050) respectively. ***(See Tables 6-7 in Appendix 1)***

Similarly, Garnett et al. (2016) project that fruit and vegetable consumption, and red meat consumption will each be negatively impacted by climate change in 2050 in two relevant regions. In 'low- and middle-income countries of South-East Asia,' vegetable consumption is projected to fall 4.5% and red meat consumption declines by 0.7%, while in 'low- and middle-income countries of the Western Pacific,' vegetable consumption is projected to fall 3.2% and red meat consumption by 0.6%. ***(See Tables 2-4 in Appendix 1)***

Further, CGIAR couples IMPACT with the GLOBE-Energy CGE model to capture effects of income changes and consumer purchasing power and make predictions for food production, food availability, and hunger under two separate climate change scenarios built from two general circulation models (HadGEM2 and IPSL2) under RCP 8.5, representing a high emissions scenario (Cenacchi et al., 2021). In each scenario, the model predicts a reduction in the total calories available for each of four major food groups (animal products, cereals, fruits and vegetables, oils and sugars) in the 'South-East Asia' region, and a subsequent rise in the number of people at risk of hunger of between 9.3 million (IPSL2 scenario) and 12.0 million (HadGEM2 scenario). ***(See Tables 9 and 10 in Appendix 1)***

In addition, Alvi and Yan (2022) construct a model integrating CGE framework and an econometric approach to estimate the impacts of climate-caused cereal productivity changes on cereal prices and consumption in four South Asia countries – Bangladesh, Sri Lanka, Pakistan, and India – under climate change in 2050. The model predicts reductions in cereal yields and an increase in cereal prices in all four countries, alongside a subsequent reduction in cereal consumption of between 5.1% (India) and 23.5% (Bangladesh). ***(See Table 11 in Appendix 1)***

Second, studies from Asia-Pacific show that both extreme climate events and climate variability are associated with a shift to unhealthy diets and a reduction in dietary diversity (Downs et al., 2021; Niles et al., 2021; Bambrick et al., 2021; Boxer et al., 2023; Foley et al., 2017; Ali et al., 2021; Bhattarai et al., 2021). ***(For the results of these specific studies, see Appendix 2)***

The key informant interviews support this, emphasizing the role of extreme weather events and climate variability in reducing dietary diversity, particularly for vulnerable households, and highlighting the pathway from climate change through food availability, access, and behavior to increased consumption of ultra-processed foods (UPFs), noted as a plausible pathway to more obesity and NCDs in a region which is already grappling with the negative impact of UPFs on health.

Two particularly interesting and relevant studies appear in the literature, which add relevant nuance to an examination of this pathway.

A study from rural Bangladesh indicated a "double vulnerability," where nutrient inadequate diets most often consumed by households with lower levels of wealth and education are also the most vulnerable to shocks (Ali et al., 2021). This suggests that climate shocks will have a disproportionate impact on vulnerable households who are already at risk of micronutrient deficiencies.

Meanwhile, a study from Nepal showed than the 2015 earthquake accelerated a transition from traditional diets to diets with more low-nutrition snack foods. Notably, this was driven by food aid after the earthquake, which was largely made up of dried foods like rice flakes, instant noodles, and packaged snacks, and led to people becoming accustomed to these foods as part of their diet. This illustrates how interventions can unintentionally contribute to the negative nutritional outcomes they seek to mitigate (Bhattarai et al., 2021).

Nutrient availability

Extensive research shows that in addition to affecting the quantity of food which is produced, climate change may also diminish the quality of food through rising CO2 levels (Fanzo et al., 2021). Simply, elevated CO2 can reduce plant protein content and micronutrients such as calcium, iron, and zinc, leading directly to micronutrient deficiencies (Owino et al., 2022).

Various prediction models estimate the levels to which this will take place for various nutrients moving forward under climate change. For example, Beach et al. (2019) present a model which predicts a decline in the per capita availability of protein, iron, and zinc under two climate change scenarios in 2050, both globally, and in the 'East Asia and Pacific' and 'Southern Asia' regions specifically. In the 'East Asia and Pacific' region, protein availability is projected to decline by between 2.8%-3.7%, iron availability by 2.2%-3.5%, and zinc availability by 2.1%-3.1%. In the 'Southern Asia' region, protein availability is projected to decline by between 4.0%-5.3%, iron availability by 2.9%-4.2%, and zinc availability by 3.0%-4.3%. ***(See Tables 12-14 in Appendix 1)***

Notably, research shows that reductions in the micronutrient content of food may disproportionately affect vulnerable populations whose diets rely mainly on nutrient-poor staple grains and for whom more nutrient-dense foods are already not accessible (Fanzo et al., 2021).

Livelihoods

Research shows that both extreme climate events and climate variability have "a severe negative impact on lives and livelihoods," particularly those livelihoods reliant on agriculture (FAO, 2023). Numerous Asia-Pacific-specific examples of this exist in the literature (Chiotha et al., 2021; Aryal et al., 2020; Amare et al., 2022; WFP et al., 2023; De Silva and Kawasaki, 2018). ***(For the results of these specific studies, see Appendix 2)***

Decreased livelihoods due to climate shocks push households into poverty, decrease food accessibility, and contribute to malnutrition and climate-related mortality, while making households less resilient to future climate shocks, highlighting the interconnectedness of climate change and socioeconomic factors (FAO, 2023).

Notably, key informant interviews highlight the way in which livelihood perturbations lead to dietary changes, increasing reliance on unhealthy foods. Moreover, the interviews mention that the loss of livelihoods due to factors like land degradation can push smallholder farmers to rely on social protection programs, increasing the prevalence of malnutrition.

Related to the livelihoods pathway, the interviews also underscored that behavioral factors such as time constraints influence food utilization, with many individuals opting for convenient but less nutritious food options due to work demands, especially in the context of urbanization.

3.3 Unpacking the pathways – *Health system*

Illness and disease

Illness and disease are well-established contributors to malnutrition**.** At once, health status impacts how nutrients in foods are absorbed and utilized by the body (Bakker et al., 2021), directly impacting nutrition, while at the same time, malnutrition can increase vulnerability to disease, as well as increase the negative consequences, creating a vicious cycle (FAO, 2023).

Exploring the pathway further, research has clearly established that climate change is associated with increases in disease and illness (Bakker et al., 2021). In Asia-Pacific, numerous studies show the connection between both extreme climate events and climate variability and illness and disease. (Campbell et al., 2022; Banerjee et al., 2021; Ali et al., 2023b; Chiotha et al., 2021; Hussain et al., 2016); Chan et al., 2014; Parliamentary Institute of Cambodia, 2018). ***(For the results of these specific studies, see Appendix 2)***

Globally, climate change has been linked to risk of diseases such as malaria due to deforestation, and increased spread of vector-borne disease such as dengue and Lyme disease due to climate-induced migration (FAO, 2023).

Notably, extreme precipitation or prolonged drought are strongly associated with increased exposure to pathogenic microbes resulting in infections and diarrheal diseases. This can exacerbate infant and child malnutrition, leading to negative growth and development outcomes as well as stunting and wasting (Owino et al., 2022).

Furthermore, extreme heat has been shown to lead to increased occurrences of heat stroke and dehydration, as well as cardiovascular and respiratory diseases (Padhy et al., 2015). The key informant interviews support this, highlighting the impact of heat stress on a range of health outcomes, such as stunting, kidney disease, and birth outcomes.

Additionally, increased illness disease can lower the availability of human labor, which is critical to the functioning of food systems, disrupting food supply chains and leading to reduced availability and accessibility of food, and exacerbating malnutrition (Owino et al., 2022).

Mental health

In addition to impacts on physical health, climate change can negatively impact mental health. For example, research has shown that exposure to extreme climate events can increase stress, anxiety, and depression, and lead to post-traumatic stress disorder (Yuzen et al., 2023). Furthermore, prolonged droughts can lead to an increase in farmer suicides, while climate change induced migration can lead to acculturation stress (Padhy et al., 2015). The key informant interviews add to this, noting that climate-induced migration can exacerbate these challenges, underscoring the multi-faceted impact of climate change on well-being.

At once, mental health issues are linked with negative impacts on physical health, again constructing a pathway from climate change to malnutrition, while more directly, research has shown that those suffering from depression, anxiety, stress, or other mental health issues, tend to make poor dietary choices (Yuzen et al., 2023).

Pregnancy complications

As mentioned above, climate change can lead to heavier female workloads due to the climate-induced labor migration of men (Richardson et al., 2024), while also increasing the amount of time women spend doing things like fetching water and collecting wood (Committee on World Food Security, 2023).

Critically, research shows that physically demanding work during pregnancy is associated with an increased risk of adverse pregnancy outcomes such as miscarriage, preterm birth, low birth weight, and small for gestational age (Cai et al., 2020).

Furthermore, research shows that increased ambient temperatures and extreme heat events can each result in negative pregnancy outcomes such as preterm birth, stillbirth, restricted fetal growth, and low birthweight (Yuzen et al., 2015; Ha, 2022). For example, a recent study from India found that working in extreme heat can more than double the risk of stillbirth and miscarriage for pregnant women (Rekha et al., 2024).

The key informant interviews add further nuance to this, noting that the impacts of climate change on pregnancy outcomes, birth complications, and the risk of infant and maternal mortality, are particularly prevalent in countries with fragile health systems, such as Myanmar, Bangladesh, Indonesia, India, and Malaysia.

Fragile health systems under strain

Critically, an increase in illness and disease, mental health issues, and pregnancy complications can put a strain on health systems which, in many cases, are already fragile. This can undermine their ability to provide basic health coverage for overall health and well-being across the broader population, including preventative services for good nutrition, highlighting the interconnectedness of climate change and public health challenges (FAO, 2023).

Moreover, climate shocks such as floods, cyclones, and heat waves can damage healthcare facilities and transportation networks, reducing access to health services when facilities are closed or roads are untraversable, and reducing the quality of care when supply chains for crucial medicines and health products are disrupted, thus impeding access to vital treatments and the provision of care (De Guzman et al., 2024). Rural populations, who often face limited access to healthcare services to begin with, are particularly at risk of climate-related disruptions in healthcare (Pendrey et al., 2021), as are those in coastal communities whose healthcare services are often susceptible to sea level rise, storms, and floods (Taylor, 2021).

Furthermore, research shows that healthcare workers can face significant additional stress when services are disrupted due to climate shocks, leading to emotional exhaustion, depression, and Post-Traumatic Stress Disorder (Ali et al., 2022), contributing to errors and delays in service, and potentially causing them to leave the field or the region in which they work, placing further strain on often understaffed systems (Zurynski et al., 2024).

Physical activity

Research shows that many adults and children in Asia-Pacific are not sufficiently physically active to support their health, which contributes to high rates of overweight, obesity, and NCDs in the region (Annear, 2022).

Critically, the research indicates that the impacts of climate change are likely to further reduce physical activity in Asia-Pacific (Annear, 2022; Swinburn et al., 2019). This will emerge through both increasing ambient temperatures and the rising frequency and intensity of extreme weather events, which each have the potential to limit outdoor activities, particularly for children, where informal play, school physical education, and organized sport are at risk.

The key informant interviews highlight that reductions in physical activity as a result of climate change are likely to contribute to higher obesity prevalence and exacerbate health issues in already obese individuals.

3.4 Unpacking the pathways – *Water system*

Water availability and accessibility

Extensive research highlights how water systems are impacted by climate change in ways which reduce the availability and accessibility of water resources that are crucial to nutrition.

First, drought conditions which disrupt water-reliant ecosystems, as well as floods which negatively impact treatment and transport, are becoming more common and more severe (FAO, 2023), impacting both the availability and quality of water, as well as the cost of obtaining it (WFP, 2024c). At the same time, extreme climate events can damage water infrastructure, further impeding access and availability (FAO, 2023). Tellingly, research shows that approximately half the world's population is experiencing severe water scarcity for at least one month per year (Ringler et al., 2023).

Further, water is critical to food production, with more than 70% of all freshwater withdrawals currently used for agriculture (Ringler et al., 2023), meaning that changes in water availability and accessibility threaten food security through risk to food production, and thus nutrition. Notably, research shows that more than 300 million farm households across the globe experience high to very high water stress (Ringler et al., 2023). A particularly relevant study of rural communities in India found that water scarcity had become a significant issue due to long dry spells in a region reliant on natural sources like rain, mountain springs, and wells for water. This had reduced productivity of farms and kitchen gardens, as well as led to crop failure in forest lands (Downs et al., 2021). The key informant interviews support this, highlighting the critical link between climate change and water scarcity, and stressing its negative impact on agricultural productivity and food security.

Finally, it can be noted that the impacts of climate change on the availability and accessibility of water have a disproportionate impact on women and girls, who are often responsible for collecting water outside of the home. Indeed, research shows women and girls spend up to ten times more time than men completing this task (WFP, 2024c). When availability and accessibility of water are lowered, it can increase the amount of time women and girls must spend collecting it. For girls, this can reduce the amount of time they spend at school, while for mothers, it can reduce the time they have to spend on the provision of care for their children, each of which are shown to negatively impact nutritional status (Colon and Dos Santos, 2024).

Water contamination and waterborne disease

Extreme heat is changing water consumption patterns and reducing the efficacy of water treatment processes, while rising sea levels and more frequent flooding increase the risk of water contamination from overflowing sanitation systems (FAO, 2023).

In addition, water is critical for sanitation and hygiene, which contributes to the prevention and mitigation of infectious diseases that exacerbate malnutrition (Richardson et al., 2024). The key informant interviews underscore the correlation between climate change induced water contamination and diarrheal diseases, disrupting the WASH cycle.

As such, the impacts of climate change on water systems increase the risk and spread of waterborne diseases, creating optimal conditions for their spread, particularly in rapidly growing urban areas (Owino et al. 2022). A representative literature review from Lao PDR found that floods and droughts constrained people from accessing safe water or utilizing water for domestic use (Parliamentary Institute of Cambodia, 2018).

Water-based livelihoods

Moreover, water systems are critical for livelihoods, through their support of agriculture and animal production, tourism, and so on. Indeed, it is estimated that three out of every four jobs globally rely on water (FAO, 2023)**.** As discussed above, disrupted livelihoods lead to malnutrition, again making water critical to nutritional outcomes.

3.5 Unpacking the pathways – *Anticipatory Action and Social Protection system*

AA and social protection programs have been shown to make people and communities more resilient to shocks, promoting livelihoods and preventing the use of negative coping strategies which reduce future resilience, while at the same time promoting nutrition by providing access to nutritious foods, removing barriers to accessing health services, and promoting sustainable food systems (Tirado et al., 2022; FAO, 2023). However, when such programs are insufficient or absent, households and communities may resort to coping and mitigation strategies that can inadvertently worsen malnutrition and long-term vulnerability.

Coping strategies

Research shows that climate-induced shocks force households to engage in negative coping strategies such as taking loans, spending savings, selling assets, eating less or less nutritious food, and removing children from school (FAO, 2023). Numerous Asia-Pacific specific examples of this taking place exist in the literature. (Grote et al., 2020; Alauddin et al., 2017; Aryal et al., 2020; Aberman et al., 2015; Aryal et al., 2021). ***(For the results of these specific studies, see Appendix 2).*** This indicates that existing social protection systems are not sufficient to protect households from the negative impacts of climate change.

The use of these coping strategies reduces the resilience of households, lowering their capacity to resist and adapt to future climate shocks (Macheka et al., 2022). In other words, climate change not only results in malnutrition, but it also lowers the resilience of households to withstand the inevitable future shocks, implying a pathway which compounds negative impacts the more frequently shocks are faced, thus exacerbating the cycle of vulnerability and malnutrition.

Mitigation strategies

Research shows that some specific climate change adaptation strategies can actually exacerbate malnutrition (Macheka et al., 2022; Stronger Foundations, 2023). For example, one study found that the mitigation costs of measures aimed at attaining a 2°C emissions reduction target would reduce global mean food consumption by 23 kcal per day per person, while increasing the global population at risk of hunger by 11 million (Fujimori et al., 2015).

Elsewhere, research shows that biofuel production, a popular strategy for reducing GHG emissions, can divert resources such as arable land, water, and labor away from the production of food crops, leading to food shortages and food price increases, thus harming nutrition, particularly for vulnerable groups (Macheka et al., 2022).

Moreover, the maladaptation of communities to climate change can exacerbate long-term risks, and thus increase adaptation needs. For example, increased income-generating activities may deplete natural resources, while migration to urban settlements can face inadequate infrastructure for water and sanitation systems (FAO, 2023).

However, research has shown that nutrition interventions can exacerbate climate change. For example, a study from Cambodia showed that current diets emit just under 700 kg of CO_2 emissions per person, per year, whereas optimized, nutrient-adequate diets would emit just under 900 kg, while also requiring a 44% increase in agricultural water use (WFP et al., 2023).

Exploring this pathway further highlights the importance of consideration of the trade-offs between increasing consumption of nutritious foods and decreasing environmental impacts. For example, while animal-source foods have a higher environmental impact than plant foods, they can be a critical source of micronutrients, particularly for vulnerable groups suffering from low dietary diversity, meaning that promoting a shift in diets away from animal-sourced foods in order to lower environmental impacts can have negative nutrition impacts for the most vulnerable.

These findings highlight the need for the development of integrated interventions which take into account the impacts on both malnutrition and climate change through the various pathways discussed in this section.

3.6 Unpacking the pathways – *Overarching principles*

Gender

It is well established that women face disproportionate negative nutrition outcomes due to gender inequality and related discriminatory social norms, as well as increased nutritional needs due to menstruation, pregnancy, and breastfeeding (Richardson et al., 2024). However, research has now established that the impacts of climate change on nutrition are gendered, disproportionately affecting women and girls (Richardson et al., 2024; Bakker et al., 2021; Committee on World Food Security, 2023).

For example, when communities are faced with extreme weather shocks, discriminatory social norms often hinder women's ability to access and consume nutritious diets. (Richardson et al., 2024). Moreover, women producers are often least able to withstand the impacts of climate shocks due to a lack of access to financial and technological resources designed for disaster risk management and recovery, contributing to increased levels of hunger and poor dietary diversity. (Committee on World Food Security, 2023). Furthermore, in the context of the nutrition transition taking place in Asia-Pacific discussed above, women often have less control over household food choices, increasing susceptibility to negative nutrition outcomes which stem from the consumption of unhealthy diets. (Bakker et al., 2021).

Additionally, the impacts of climate change on malnutrition have been shown to be worst for pregnant and lactating women, along with their children (Fanzo et al. 2021; Richardson et al., 2024; Fanzo et al., 2018), indicating that the effects of climate change have the potential to worsen the intergenerational cycle of malnutrition.

Notably, research shows that the effects of climate change can lead to heavier female workloads after climate-induced labor migration of men (Richardson et al., 2024), while also increasing the amount of time women may need to spend doing things like fetching water, collecting wood, and so on (Committee on World Food Security, 2023).) This can negatively impact their ability to provide care for their children, and thus increase levels of child malnutrition.

Simply, the impacts of climate change disproportionately affect women, and this further exacerbates existing gender inequality. To illustrate these disproportionate impacts, UN Women (2023) used the International Futures model (Hughes, 1999) to make various predictions for the impacts of climate change on gender inequality in Asia-Pacific. They found that climate change would result in the rise of gender inequality measured as a percentage change in Gini, as well as a disproportionate increase in female food insecurity and poverty. ***(See Tables 16-17 in Appendix 1)***

Furthermore, following the gender pathway in the other direction, research shows that gender inequality makes communities less resilient and adaptive to climate shocks (FAO, 2023; Owino et al., 2022; Tirado et al., 2022), while failing to take women's specialized knowledge on agriculture and food systems into account in the decision-making process can lead to poor outcomes such as loss of biodiversity, water pollution, soil degradation, loss of forest cover, and failure to mitigate or adapt to climate change (Committee on World Food Security, 2023).

Equity

Expanding upon the pathway related to gender, it is well established that the impacts of climate change are disproportionately felt by marginalized groups (Salm et al., 2020; Hill and Hiwasaki, 2019), including racial and ethnic minorities, indigenous communities, migrants, the elderly, disabled individuals, and economically disadvantaged populations.

The process has been described as a "vicious cycle" (Islam and Winkel, 2017) in which inequality means less resources for disadvantaged groups to undertake coping and recovery measures, causing them to suffer disproportionately from the adverse effects of climate change, and thus resulting in greater subsequent inequality.

The key informant interviews add further nuance to this point, highlighting that marginalized groups are more likely to live on land that is more prone to flooding and sea level rises, while noting that the impacts of COVID-19 and the 2018 food crisis were shown to have a substantially worse impact on marginalized groups.

At the same time, the pathway operates in the other direction, with research indicating that inequality related to wealth, political influence, and social hierarchies based on race, religious affiliation, and gender increases GHG emissions by driving emissions-intensive consumption and production, facilitating the obstruction of climate policies which undermine the interests of the powerful, and undermining public support for climate initiatives in the general public (Green and Healy, 2022). Moreover, inequality restricts the ability of marginalized groups to adopt low-carbon behaviors due to a lack of access to resources (Garget, 2024).

3.7 The pathways from climate change to all forms of malnutrition

Based on the main pathways discussed in the literature, including agri-food, health, water, and social protection, and region-specific insights from the interviews about these pathways, we attempted to illustrate the pathways and their respective unique Asia-Pacific region features (Figure 17).

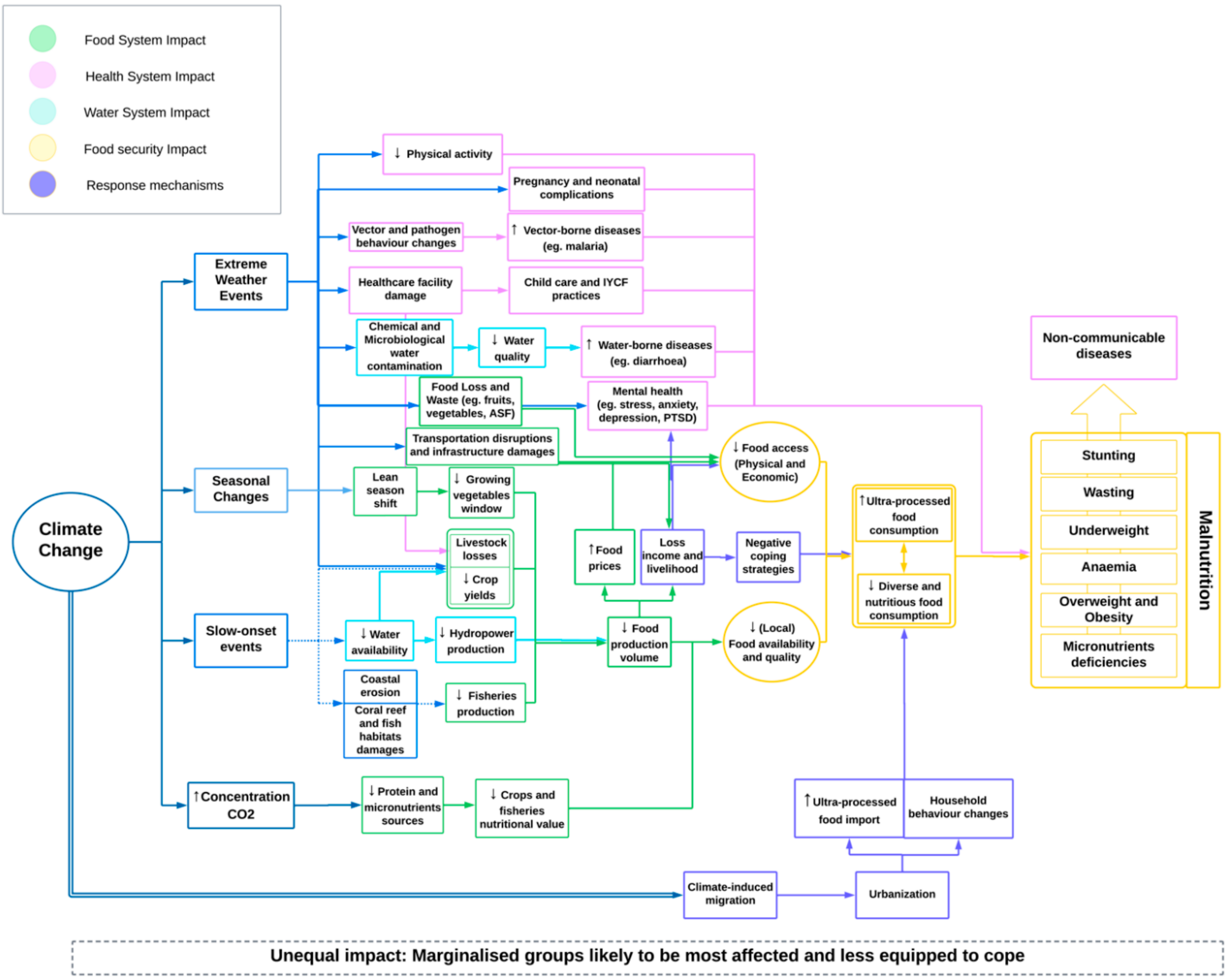

Figure 17: Pathways from climate change to all forms of malnutrition in the Asia-Pacific region (Dikoda 2024)

Section 4: Integration of climate change and nutrition in interventions

Increasingly, it has been recognized that climate change and malnutrition cannot be addressed independently of one another, but rather must be intertwined and approached together within interventions. However, there is a lack of emphasis on nutrition in most climate change mitigation and adaptation strategies (Macheka et al., 2022), and more robust evidence is needed to build understanding on how the two can be integrated, as well as the mutually reinforcing benefits that such integration can provide. As such, the following section will explore the existing literature on opportunities for climate change and malnutrition to be integrated and addressed together within interventions and adaptation strategies.

It will do so by analyzing the continuum of responses, beginning with **immediate reactions to shocks**, progressing through **strategies that build resilience** and the **promotion of nutrition and health**, and culminating with **overarching principles** which run through every response.

In doing so, the section will explore not only how immediate nutritional needs are met following crises, but also how longer-term health and nutritional outcomes are secured through sustainable practices. Understanding these dynamics is critical to crafting interventions that are both effective in the short term and beneficial for long-term health and nutrition resilience.

Key findings

IMMEDIATE REACTIONS TO SHOCKS:

Anticipatory Action (AA): Utilizes early warning systems for pre-emptive measures to mitigate the impacts of climate shocks on communities, demonstrating positive outcomes in enhancing resilience and promoting nutrition, particularly for vulnerable groups.

STRATEGIES THAT BUILD RESILIENCE:

AA and Social protection system: Enhance resilience to climate shocks, supporting livelihoods, and promoting nutrition through access to nutritious foods and sustainable food systems.

Livelihood diversification: Builds resilience to the impacts of climate change on nutrition, particularly in rural areas where households rely on climate-sensitive food production for livelihoods.

Underutilized and indigenous crops: Supporting the production of underutilized and indigenous crops can promote nutrition while enhancing the resilience of food systems to climate impacts, as well as lower environmental impacts of food production.

Food fortification: Biofortification and large-scale food fortification (LSFF) are cost effective approaches to addressing micronutrient deficiencies.

Red meat: Reducing the production and consumption of red meat and towards plant-based diets and novel meat alternatives can have a double benefit for nutrition and environmental sustainability in certain contexts.

Food Loss and Waste: Addressing post-harvest losses and waste is critical for improving food availability, reducing environmental impact, and promoting nutrition.

Water Security: Strengthening water resilience is essential for sustaining food production, health, livelihoods, and food security under climate stress.

PROMOTION OF NUTRITION AND HEALTH:

Promote nutritious diets: Utilizing food-based dietary guidelines, marketing initiatives, and mandatory nutrition and environmental criteria in programs can create a food environment which promotes and facilitates the consumption of nutritious diets.

Breastfeeding initiatives: Breastfeeding not only promotes the health and nutrition of mothers and children, but has significantly less environmental impact than commercial milk formula.

OVERARCHING PRINCIPLES:

Gender Equality: Empowering women leads to better health, nutrition, and increased resilience to climate shocks, underscoring the importance of including women in decision-making processes.

Equity: Addressing the root causes of inequity can help reduce the negative impacts of climate change on nutrition outcomes, while incorporating equity into climate change initiatives can make efforts more effective and sustainable.

Assessment tools: Developing assessment tools like the Diet Impact Assessment (DIA), ENHANCE, and the CotD are vital for integrating nutrition improvement with climate change mitigation efforts.

4.1 Immediate reaction to shocks

Anticipatory Action

Anticipatory Action (AA) enables the implementation and financing of actions before extreme climate events occur, allowing governments and communities to act days, weeks, even months or years in advance to mitigate the impact of shocks on food security and livelihoods, and thus malnutrition. Indeed, the WFP specifies that in order for an action to be considered 'anticipatory,' it should reach recipients before the impact of a hazard (WFP, 2022).

Unlike more traditional social protection programs, which build resilience continually over the long-term, but cannot be implemented within short lead times, Anticipatory Action is focused on shorter-term, taken in response to specific shocks, bridging the gap between longer term risk reduction efforts, which will be discussed further in the section below, and immediate response.

Using early warning systems, predefined actions are taken ahead of predicted hazards to mitigate loss and damage before they occur, safeguard nutrition, and protect livelihoods (WFP, 2022). This can include cash or food transfers and social protection payouts which automatically enact at a certain threshold as defined by impact-based forecasts, evacuation of exposed people, livestock, or other assets, reinforcement or rehabilitation of vulnerable buildings, distribution of WASH items to prevent the spread of disease or of climate-tolerant inputs to improve the resilience of crop production, as well as early warning messaging to inform communities of impending risks (WFP, 2022).

A variety of positive outcomes relevant to nutrition provided by AA have been recorded, including in the Asia-Pacific region.

First AA has been shown to protect against crop losses through early harvesting, protection from hazard-induced pests and diseases, and the provision of stress-tolerant or short-cycle seeds (FAO, 2022). In the Philippines, for example, anticipatory actions triggered before a 2019 drought reduced crop failures and allowed a wider variety of vegetables to be grown, contributing to the maintenance of an acceptable diet among farmers and more resilient incomes as vegetables were sold at local markets (FAO, 2022).

Second, AA has been shown to protect livestock through feed distribution and animal health campaigns which reduce animal mortality, maintain animal body condition and productivity, and support reproductive capacity (FAO, 2022). In Afghanistan, for example, feed distribution and animal health campaigns ahead of a 2021 drought improved the health of cows, sheep, and goats, reduced mortality rates, and increased milk production, while allowing producers to sell their livestock at higher prices (FAO, 2022).

Moving beyond crops and livestock, AA has been shown to protect and improve numerous components which contribute to nutrition, including household food security, dietary diversity and food consumption, health status, and the use of coping strategies (FAO, 2023b). In Bangladesh, for example, mobile cash transfers to vulnerable communities prior to flood in 2017 and 2019 were shown to result in higher food consumption, with 36% of households less likely to go a day without eating during the floods, and higher consumption measured three months afterwards, as well as lower levels of asset loss, less costly borrowing coping strategies, and lessened psychological stress (WFP, 2021). Similarly, anticipatory cash transfers before 2022 floods in Nepal allowed households to consumer more food, especially animal protein, and avoid negative coping strategies, while also contributing to enhanced mental health (WFP, 2024d).

In each case, AA positively impacts the pathways between climate change and malnutrition detailed in the previous section, while bridging the gap between emergency response and long-term resilience.

Critically, AA can be directed most specifically towards vulnerable populations and segments of the population already facing chronic malnutrition, including pregnant and breastfeeding women, children under five, and adolescent girls. This can include extended cash benefits, nutrition 'top-ups' and specialized nutrition packages, as well as assistance which promotes breastfeeding practices, safeguarding lives and livelihoods of the most vulnerable from the immediate effects of hazards and thus reducing overall humanitarian needs and reducing the cost of humanitarian response. For example, where anticipatory cash transfers were provided to vulnerable households before floods in Nepal in 2022, cash top-ups were provided to women and girls to facilitate access to obstetrics care and gender-based violence services, while comprehensive relief packages containing essential food and non-food items were also delivered (WFP, 2023b).

Opportunities for further improving the nutrition-sensitivity of AA include using collaboration between governmental, humanitarian, and development partners to institutionalize AA as part of wider emergency response and preparedness initiatives. This can include sharing of risk data and forecast information between entities and organizations, creating multi-sectoral working groups to establish national frameworks, and harmonizing actions between different levels of government and partner organizations (Asia-Pacific Technical Working Group on Anticipatory Action, 2024).

Critically, it should also include increasing financing for AA programs, particularly in climate and conflict affected countries, which has been highlighted by numerous sources as a critical step moving forward (IRC, 2023; AATF, 2022).

Relatedly, numerous sources have stressed the importance of increasing the value of the cash transfers provided by AA initiatives, in order to increase the impact of programs on nutrition (Chaves-Gonzalez et al., 2022). As but one example, in Bangladesh, AA beneficiaries stated that they needed an additional $193 (USD) for more substantial quality-of-life improvements (Asia-Pacific Technical Working Group on Anticipatory Action and Asia-Pacific Regional Cash Working Group. 2022). Here, not only the overall value of cash transfers can be considered, but specifically their impact on nutrition by incorporating food price monitoring data and the cost of diets in order to understand the level of assistance needed to provide access to nutritious diets, and thus inform anticipatory action in a nutrition-sensitive way (Wallingford et al., 2024).

Further, integrating consideration of vulnerable groups who are most susceptible to the impacts of climate change on malnutrition within AA frameworks, including in monitoring and evaluation, as well as budgeting, can allow equity to be built into initiatives and ensure the protection of marginalized groups who are most impacted, while addressing discriminatory and exclusionary practices.

Similarly, the consideration of community specific health and nutrition profiles should also be included in AA frameworks, examining context-specific factors such as food insecurity, maternal and child nutrition, vaccination coverage, access to water, and exposure to diseases, and unpacking obstacles related to geography, infrastructure, utilities, and supply chains (McIver et al., 2024). At the same time, community members should be involved in the design and implementation of AA strategies to ensure that interventions are culturally appropriate and aligned with local dietary habits.

4.2 Strategies that build resilience

Anticipatory Action and Social Protection System

The discussion of Anticipatory Action highlights the importance of social protection systems more broadly when considering responses to climate shocks. Where AA systems can be effective in providing a flexible, rapid, and immediate reaction to specific shocks, more traditional, longer-term social protection programs can be used on an ongoing basis to address the root causes of vulnerability and safeguard essential needs in the long-term.

Simply, effective social protection initiatives can make people and communities more resilient to shocks, promoting livelihoods and protecting against poverty, preventing the use of negative coping strategies which reduce future resilience, while at the same time promoting nutrition by providing access to nutritious foods, removing barriers to accessing health services, and promoting sustainable food systems (FAO, 2023; Tirado et al., 2022). Indeed, in the key informant interviews, social protection was highlighted as a good starting point for integrated climate and nutrition action.

Social protection instruments can include social assistance programs such as cash or asset transfers and public works or school feeding programs, social insurance such as pensions or insurance for food producers, social care services such as exemptions from healthcare or education fees, and labor market interventions such as unemployment benefits and wage subsidies (WFP, 2023c). Together, these instruments provide three levels of support, at once increasing household assets (social assistance), protecting against shocks (social insurance), and strengthening support systems households can call upon when needed (social protection) (WFP, 2024e).

Importantly, social protection initiatives can be directed to specifically address malnutrition in communities faced with climate shocks. Indeed, the WFP (2024) advocates that nutrition-related objectives should be explicitly integrated within social protection initiatives, from project design, through monitoring and evaluation, to learning, so that initiatives can be made to target forms of malnutrition directly.

Targeted cash and asset transfer programs which ensure direct access to food, for example, have been shown to reduce the impacts of extreme climate events (Tirado et al., 2022) while positively impacting food consumption and dietary diversity, particularly among women and children (FAO, 2023).

Initiatives focused on increasing the availability and accessibility of nutrient-dense foods in particular should be pursued. This could involve partnerships with local producers or incentives for agribusiness to diversify crop production towards more nutritious options.

Furthermore, nutrition-focused social protection can be supported by Social Behavior Change (SBC) initiatives which encourage behavioral change towards adaptation (WFP, 2019). This can be provided through educational materials and programs, marketing campaigns, counseling, and community mobilization, which are together designed to improve nutrition knowledge, attitudes, skills, and practices, empowering households to make nutritious, equitable choices if and when these choices become available.

In addition, the nutrition sensitivity of social protection initiatives can be further enhanced by incorporating the cost of diets into planning and action. Where social protection initiatives aim to reduce the unaffordability of a nutritious diet for vulnerable households, consideration of the cost of the diet can ensure benefits are adequate to provide access to a nutritious diet (UNICEF, 2024c), while allowing the impacts of programs to be measured in terms of their impacts on accessibility of nutritious foods (Lewis et al., 2023).

Fill the Nutrient Gap (FNG) analyses provide a relevant example of this approach (Wallingford et al., 2024). By combining context-specific data on the daily cost of a nutrient adequate diet with food availability data, FNG can identify the most cost-effective interventions for meeting nutritional needs in populations at risk of malnutrition, while identifying specific barriers to healthy eating. This analysis can be directed towards specific regions and sub-regions, as well as subpopulations for which interventions may be particularly impactful, such as pregnant and breastfeeding women or children.

This latter point is an important one, as the ability to assess the impacts of interventions on the most vulnerable populations and direct appropriate assistance to them is a fundamental aspect of successful social protection.

This can include pregnant and breastfeeding women and children under five, who can be specifically targeted with 'top-up' cash transfers and specialized nutritious food, alongside awareness training on maternal and infant and young child nutrition practices (WFP, 2023d).

Further, in many low- and middle-income countries, where large portions of the population work in agriculture and depend on functioning food production systems for livelihoods, social protection can target farmers with financing for climate adaptation measures (Bakker et al., 2021), protecting livelihoods and promoting the availability and accessibility of nutritious foods. Nutrition can further be built into programs targeting farmers by incorporating a 'soft conditionality,' where financing is made contingent on planting nutritious and sustainable crops.

Notably in the context of growing climate-induced migration discussed above, social protection programs can also be specifically designed and directed towards those who have been displaced, who are disproportionately vulnerable to the impacts of climate change on malnutrition. It has been noted that this type of focus can not only improve nutrition outcomes, but reduce the risk of additional displacement (HPN, 2024).

More broadly, when considering the impacts of social protection on vulnerable groups, the WFP (2024) recommends that the construction of initiatives should move away from an 'instrument first' approach (choosing cash or food), and towards first evaluating the existing landscape as it appears in local contexts, including population vulnerabilities and inequities, geographic characteristics and vulnerability to shocks and hazards, and the potential to build agency and equity.

Livelihood diversification

In many Asia-Pacific countries, rural households rely on one form of employment for their livelihoods, most often in climate-sensitive food production sectors, making them particularly vulnerable to climate shocks (Nyathi, 2024). As such, livelihood diversification has been noted as a critical strategy to build resilience and reduce vulnerability to the impacts of climate change on nutrition (Nyathi, 2024, Beltrán-Tolosa et al., 2022; Roscher et al., 2022).

Livelihood diversification can mean participating in new non-agricultural activities in a different economic sector and ecosystem in order to diversify sources of income (Nyathi, 2024). For example, those working in vulnerable Pacific Island coastal fisheries may add eco-tourism employment to their portfolio (Beltrán-Tolosa et al., 2022). It can also mean diversifying livelihoods within the same sector, such as through expanding the types of crops grown to include different varieties with varying resiliencies to different climate shocks, or promoting a mix of crop and livestock production (Roscher et al., 2022).

Research has shown that livelihood diversification increases resilience to climate change among rural and smallholder farming households (Mohammed et al., 2021), providing the potential to raise household income and reduce poverty (Mondal et al., 2023; Roscher, 2022), as well as increase purchasing power (Nyathi, 2024) Moreover, livelihood diversification has been shown to reduce household food insecurity (Nyathi, 2024), and improve dietary diversity (Matsuura, 2023; Ritzema et al., 2019).

Often, barriers to livelihood diversification exist in the form of socioeconomic and financial costs (Nyathi, 2024). As such, support can be provided in order to facilitate livelihood diversification, particularly in vulnerable rural communities. This can include improving access to irrigation infrastructure, which has been shown to be a significant determinant of livelihood diversification (Matsuura, 2023), as well as infrastructure which connects individuals and producers to markets, which has been shown to greatly impact the success of livelihood diversification strategies (Nyathi, 2024).

It can also include supporting the expansion of household assets, a lack of which has been shown to be one of the "main obstacles" to diversifying sources of income (Nyathi, 2024), as well as increasing the access of rural populations to financial credit, and providing training in new types of products, vocations, and adaptive strategies (Nyathi, 2024).

Finally, livelihood diversification has been noted as an opportunity to promote a transition towards more climate resilient, sustainable, and resource-efficient livelihoods (World Bank, 2021). In effect, where new livelihoods are pursued, these livelihoods should be organized in a way which is both more resilient to climate shocks in the present, and less impactful on the environment moving forward (ILO, 2019).

Underutilized and indigenous crops

Research shows that many underused plant species not only have exceptional nutritional profiles, but notable traits for adapting to climate change (Bakker et al., 2021). This is critical due to the risk climate change will put on both crop yields and the nutritional content of foods.

For example, many indigenous crops and vegetables have a higher nutritional value than more dominant staples and conventional vegetables (Bakker et al., 2021), while at the same time showing a better resilience to climate shocks and variability (Richardson et al., 2024). Similarly, pulses have been shown to improve nutrient intake and avert deaths, while also using less water than conventional crops, as well as enhancing the availability of reactive nitrogen in the land on which they are cultivated, thus increasing crop yields (Ricciardi et al., 2024).

In addition, research has shown that millets have substantial and overlapping benefits to nutrition and environmental sustainability when compared to rice. Not only do millets have less calories and more micronutrients, but they require far less water to produce than rice, generate less GHG emissions, and are highly tolerant to climate extremes such as high temperatures, droughts, and floods (Babu et al., 2024).

Taken together, initiatives which diversify food production including underutilized crops like pulses, indigenous grains and vegetables, and millets can both increase nutrient intakes while also making food systems more resilient to temperature and precipitation changes, extreme weather events, as well as pests and disease (FAO, 2023).

This can be seen as particularly important considering that within current global food systems, only three crops (rice, maize, and wheat) contribute some 60% of calories consumed by humans (Bakker et al., 2021), and 80-90% of human diets rely on 12-20 species (Owino et al., 2022). This has resulted in a critical loss of biodiversity which puts food production, food security, and nutrition at risk.

Here, it must be mentioned that challenges exist around utilizing indigenous and underutilized products to promote nutrition under climate change, including neglect in policy, suboptimal production capacity and value chains, as well as difficult market conditions and low demand (WFP, 2020). As such, the successful use of these products to promote nutrition can be seen as highly context specific.

However, research does indicate the viability of these products to promote nutrition in an Asia-Pacific context, particularly for vulnerable groups. For example, the use of underutilized crops from several food groups – including Sorghum bicolor, Canna edulis, Colocasia esculenta (the starchy roots and leaves), Plectranthus rotundifolius, Amorphophallus paeoniifolius, Moringa oleifera (the leaves and pods), Limonia acidissima, and Benincasa hispida – were found to improve the nutrient intake of young children in Indonesia (Andrias et al., 2019), while the use of indigenous foods among a tribal community in India was shown to facilitate better micronutrient intakes among women (Ghosh-Jerath et al., 2016).

Furthermore, research has shown that underutilized and indigenous foods can reduce the cost of a nutritious diet (Akinola et al., 2021; Sarfo et al., 2020; Termote et al., 2014), while increasing the incomes of smallholder farmers who produce them (WFP, 2020).

In order to support the production of these underutilized crops, governments can include their use in national programs such as school feeding, linking local farmers to local schools, while redirecting agricultural subsidies away from less nutritious foods and towards indigenous vegetables, pulses, and millets. Moreover, attention can be directed towards the promotion and marketing of underutilized and indigenous food products in order to increase their demand, as well as towards specific training and capacity-building of smallholder farmers to support their production. Furthermore, support should be given to community seed banks which preserve the genetic diversity of indigenous and underutilized crops, and initiate breeding of new climate-resilient varieties.

Box 1: Underutilized crops in the Asia-Pacific region

- Future Smart Foods (FAO 2018) have been identified for South and Southeast Asia. These crops are nutritionally dense, climate resilient, economically viable, and locally available or adaptable.

Potential future smart foods in eight countries in South and Southeast Asia (From FAO 2018)

Cereals	Roots and tubers	Pulses	Fruits and vegetables	Nuts, seeds and spices
Amaranth	Elephant foot yam	Black gram	Chayote	Linseed
Buckwheat	Fancy yam	Cow pea	Drumstick	Nepali butter tree
Finger millet	Purple yam	Faba bean	Fenugreek	Nepali pepper
Foxtail millet	Swamp taro	Grass pea	Indian gooseberry	Perilla
Grain amaranth	Sweet potato	Horse gram	Jackfruit	Walnut
Proso millet	Taro	Lentil	Pumpkin	
Quinoa		Mung bean	Roselle	
Sorghum		Rice bean	Snake gourd	
Specialty rice		Soybean	Wood apple	
Tartary buckwheat				

Food fortification

With micronutrient deficiencies prevalent in Asia-Pacific and, as discussed above, set to rise as a result of climate change, food fortification – the practice of deliberately increasing the content of essential micronutrients in food – can be a significant instrument to promote nutrition in the context of climate change, providing a safety net for essential vitamins and minerals, protecting households and families when they are unable to access a diverse diet. Indeed, research indicates that food fortification can reduce the cost of a nutritious diet by 20% (Olson et al., 2021).

This can begin with biofortification. This is a process in which the micronutrient content of staple crops is enhanced prior to harvest, giving food a higher nutritional status (Owino et al., 2022). Biofortification has been shown to significantly improve nutrition outcomes. For example, it has been shown to be a cost-effective approach to addressing deficiencies in vitamin A, iron, and zinc (Bakker et al., 2021), particularly in children, where studies have shown significant improvements in child iron deficiency, serum retinol, and carotene concentration (Owino et al., 2022). Moreover, research has shown that fortified rice alone could reduce the household cost of nutrient adequate diets by 8% (WFP et al., 2023).

At the same time, biofortification can be beneficial both to resilience from climate shocks as well as future climate change. For example, crops can be biofortified to be more heat- and drought-tolerant (Bakker et al., 2021). At the same time, research showed that fortified rice can decrease GHG emissions by 13% and water use by 7% (WFP et al., 2023).

However, food fortification must go beyond biofortification and include large-scale food fortification (LSFF), in which micronutrients are added to widely consumed foods such as rice, wheat, vegetable oil, salts and condiments, and milk, during post-harvest processing.

According to the WFP (2022b), LSFF is "one of the most effective strategies to reduce micronutrient deficiencies on a large scale." As but one example, LSFF has been shown to reduce the likelihood of anemia by 34% (WFP, 2022b). Moreover, global analysis places LSFF as among the top nutrition interventions in terms of economic return on investment, including one study which found that every $1 (USD) invested generates $27 (USD) of economic return from averted disease, improved earnings, and enhanced workplace productivity (WFP, 2022b).

Rice in particular is a staple food targeted by the WFP for LSFF. It has been noted that locations where rice is a significant contributor to diet overlap with areas where micronutrient deficiencies are most common (WFP, 2018). As such, the WFP supports LSFF of rice across Asia-Pacific, establishing a fortified rice supply chain through government safety nets, school food programs, and private sector social responsibility programs.

Going further, food programs and subsidies can be made to include mandatory fortification, particularly those already existing structures, systems, and budgets (UNICEF, 2021). To ensure that the costs of fortification are not passed from producers to consumers in a way which reduces the accessibility of nutritious diets, governments can reduce financial and regulatory barriers such as registration and taxes on food industry actors, while implementing robust and efficient monitoring and enforcement practices in order to ensure the quality and presence of micronutrients in fortified foods.

Moreover, technical assistance can be provided to manufacturers in order to strengthen quality control and assurance, while micronutrient status data collection should be pursued to support and guide LSFF standards and policies, including those tracking the quality, coverage, and impact of programs.

Red meat

Production and consumption of red meat is currently on the rise across the globe and is projected to increase by an additional 50% by 2050 (WHO, 2023). This has negative implications for both nutrition and environmental sustainability.

First, excessive consumption of red meat is associated with an increased risk of NCDs, while also providing a significant contribution to the risk of foodborne diseases and food safety risks, with over one-third of all foodborne diseases linked to animal-sourced foods, including red meat (WHO, 2023).

At the same time, production of red meat has significant negative environmental impacts. Together with dairy milk production, red meat production contributes 55% of total global agriculture GHG emissions, while 30% of global flora and fauna biodiversity has been impacted by livestock-associated deforestation (WHO, 2023). Research shows that a transition to diets with a smaller proportion of calories from animal sourced foods, and particularly red meat, can reduce diet-related GHG emissions by nearly 50% and premature mortality by nearly 20%, while also resulting in less food waste (FAO, 2019).

Furthermore, meat production uses approximately 22% of global freshwater, of which red meat has the largest footprint, while also having the potential to contaminate freshwater supplies through nutrient use in feed production and manure management (Rust et al., 2020). This indicates that as water availability and accessibility become stressed under climate change, meat production has the potential to exacerbate the problem, while a reduction in said production could help protect water systems.

In light of these impacts, alternatives to the consumption of red meat can be pursued, including plant-based alternatives, as well as novel meat alternatives such as plant-based meat analogues and insects. Here, social protection systems can be leveraged to diversify protein sources and ensure access to animal source food for vulnerable population groups in particular, while demand for plant-based meat alternatives can be driven further through their inclusion in school feeding programs. Moreover, support and incentives can be provided to farmers who are transitioning from livestock-based agriculture to plant-based or mixed farming systems.

Here, it is important to mention that animal source foods, including red meat, can be an important element of a nutritious diet, particularly for those facing micronutrient deficiencies (GAIN, 2020). They provide a variety of micronutrients simultaneously which can fill gaps at a lower volume of intake than plant source foods, providing significant benefits for the physical and cognitive development of children, and the maintenance of health in adulthood (Leroy et al., 2022), especially among vulnerable groups in resource-poor settings (GAIN, 2020). As such, it has been noted that some groups could substantially benefit from increasing their consumption of animal source foods (Beal et al., 2023). In other words, while reduction in the production and consumption of red meat can have positive environmental impacts, and improve nutrition and health in some situations, context is critical to consider.

In situations where the increased consumption of meat could be beneficial, it is important to direct efforts towards more sustainable production (GAIN, 2020), including by improving efficiency in feeding practices, breeding, veterinary care, and grazing management, and better managing animal waste to reduce emissions (Waite, 2022). Research suggests that through sustainable production improvements, animal source foods can play an important role in a circular and diverse agro-ecosystems, helping to restore biodiversity and degraded land, restore soil health, benefit plant food production, and even mitigate GHG emissions from food production (Beal et al., 2023; Leroy et al., 2022).

Finally, it is also important to mention an avenue closely related to red meat production and consumption, that is, the production and consumption of dairy products. Like red meat, dairy production has been shown to increase GHG emissions, and reduce biodiversity through unsustainable practices and feed production (Mitloehner and Peterson, 2021). Indeed, research has shown that the dairy industry contributes 3.4% of the world's total of yearly GHG emissions, more than the aviation and shipping industries combined (Kasriel, 2020). However, the consumption of dairy products has been shown to protect against disease, including reducing the risk of diabetes and cardiovascular disease, particularly stroke, as well as reducing the risk of colorectal cancer, bladder cancer, gastric cancer, and breast cancer (Thorning et al., 2016). As such, dairy cannot be viewed as the same type of multidirectional pathway between climate change and malnutrition as red meat, and thus initiatives promoting its production and consumption are not relevant here.

Food loss and waste

As discussed above, post-harvest food loss has been well-noted as a significant problem within global food systems, with research indicating that 1.3 billion metric tons of food produced for human consumption is lost before it is eaten, about one third of the total produce globally (Bakker et al., 2021). This happens along the supply chain, in food storage, processing, and transportation, and, as discussed in the pathways section, is rising due to climate change altering temperatures and water systems, and damaging infrastructure.

Nutrient-rich foods such as fruits and vegetables, dairy products, meat and fish, and seeds and nuts are often the worst affected as they are highly perishable. For example, research shows that 50% of all fruits and vegetables produced globally are lost or wasted (Bakker et al., 2021).

This waste has significant impacts on malnutrition, lowering the availability and accessibility of nutritious foods, particularly for vulnerable groups (FAO, 2023), while also negatively impacting farmers' livelihoods (Bakker et al., 2021). At the same time, it is estimated that food loss and waste contribute 8-10% of global GHG emissions (Stronger Foundations, 2023).

As such, initiatives which reduce food loss and waste have been identified as having a double benefit for climate change and malnutrition. For example, one study found that reducing food loss and waste by 25% globally would reduce the food calorie gap by 12%, the land use gap by 27%, and the GHG mitigation gap by 15% (Bakker et al., 2021), while elsewhere it has been shown that reducing food loss and waste would increase the availability of nutritious foods, lower food prices, and improve livelihoods, particularly for vulnerable groups (FAO, 2023).

To achieve this, the literature notes that developing and promoting technologies to improve the storage and transportation of foods, particularly in low-income countries, can be an effective intervention (UN Nutrition, 2023). For example, studies suggest that expanding cold chain access in developing countries could prevent more CO2 emissions than currently produce by the United Kingdom (Stronger Foundations, 2023), while strengthening food security and alleviating poverty (Bakker et al., 2021).

This can be supported through investment in technologies to improve the efficiency of food storage and transportation, particularly nutrient-dense foods such as fruits and vegetables, as well as in the development of innovations in food packaging technology, including alternative food packing materials such as bio-sourced plastics and biopolymers, which have a lower health and environmental impact (UN Nutrition, 2023).

In addition, governments can incentivize the efficient distribution of food through support of urban and peri-urban food systems which can reduce transport-related emissions and allow consumers to rely on more locally produced foods, while investing in local transportation networks to strengthen small-scale supply chains. This can include financial support for small-scale producers, and facilitation of market access, as well as education and training for producers and retailers on best practices for harvesting, storing, transporting food, and effective use of cold storage technologies. A relevant example can be seen in the FAO-NORAD project Empowering Women in Small-scale Fisheries for Sustainable Food Systems in sub-Saharan Africa, which supports small-scale fisheries organizations to build capacity and reduce food losses, while improving livelihoods alongside food safety (FAO, 2021).

Water

As discussed in the previous section, climate shocks such as floods, droughts, cyclones, and extreme temperatures have a significant impact on water systems, reducing the availability, accessibility, and safety of water which is critical for health, livelihoods, and food security, and thus nutrition. As such, long-term nutrition resilience to climate shocks must include interventions addressing water security. Indeed, the WFP's Strategic Plan (2022-2025) stresses the importance of addressing water issues to improve nutrition (WFP, 2024b).

Such interventions can include strengthening the climate resilience of rainfed food production systems through improved structural measures and incentives for watershed conservation (Bakker et al., 2021), as well as utilizing technological innovation in water management (FAO, 2023). This can incorporate the construction of small-scale reservoirs, rainwater harvesting systems, and other water conservation structures. Such assets not only improve water availability but also enhance community resilience and integrated outcomes across food security and livelihoods (WFP, 2024b).

They can include infrastructure projects such as improvements to irrigation systems for agriculture and livestock, or construction of new ones, in order to reduce reliance on shifting precipitation patterns for food production and lower vulnerability to drought (WFP, 2024c), as well as construction of flood barriers in regions prone to flooding (WFP, 2024c). Furthermore, focus can be directed towards ecosystem restoration and protection, including through soil conservation, water harvesting, and tree planting to enhance the ecology of food systems (WFP, 2024c).

More broadly, food production systems can be encouraged to adopt more environmentally sustainable approaches which counteract the GHG emissions generated by any expansion of production facilitated by the water management practices discussed. This can include improving carbon storage and moisture retention in soils, using waste as a source of nutrients or biofuel, reusing wastewater, and protecting wetlands, as well as providing training to local stakeholders on sustainable water management practices, including the use of modern technologies for water efficiency and monitoring (UN-Water, 2024). In addition, support can be directed to the enhancement of local and national hydrometeorological services to improve weather forecasting for water resource management (WFP, 2024c).

Going further, the FAO highlights the need to integrate nutrition-promoting health components such as WASH financing as part of climate action, in order to reduce disease and malnutrition from unsafe water, a particular problem during extreme climate events (FAO, 2023).

The WFP provides a relevant example of an all-encompassing approach to addressing water systems to promote nutrition through their Food Assistance for Assets (FFA) initiative, in which food or cash assistance is provided to vulnerable populations in exchange for community asset-creation activities, including soil and water conservation, land rehabilitation, tree planting, road building, and building or fixing irrigation systems and flood barriers. In addition, technical advice is provided to increase community capacity beyond the context of the intervention. Taken together, FFA initiatives not only improve food security in the short term, but build resilience and enhance the capacity of communities to adapt to climate change in the future (WFP, 2024f).

An oft-cited example articulating the effectiveness of FFA initiatives comes from the Sahel region in Africa, where resilience building activities, highlighted by the digging of "half-moons" which help with water retention and agricultural productivity, have been pursued since 2014 (WFP, 2020b). There, 1.4 million people have benefitted from the WFP's activities in the region, while more than 40,000 hectares of degraded land have been rehabilitated (WFP, 2020b).

Research shows that additional benefits include increasing incomes for local producers and reductions in seasonal migrations which improve community capacity (WFP-USA, 2019). Moreover, over 500 hectares of community gardens which produce fresh fruits and vegetables have been created, some of which provide for school meal programs, and by doing so, increase the attendance rates and performance of girls at school (WFP, 2020b). Research even indicates that conflict in the region between livestock and crop producers has been lessened, an important benefit in an area which often faces a variety of socio-political conflicts (WFP-USA, 2019).

4.3 Promotion of nutrition and health

Promote nutritious diets

Research shows that consumption of nutrient-poor, ultra-processed foods high in fat, sugar, and salt is on the rise all over the world (Swinburn et al., 2019), particularly with children, who have been the subject of extensive marketing (UNICEF, 2024). Not only do these foods contribute to malnutrition, including obesity and diet-related NCDs, as well as undernutrition and micronutrient deficiencies (Swinburn et al., 2019), but they are associated with numerous negative environmental impacts, including higher GHG emissions, more substantial biodiversity loss, and greater pollution than other food groups (UNICEF, 2024). For example, research from Australia shows that ultra-processed food consumption is estimated to contribute a substantial percentage of all diet-related environmental effects – 35% of water use, 39% of energy use, 33% of carbon dioxide equivalents, and 35% of land use (Swinburn et al., 2019).

As such, the promotion of nutritious diets which move away from the consumption of ultra-processed foods can significantly promote both nutrition and the reduction of environmental effects which contribute to, and are exacerbated by, climate change. The critical factor when constructing interventions is to recognize that poor dietary behaviors are a product of the food environment they exist in, and thus, this environment must be addressed holistically to promote more positive behaviors.

More simply, achieving long-term climate and nutrition resilience cannot be achieved without creating an enabling environment through policy and regulatory measures and fiscal tools across a range of sectors.

One prominent suggestion in the literature is the development of food-based dietary guidelines at the country level which include both nutritional goals and environmental sustainability (UN Nutrition, 2023). This can be done with consideration of the nutrition-climate integrations discussed in this section.

Critically, the marketing and advertising which influences consumer decisions must be addressed (Bakker et al., 2021). This can be done through efforts such as limiting or banning the marketing of unhealthy foods, particularly to children (UN Nutrition, 2023), taxation on unhealthy products, as has been done in the 'War on Sugar' in the Pacific Islands, and product labeling which contains warnings for high sugar, salt, or fat content (Swinburn et al., 2019). Marketing may also be made to include links to both nutrition and climate change, such as by providing information on the impact of certain foods on the environment (Bakker et al., 2021), promoting social responsibility amongst increasingly climate conscious consumers.

It can also include media campaigns which disseminate information on nutritious diets and healthy eating, including on the health and environmental benefits of sustainable diets, in order to shift public perception on nutrition, increase knowledge, and encourage consumption of nutrition-promoting diets, such as through television or social media campaigns, or smartphone applications (GAIN, 2023).

Furthermore, school food and nutrition programs which include education and nutritional knowledge can be an excellent opportunity to develop lifelong healthy food choices in children, while also an opportunity to promote sustainability and resilience in local food systems through the producers who provide food for such programs (UN Nutrition, 2023).

Relatedly, policymakers can add mandatory nutrition and environmental criteria to food procurement policies, not only for school food programs, but in health care facilities, universities, and other public spaces, as well as safety nets and emergency response programs (GAIN, 2023).

Breastfeeding initiatives

Breastfeeding is often referred to as the first food system. The importance of breastfeeding for health and nutrition outcomes has been well-established. For children, breastfeeding protects against undernutrition and can reduce the risk of developing NCDs later in life, while it also protects mothers from certain types of cancers as well as NCDs (Richardson et al., 2024). Moreover, in the context of climate change impacts which, as discussed, can impact water safety, breastfeeding can protect children from waterborne disease. In addition, research shows that breastfeeding can reduce the cost of a nutritious diet, even when the higher nutritional needs of lactating mothers are met (Mulabisano et al., 2022; USAID, 2022).

At the same time, research has shown that breastfeeding has a much lower environmental impact compared to commercial milk formula. For example, a recent study found that formula feeding has more than twice the carbon footprint of breastfeeding (Pope et al., 2021).

As such, initiatives which promote, facilitate, and protect breastfeeding not only promote health and nutrition, but can reduce emissions and thus contribute to emissions reductions targets and the potential impacts of climate change in the future.

These initiatives could include policies and programs for adopting and enforcing the International Code of Marketing of Breast-milk Substitutes (BMS code), enacting workplace breastfeeding practices and allowing adequate maternity leave to establish breastfeeding practices after birth, providing breastfeeding education and counseling to new mothers, as well as tracking data to measure progress on breastfeeding programs (Smith et al., 2023). Breastfeeding can even be included in carbon offset schemes (Richardson et al., 2024).

4.4 Overarching principles

Gender Equality

Research shows that women's empowerment leads to better health and nutrition outcomes for women, as well as their children and household. Indeed, studies have found that women's empowerment through education and equality policies have been a key driver of reduction of malnutrition in 115 countries (Tirado et al., 2022).

At the same time, it has been shown that women's empowerment increases the resilience and adaptive capacities of communities to climate shocks. For example, studies from India and Malawi have shown that initiatives reducing social injustice, including gender inequity, foster sustainable and resilient food systems (Owino et al., 2022), while elsewhere, it has been shown that empowered women increase the climate resilience of their communities for food security and nutrition (Tirado et al., 2022).

Simply, initiatives which promote gender equality address both malnutrition and climate resilience. Such initiatives could include those which place women in a position to make nutrition decisions for themselves and their families, which is missing in many male-dominated societies (Committee on World Food Security, 2023), as well as supporting empowerment and inclusion in health, education, and agriculture (Committee on World Food Security, 2023).

Further, initiatives could include increasing women's access to economic resources and opportunities, such as credit and land ownership rights, and investing in girl's education by removing barriers to schooling such as fees and cultural practices, as well as implementing programs that encourage high school and college attendance for girls, and offer vocational training and adult education programs for women which focus on literacy and numeracy skills, technology, and other job-relevant skills. They could include those which improve access to comprehensive health services for women, including reproductive health care, maternal health services, and gender-specific health interventions.

Moreover, many women farmers possess unique and critical knowledge on food systems and what works in the face of climate change, yet they are often not included in the decision-making process. The inclusion of women and this knowledge in the construction of interventions can improve both climate and nutrition outcomes, while conversely, failure to take women's specialized knowledge into account in policy and planning can lead to poor outcomes, including loss of biodiversity, water pollution, soil degradation, loss of forest cover, and failure to mitigate or adapt to climate change (Committee on World Food Security, 2023).

Equity

Expanding upon the concept of gender equality underpinning integration of climate change and nutrition within initiatives, research has shown that addressing the root causes of inequity, including through policies related to housing, labor, urban planning, education, and social protection, can help reduce the negative impacts of climate change on nutrition outcomes (Salm et al., 2020). Notably, the Nutrition Equity Framework suggests that addressing the inequality based social and political causes of malnutrition "is likely to be the most fundamental and sustainable way of improving nutrition equity" (Nisbett et al., 2022).

At the same time, research indicates that incorporating equity into climate change initiatives makes them more effective and more sustainable (Gloor et al., 2022), while buffering said initiatives from a risk that overall gains will be overwhelmed and invalidated by disproportionate negative impacts of climate change on marginalized groups (Deloitte, 2023). Indeed, it has been explicitly suggested that promoting equity is an integral part of addressing climate change (Green and Healy, 2022).

As such, initiatives which address inequity and promote empowerment of marginalized groups can be used to address both climate change and malnutrition. As suggested by Nisbett et al. (2022) in their discussion of the Nutrition Equity Framework, such initiatives must begin with recognition of groups that are marginalized, and the acknowledgement of the role of inequity, including daily and historical injustices, unfairness in resource and human capital distribution, and exclusion from political voice and agency, in shaping who is malnourished.

From there, initiatives should directly devote resources towards marginalized groups, including those designed to reduce poverty and build the resilience of disadvantaged communities and households, such as social protection tools and those providing access to financial, health, education, and technological resources which build opportunities.

Critically, as initiatives are designed, marginalized groups must be included in the decision-making process, empowering them to construct solutions for themselves, which has been shown to increase the effect and benefits of said initiatives (Fang et al., 2022).

Furthermore, research indicates that the disaggregated data required to quantify and track the ways in which inequity shapes nutrition in the context of climate change is sorely lacking (HLPE, 2023), highlighting the necessity of creating data along social, economic, and geographical groupings in order to inform initiatives which address both climate change and nutrition through equity.

Assessment tools

When promoting nutrition through interventions which can also address the drivers and impacts of climate change, an assessment of said interventions before they are implemented is a critical step both in understanding potential effects and obtaining funding. Three critical tools exist which can facilitate this process.

First, at COP28, the new Diet Impact Assessment (DIA) tool was unveiled as an instrument specifically designed to aid policymakers seeking to improve both human and environmental health. Using the latest statistical databases, the tool allows specific diet scenarios generated within interventions to be examined for nutrition indicators such as food consumption and cost-of-diet, along with health indicators such as avoidable deaths and risk factors for major diseases, as well as environmental analysis covering GHG emissions, land and water use, and fertilizer use for different unique diet scenarios. The tool can be used to effectively examine the impacts of food interventions on nutrition and health, as well as environmental sustainability.

Second, the Cost of the Diet (CotD) is a tool which allows for the estimation of the amount and combination of local foods needed to provide individuals or families with a diet that meets their average needs for energy and the WHO's recommended intakes of protein, fat, and micronutrients, and the minimum cost of said diet. The tool takes into account seasonal variation in prices, nutrients hardest to obtain from locally available foods, and foods which are the least expensive sources of energy and nutrients. Critically, the tool can be used to estimate and examine the potential impact of a sudden shock on the cost, quality, composition, and affordability of a nutritious diet, including weather events such as droughts and floods, based on the season in which the shock appears, and how long its effects are felt. With the impacts of the cost of a nutritious diet on nutrition, particularly in the context of climate change, discussed above, the CotD can be an integral tool in the design of interventions which address both climate change and nutrition.

Finally, building on the CotD, the WFP's (2023) ENHANCE tool provides an analytical model which allows for the examination of the interplay between cost, affordability, nutritional value, and environmental impact of different dietary scenarios. Critically, it allows for the exploration of context-specific actions through the introduction of variables such as fortified foods, consumer subsidies, changes in consumption patterns, and different climate shocks. The tool can be used to examine how interventions across multiple sectors can help mitigate the impact of climate change and promote nutrition.

Conclusion

This report underscores the substantial and multifaceted impacts of climate change on all forms of malnutrition in Asia-Pacific. Through a comprehensive literature review strengthened by key informant interviews, the report highlights a stark increase in malnutrition outcomes in the region, including stunting, wasting, and micronutrient deficiencies, as well as likely obesity and NCD outcomes, necessitating urgent mitigation strategies.

Importantly, the literature review uncovered significant gaps in existing research regarding the impacts of climate change on obesity in Asia-Pacific, as well as gender-specific impacts and the disproportionate effects felt by vulnerable populations in the region. Together, these gaps provide critical avenues for future research which must be undertaken to better understand impacts of climate change on malnutrition in a way which is critical for mitigating its effects.

Looking further into Asia-Pacific, the report built upon a new tool kit for assessing climate change and malnutrition risks in the region to construct an overall risk ranking for a variety of countries based on numerous socioeconomic and health indicators. These rankings indicate that countries like Afghanistan, Lao PDR, Kiribati, Timor-Leste, Vanuatu, India, Myanmar, and Indonesia face significant challenges. Meanwhile, lower scores for Pacific Island countries indicate a critical lack of data, again providing an important avenue for future research.

Moving beyond Asia-Pacific, the report thoroughly unpacked the multi-directional pathways between climate change and all forms of malnutrition on a global scale. These pathways emerged across four systems – food, health, water, and social protection.

Within the food system, notable challenges include reduced food production and higher food prices, alongside livelihood reductions, each of which are contributing to a shift away from nutritious foods towards processed options. At the same time, food safety risks and food waste are increasing, while the nutritional content of crops is falling due to rising CO2 levels. The health system endures challenges from a climate-driven increase in chronic diseases, pregnancy complications, and negative mental health effects, while within the water system, water scarcity and contamination amplify food insecurity and malnutrition issues.

Faced with these challenges, social protection systems struggle to safeguard households from impacts, with coping strategies on the rise, and some mitigation strategies even exacerbating malnutrition or climate change. Moreover, throughout each of these pathways, gender disparities and the inequity experienced by vulnerable populations provide disproportionate impacts on women, children, and marginalized groups.

Fundamentally, an examination of the pathways between climate change and malnutrition highlights the interconnectedness between systems, stressing the need for comprehensive strategies to mitigate often mutually reinforcing impacts.

With a robust cache of both Asia-Pacific-specific and global data compiled, this report identified critical opportunities for climate change and malnutrition to be integrated and addressed together within interventions and adaptation strategies, highlighting the mutually reinforcing benefits that such integration can deliver. In doing so, the report provides sustainable solutions across a continuum of responses, beginning with immediate reactions to shocks, progressing through strategies that build resilience and the promotion of nutrition and health, and culminating with the overarching principles which must run through every response.

Notably, Anticipatory Action emerged as a significant opportunity to generate positive nutritional outcomes when faced with frequent climate shocks, particularly for vulnerable groups. Moving forward, the expansion of AA programs can and should be pursued as a cost-effective way to enhance resilience, safeguard lives and livelihoods, and mitigate both overall humanitarian needs and the price of humanitarian response.

Going further, food fortification, the utilization of indigenous crops, breastfeeding initiatives, and a shift away from red meat towards plant-based diets were each highlighted as opportunities to improve nutrition while reducing environmental impacts. Each can be supported by marketing initiatives, education programs, and mandatory nutrition and environmental criteria to create a food environment which promotes and facilitates the consumption of nutritious diets.

In addition, addressing post-harvest food losses and waste was noted as critical for improving food availability at the same time as reducing environmental impact, while strengthening water resilience was shown as essential for sustaining food production, health, and livelihoods under climate stress.

Most broadly, to effectively integrate climate change and nutrition within initiatives, the report highlights the necessity of addressing the equity of vulnerable groups and involving impacted communities in strategy design, which are shown improve nutritional outcomes and resilience while reducing environmental impacts.

Taken together, this report provides a roadmap for policymakers, practitioners, and researchers to develop integrated, sustainable solutions across a continuum of responses. Through these efforts, the report can inform the integration of nutrition-focused strategies into the climate response systems in countries most at risk, building more resilient and nutrition-sensitive systems across the Asia-Pacific region.

Appendix 1: Tables and Figures

Table 3: Consumption of fruits and vegetables (g/day) in 2010 and 2050 for the reference scenario without climate change and for the mean of the main climate change scenarios (Springmann et al. 2016).

Region	Baseline of 2010	2050 reference scenario (without climate change)	2050 climate change scenarios (mean)
Global	342.2	378.0	363.1
South-East Asia LMIC	215.3	321.8	307.3
Western Pacific LMIC	539.0	602.1	579.2

Table 4: Red meat consumption (g/day) in 2010 and 2050 for the reference scenario without climate change and for the mean of the main climate change scenarios (Springmann et al. 2016).

Region	Baseline of 2010	2050 reference scenario (without climate change)	2050 climate change scenarios (mean)
Global	62.6	66.5	66.0
South-East Asia LMIC	9.1	14.1	14.0
Western Pacific LMIC	101.7	126.0	125.3

Table 5: Food availability (total kcal/day) in 2010 and 2050 for the reference scenario without climate change and for the mean of the main climate change scenarios (Springmann et al. 2016).

Region	Baseline of 2010	2050 reference scenario (without climate change)	2050 climate change scenarios (mean)
Global	2,817	3,107	3,008
South-East Asia LMIC	2,406	2,857	2,741
Western Pacific LMIC	3,017	3,513	3,402

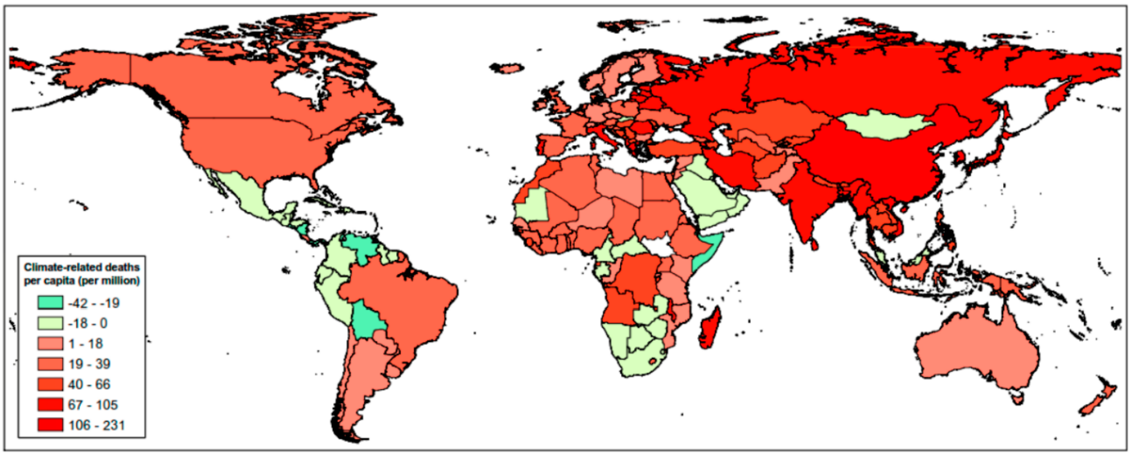

Figure 18: Per capita climate related deaths (in deaths per millions) in 2050 (Springmann et al. 2016).

Table 6: Aggregate food production (index, 2010 = 1.00) projections for 2030 and 2050, considering scenarios with and without climate change across three regions in the Asia-Pacific (IFPRI 2022).

		Without Climate Change		With Climate Change	
Region	**2010**	**2030**	**2050**	**2030**	**2050**
East Asia & Pacific	1.00	1.293	1.563	1.281	1.543
South Asia	1.00	1.571	2.053	1.499	1.902
Southeast Asia	1.00	1.238	1.367	1.249	1.396

Table 6a: Aggregate food production (index, 2010 = 1.00) projections for 2030 and 2050, considering scenarios with and without climate change across countries in the Asia-Pacific (IFPRI 2022).

		Without Climate Change		With Climate Change	
Country	**2010**	**2030**	**2050**	**2030**	**2050**
Bangladesh	1.00	1.406	1.632	1.330	1.458
India	1.00	1.627	2.164	1.549	2.003
Nepal	1.00	1.327	1.601	1.373	1.705
Pakistan	1.00	1.329	1.630	1.262	1.493
Sri Lanka	1.00	1.398	1.732	1.391	1.712
Cambodia	1.00	1.176	1.302	1.102	1.155
Fiji	1.00	1.158	1.341	1.090	1.176
Indonesia	1.00	1.262	1.466	1.251	1.442
Lao PDR	1.00	1.311	1.553	1.266	1.463
Malaysia	1.00	1.231	1.393	1.224	1.370
Myanmar	1.00	1.347	1.552	1.335	1.525
Papua New Guinea	1.00	1.432	1.879	1.464	1.970
Philippines	1.00	1.325	1.676	1.313	1.654
Solomon Islands	1.00	1.295	1.607	1.230	1.454
Thailand	1.00	1.150	1.240	1.091	1.114
Vanuatu	1.00	1.263	1.578	1.226	1.477
Vietnam	1.00	1.247	1.360	1.193	1.236

Table 7: Per capita food consumption (kcal per capita per day) projections for 2030 and 2050, considering scenarios with and without climate change across three regions in the Asia-Pacific (IFPRI 2022).

		Without Climate Change		With Climate Change	
Region	**2010**	**2030**	**2050**	**2030**	**2050**
East Asia & Pacific	2,906	2,994	3,076	2,962	3,004
South Asia	2,365	2,680	2,976	2,634	2,863
Southeast Asia	2,875	3,335	3,463	3,279	3,340

Table7a: Per capita food consumption (kcal per capita per day) projections for 2030 and 2050, considering scenarios with and without climate change across countries in the Asia-Pacific (IFPRI 2022).

		Without Climate Change		With Climate Change	
Country	**2010**	**2030**	**2050**	**2030**	**2050**
Bangladesh	2,426	2,714	2,911	2,653	2,781
India	2,354	2,697	2,997	2,651	2,883
Nepal	2,425	2,695	3,186	2,625	3,028
Pakistan	2,379	2,540	2,862	2,514	2,787
Sri Lanka	2,396	2,719	2,909	2,658	2,775
Cambodia	2,348	2,515	2,614	2,463	2,508
Fiji	2,819	3,107	3,752	3,060	3,615
Indonesia	2,540	2,988	3,279	2,904	3,101
Lao PDR	2,267	2,417	2,483	2,364	2,378
Malaysia	2,838	3,173	3,462	3,143	3,383
Myanmar	2,168	2,468	2,586	2,415	2,479
Papua New Guinea	2,298	2,789	3,151	2,750	3,063
Philippines	2,503	2,641	2,777	2,602	2,690
Solomon Islands	2,487	2,770	3,088	2,733	2,998
Thailand	2,742	3,012	3,183	2,974	3,103
Vanuatu	2,824	3,094	3,597	3,039	3,467
Vietnam	2,512	2,709	2,827	2,652	2,708

Table 8: Hunger (millions of people at risk) projections for 2030 and 2050, considering scenarios with and without climate change across three regions in the Asia-Pacific (IFPRI 2022).

		Without Climate Change		With Climate Change	
Region	**2010**	**2030**	**2050**	**2030**	**2050**
East Asia & Pacific	3.2	2.7	2.0	3.1	2.7
South Asia	261.5	128.9	79.8	151.6	86.6
Southeast Asia	268.0	109.1	92.4	116.7	105.5

Table 8a: Hunger (millions of people at risk) projections for 2030 and 2050, considering scenarios with and without climate change across countries in the Asia-Pacific (IFPRI 2022).

		Without Climate Change		With Climate Change	
Country	**2010**	**2030**	**2050**	**2030**	**2050**
Bangladesh	26.0	11.3	6.9	14.8	8.7
India	189.7	73.9	45.0	90.6	44.9
Nepal	2.7	2.0	0.8	2.4	1.5
Pakistan	37.6	38.0	24.4	39.9	28.0
Sri Lanka	5.4	3.5	2.7	3.9	3.3
Cambodia	2.4	1.9	1.5	2.2	2.0
Fiji	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Indonesia	32.4	12.9	7.2	15.5	11.2
Lao PDR	1.5	1.4	1.3	1.6	1.7
Malaysia	0.9	0.8	0.9	0.8	0.9
Myanmar	10.5	6.5	4.9	7.2	6.1
Papua New Guinea	0.9	0.2	0.3	0.2	0.3
Philippines	12.1	12.2	11.0	13.2	13.1
Solomon Islands	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Thailand	6.2	3.1	1.8	3.5	2.3
Vanuatu	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Vietnam	12.9	9.5	7.2	10.9	9.7

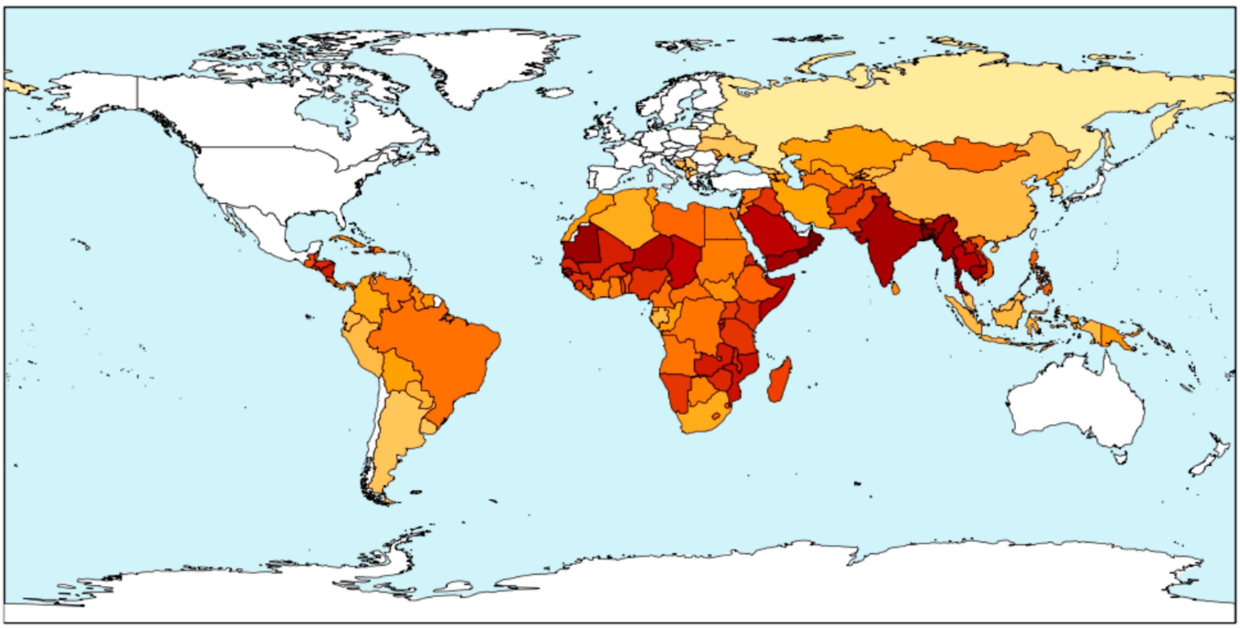

*Figure 19: Map of vulnerability of country food security to climate risk at 1.5 degrees Celsius (**Betts, 2018**)*

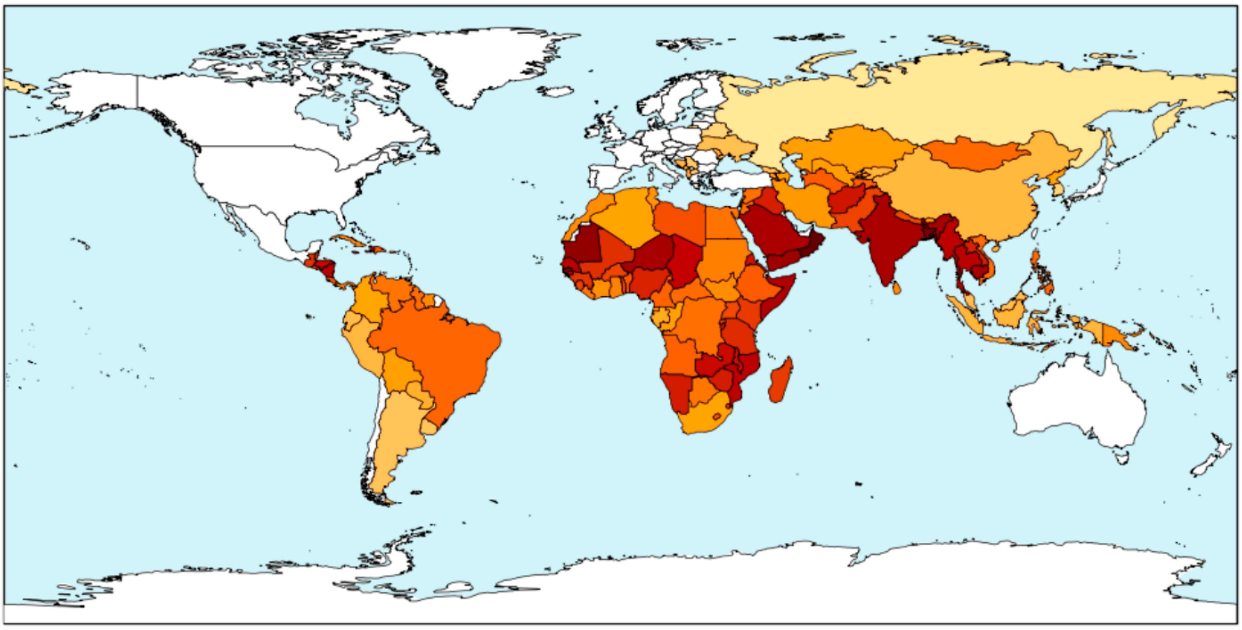

Figure 20: Map of vulnerability of country food security to climate risk at 2 degrees Celsius ***(Betts, 2018)***

Table 9: Change in production for commodity groups in 2050 in South-East Asia compared to no climate change (Cenacchi et al. 2021).

Commodity	HGEM2	IPSL2
Animal products	-0.8%	-0.7%
Cereals	-7.7%	-5.8%
Fruits and Vegetables	-4.0%	-3.3%
Oils and Sugars	-4.4%	-3.7%
Others (including pulses)	-5.7%	-4.4%
Roots and Tubers	-0.8%	0.4%

Table 10: Percent change yield for major crops in 2050 in South-East Asia compared to no climate change (Cenacchi et al. 2021).

Commodity	HGEM2	IPSL2
Maize	-23.4%	-21.5%
Sugarcane	-16.7%	-13.7%
All cereals	-9.1%	-7.1%
All crops	-6.5%	-5.3%
Rice	-5.2%	-3.2%
Palm Fruit	-5.0%	-4.0%
Cassava	-0.3%	1.29%

Table 11: Projection of cereal yields, cereal prices, and cereal consumption under climate change in 2050 (Yan and Alvi, 2022).

Country	Cereal yield	Cereal prices	Cereal consumption
India	-7.1%	13.7%	-5.1%
Pakistan	-10.7%	43.2%	-17.2%
Bangladesh	-16.4%	50.7%	-23.5%
Sri Lanka	-9.5%	31.5%	-9.9%

Table 12: Protein availability, g per person per day for 2010 and 2050 (Beach et al. 2019).

Region	2010	2050 - climate scenario	2050 – nutrient scenarios	
			Loladze (2014)	Myers et al. (2014)
Global	95.09	111.82	107.27	108.54
East Asia and Pacific	104.81	134.15	129.23	130.40
Southern Asia	65.87	94.51	89.53	90.69

2050-climate scenario: effects of climate change (eg, temperature, precipitation) and socioeconomic conditions (eg, market forces, technology) are projected to 2050 with CO2 fertilisation but without any nutrient effects.
2050-nutrient scenario: CO2 nutrient content effects are applied on top of the 2050-climate scenario.

Table 13: Iron availability, mg per person per day (Beach et al. 2019).

Region	2010	2050 - climate scenario	2050 – nutrient scenarios	
			Loladze (2014)	Myers et al. (2014)
Global	23.78	28.50	27.70	27.47
East Asia and Pacific	27.08	32.75	32.03	31.62
Southern Asia	17.31	26.79	26.02	25.67

2050-climate scenario: effects of climate change (eg, temperature, precipitation) and socioeconomic conditions (eg, market forces, technology) are projected to 2050 with CO2 fertilisation but without any nutrient effects.
2050-nutrient scenario: CO2 nutrient content effects are applied on top of the 2050-climate scenario.

Table 14: Zinc availability, mg per person per day (Beach et al. 2019).

Region	2010	2050 - climate scenario	2050 – nutrient scenarios	
			Loladze (2014)	Myers et al. (2014)
Global	14.52	17.17	16.75	16.59
East Asia and Pacific	15.65	19.57	19.16	18.97
Southern Asia	9.73	12.87	12.49	12.32

2050-climate scenario: effects of climate change (eg, temperature, precipitation) and socioeconomic conditions (eg, market forces, technology) are projected to 2050 with CO2 fertilisation but without any nutrient effects.
2050-nutrient scenario: CO2 nutrient content effects are applied on top of the 2050-climate scenario.

Table 15: Climate-attributable effects on Gini for Asia-Pacific in 2030 and 2050 measured as a percent change (Hughes 1999).

Year, climate path	Percent change Gini
2030 Current Path	1.4%
2030 Worse Climate Path	2.2%
2050 Current Path	7.1%
2050 Worse Climate Path	9.8%

Table 16: Climate-attributable effect of Worse Climate Path on food insecurity, female food insecurity, and extreme poverty measured as a percent change for Asia-Pacific in 2030 and 2050 (Hughes 1999).

	2030	2050
Food insecurity	5%	17%
Female food insecurity	6%	23%
Extreme poverty	18%	192%

Table 17: Climate-attributable effect on female and males in the 25-34 age group across poverty thresholds measured in millions in 2030 and 2050 for Asia-Pacific (Hughes 1999).

Poverty threshold	Climate path	2030		2050	
		Female	Male	Female	Male
$2.15	Current path	0.9	0.4	1.6	0.6
$2.15	Worse Climate Path	1.7	1.4	4.0	1.5
$3.65	Current path	1.8	1.5	5.8	5.2
$3.65	Worse Climate Path	4.5	4.4	14.1	12.9
$6.85	Current Path	1.3	1.0	7.8	7.3
$6.85	Worse Climate Path	4.2	4.2	21.3	20.5

Appendix 2: Additional Results

Diets

- **Rainfall shocks were associated with household hunger in Bangladesh (Cooper, 2018)**

This study modeled the effects of extreme rainfall on indicators of nutrition and food security, finding a strong association between extreme precipitation and household hunger in Bangladesh. Notably, the study found that in certain contexts, empowering women can mitigate the effects of precipitation shocks on hunger.

- **Floods negatively impacted household food consumption in rural Cambodia (Grote et al., 2020)**

Using a two-year panel dataset from rural Cambodia, researchers found that floods negatively impact household food consumption.

- **Cyclone and drought associated with lower food consumption in Bangladesh (Islam et al., 2022)**

Using three rounds of longitudinal datasets from Bangladesh, researchers found both cyclone- and drought-prone areas consumed less food than those in other areas.

- **Climate variability contributed to shift to unhealthy diets in India (Downs et al., 2021)**

In a mixed-methods study of indigenous communities in Jharkhand, India, which included household and agricultural surveys and focus group discussions, researchers found that climate variability has reduced the availability and accessibility of diverse foods, contributing to a shift from a traditional diet comprised of indigenous rice, vegetables, and roots and tubers towards a cereal based diet with low amounts of pulses, roots and tubers, or green leafy vegetables.

- **Extreme high temperatures reduced child diet diversity in Asia (Niles et al., 2021)**

Combining survey data with 30 years of precipitation and temperature data, researchers determined that high temperature anomalies had a consistent negative relationship with child diet diversity in Asia.

- **Climate change impacts led to unhealthy diets in Vanuatu (Bambrick et al., 2021)**

Combining semi-structured interviews with community fieldwork in two villages in Vanuatu, researchers found climate impacts – including both extreme events such as cyclones and extreme variability such as more frequent dry or wet periods – led to a decreased availability of local crops, mainly fruits and vegetables, and an increased dependence on imported, store-bought foods, leading to a lower-quality diet and increased risk of NCDs.

- **Climate change impacts increased reliance on unhealthy foods in Fiji (Boxer et al., 2023)**

A literature review of 22 studies revealed that rising heat and inconsistent rainfall, as well as climate-related disasters, were affecting the food supply chain in Fiji, leading to an increased reliance on processed, packaged foods.

- **Climate change contributed to a shift to unhealthy diets in Pacific Island countries (Foley et al., 2017)**

A comprehensive review of literature from Pacific Island countries found that climate change impacted food and nutrition security through changes in local food production and transition from traditional diets to dependence on less nutritious imported foods.

Livelihoods

- **High temperatures were associated with lost livelihoods for smallholder farmers in India and Bangladesh (Chiotha et al., 2021)**

Combining a literature review with field observations and informal interviews with key informants in three countries, including India and Bangladesh, researchers found that temperature increases make heat stress more widespread and reduce the total number of work hours, thus resulting in lost livelihoods for smallholder farmers.

- **Climate risks impacted farmers' livelihoods in coastal Bangladesh (Aryal et al., 2020)**

Through farming household surveys in coastal Bangladesh, researchers found that 49% of farmers' households reported climate-related risks had a high degree of influence on their livelihoods, while 41% reported the effect was medium, and only 8% reported the effect was low, and 2% that there was no effect.

- **Agricultural income is highly vulnerable to climate change in Thailand and Vietnam (Amare et al., 2022)**

Looking at smallholder farmers in four countries, including Thailand and Vietnam, researchers found that agricultural income was highly vulnerable to changes in precipitation and temperature through impacts on agricultural yields.

- **Low income and livelihood dependence on natural resources was associated with losses from droughts and floods in Sri Lanka (De Silva and Kawasaki, 2018)**

Using household surveys conducted in the North Central province of Sri Lanka, researchers found that households depending heavily on natural resources for their livelihood, and those with low income, suffer the greatest losses from floods and droughts.

Coping strategies

- **Droughts and floods led to negative coping strategies in rural Cambodia (Grote et al., 2020)**

Using a two-year panel dataset from rural Cambodia, researchers found that droughts and floods pushed households into selling durable assets.

- **Extreme weather events led to negative coping strategies in Bangladesh (Alauddin et al., 2017)**

Combining community surveys and face-to-face interviews conducted in 2013-2014 in two villages in Bangladesh, researchers found that in the past 15-20 years, extreme weather events had caused households to use coping strategies in response to damage to crops, including selling household assets like livestock and arable land, borrowing money, using savings, and reduced food intake.

- **Climate risks caused farmers to use negative coping strategies in coastal Bangladesh (Aryal et al., 2020)**

Through farming household surveys in coastal Bangladesh, researchers found that climate risks including cyclones, excessive rain and flooding, pests, and livestock diseases, caused farmers to use coping strategies, including using savings or borrowing money (42% of households), and reducing household food consumption (26%).

- **Climate shocks led to negative coping strategies in Bangladesh (Aberman et al., 2015)**

Through qualitative studies conducted in four countries, including Bangladesh, researchers found that to cope with the shocks of climate change, households used coping strategies such as selling household assets including livestock, and decreasing food consumption.

- **Climate risks caused farmers to use negative coping strategies in Bangladesh, India, and Nepal (Aryal et al., 2021)**

Using comprehensive data from farm households in five countries, including Bangladesh, India, and Nepal, researchers found that climate risks like excessive rainfall, cyclones, and pests caused farmers to use coping strategies like selling household assets, using savings and borrowing money, and reducing food consumption.

Disease

- **High temperature and heavy rainfall were associated with illness in South Asia (Campbell et al., 2022)**

A comprehensive literature review encompassing 42 studies between 2010 and 2020 found a positive association between diarrheal diseases and meteorological factors including high temperature and heavy rainfall events in South Asia. Additionally, the study noted a positive association between extreme precipitation and gastrointestinal illness among children, as well as between temperature and precipitation events and the risk of respiratory infections.

- **High temperatures, humidity, and wind-speed were associated with increase in diseases in India (Banerjee et al., 2021)**

In a study of children under 16 in Varanasi city, India, from 2017-2020, researchers found increases in maximum temperature were associated with an increase in diarrhea and skin-disease cases, while a rise in humidity was associated with an increase in cases of cold and flu, and malaria. A change in wind-speed was positively associated with diarrhea.

- **High temperatures were associated with gestational hypertensive disease in India and Pakistan (Ali et al., 2023b)**

Combining data from a multi-country maternal and child heath registry with meteorological data between 2014 and 2020, researchers found greater temperatures in the third trimester of pregnancy were associated with increased risk of gestational hypertensive disease in India and Pakistan.

- **Extreme weather events were associated with the transmission and outbreak of disease in India and Bangladesh (Chiotha et al., 2021)**

Using a literature review supported by field observations and informal interviews with key informants in three countries, including India and Bangladesh, researchers found that extreme weather events such as cyclones, flooding, and droughts can raise the transmission and outbreak of infectious diseases among smallholder farmers, including dengue, malaria, cholera, diarrhea, dysentery, acute respiratory infections, and pulmonary tuberculosis. Notably, researchers noted that extreme weather events can exacerbate the incidence of some non-communicable diseases (NCDs) including cardiovascular disease, cancers, and respiratory issues among smallholder farmers. Heat-triggered chronic kidney disease associated with recurrent dehydration was also noted in India.

- **Flooding in Malaysia increased instances of diarrhea (Hussain et al., 2016)**

Researchers found that the 2014 flood in Malaysia dramatically increased incidences of diarrhea, including, most notably, among children less than two years old.

- **Droughts increased the risk of infectious disease for smallholder farmers in India and Bangladesh (Chiotha et al., 2021)**

Using a literature review supported by field observations and informal interviews with key informants in three countries, including India and Bangladesh, researchers found that smallholder farmers were at a higher risk of infectious diseases during droughts.

- **Flooding increased the occurrence of waterborne diseases in Cambodia (Chan et al., 2014)**

A comprehensive literature review on the health impacts of floods, droughts, and typhoons in 16 Cambodian provinces between 2001 and 2012 revealed that flooding increased the occurrence of waterborne diseases such as diarrheal disease, ear, nose, and throat infections, dermatitis, and conjunctivitis.

- **Climate change increased infectious disease in Lao PDR (Parliamentary Institute of Cambodia, 2018)**

A comprehensive literature review on the impacts of climate change on child malnutrition in Lao PDR found that during floods, droughts, and periods of high temperatures, infectious diseases increase as a result of unsafe water, poor sanitation, and hygiene practices, including diarrhea, malaria, respiratory tract infections, pneumonia, and parasites.

Protein deficiency

While it is not a micronutrient deficiency, one prediction model speaks to rising levels of protein deficiency as a result of climate change.

Combining a meta-analysis of published literature with global food balance sheets, Medek et al. (2017) modeled global and country-specific risks of protein deficiency attributable to anthropogenic CO2 emissions by 2050. Projections for three relevant regions were presented – 'East and Southeast Asia and the Pacific,' 'South Asia,' and 'India.' The model projected that 15.99 million additional people would be at risk of protein deficiency in 'East Asia and the Pacific' in 2050, while an additional 15.86 million would be at risk in South Asia, and an astonishing 53.41 million in India.

Further, the model combines literature on the effect of CO2 emissions on the protein concentrations of edible portions of crops with protein intake distributions within countries using Gini coefficients, as well as estimated average protein requirements weighted by population age structure, to estimate the per-country change in dietary protein intake under elevated CO2, and subsequently, those countries at risk of deficiency (Figure 10 and 11).

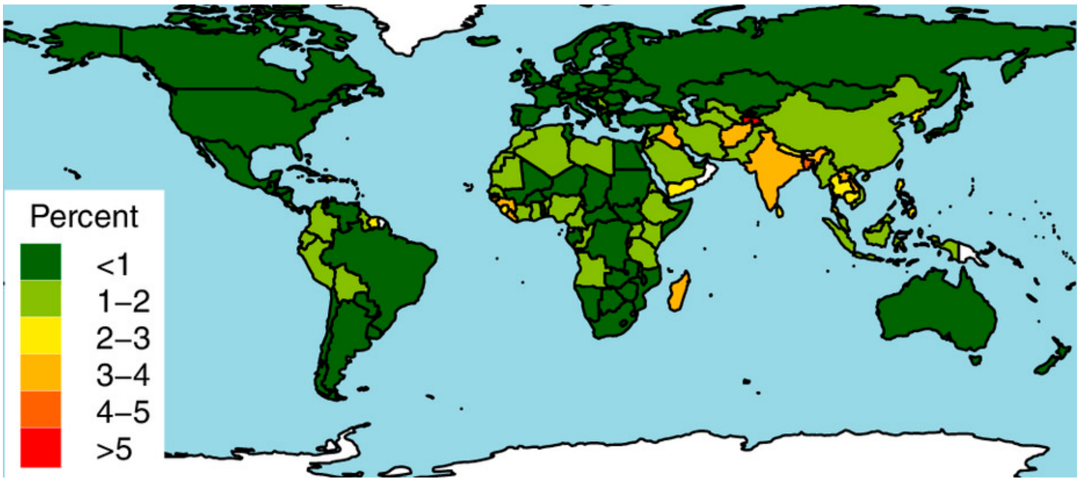

Figure 21: Percent of the population newly at risk of protein deficiency under elevated CO2 in 2050 (Medek et al. 2017).

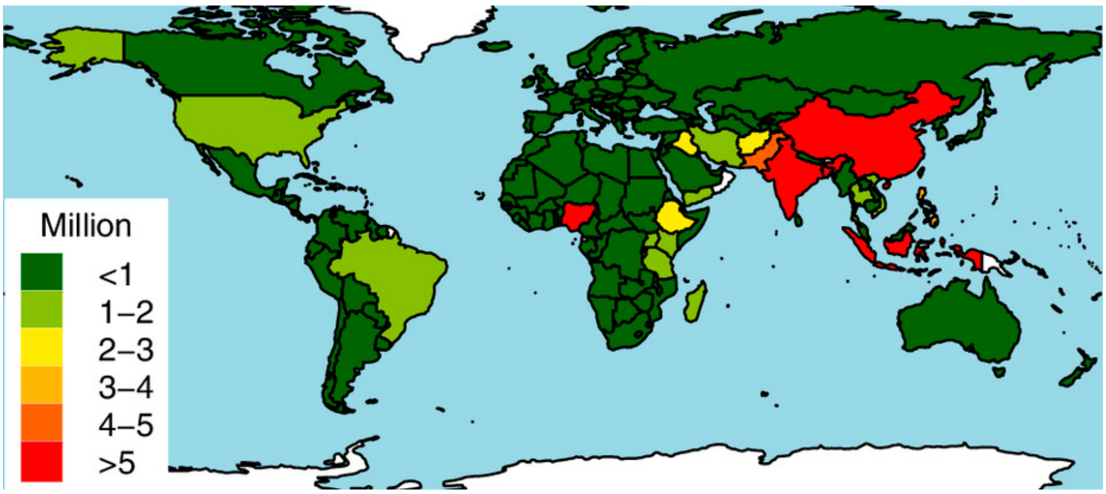

Figure 22: Millions of people newly at risk of protein deficiency under elevated CO2 in 2050 (Medek et al. 2017).

Appendix 3: Tables and Figures

Elements recommended for reporting (source: Headey and Venkat, 2024)

1. Describes the rationale for the study?
2. Identifies dependent and independent variables?
3. Hypothesizes mechanisms/impact pathways?
4. Describes sources, sample design, representativeness?
5. For case-control studies, describes control population?
6. Describes selection criteria for chosen data sources?
7. Uses continuous nutrition outcome indicators?
8. Describe spatial and temporal unit for weather data?
9. Provides detailed definition of weather phenomenon?
10. Discusses potential measurement errors?
11. Discusses statistical power to detect impacts?
12. Discusses dynamics and lags in indicators used?
13. Describes estimation controls for spatial fixed effects?
14. Describes other controls confounders?
15. Describes treatment of spatial/temporal autocorrelation?
16. Describe sub-samples of analysis? Age and gender?
17. Describe tests of hypothesized impact pathway(s)?
18. Describe tests of hypothesized factors that magnify/attenuate impacts?
19. Describes tests to assess violation of exogeneity?
20. Describes any selection or misclassification biases?
21. Discusses and interprets magnitude of key coefficients?
22. Reports tests for alternative methods?
23. Reports tests of exogeneity assumptions?
24. Reports heterogeneity tests of differential effects across spatial units, surveys, age, gender, resilience factors?
25. Describes study limitations?
26. Compares and contrasts results to other findings?

Annex

ANNEX 1: KEY INFORMANT INTERVIEW METHODOLOGY

The questions used to guide the key informant interviews include:

1. **Are you aware of any estimates of the impact of climate change on any form of malnutrition in the Asia-Pacific region?**

2. **In your experience, what are, and will be, the main pathways for the impact of climate change on all forms of malnutrition in the Asia Pacific region? We acknowledge that pathways are context specific, and that there will different pathways depending on the context.**

3. **Have you used, or are you aware of any methodologies that have been applied to assess/ identify countries most at risk of the negative impacts of climate change on nutrition?**

4. **Based on your experience, what are some best practices for integrating nutrition into climate change interventions/ anticipatory actions?**

5. **Please share any other actions/interventions you see as key going forward to ensure nutrition is well integrated in climate change anticipatory actions, any unreported good practices you are aware of, and what you see as main research gaps to inform practice going forward.**

ANNEX 2: WFP COUNTRY PROFILES FOR SELECTED AGRI-FOOD SYSTEM, CLIMATE AND WASH INDICATORS

Agri-food system indicators

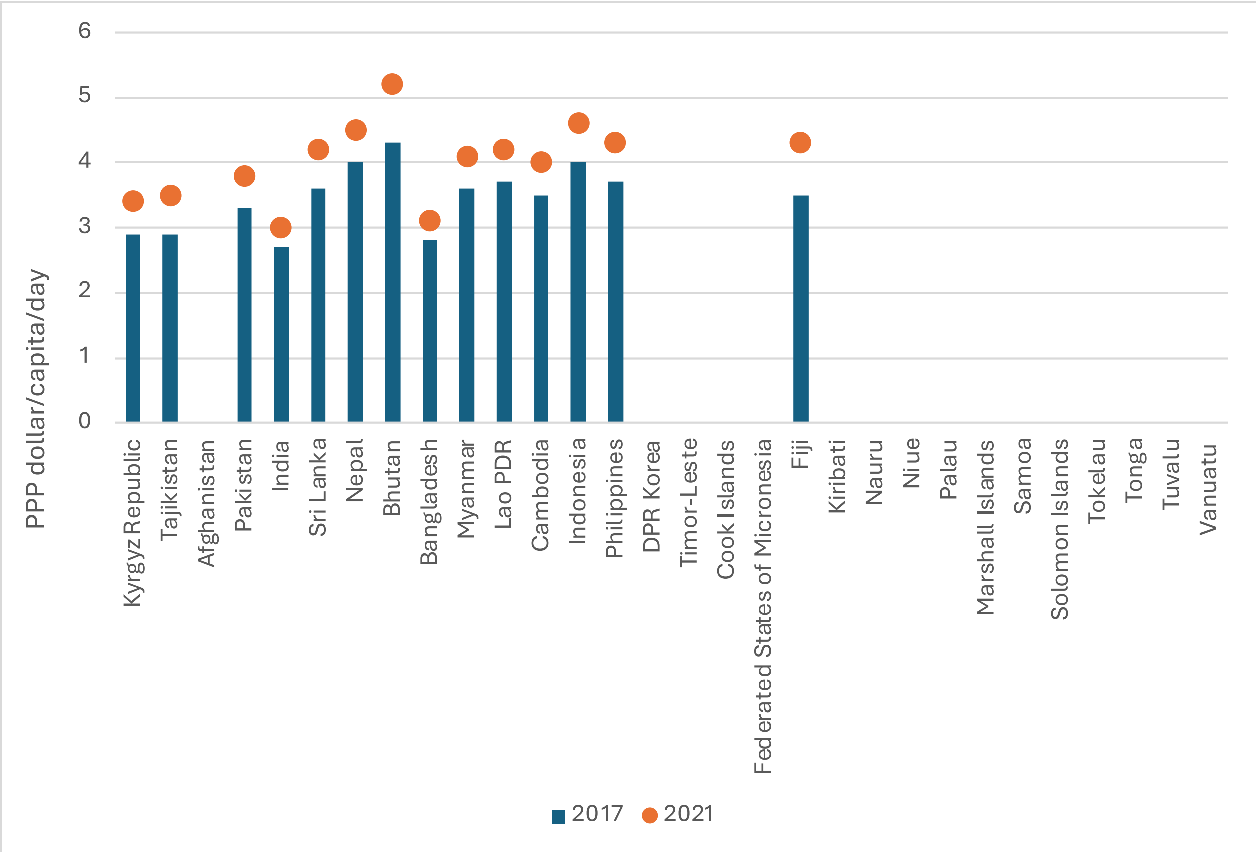

Figure 23: Cost of a healthy diet (the per capita cost of the least expensive locally available foods to meet requirements for energy and food-based dietary guidelines, per capita, per day (current Purchasing Power Parities US$); Source: FAO)

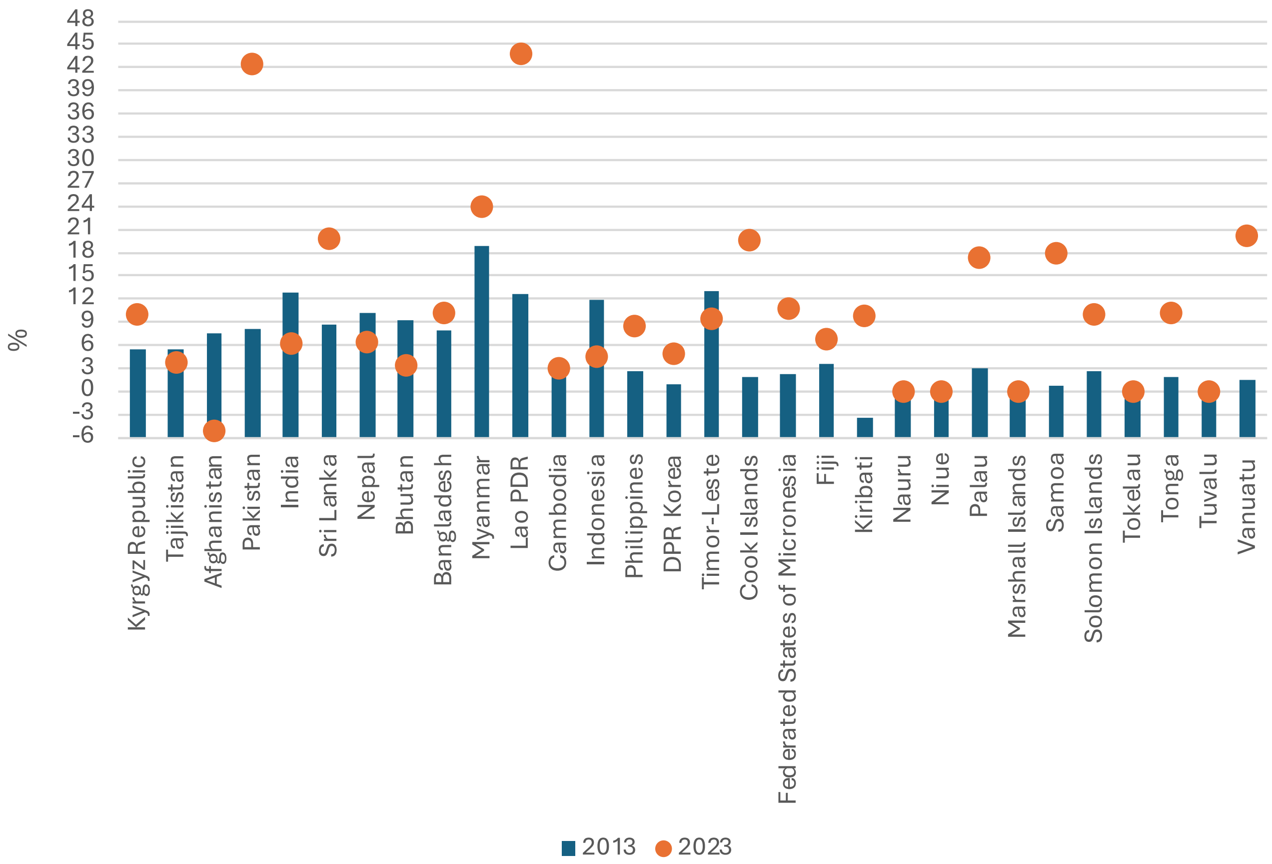

Figure 24: Food price inflation (Source: FAO)

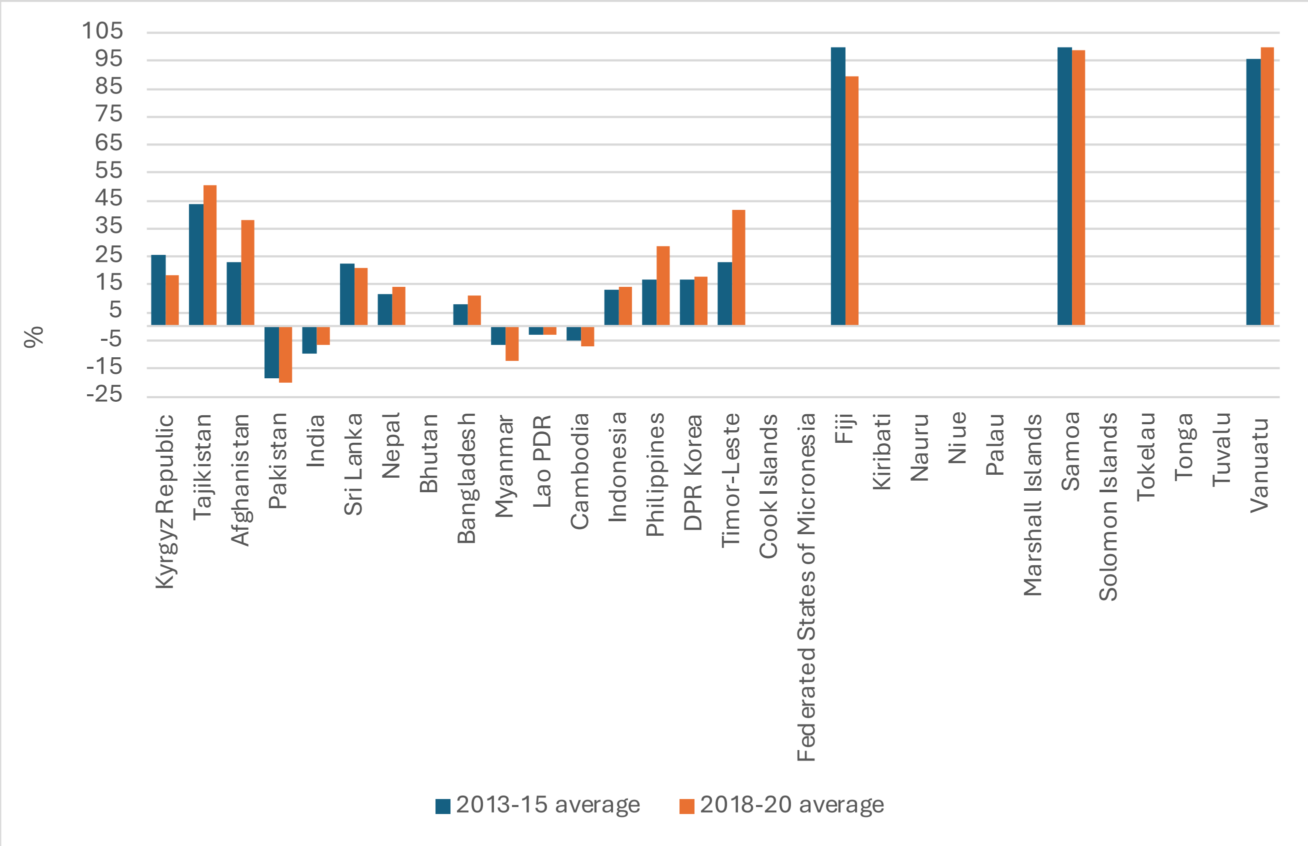

Figure 25: Cereal import dependency ratio (3 years average; Source: FAO)

*The cereal imports dependency ratio tells how much of the available domestic food supply of cereals has been imported and how much comes from the country's own production. It is computed as (cereal imports - cereal exports)/(cereal production+cereal imports - cereal exports) * 100. Given this formula the indicator assumes only values <= 100. Negative values indicate that the country is a net exporter of cereals.*

Climate indicators

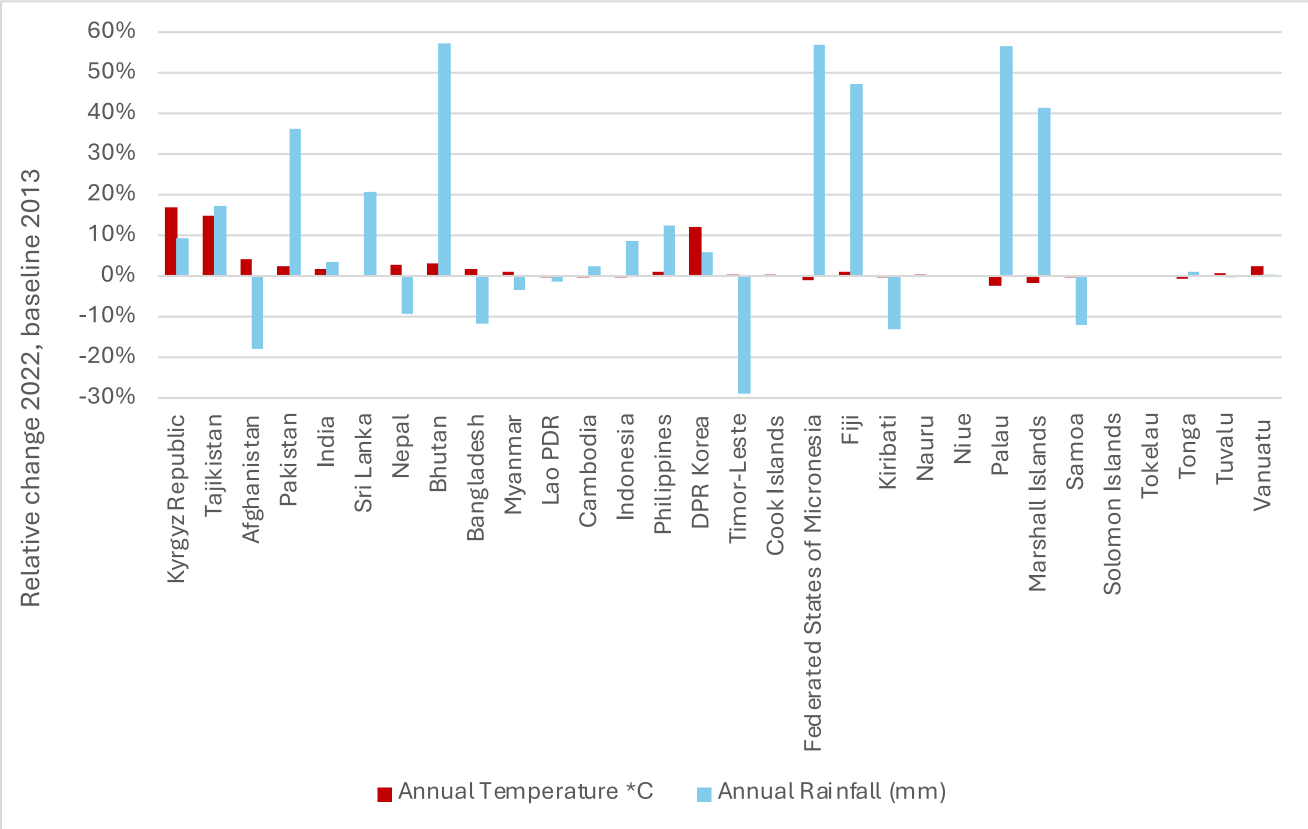

Figure 26: Relative change of the annual mean temperature and Annual rainfall between 2013 and 2022

Water, Sanitation and Hygiene indicators

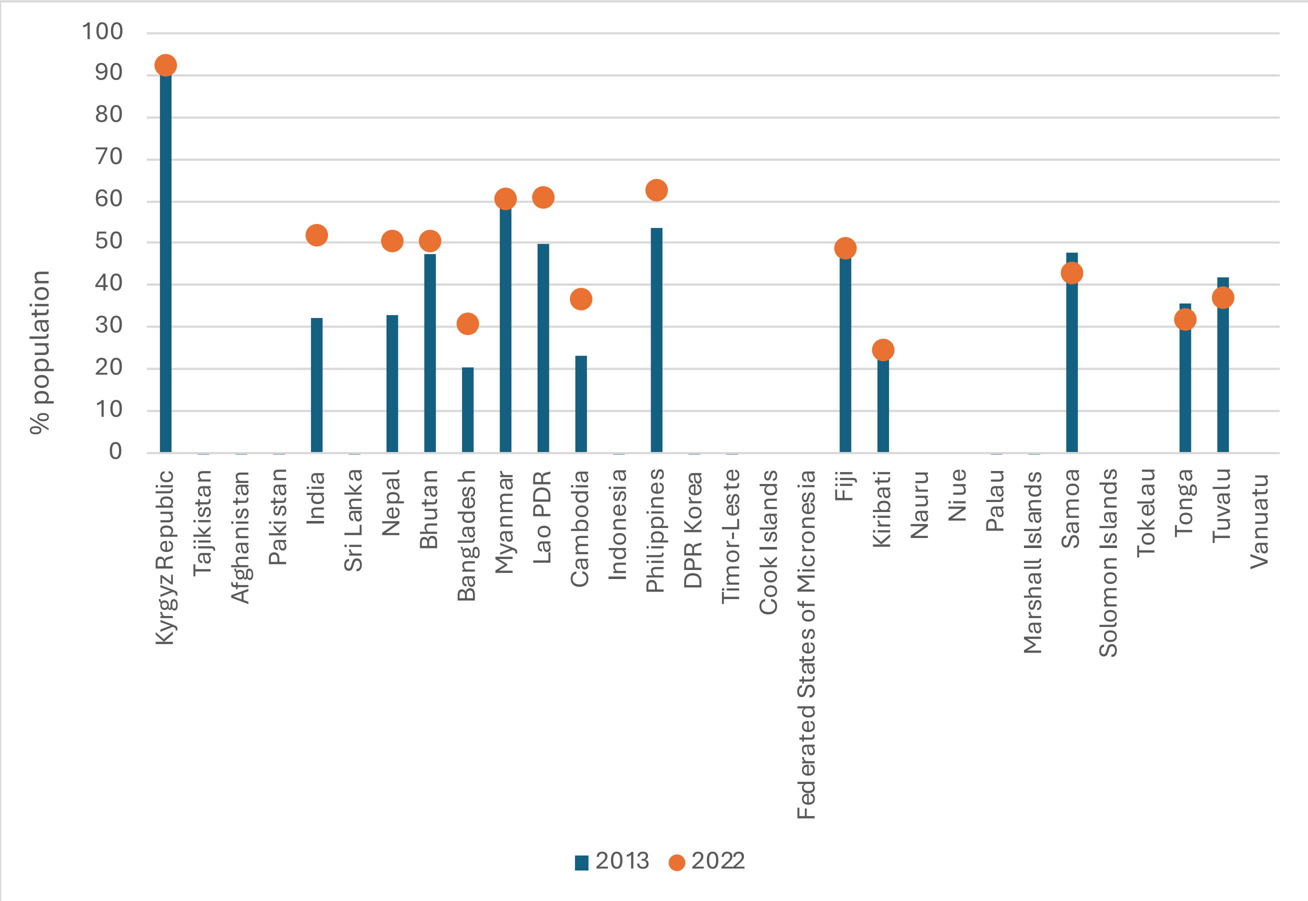

Figure 27: People using safely managed sanitation services (Source: WHO-UNICEF)

The percentage of people using at least basic sanitation services, that is, improved sanitation facilities that are not shared with other households. This indicator encompasses both people using basic sanitation services as well as those using safely managed sanitation services. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, compositing toilets or pit latrines with slabs.

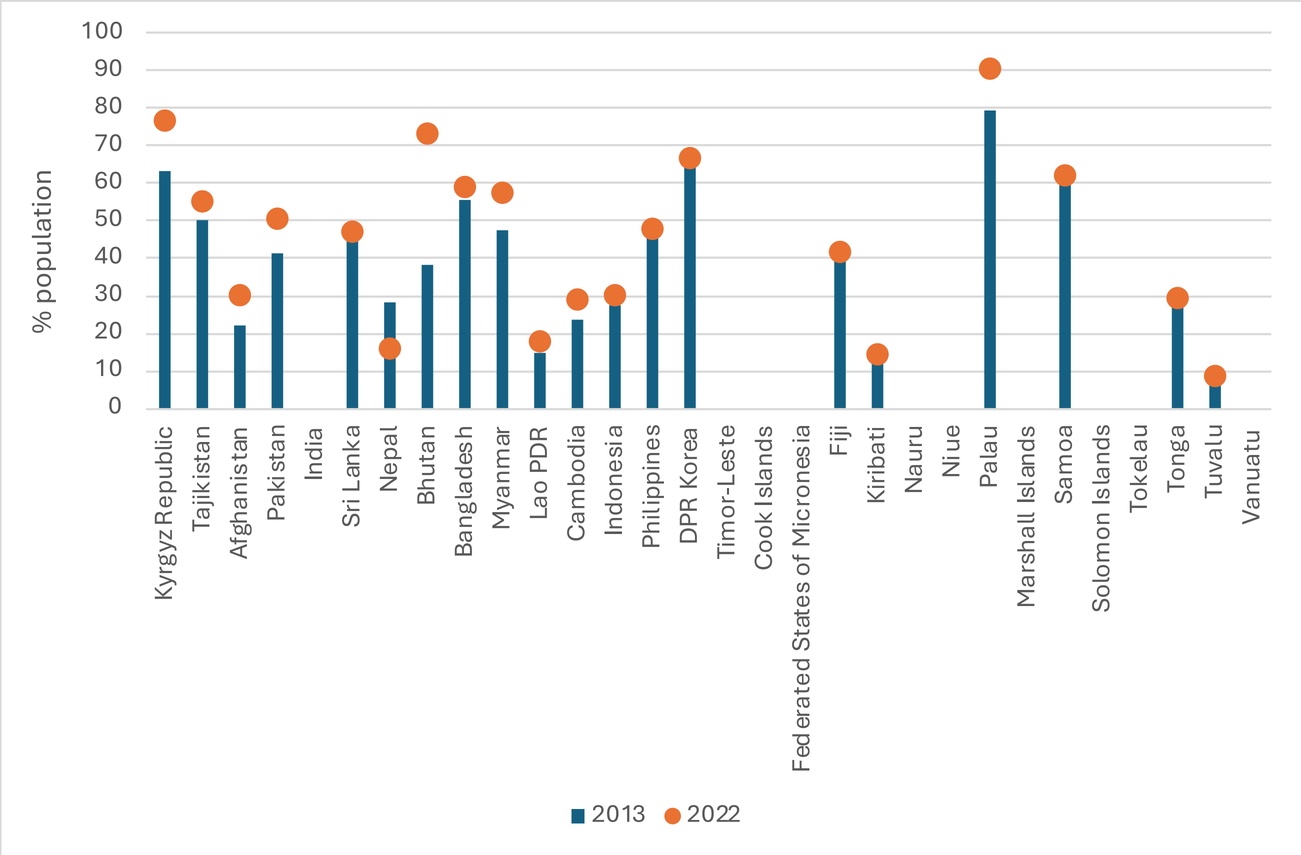

Figure 28: Population using safely managed drinking water services (Source: WHO-UNICEF)

The percentage of people using drinking water from an improved source that is accessible on premises, available when needed and free from faecal and priority chemical contamination. Improved water sources include piped water, boreholes or tubewells, protected dug wells, protected springs, and packaged or delivered water.

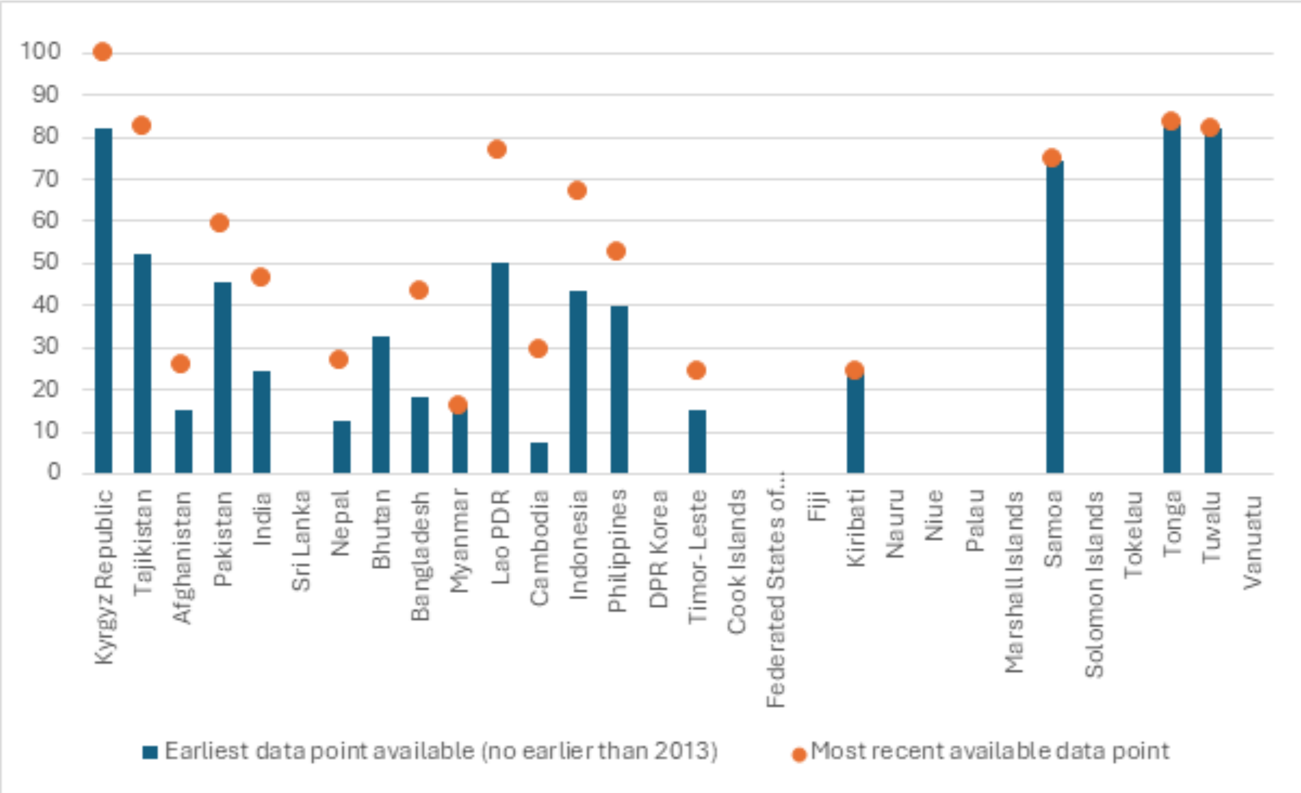

Figure 29: Percentage households with a refrigerator (Source: Global Data Lab)

ANNEX 3: MATRIX FOR NUTRITION, HEALTH, WASH, AGRI-FOOD SYSTEM, CLIMATE AND RESILIENCE INDICATORS

Domain	Sub-domain	Indicator	Kyrgyz Republic	Tajikistan	Afghanistan	Pakistan	India	Sri Lanka	Nepal	Bhutan	Bangladesh	Myanmar
Nutrition	Food Security	Prevalence of undernourishment	4.8	9.3	30.1	18.5	16.6	5.3	5.4	N/a	11.2	3.8
Nutrition	Food Security	Household Dietary Diversity Score (HDDS)	6.2	6.6	3.7	5	4.6	6.2	5.2		4.8	
Nutrition	Nutritional status - Children	Children under 5y who are stunted (height-for-age)	11.8	17.5	38.2	37.6	35.5	17.3	24.8	N/a	28	26.7
Nutrition	Nutritional status - Children	Children under 5y who are wasted (weight-for-heig	2	5.6	5.1	7.1	18.7	15.1	7.7	N/a	9.8	7.4
Nutrition	Nutritional status - Children	Children under 5y who are underweight (weight-for-a	1.8	7.6	19.1	23.1	31.5	20.5	18.7	N/a	22.6	19.5
Nutrition	Nutritional status - Children	Children under 5y who are overweight	6.9	3.3	4.1	2.5	3.5	2	1.3	N/a	2.4	0.8
Nutrition	Nutritional status - Children	Children under 5y who are overweight and obese										
Nutrition	Nutritional status - Children	Prevalence of anaemia in children under 5y	33.4	37	44.9	53	53.4	25.1	44.6	44.7	43.1	49.6
Nutrition	Nutritional status - Adult	Prevalence of obesity among adults (18+)	26.6	23.8	19.2	23	7.3	10.6	7	12.2	5.3	7.4
Nutrition	Nutritional status - Adult	Prevalence of overweight among adults (18+)	58.1	58.8	48.6	54.8	29.5	38.8	30.9	46.7	27	27
Nutrition	Nutritional status - Adult	Prevalence of underweight among adults (18+)	3.3	3.7	6.1	7.5	13.9	13.2	9.7	3.1	13.2	14.1
Nutrition	Nutritional status - Adult	Prevalence of anaemia in women of reproductive a	35.8	35.2	42.6	41.3	53	34.6	35.7	38.6	36.7	42.1
Health	Nutrition	Low birthweight prevalence	6.04	8.72	N/a	N/a	27.44	17.98	19.73	11.43	23.05	12.48
Health	Noncommunicable disease	Noncommunicable disease mortality rate (deaths pe	588.1	876.1	881.2	753.4	558.5	466.7	602.7	545.6	473.7	673.7
Health	Noncommunicable disease	DALY rates from non-communicable diseases (NCI	22541.78	27901.25	33303.39	27623.54	22071.57	18456.53	23282.38	21044.62	20089.94	25830.84
Health	Health-Climate Change	Estimated malaria incidence (per 1000 population at	0	0	9.06	11.45	2.56	0	0	0	1.22	12.37
Health	Health-Climate Change	Total number of malaria cases (presumed + confirm	0	0	86 370	400 316	161 753	26	650	23	7294	79001
WASH	Wash	People using safely managed sanitation services (%	92.6	..	..	..	52.1	..	50.6	50.5	31.0	60.6
WASH	Wash	Population using safely managed drinking water se	76.5	55.3	30.0	50.6	..	47.1	16.1	73.3	59.1	57.4
WASH	Food safety	Household with a refrigerator (%)										
WASH	Wash-disease	Number of diarrhoea deaths from inadequate water,	50.0	394	4121.0	71611.0	445638.0	368.0	4235.0	96.0	25579.0	4765.0
WASH	Wash-disease	Mortality rate attributed to exposure to unsafe WASH	2.3	9	16.6	38.8	36.4	4.8	17.8	15.7	18.2	12.9
Climate	Climate	Food systems greenhouse gas emissions (kT CO2eq)										
Climate	Climate	Annual mean temperature °C	3.93	5.09	14.48	22.2	25.2	27.2	14.4	10.6	25.7	24.0
Climate	Climate	Annual rainfall (mm)	511.8	753.05	301.3	442.9	1298.5	1838.1	1213.6	1656.2	1762.3	2061.4
Agri-food System	Agricultural Production	Crop production index	106.82	131.33	121.34	104.13	123.29	95.73	116.66	68.09	119.1	94.24
Agri-food System	Agricultural Production	Livestock production index	118.48	185.93	95.4	125.3	132.52	125.14	144.45	132.29	153.13	35.52
Agri-food System	Agricultural Production	Food production index (2014-2016=100)	112.75	150.12	111.43	122.82	127.82	99.24	123.18	77.75	125.2	76.96
Agri-food System	Agricultural Production	Arable land (% of land area)	6.71	6.04	12.00	39.58	51.95	22.18	14.75	2.46	62.30	16.84
Agri-food System	Agricultural Production	Land under cereal production (ha)	588651	405424	2141199	14011020	99558760	1198727	3457671	20692	12496558	7871589
Agri-food System	Agricultural Production (crop yie	Cereal yield (kg/cultivated ha)	3249.4	3265.8	2253.3	3405.7	3566.6	3046.9	3218.5	3448.9	5005.3	3456.7
Agri-food System	Food Price	Cost of a healthy diet (current PPP dollar/capita/da	3.5	3.6	N/a	3.9	3.1	4.3	4.6	5.3	3.2	4.2
Agri-food System	Food Price	Indicator of food price anomalies (IFPA), by type of pr	0.53	1.11	0.34 (2021)	0.58	0.53	5.41	N/a	N/a	2.67	N/a
Agri-food System	Food Price	Indicator of food price anomalies (IFPA), by type of pr	N/a	N/a	N/a	-0.35	0.04	0.85	N/a	N/a	-0.13	1.66
Agri-food System	Food Price	Consumer prices, food indeces (2015=100)	157.59	179.57	151.88	257.82	143.28	254.61	149.1	158.39	163.76	196.4
Agri-food System	Food Price	Food price inflation (%)	9.92	3.69	-5.13	42.5	6.2	19.76	6.35	3.4	10.1	23.86
Agri-food System	Food Import	Food import (% merchandise imports)	11.74	22.13	26.92	13.21	4.69	13.90	17.96	N/a	16.56	12.25
Agri-food System	Food Import	Cereal import dependency ratio (3 year average) (%	18.50	50.40	38.10	-20.20	-6.40	20.90	14.20	N/a	11.20	-12.50
Agri-food System	Food Import	Import quantity cereals (t)	238671.99	1119287.20	1283139.24	2395236.40	247156.39	1560129.70	1253318.46	112542.44	7324132.47	242099.01
Agri-food System	Water	Annual freshwater withdrawals, agriculture (% of tota	92.7	74.5	98.2	94.0	90.4	87.4	98.1	94.1	87.8	88.6
Resilience		ND-GAIN country index	53.3	47.6	32.8	39.6	44.6	46.6	43.5	48.4	37.5	37.7
Resilience		Rural population (% of total population)	62.539	72.032	73.384	62.269	64.128	80.974	78.549	56.314	60.289	68.229
Resilience	equity	Unemployment, female (% of female labor force) (mo	4.305	5.425	29.193	7.732	3.935	10.264	12.498	8.077	6.504	3.546
Resilience	equity	Unemployment, male (% of male labor force) (model	3.848	7.814	14.411	5.109	4.963	4.845	10.04	4.472	3.073	2.542
Nutrition		Number of high score	0	0	6	4	7	2	3	2	6	4
Health		Number of high score	0	1	2	0	1	1	1	1	1	1
WASH		Number of high score	0	0	1	1	2	0	1	0	1	0
Climate		Number of high score	1	1	1	1	1	1	1	1	0	0
Agri-food System		Number of high score	3	4	2	3	0	4	2	2	2	6
Resilience		Number of high score	0	0	2	0	0	1	2	2	0	0
		Total score	4	6	12	9	11	8	8	6	10	11
		Countries	Kyrgyz Republic	Tajikistan	Afghanistan	Pakistan	India	Sri Lanka	Nepal	Bhutan	Bangladesh	Myanmar

Domain	Sub-domain	Indicator	Lao PDR	Cambodia	Indonesia	Philippines	DPR Korea	Timor-Leste	Cook Islands	d States of Mi	Fiji	Kiribati
Nutrition	Food Security	Prevalence of undernourishment	4.7	4.8	5.9	5.2	45.5	22.3	N/a	N/a	6.6	12.1
Nutrition	Food Security	Household Dietary Diversity Score (HDDS)	5.6	5.2	6.8	6.3						
Nutrition	Nutritional status - Children	Children under 5y who are stunted (height-for-age)	33.1	21.9	30.8	33.1	19.1	46.7	N/a	N/a	7.2	15.2
Nutrition	Nutritional status - Children	Children under 5y who are wasted (weight-for-heig	9	9.6	10.2	6.8	2.5	8.3	N/a	N/a	4.6	3.5
Nutrition	Nutritional status - Children	Children under 5y who are underweight (weight-for-a	21.1	16.3	17.7	21.4	9.3	31.9	N/a	N/a	4.6	6.9
Nutrition	Nutritional status - Children	Children under 5y who are overweight	3.5	4.1	8	3.3	2.3	1.3	N/a	N/a	7.7	2.1
Nutrition	Nutritional status - Children	Children under 5y who are overweight and obese										
Nutrition	Nutritional status - Children	Prevalence of anaemia in children under 5y	41.4	49	38.4	13.5	31.6	46.3	27	36.7	39.9	49.4
Nutrition	Nutritional status - Adult	Prevalence of obesity among adults (18+)	8	4.4	11.2	8.7	10.8	2.4	68.9	47.1	33.8	46.3
Nutrition	Nutritional status - Adult	Prevalence of overweight among adults (18+)	31	25.1	38.1	35	37	14.4	88.3	71.7	65.8	79.1
Nutrition	Nutritional status - Adult	Prevalence of underweight among adults (18+)	8.2	11.5	9.2	9.8	9.8	19.6	0.5	2	4.2	0.9
Nutrition	Nutritional status - Adult	Prevalence of anaemia in women of reproductive a	39.5	47.1	31.2	12.3	33.9	29.9	27.1	25	32	32.6
Health	Nutrition	Low birthweight prevalence	16.73	11.45	9.93	21.14	N/a	18.21	10.30	N/a	7.40	9.03
Health	Noncommunicable disease	Noncommunicable disease mortality rate (deaths pe	*699.9*	*652.4*	*660.7*	*713.6*	*597*	*570.4*		*1171.4*	*923.4*	*1281.4*
Health	Noncommunicable disease	DALY rates from non-communicable diseases (NCI	*25287.21*	*23979.08*	*24284.06*	*23163.47*	*22644.73*	*23076.33*	21803.12	*36712.78*	*31693.75*	*42018.83*
Health	Health-Climate Change	Estimated malaria incidence (per 1000 population at	0.95	1.48	4.19	0.12	0.21	0	N/a	N/a	N/a	N/a
Health	Health-Climate Change	Total number of malaria cases (presumed + confirm	3926	4382	304607	4297	2357	0	N/a	N/a	N/a	N/a
WASH	Wash	People using safely managed sanitation services (%	61.1	36.7	..	62.7	..	..			48.8	24.8
WASH	Wash	Population using safely managed drinking water se	17.9	29.1	30.3	47.9	66.5	..			41.9	14.4
WASH	Food safety	Household with a refrigerator (%)										
WASH	Wash-disease	Number of diarrhoea deaths from inadequate water,	1037.0	1488.0	35999.0	4172.0	204.0	173	N/a	8	61.0	35.0
WASH	Wash-disease	Mortality rate attributed to exposure to unsafe WASH	20.5	17.1	15.8	16.9	4.1	20.4	N/a	14	10.8	37.4
Climate	Climate	Food systems greenhouse gas emissions (kT CO2eq)										
Climate	Climate	Annual mean temperature °C	24.1	27.3	26.0	26.6	7.5	24.9	24.6	27.5	25.0	27.8
Climate	Climate	Annual rainfall (mm)	2037.7	2148.2	3148.5	3068.7	1256.5	1116.5	2060.4	4761.1	3794.2	1238.1
Agri-food System	Agricultural Production	Crop production index	113.65	130.37	111.41	103.98	92.58	107.66	N/a	125.71	125.17	95.75
Agri-food System	Agricultural Production	Livestock production index	183.17	95.81	189.99	90.42	95.4	92.01	N/a	104.04	167.44	112.73
Agri-food System	Agricultural Production	Food production index (2014-2016=100)	114.84	123.74	117.14	100.51	92.69	101.69	N/a	121.63	139.65	97.32
Agri-food System	Agricultural Production	Arable land (% of land area)	5.30	23.35	13.90	18.75	19.06	7.50	N/a	2.86	4.20	
Agri-food System	Agricultural Production	Land under cereal production (ha)	910959	3499434	14519903	7330074	1325807	79665	N/a	166	3594	
Agri-food System	Agricultural Production (crop yie	Cereal yield (kg/cultivated ha)	4454.2	3654	5393.5	3821.6	3516.5	2046.1	N/a	1712.9	4090.3	
Agri-food System	Food Price	Cost of a healthy diet (current PPP dollar/capita/da	4.3	4.1	4.7	4.4	N/a	N/a	N/a	N/a	4.4	N/a
Agri-food System	Food Price	Indicator of food price anomalies (IFPA), by type of pi	N/a	N/a	4.62	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Agri-food System	Food Price	Indicator of food price anomalies (IFPA), by type of pi	0.97	0.06	-0.46	-0.07	N/a	N/a	N/a	N/a	N/a	N/a
Agri-food System	Food Price	Consumer prices, food indeces (2015=100)	202.36	132.46	137.54	138.09	133.1	126.67	145.49	115.36	132.18	120.57
Agri-food System	Food Price	Food price inflation (%)	43.79	3.04	4.5	8.56	4.93	9.47	19.7	10.69	6.76	9.76
Agri-food System	Food Import	Food import (% merchandise imports)	16.13	6.14	11.02	13.92	N/a	28.17	N/a	N/a	19.49	41.44
Agri-food System	Food Import	Cereal import dependency ratio (3 year average) (%	-2.90	-7.10	14.00	28.50	17.80	41.8 (2017-2019)	N/a	N/a	89.20	N/a
Agri-food System	Food Import	Import quantity cereals (t)	68133.62	149828.70	11065033.83	10498163.88	84866.30	160668.57	270.44	N/a	168846.83	13557.25
Agri-food System	Water	Annual freshwater withdrawals, agriculture (% of tota	95.9	94.0	85.2	79.0	76.3	91.4	N/a	N/a	58.9	N/a
Resilience		ND-GAIN country index	43.8	40.1	47.6	43.7	43.6	43.7	N/a	37.2	51.2	N/a
Resilience		Rural population (% of total population)	62.408	74.886	42.066	52.023	37.084	67.926		76.783	41.771	42.942
Resilience	equity	Unemployment, female (% of female labor force) (mo	3.159	0.247	2.996	2.545	3.153	2.288			5.492	
Resilience	equity	Unemployment, male (% of male labor force) (model	4.339	0.189	3.459	2.054	2.874	1.379			3.614	
Nutrition		Number of high score	4	4	4	3	1	5	2	2	2	3
Health		Number of high score	1	0	1	1	0	1	0	2	2	2
WASH		Number of high score	1	2	1	0	0	1	0	0	1	3
Climate		Number of high score	0	1	1	1	1	1	0	1	0	1
Agri-food System		Number of high score	7	2	3	2	0	4	0	3	3	3
Resilience		Number of high score	0	0	1	1	1	0	0	0	1	1
		Total score	13	9	10	7	2	12	2	8	8	12
		Countries	Lao PDR	Cambodia	Indonesia	Philippines	DPR Korea	Timor-Leste	Cook Islands	d States of Mi	Fiji	Kiribati

Domain	Sub-domain	Indicator	Nauru	Niue	Palau	Iarshall Island	Samoa	olomon Island	Tokelau	Tonga	Tuvalu	Vanuatu
Nutrition	Food Security	Prevalence of undernourishment	N/a	N/a	N/a	N/a	4.6	19	N/a	N/a	N/a	9.5
Nutrition	Food Security	Household Dietary Diversity Score (HDDS)										
Nutrition	Nutritional status - Children	Children under 5y who are stunted (height-for-age)	N/a	N/a	N/a	34.8	7.3	31.7	N/a	2.2	5.7	
Nutrition	Nutritional status - Children	Children under 5y who are wasted (weight-for-heig	N/a	N/a	N/a	3.5	3.1	8.5	N/a	1.1	2.8	
Nutrition	Nutritional status - Children	Children under 5y who are underweight (weight-for-a	N/a	N/a	N/a	11.9	3.4	16.2	N/a	0.8	2.9	
Nutrition	Nutritional status - Children	Children under 5y who are overweight	N/a	N/a	N/a	4.1	8.7	4.5	N/a	11.2	4.2	
Nutrition	Nutritional status - Children	Children under 5y who are overweight and obese										
Nutrition	Nutritional status - Children	Prevalence of anaemia in children under 5y	41.8	36.3	33.5	39.5	35.5	35.5	N/a	34	41.9	31
Nutrition	Nutritional status - Adult	Prevalence of obesity among adults (18+)	69.9	66.6	41.1	45.9	62.4	22.6	69.8	71.7	64.2	21.3
Nutrition	Nutritional status - Adult	Prevalence of overweight among adults (18+)	88.8	88.5	71.3	73.2	87.7	56.9	90.2	90.4	85.8	51.3
Nutrition	Nutritional status - Adult	Prevalence of underweight among adults (18+)	0.4	0.7	1.4	1.9	0.4	2.5	0.5	0.3	0.8	2.6
Nutrition	Nutritional status - Adult	Prevalence of aneamia in women of reproductive a	29.6	27.3	28.5	30.6	26.8	26.8	N/a	28.5	27.5	28.5
Health	Nutrition	Low birthweight prevalence	N/a	N/a	13.53	N/a	N/a	13.23	N/a	N/a	N/a	13.06
Health	Noncommunicable disease	Noncommunicable disease mortality rate (deaths per 100,000 population)						909.1		624.8		986.3
Health	Noncommunicable disease	DALY rates from non-communicable diseases (NCI	39308.13	27636.19	29982.28	34967.81	26856.19	44700.53	25437.27	23714.12	30835.83	33457.86
Health	Health-Climate Change	Estimated malaria incidence (per 1000 population at	N/a	N/a	N/a	N/a	N/a	223.48	N/a	N/a	N/a	6.23
Health	Health-Climate Change	Total number of malaria cases (presumed + confirm	N/a	N/a	N/a	N/a	N/a	129758	N/a	N/a	N/a	322
WASH	Wash	People using safely managed sanitation services (% of population)			..	..	42.9			32.0	37.2	..
WASH	Wash	Population using safely managed drinking water services (% population)			90.4	..	62.2			29.5	8.7	..
WASH	Food safety	Household with a refrigerator (%)										
WASH	Wash-disease	Number of diarrhoea deaths from inadequate water,	N/a	N/a	N/a	N/a	N/a	161	N/a	3.0	N/a	55
WASH	Wash-disease	Mortality rate attributed to exposure to unsafe WASH	N/a	N/a	N/a	N/a	8.2	32.7	N/a	7.1	N/a	25
Climate	Climate	Food systems greenhouse gas emissions (kT CO2eq)										
Climate	Climate	Annual mean temperature °C	27.9	N/a	27.5	27.9	27.5	25.9	N/a	25.1	28.6	24.8
Climate	Climate	Annual rainfall (mm)	2382.0	N/a	4338.8	3011.5	2784.6	3183.8	N/a	1750.6	2850.9	2831.7
Agri-food Systen	Agricultural Production	Crop production index	102.69			90.84	84.07	108		97.18	112.68	84.55
Agri-food Systen	Agricultural Production	Livestock production index	89.43			N/a	80.63	101.66		100.86	106.49	75.5
Agri-food Systen	Agricultural Production	Food production index (2014-2016=100)	99.71		90.2	90.84	83.05	100.49		97.78	110.82	82.96
Agri-food Systen	Agricultural Production	Arable land (% of land area)			0.65	2.78	4.06	0.82		27.78		1.64
Agri-food Systen	Agricultural Production	Land under cereal production (ha)						1447				1523
Agri-food Systen	Agricultural Production (crop yie	Cereal yield (kg/cultivated ha)						1903.1				608.2
Agri-food Systen	Food Price	Cost of a healthy diet (current PPP dollar/capita/da	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Agri-food Systen	Food Price	Indicator of food price anomalies (IFPA), by type of pi	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Agri-food Systen	Food Price	Indicator of food price anomalies (IFPA), by type of pi	N/a	N/a	N/a	N/a	0.54	N/a	N/a	N/a	N/a	N/a
Agri-food Systen	Food Price	Consumer prices, food indeces (2015=100)	N/a	N/a	144.22	N/a	156.17	118.38	N/a	156.38	N/a	178.51
Agri-food Systen	Food Price	Food price inflation (%)	N/a	N/a	17.42	N/a	17.84	9.92	N/a	10.25	N/a	20.26
Agri-food Systen	Food Import	Food import (% merchandise imports)	N/a	N/a	22.96	81.46	30.91	22.19	N/a	27.18	N/a	N/a
Agri-food Systen	Food Import	Cereal import dependency ratio (3 year average) (%	N/a	N/a	N/a	N/a	98.6 (2017-20	N/a	N/a	N/a	N/a	100.00
Agri-food Systen	Food Import	Import quantity cereals (t)	319.95	N/a	N/a	N/a	9550.08	46031.68	N/a	395.10	868.62	20879.48
Agri-food Systen	Water	Annual freshwater withdrawals, agriculture (% of tota	N/a	N/a	N/a				N/a	N/a	N/a	N/a
Resilience		ND-GAIN country index	45.6	N/a	47.1	39.6	46.6	39.8	N/a	41.1	N/a	41.4
Resilience		Rural population (% of total population)			18.044	21.48	82.384	74.416		76.875	34.473	74.184
Resilience	equity	Unemployment, female (% of female labor force) (modeled ILO estimate)					14.789	1.655		3.064		6.621
Resilience	equity	Unemployment, male (% of male labor force) (modeled ILO estimate)					6.278	1.551		1.88		4.13
Nutrition		Number of high score	3	3	2	3	2	3	2	2	3	0
Health		Number of high score	1	0	1	1	0	4	0	0	1	2
WASH		Number of high score	0	0	0	0	1	1	0	2	2	1
Climate		Number of high score	1	0	1	1	1	0	0	0	1	0
Agri-food System		Number of high score	2	0	2	4	4	3	0	0	0	9
Resilience		Number of high score	0	0	1	1	1	0	0	0	1	0
		Total score	7	3	6	9	8	11	2	4	7	12
		Countries	Nauru	Niue	Palau	Iarshall Island	Samoa	olomon Island	Tokelau	Tonga	Tuvalu	Vanuatu

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