Working paper: version 1.0 (2024)

Assessing Multidimensional Food System Risks in Asia and the Pacific

INsights on Food SystEm Risks – INFER

ESCAP
Economic and Social Commission for Asia and the Pacific

WFP
World Food Programme

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Available online at: https://www.unescap.org/projects/infer

About this study

This working paper introduces INFER (INsights on Food SystEm Risks), a risk assessment framework that provides insights into multidimensional risks to three food system outcomes: human health and nutrition; ecosystem health and sustainability; and shared prosperity. It spans six dimensions of food security. Building on publicly available data, INFER enables tracking of risk over time and comparison across countries. It therefore strengthens the tools available for food systems monitoring and for ensuring that food systems resilience-building strategies are risk-informed. The results of applying INFER for Asia and the Pacific are presented, including profiles for Bangladesh, Fiji, Kazakhstan, Lao People's Democratic Republic, Pakistan, Sri Lanka and Uzbekistan, which have been prepared using international, rather than national, data sources.

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1. A new food system risk assessment framework: INFER

Ongoing geopolitical conflicts, the most recent global pandemic and the increasing impacts of climate change have highlighted the multifaceted risks to food systems in Asia and the Pacific. The war in Ukraine and the repercussions of COVID-19 have contributed to a sharp rise in food, energy and fertilizer prices, driving recent trends in food insecurity, poverty and inequality in many Asia-Pacific countries (Box 1).

Food systems themselves are important drivers of climate and environmental change, causing land degradation, climate variability, biodiversity loss and the pollution of air, water and soils, which in turn compromise food production, livelihoods, and human and ecosystem health. The risk to food systems is further shaped by their ability to adapt, in response to institutional, technological, political, economic, socio-cultural and other drivers (FAO et al., 2019). These factors should be taken into account when building resilient, healthy, fair and sustainable food systems.

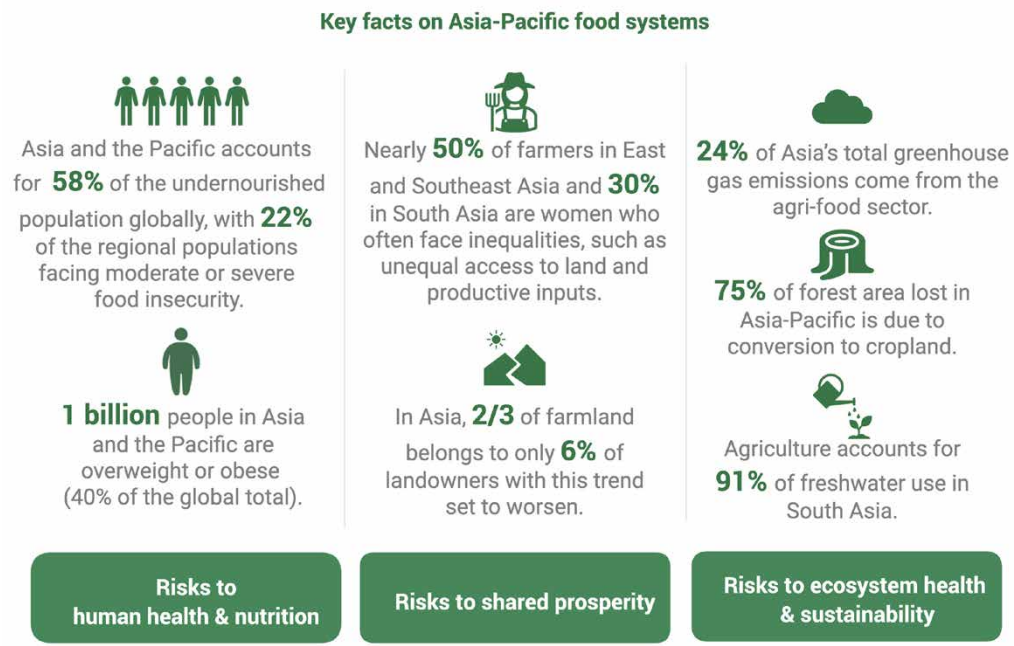
The INFER (INsights on Food SystEm Risks) framework provides a structured approach for assessing multidimensional risks to food systems. The framework conceptualizes risk as a product of hazard and exposure, vulnerability and lack of adaptive capacity, building on the United Nations disaster risk-management literature (UNDP, 2004) and the INFORM risk model (Marin-Ferrer et al., 2017; De Groeve et al., 2014) (see Table 1 for INFER's definitions).

INFER reflects the most up-to-date framing of household food security and nutrition across six food security dimensions: availability, access, utilization, stability, agency and sustainability. Identifying and managing risk across these six dimensions is essential for delivering desirable food system outcomes for people, the planet and prosperity. Figure 1 highlights key challenges facing the region with respect to food system outcomes in these three areas. Box 1 further describes key factors influencing food security in the region.

Table 1. Defining INFER risk dimensions

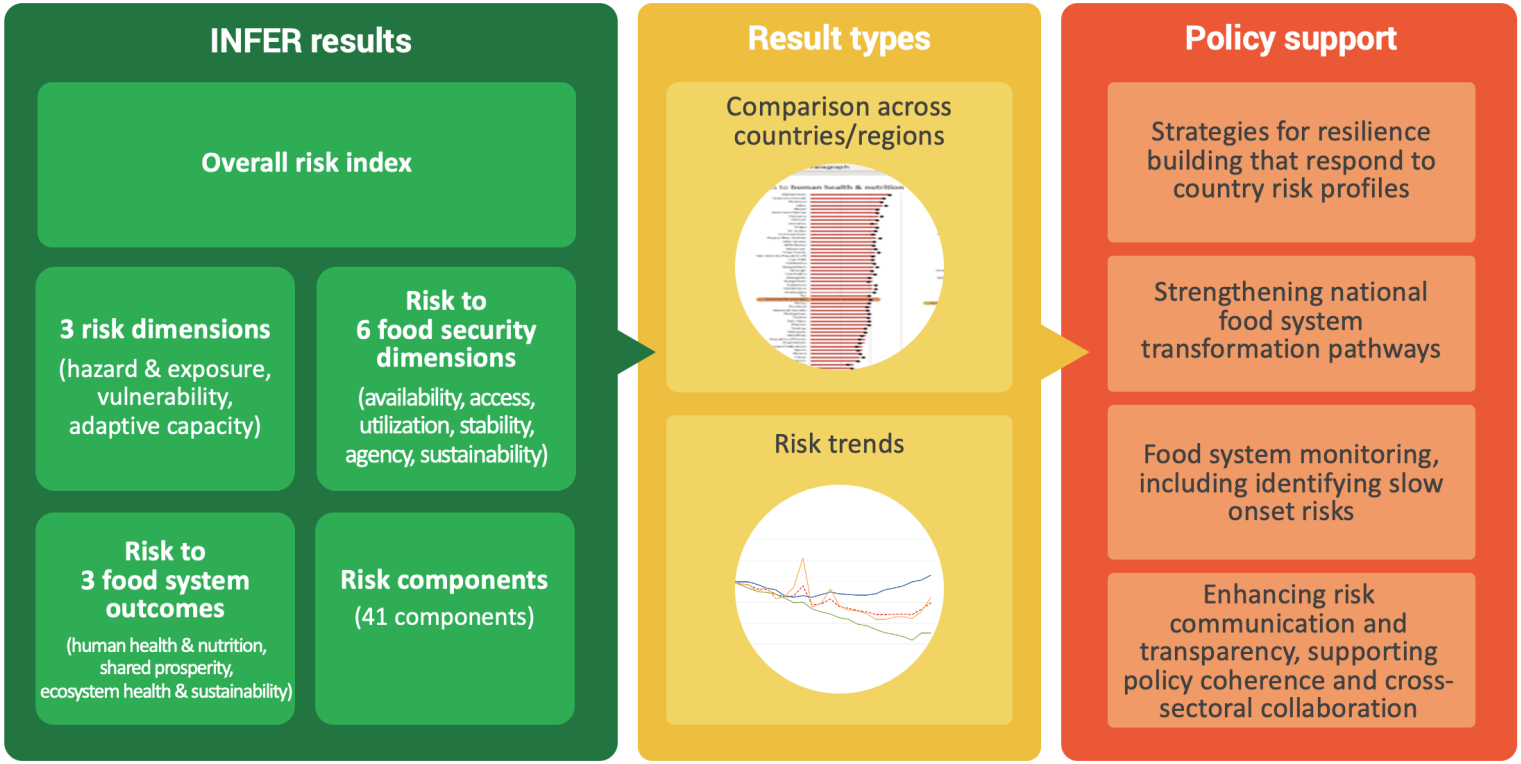
Risk dimension	Definitions in INFER
Hazard and exposure	Events with potential to disrupt food systems that could occur and exposure to them
Vulnerability	The susceptibility of communities to those hazards
Adaptive capacity	The ability of institutions, households and individuals to take positive measures to respond to a food system disruption

Figure 1. Risks to building sustainable food systems in Asia and the Pacific



INFER can be applied at the global, regional, national and subnational levels to assess risk to food systems and support policymaking (Figure 2). This working paper demonstrates INFER's application to the Asia and Pacific region and indicates opportunities to adapt the framework for use at the national and subnational level. Following an introduction to INFER and the study background in section 1, section 2 further explains the INFER data and methodology. Section 3 presents results of the framework application, including overall food system trends, characteristics and outcomes across the Asia-Pacific region and country groups. Section 4 discusses further development of INFER, followed by conclusions on the utility of INFER and proposed next steps in section 5. Seven country food system risk profiles generated by INFER are included in annex 1.

Figure 2. Key features of the INFER food system risk assessment framework



2. Why a new risk assessment model – and how can it be used?

INFER provides insights on multidimensional risk – and resilience

Risk can be understood as the potential for an unwanted outcome resulting from a threat, a natural or anthropogenic occurrence, entity or action. Food system risks are multidimensional. That is, they are triggered by different threats, transmitted through different pathways, with different implications for different groups of people and entities – and for different desirable food system outcomes. The INFER framework focuses attention on risk to food system outcomes as transmitted through the six dimensions of food security.

Resilience-building is an important focus of national food system transformation pathways. The inter-agency Food Security Information Network (FSIN) defines the relationship between food security (which may be understood as absence of, or a situation of low, food system risk) and resilience, as **food security = f (shocks and stressors, vulnerabilities, resilience capacities)**. Here, **resilience capacity** is described by the FSIN as "a capacity that prevents individuals, household and communities from falling below a normatively defined level for a given developmental outcome" (WFP, 2014). Resilience capacities have also been described in more specific terms as comprising absorptive, anticipatory, adaptive and transformative capacities (ESCAP et al., 2018). The components identified under the INFER **adaptive capacity dimension of risk** take a strong reference from two important determinants of system resilience – system robustness (resource base, government effectiveness, infrastructure and institutions) and resourcefulness (e.g. participation and voice, resources and capabilities) (ESCAP et al., 2012).

INFER responds to increasingly influential threats

INFER responds to increasingly influential threats and aspects of vulnerability that lead to both immediate and slow onset food system crises. While INFER is composed of more than 40 components that capture different aspects of food system risks, some key elements of the changing riskscape INFER aims to respond to include:

- **Food price and input inflation**. *International* food price and input inflation are included as food system hazard, and domestic food price inflation as an indicator of system vulnerability.
- **Trade disruptions**. INFER includes a novel indicator for trade network concentration – a useful indicator of system redundancy, an important system characteristic the promotes resilience (Kharrazi, 2018). A previous study of trade in 79 staples concluded that trade networks were becoming less resilient, (ESCAP et al., 2018). INFER therefore incorporates risks related to a country importing key food commodities and agricultural inputs from a narrow range of countries.
- **Epidemics, extreme weather events** (including flooding and extreme heat events for example), and **conflict**.
- **The share of particularly vulnerable groups**. For example internally displaced persons, or populations affected by natural disaster in the last ten years, as well as gender and rural–urban inequalities, under vulnerability.
- **Intensity of agricultural inputs**. An indicator of vulnerability, where external food price spikes and supply disruptions are likely to have a bigger input in countries with highly input-intensive food systems.
- **Greenhouse gas emissions**. An indicator of system "rigidity" (low adaptive capacity) where high emissions indicate that food systems may be less able to adapt to low environmental footprint modes of production.

How can the model be used?

The INFER framework supports food system policymakers in:

- **Providing clarity on risk trends and resilience-building strategies that respond to national risk profiles**. Government officials and researchers with functions that relate to food systems risk, including those responsible for situational risk assessment, risk communications, macroeconomic and fiscal policymakers, and agricultural planners. Those working on climate risk and food security at the household and community levels and with farmers and vulnerable groups will be able to strengthen the evidence base for their engagement with other sectors through the data provided. Private sector entities with research functions can also benefit.

- **Strengthening national food system transformation strategies**. National food system dialogue convenors and others working to promote national food system transformation will be able to use INFER's insights to ensure that national food system transformation strategies are risk-informed and responsive to risk within and across the six dimensions of food security. INFER supports effective and transparent risk communication, which can contribute to strengthened policy coherence.

- **Informing climate risk assessment and national adaptation planning**. Government and other stakeholders can use INFER's results to convene different sectors to co-develop responses to food system risks triggered by climate-related threats. National adaptation planners can identify the key drivers of food system vulnerability and develop national adaptation plans that are informed by the food system risk profile of each country, complementing other types of inputs to adaptation planning.

This working paper presents the results of applying INFER at the regional level. The regional application of INFER enables all the above groups to compare their countries with others. The regional application of INFER reveals trends across the region, common challenges, emerging issues and, potentially, groups of countries with similar risk profiles. It uses official published data from international organizations, rather than national sources, to support comparison across countries and draw conclusions for policy advocacy and research.

Going forward, the national or subnational application of INFER will use national, approved and validated data and engage a wide range of national entities in the process. It would also use geospatial data to map variations in risk across administrative regions to generate insights on food system risk at the national level.

The INFER Dashboard, available online at www.unescap.org/projects/infer, presents the full and most-updated results for the region overall and for each of the 49 countries.

Box 1. Food insecurity in Asia and the Pacific

Rising food insecurity, with children and women most affected

The compounding impacts of COVID-19, the war in Ukraine, macroeconomic and climate–food–energy–water dynamics pushed 58 million people in Asia and the Pacific into hunger (SDG indicator 2.1.1) compared to 2019. In 2022, 402 million people in the region were undernourished, representing 55 percent of the global hunger population (FAO et al., 2023).

One quarter of people in Asia faced chronic food insecurity (SDG indicator 2.1.2) in 2022, 163 million more than in 2019. While in Central Asia and South-East Asia, one in six people were affected by moderate or severe chronic food insecurity, in southern Asia and western Asia, the percentage reached 40 and 36 percent, respectively. (FAO et al., 2023). Seventy-two percent of people in South Asia and 55 percent of people in South-East Asia were unable to afford a healthy diet in 2021. Food insecurity is generally higher in rural areas compared to urban areas, and more prevalent among adult women than men in Asia and the Pacific, as in other regions.

Compared to ten years ago, there has been progress in children wasting and stunting; however, around 9 percent of children still show wasting and 22 percent are stunted across Asia and the Pacific, which is far from the Agenda 2030 target. The percentage of both overweight children and obese adults is increasing (FAO et al., 2023). Anaemia among women aged 15–49 is increasing in most countries of the region (FAO et al., 2022).

Economic and market factors

Global food and energy prices reached all-time highs in 2022, increasing the pressure on the highly exposed Asia-Pacific region, where most countries are net energy and food importers and where food and energy account for up to 40 percent of the consumer price index basket in many economies (ESCAP, 2022). In December 2022, annual food price inflation reached as high as 64 percent in Sri Lanka, 36 percent in Pakistan, 18 percent in Myanmar and 8 percent in Bangladesh (FSIN and GNAFC, 2023). Export bans and other restrictions, currency depreciation and rising sovereign debt further compounded food system risks.

Climate change

Adding to the riskscape, the impacts of climate change and variability on food security are likely to increase in Asia and the Pacific (IPCC, 2022). Today, six of the top ten countries most affected by climate disasters are in the Asia-Pacific region (UNDRR and CRED, 2020). Fisheries, aquaculture and crop production are projected to decline, particularly in South and South-East Asia, along with declines in livestock production. Pest occurrence is also likely to increase due to climate change, threatening most rice-producing countries in the region (IPCC, 2022).

On the other hand, the food system itself is the source of 34 percent of global greenhouse gas emissions (Crippa et al., 2021) and is the primary driver of biodiversity loss, with agriculture alone being identified as a threat to 86 percent of species at risk of extinction (Benton et al., 2021). Globally, 70 percent of fresh water is used in agricultural production (IPCC, 2019), while the number reaches 95 percent in some South Asian and Central Asian countries (FAO, 2023). The climate–food–energy–water nexus plays a particularly important role in food security in such countries.

Socio-political and demographic factors

Conflicts and other socio-political crises continue to arise in the region, disrupting supply chains and constraining production. The region is also home to the highest population in informal settlements in the world, increasing potential exposure to epidemics and other threats to human, animal, plant and environmental health that pose risks to food security. While the situation differs across countries, vulnerable populations, including smallholders, migrants, women, children and people in poverty are often most at risk of food insecurity.

Latest acute food security updates in selected Asia-Pacific countries

Afghanistan

According to the latest available food security analysis, 15.3 million people (35 percent of the population analysed) are projected to face high levels of acute food insecurity (Integrated Food Security Phase Classification (IPC) Phase 3 and above) between May and October 2023, including just under 2.8 million people in emergency (IPC Phase 4).[1] The levels of acute food insecurity have declined compared to the same season in 2022, largely due to seasonal improvements and the scale-up of humanitarian assistance in 2022; however, acute food insecurity could deteriorate. The already alarming food security situation is likely to continue in the outlook period due to a possible drop of foreign earnings from humanitarian funding, which allowed for a precarious stabilization of the Afghan economy in late 2022, and a growing trade deficit.

Bangladesh

Between May and September 2023, 11.9 million people (31 percent of the population analysed) in identified hotspot areas were estimated to be facing high levels of acute food insecurity (IPC Phase 3 and above). Over 2 million people (6 percent of the people analysed) are projected to be in IPC Phase 4 (Emergency) with a majority of these people being forcibly displaced Myanmar nationals.[2] High inflation, coupled with reduced incomes and repeated climatic shocks, are putting extreme stress on the poorest households and driving acute food insecurity in the analysed population. It is likely that household access to food will further deteriorate in this period due to the slow recovery from shocks that occurred in 2022, a lean season, and extreme weather events such as cyclones and flooding.

Myanmar

According to the latest Humanitarian Needs Overview, 15.2 million people, or 28 percent of the population, were estimated to be acutely food insecure in 2022, as per WFP rCARI methodology (OCHA, 2023),[3] representing a sharp deterioration and increase by 2 million people compared to 2021. Acute food insecurity could further increase as armed conflict is likely to intensify in the coming months, amid economic uncertainty, lack of humanitarian access, displacement and high food prices.

Pakistan

An estimated 10.5 million people (29 percent of the population analysed) were experiencing high levels of acute food insecurity (IPC Phase 3 or above) between April and October 2023 in the three most vulnerable provinces of Pakistan (Balochistan, Khyber Pakhtunkhwa and Sindh). Of these, some 2.1 million people (6 percent of the analysed population) were in IPC Phase 4 (Emergency), and 8.4 million people (23 percent of the analysed population) were in IPC Phase 3 (Crisis).[4] Acute food insecurity is likely to further deteriorate over the coming months if the economic and political crisis further worsens, compounding the effects of the 2022 flooding.

Sri Lanka

An estimated 17 percent of the population is in moderate acute food insecurity in Sri Lanka, especially in the northern, eastern and central provinces, indicating an improvement compared to 2022 (FAO and WFP, 2023). Despite this positive trend, food insecurity remains high in certain districts. The highest level of acute food insecurity was found within the tea plantation communities and among daily wage labourers and households who rely on social assistance programmes, such as Samurdhi, as their main source of income. Acute food insecurity in the coming months remains a concern, due to expectations of a below-average agricultural output for the second consecutive year in 2023, owing to the effects of the severe macroeconomic crisis that has limited imports of most agricultural inputs.

[1,2,4] Data for Afghanistan, Bangladesh, Myanmar, Pakistan and Sri Lanka based on IPC country analysis: https://www.ipcinfo.org/ipc-country-analysis/.

[3] The WFP remote Consolidated Approach for Reporting Indicators of Food Security (rCARI) methodology is implemented through remote surveys (phone- or web-based) and rests on a reduced questionnaire adjusted for remote data collection compared to the traditional WFP CARI methodology. Comparability studies between the results of rCARI analyses and the results of the traditional CARI methodology are ongoing.

3. Data and methodology

INFER structure

The framework identifies risk as composed of three dimensions: hazard and exposure; vulnerability; and adaptive capacity (Figure 3).

Each risk dimension comprises specific risk categories; three categories under the dimension of hazard and exposure (natural, economic, socio-political) and six categories under the risk dimensions of vulnerability and adaptive capacity, respectively (availability, access, utilization, stability, agency, sustainability). Each category of risk is made up of risk components built with relevant indicators (see Figure 4).

An overall risk score

INFER calculates an overall food system risk score for each country as an equally weighted product of the three risk dimensions whereby:

$$Risk = Hazard\ and\ exposure\ (HE)^{1/3} \times Vulnerability\ (VU)^{1/3} \times Lack\ of\ adaptive\ capacity\ (LAC)^{1/3}$$

At the indicator level, each data set is normalized to the range of 0 to 100, whereby:

$$x_{norm} = \frac{x\text{-}x_{min}}{x_{max}\text{-}x_{min}} \times 100$$

Outlier values more than three standard deviations above or below the mean value of that data set are replaced by the outlier threshold values. Indicator polarities were identified based on their positive or negative contribution to risk, and adjusted to fit each model component.

The arithmetic mean is used to aggregate indicators, first to the component, second to the category, and finally to the dimension level, with equal weighting of each element at each stage of aggregation.

A score for risk to three food systems outcomes

INFER assesses and tracks the risks to three food system outcomes: human health and nutrition; shared prosperity; and ecosystem health and sustainability. The risk scores for each of the food system outcomes are calculated by adapting the risk equation for overall risk, integrating specific food security dimensions, as follows:

Risk to human health and nutrition

$$= HE^{1/3} \times VU^{1/3}_{availability,\ utilization} \times LAC^{1/3}_{availability,\ utilization}$$

Risk to shared prosperity

$$= HE^{1/3} \times VU^{1/3}_{agency,\ access,\ stability} \times LAC^{1/3}_{agency,\ access,\ stability}$$

Risk to ecosystem health and sustainability

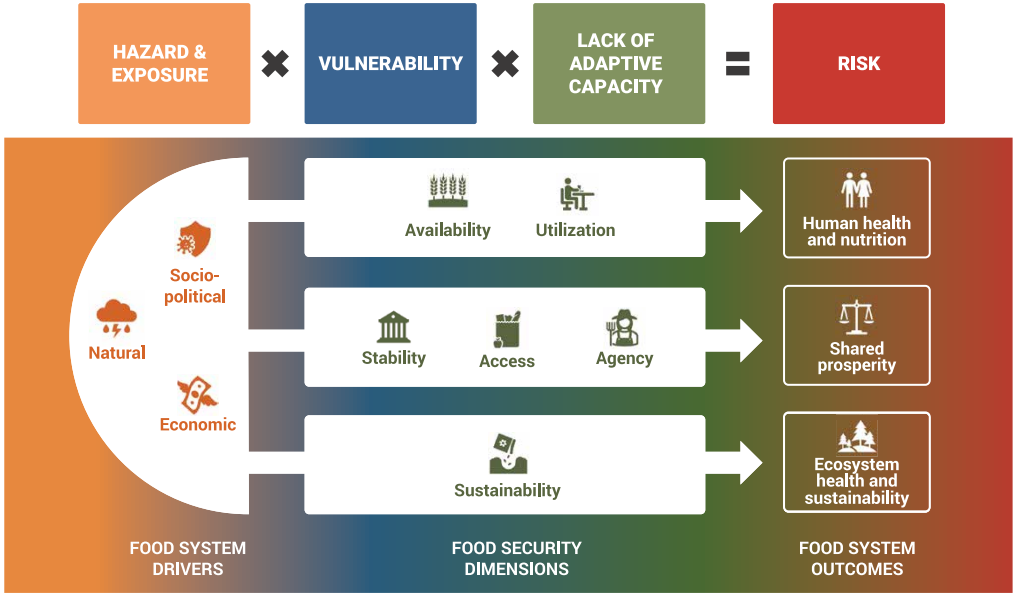
$$= HE^{1/3} \times VU^{1/3}_{sustainability} \times LAC^{1/3}_{sustainability}$$

Data selection

The INFER risk index builds on 95 indicators shortlisted from a long list of over 230 indicators by experts from ESCAP and WFP in consultation with experts from FAO, UNEP and other organizations, based on relevance to the INFER structure (see descriptions of each aspect of the framework provided in Figure 5), influence on transmission of risk in food systems, orientation to the Asia-Pacific food system context, and the application of specific quality criteria. For a complete list of indicators, their descriptions and sources, see annex 3.

Quality criteria include coverage of Asia-Pacific countries and across time, and public accessibility of data sources. Correlation analysis was performed across the entire set of indicators and within index components to reduce redundancy in the indicator set, further informing the indicator section process (annex 4). Certain indicators that did not meet data quality criteria but that would be valuable for INFER subnational model development, are listed as supplemental indicators in annex 3.

Figure 3. The INFER food system risk assessment framework



Missing data

Gaps in time series data were filled using linear interpolation, except in cases when the lack of data made this unworkable. In these instances, the average value for the countries in the relevant World Bank income category, for that year, was substituted. A summary of the data coverage by country is available in annex 4.

Implicit weighting

The effective weight of each indicator and component (group of indicators) is determined by the number of categories in each dimension of risk. The same is true at other levels of the model. For any in-depth exploration of risk at the national level, the structure and implicit weighting should be adapted to the national context (see annex 5).

Robustness testing

To examine the robustness of INFER's results to changes in indicator values, we conducted a Monte Carlo simulation. To this end, three component-level indicators and a year were randomly chosen and changed within the range of −100 percent to 100 percent of their original value for all countries, and the results, i.e. values for *Risk, HE, VU and LAC*, were recalculated. This simulation was repeated 1,000 times and the average of the 1,000 results was taken. Results indicate that the values of *Risk, HE, VU and LAC* are robust to data uncertainties, as they show less than 2 percent difference from their original values.

Figure 4. The INFER framework

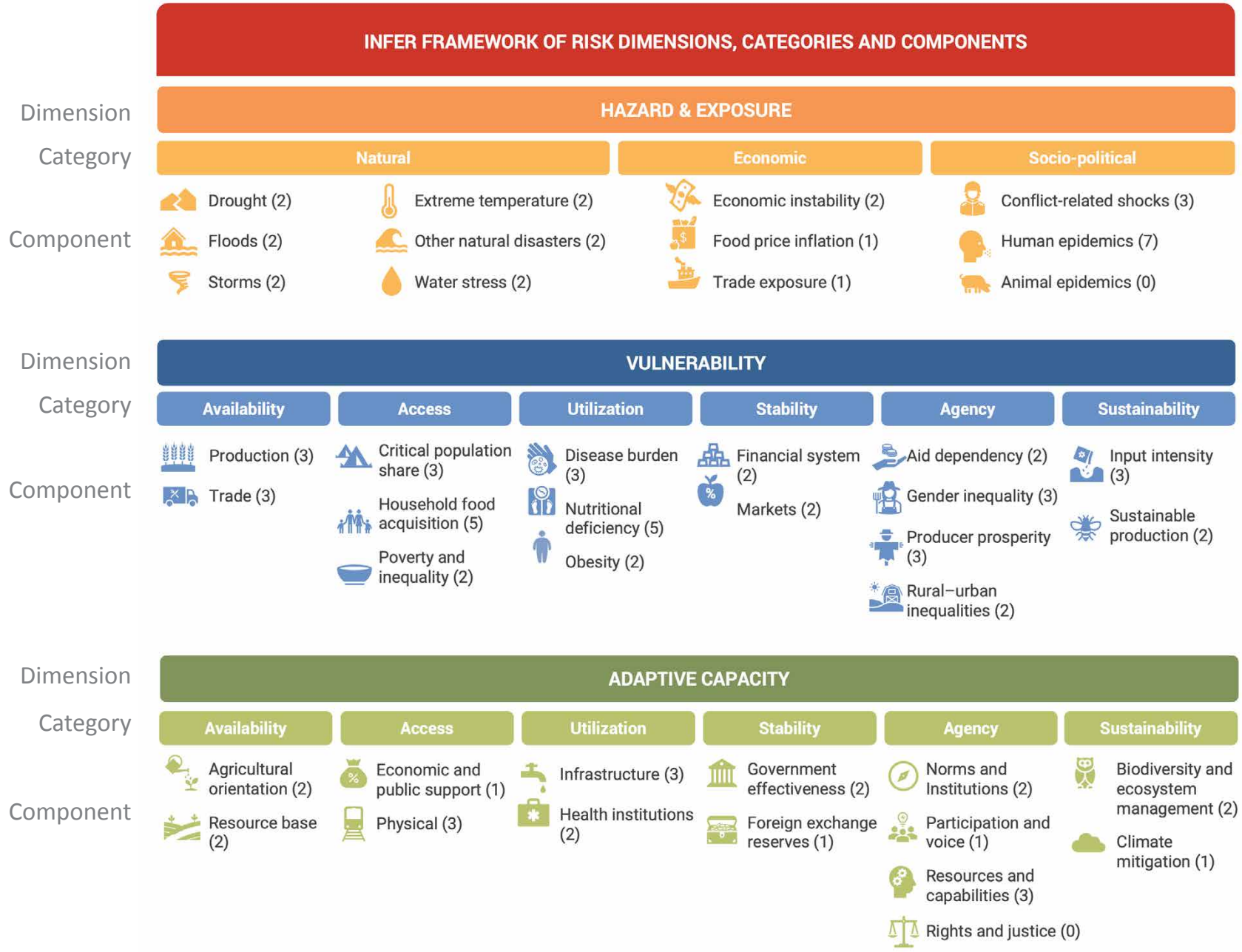


Figure 5. Risks to three food system outcomes and six food security dimensions in the INFER risk framework

Three food system outcomes

The INFER risk framework points to risk to three desirable food system outcomes:

People: Human health and nutrition outcomes are promoted by consistent access to affordable, nutritious food in adequate quantities, and positive health outcomes for those involved in food production and the supply chain. Ecosystem health and shared prosperity are intimately connected.

Planet: Ecosystem health and sustainability show that food systems help to maintain the flow of critical ecosystem services within the natural carrying capacity of the resource base, sustaining long-term production of diverse and nutritious food and climate resilience.

Six food security dimensions

The selection of indicators for the INFER risk framework is guided by the definitions of six food security dimensions identified by the High-Level Panel of Experts of the Committee on World Food Security (HLPE/CFS, 2020). Key aspects of each definition are emphasized by the risk framework to guide definition of model components and indicators:

Availability: *The availability of sufficient quantities of food of appropriate quality and diversity supplied through domestic production or imports*. The risk framework focuses on the longer-term production, trade policies and network concentrations that could constrain food availability, and the institutional and other conditions that support a country's ability to increase the supply of diverse food sources in a crisis.

Utilization: *Having an adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met*. The risk framework focuses on health conditions that indicate or negatively impact nutritional shortcomings, and the physical and institutional infrastructure and support that provide the enabling conditions for nutritional well-being.

Sustainability: *Food system practices that contribute to long-term regeneration of natural, social and economic systems, ensuring the food needs of the present generations are met without compromising the food needs of future generations*. The risk framework focuses on the environmental sustainability aspect of sustainability, recognizing that in many, if not most, cases environmental sustainability underpins the sustainability of social and economic systems. It captures the environmental pressures related to food production and indicators of governance of the natural resource base required for food systems sustainability – particularly in the face of climate threats.

Prosperity: Shared prosperity is promoted by equity in access to adequate, nutritious and diverse food, and when producers and stakeholders along the supply chain are able to earn a secure livelihood. It points to food systems that support human dignity, empowerment and human resilience.

Agency: *Individuals or groups having the capacity to act independently to make choices about food eaten, produced, processed and distributed and to engage in policy processes that shape food systems. Requires socio-political systems that uphold governance structures for food security and nutrition*. The risk framework focuses on the economic/market and socio-cultural factors that indicate constraints on the options of households and producers due to social disparities, as well as key aspects of empowerment including participation and voice, norms and institutions, rights and justice, and resources and capabilities.

Access: *Having personal or household financial means to acquire food for an adequate diet at a level to ensure that satisfaction of other basic needs are not threatened or compromised; and that adequate food is accessible to everyone, including vulnerable individuals and groups*. The risk framework focuses on households and critical population groups that can face barriers in access to food or unique challenges in accessing nutrition adequate for their needs, as well as the physical and institutional infrastructure and support available.

Stability: *A household or individual must not risk losing access to food as a consequence of sudden shocks or cyclical events; stability can impact both availability and access dimensions of food security*. The risk framework focuses on the conditions that accelerate the transmission of supply disruptions and price shocks, and a country's ability to take measures to keep supply and prices stable, respond to short-term constraints and deal with crises.

Food system outcomes

The food system outcomes highlighted by this model are framed by three Ps of the 2030 Agenda for Sustainable Development – People, Planet and Prosperity – and are aligned with the conclusions of the HLPE/CFS (2020). The HLPE/CFS report notes that "sustainable food systems are: productive and prosperous (to ensure the availability of sufficient food); equitable and inclusive (to ensure access for all people to food and to livelihoods within that system); empowering and respectful (to ensure agency for all people and groups, including those who are most vulnerable and marginalized to make choices and exercise voice in shaping that system); resilient (to ensure stability in the face of shocks and crises); regenerative (to ensure sustainability in all its dimensions); and healthy and nutritious (to ensure nutrient uptake and utilization)." These outcomes are interrelated and codependent. Each food security dimension is linked to a specific food system outcome based on an understanding of the influence that each might have. This framing does not exclude the influence that other dimensions might have on the food system outcome being considered.

4. Assessing food system risks in Asia and the Pacific: framework application

This section shows the results of INFER's application in the Asia-Pacific region.

4.1 Risk trends – Asia-Pacific countries

Most Asia-Pacific countries have experienced an increase in multidimensional risk in food systems in the last five years. Table 2 summarizes the results for Asia-Pacific countries, showing the overall INFER risk score and breakdown by risk dimension. The breakdown of the risk score shown in the table emphasizes the relative contribution of each risk dimension to the overall risk score. In some countries, reducing hazard incidence and exposure may be pivotal in reducing overall risk; in other countries, vulnerability reduction may be an important priority.

Table 2: INFER overall risk scores, scores for risk dimensions and change in Asia-Pacific countries, 2022

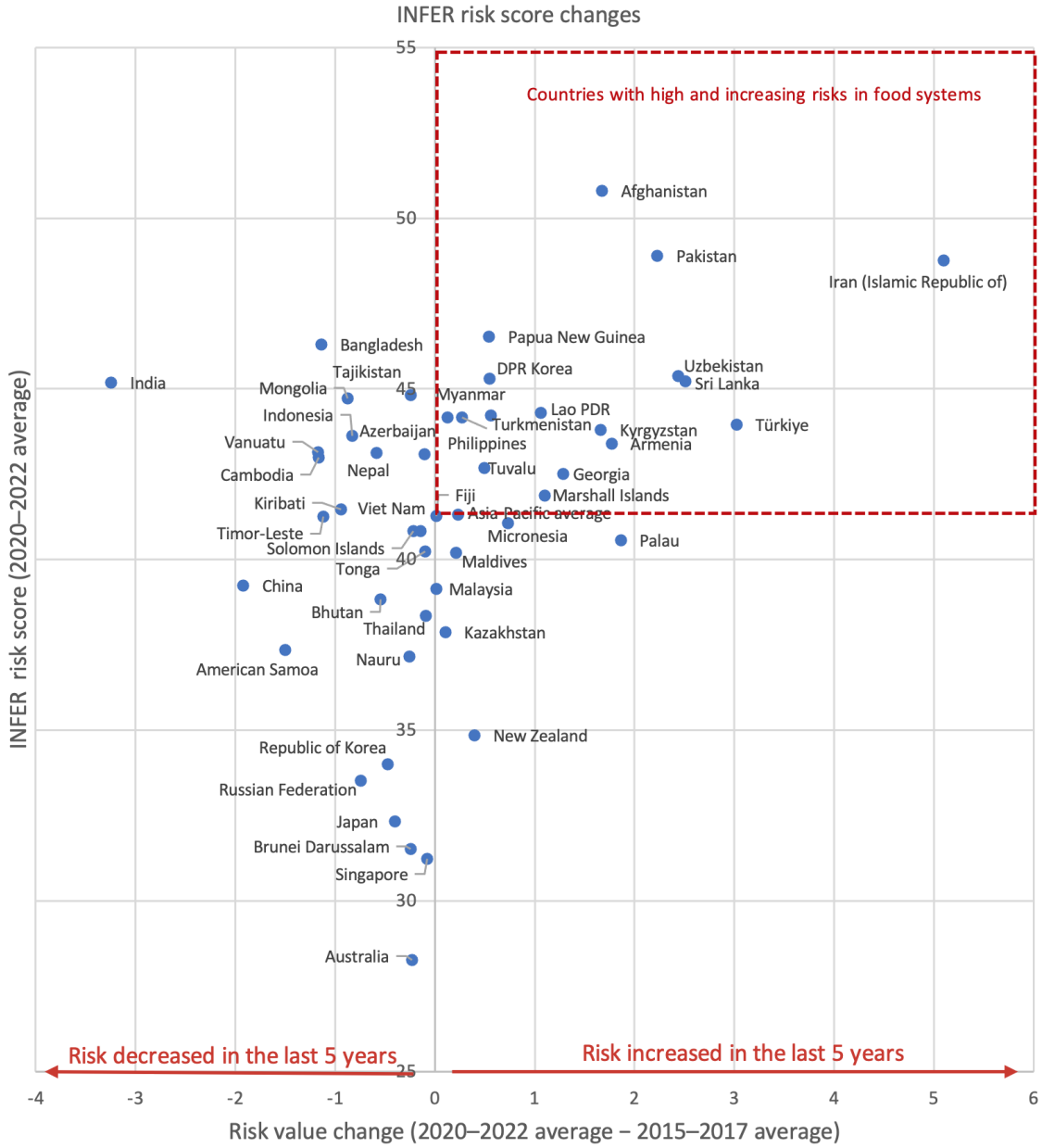
Rank by risk index, overall	Country	Overall risk	Hazard and exposure	Vulnerability	Lack of adaptive capacity	Overall risk change in 5 years*
1	Afghanistan	52.72	47.65	46.52	66.08	▲1.67
2	Pakistan	50.76	45.89	43.81	65.05	▲2.23
3	Iran (Islamic Republic of)	48.80	49.30	42.80	55.07	▲5.10
4	Sri Lanka	48.31	44.51	45.18	56.06	▲2.51
5	Democratic People's Republic of Korea	47.07	37.65	46.25	59.91	▲0.54
6	Papua New Guinea	46.93	37.17	44.19	62.90	▲0.54
7	Mongolia	46.65	39.19	41.16	62.92	▼-0.87
8	Bangladesh	46.51	37.51	43.45	61.72	▼-1.14
9	Myanmar	46.44	39.10	40.06	63.94	▲0.12
10	Lao People's Democratic Republic	46.25	38.91	43.41	58.59	▲1.06
11	Uzbekistan	45.58	41.72	44.25	51.28	▲2.44
12	Turkmenistan	45.27	40.70	39.06	58.36	▲0.56
13	India	44.98	36.14	43.59	57.77	▼-3.24
14	Kyrgyzstan	44.76	39.90	40.67	55.29	▲1.66
15	Türkiye	44.58	44.00	40.28	49.98	▲3.02
16	Tajikistan	44.54	36.92	39.62	60.39	▼-0.24
17	Azerbaijan	44.52	41.67	40.77	51.95	▼-0.11
18	Armenia	44.35	40.67	39.44	54.38	▲1.77
19	Philippines	44.09	37.19	41.23	55.90	▲0.27
20	Nepal	43.98	35.26	39.34	61.34	▼-0.58
21	Indonesia	43.98	38.17	38.76	57.50	▼-0.83
22	Tuvalu	43.75	33.64	45.72	54.43	▲0.50
23	Georgia	43.33	40.87	39.89	49.92	▲1.28
24	Vanuatu	43.19	37.07	41.02	52.98	▼-1.17
25	Cambodia	42.97	33.55	39.49	59.90	▼-1.17
26	Marshall Islands	42.70	32.69	44.81	53.14	▲1.10
27	Solomon Islands	42.27	35.01	41.02	52.59	▼-0.22
28	Fiji	42.13	35.15	42.05	50.59	▲0.01
29	Palau	42.09	32.98	43.65	51.79	▲1.86
	Asia-Pacific average	42.07	36.08	40.47	51.68	▲0.23
30	Kiribati	41.80	32.10	38.42	59.21	▼-0.94
31	Micronesia (Federated States of)	41.48	29.24	45.63	53.49	▲0.73
32	Tonga	41.09	30.75	42.95	52.52	▼-0.10
33	Timor-Leste	41.02	32.30	35.21	60.71	▼-1.12
34	Viet Nam	40.14	34.03	36.56	51.99	▼-0.14
35	Maldives	40.06	29.31	39.71	55.25	▲0.21
36	Malaysia	39.51	37.31	38.87	42.54	▲0.02
37	Thailand	39.32	33.88	37.68	47.61	▼-0.09
38	American Samoa	38.99	31.73	36.48	51.20	▼-1.50
39	China	38.99	35.06	36.58	46.21	▼-1.92
40	Kazakhstan	38.82	34.06	37.50	45.79	▲0.10
41	Bhutan	38.13	30.58	41.55	43.63	▼-0.55
42	Nauru	37.30	31.09	38.44	43.44	▼-0.25
43	New Zealand	35.32	30.68	41.18	34.88	▲0.40
44	Russian Federation	35.06	32.56	32.88	40.25	▼-0.74
45	Republic of Korea	34.89	35.73	36.77	32.33	▼-0.47
46	Japan	33.79	34.83	38.69	28.64	▼-0.40
47	Singapore	32.17	32.90	38.11	26.57	▼-0.08
48	Brunei Darussalam	31.60	28.31	32.84	33.94	▼-0.24
49	Australia	28.44	21.43	35.41	30.32	▼-0.23

*Note: "Overall risk change in 5 years" shows the difference between 2020–2022 average and 2015–2017 average

Figure 6 compares changes in overall INFER risk score in the last five years (average 2015–2017 to average 2020–2022) with the average risk score 2020–2022, to better understand the significance of these changes.

It shows that some countries face particularly high and increasing risks in food systems (e.g. Afghanistan, Pakistan and Islamic Republic of Iran). Some countries, albeit having relatively low risk compared to the Asian-Pacific average, are also seeing risk increases compared to five years ago (e.g. Australia, New Zealand and Republic of Korea). On the other hand, in some high-risk countries the INFER multidimensional risk score has declined over the last five years (e.g. India, Nepal and Bangladesh) (Figure 6).

Figure 6: Status of food system risk in 2020–2022 vs. risk change in five years



4.2 Risk trends and drivers – Asia-Pacific region

INFER's application to Asia-Pacific countries as a group shows that since 2000 there has been a slight decline in overall food system risk (Figure 7), driven by improvement in adaptive capacity. Except for the two spikes in 2007–2008 and 2010–2012 linked to the world food price crises during those periods, risks related to hazard and exposure also showed an overall decrease, possibly reflecting reduced impacts due to improved disaster risk reduction. However, risk related to vulnerability in Asia and the Pacific continued to rise from 2007–2008 onwards.

The COVID-19 pandemic has reversed positive trends and accelerated negative trends. All three dimensions of risk increased after 2019, shaping "the perfect storm" experienced in many countries in recent years.

Figure 8 shows the risk trends for the six dimensions of food security. Across the six dimensions, risks related to stability (referring to market, financial and governance conditions) have increased significantly since 2000. While the graph shows an overall decline of risks to other dimensions, it is also clear that improvements have been limited – particularly in the case of the sustainability food security dimension (focused on environmental stresses) The most important improvements have been in the utilization food security dimension. However, the rate of improvement has slowed since around 2015 and **during 2019–2020 there has been a concerning shift, with the risks for all dimensions of food security now increasing.**

Figure 7. Change in food system hazard and exposure, vulnerability and lack of adaptive capacity in Asia and the Pacific, 2000–2022

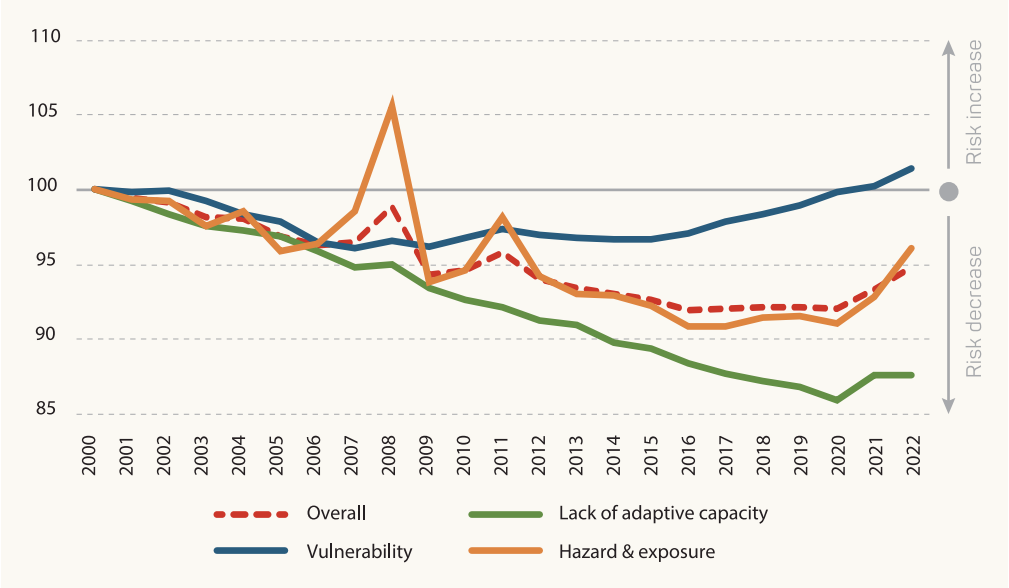
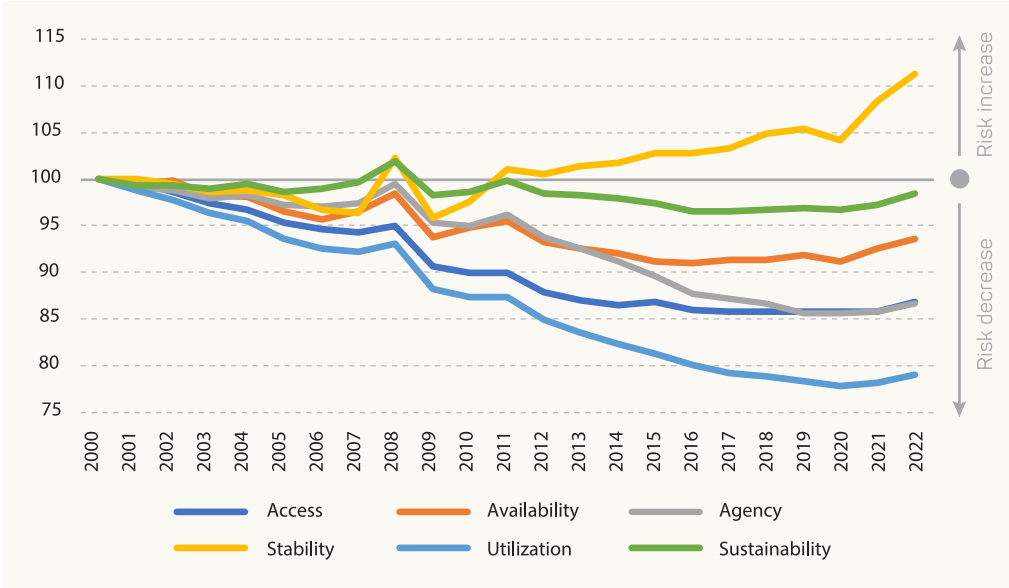


Figure 8. Change in Asia-Pacific food security dimension risks, 2000–2022



Figures 9 and 10 provide insights into the underlying trends that are driving the changes food systems risk, based on the INFER structure.

Three categories of risk are defined under the Hazard and Exposure dimension of risk – natural hazard and exposure, economic hazard and exposure and socio-political hazard and exposure. Each is comprised of different components (see Figure 4).

Trends in the components under each of the six food security dimension are shown in Figure 10.

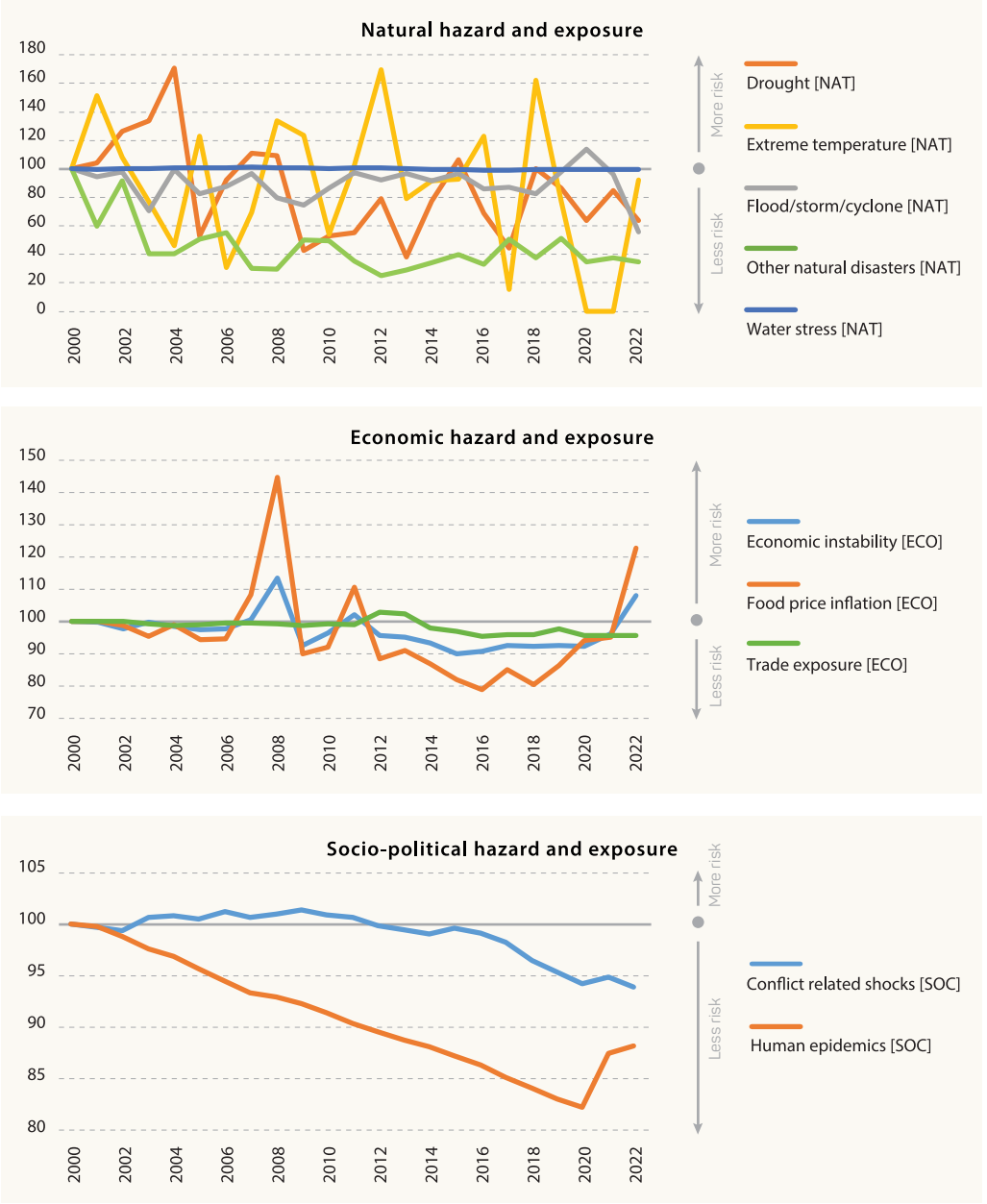
Availability: While food production is increasing, pressures on the natural resource base, including use of renewable water resources, undermine food security.

Access: While poverty and inequality have declined, overall the share of populations likely to experience extreme difficulty with food security – including displaced persons, people affected by disaster in the last 10 years, and populations over 60 years old – is increasing.

Utilization: There is a notable increase in adult and child obesity, while other risk indicators, including disease burden, nutritional deficiency and lack of health infrastructure, are improving.

Stability: INFER focuses on market aspects of food system stability, indicated by food and general consumer prices, which have increased significantly. Improvements in adaptive capacity related to foreign exchange reserves were reversed when the COVID-19 pandemic hit.

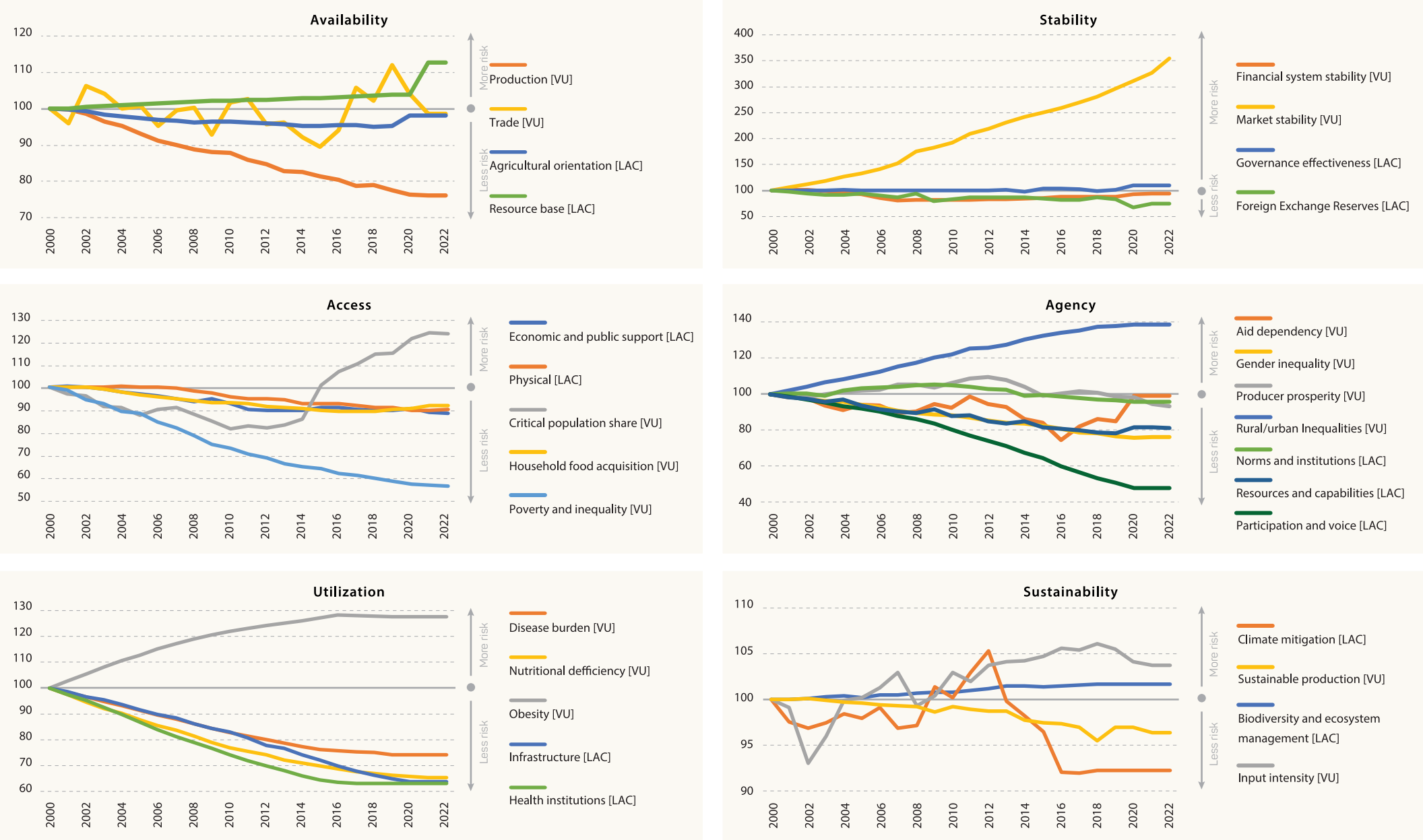
Figure 9. Change in Asia-Pacific food system hazard and exposure components, 2000–2022



Agency: Most components show improvements, with the exception of rural to urban inequality, and, since around 2016, food aid dependency. The component on participation and voice, is based on a limited data set (internet connectivity). Indicators such as civic engagement and women's representation in parliaments and access to contraception, as well as other indicators highlighted as supplemental indicators in annex 3 would strengthen the capture of trends for this food security dimension in subnational and subsequent applications of INFER.

Sustainability: Input intensity – assessed by intensity of use of fertilizer, water and energy in agriculture – has increased since 2000, remaining relatively unchanged since 2014, after a period of rapid increase. Other components related to sustainability also show limited improvement.

Figure 10. Change in Asia-Pacific food security dimension risk, 2000–2022



4.3 Risk profiles – Asia-Pacific country groupings

Results from the INFER framework show that low- and lower-middle-income economies and least developed countries have relatively high risk across the food value chain, from food availability (production and trade) to food access (economic and physical access) and through to utilization (healthy and safe consumption) (figures 11 and 12). On the other hand, high-income economies in general face lower risk compared to other income groupings, with the main sources of risk including a high environmental footprint and economic and financial factors that impact market stability.

Compared to the Asia-Pacific average, small island developing states face higher risk in relation to the healthy and safe utilization of food and ensuring agency. Landlocked developing countries show lower risk in relation to food utilization but higher risk in the sustainability, stability and availability food security dimensions.

Figure 11. Risk by food security dimension, Asia-Pacific income groups, 2022

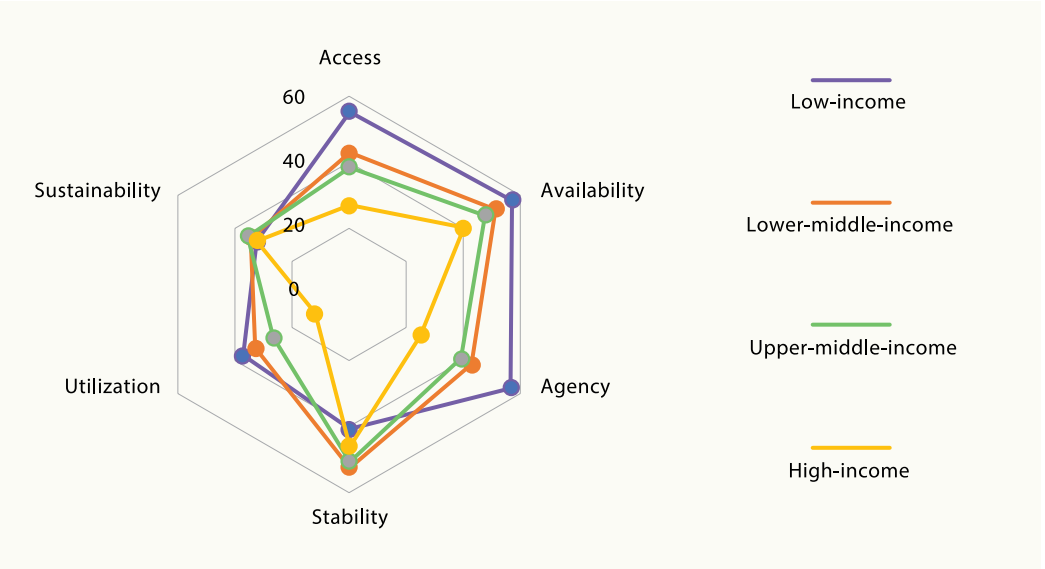
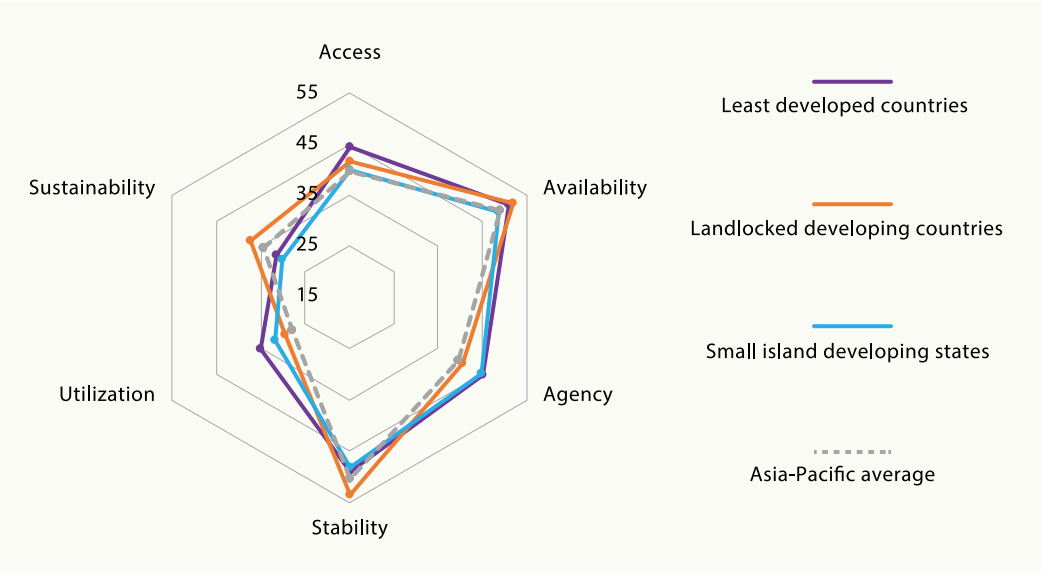


Figure 12. Risk by food security dimension, countries in special situations, 2022



4.4 Risks to food system outcomes

Figure 13 shows changes in risks to food system outcomes – with a focus on the three outcomes of human health and nutrition, ecosystem health and sustainability, and shared prosperity – for the Asia-Pacific region, for countries grouped by income and by groupings of countries in special situations, as defined in annex 6.

On average, risks to human health and nutrition decreased the fastest in Asia and the Pacific over the past two decades, while risks to ecosystem health and sustainability showed the least improvement. Different trends can be observed in different country income groups and groups of countries in special situations (least developed countries, landlocked developing countries and small island developing states).

Figures 14, 15 and 16 show the risks to each food system outcome by country. Among Asia-Pacific countries, the risks to human health and nutrition are the highest in Afghanistan, Solomon Islands, Pakistan and India. Many countries including Armenia, the Republic of Korea, Kazakhstan, the Russian Federation and Australia are seeing increasing risks to this food system outcome compared to five years ago (Figure 14).

Risks to shared prosperity are highest for a similar group of countries Including Afghanistan, Pakistan, the Islamic Republic of Iran and Sri Lanka. The risk in 2022 across the majority of countries is higher than in 2017, with few exceptions (Figure 15)**. The countries assessed as having the highest risk related to ecosystem health and sustainability are Mongolia, Turkmenistan, New Zealand and Indonesia**. Some high-risk countries are seeing risk reductions compared to five years ago (e.g. India, China, Kazakhstan and Bangladesh), while the majority of countries are recording slow progress (Figure 16).

Figure 13. Change in risks to food system outcomes, 2000–2022

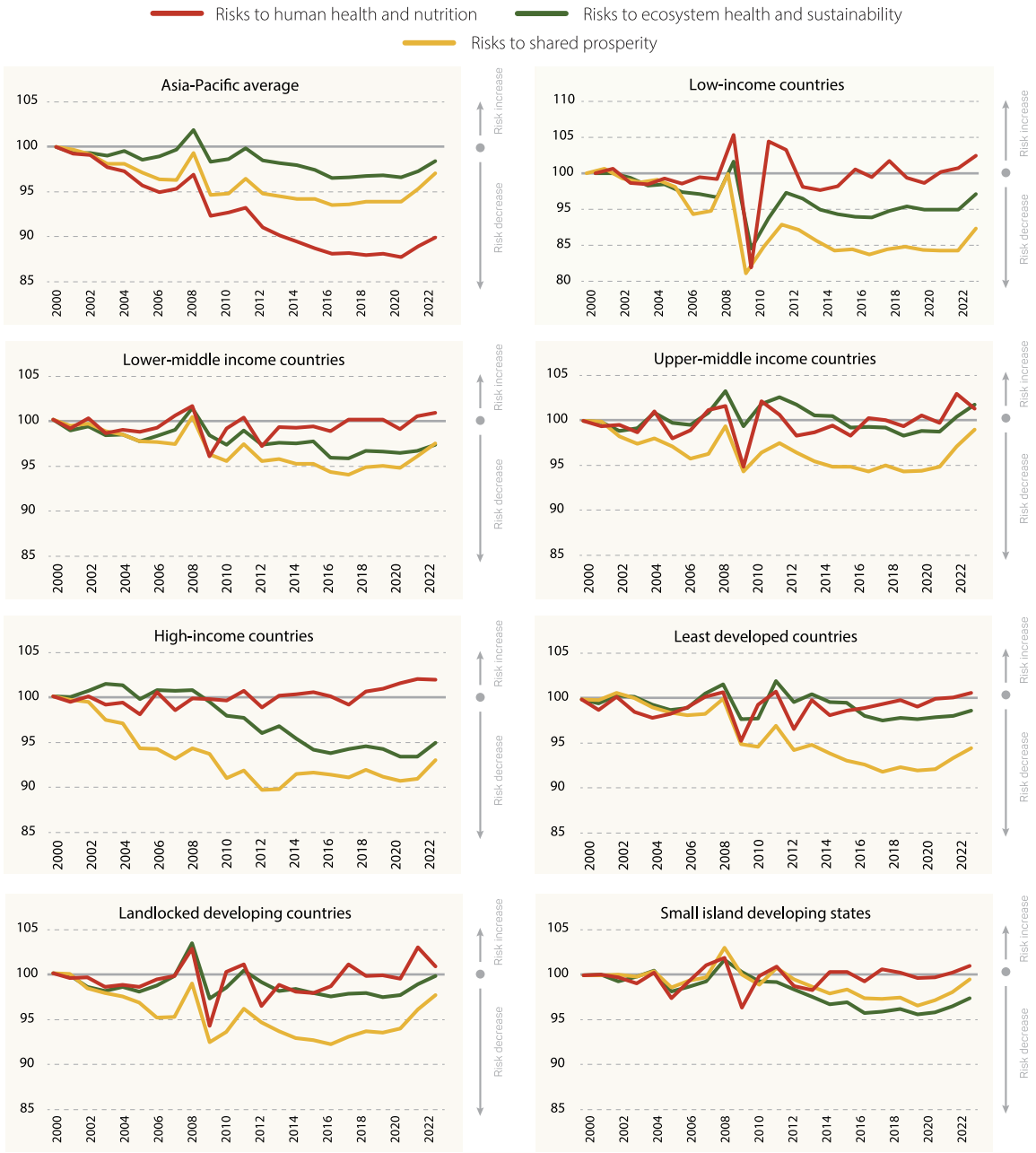


Figure 14. Risks to human health and nutrition

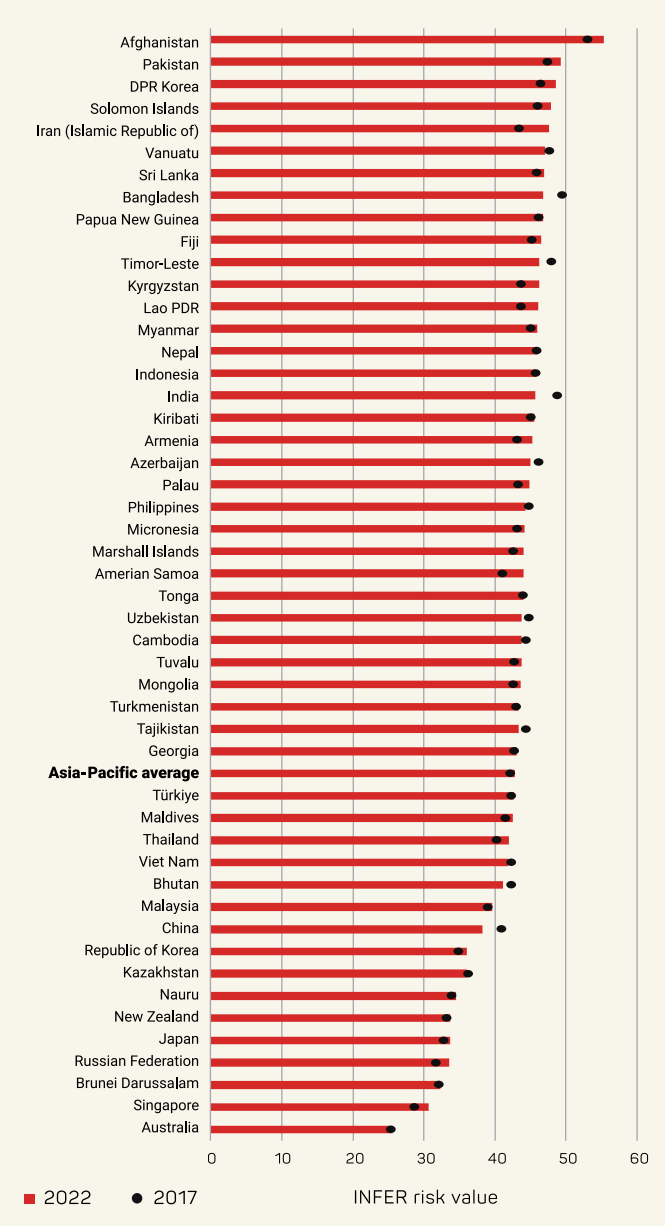


Figure 15. Risks to shared prosperity

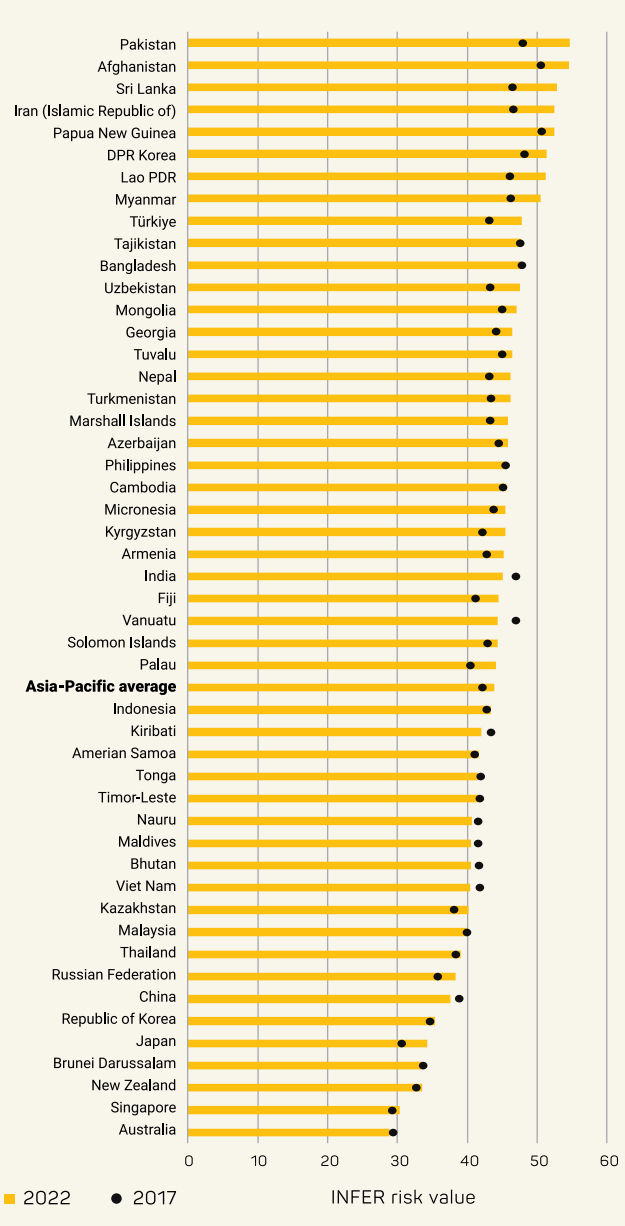
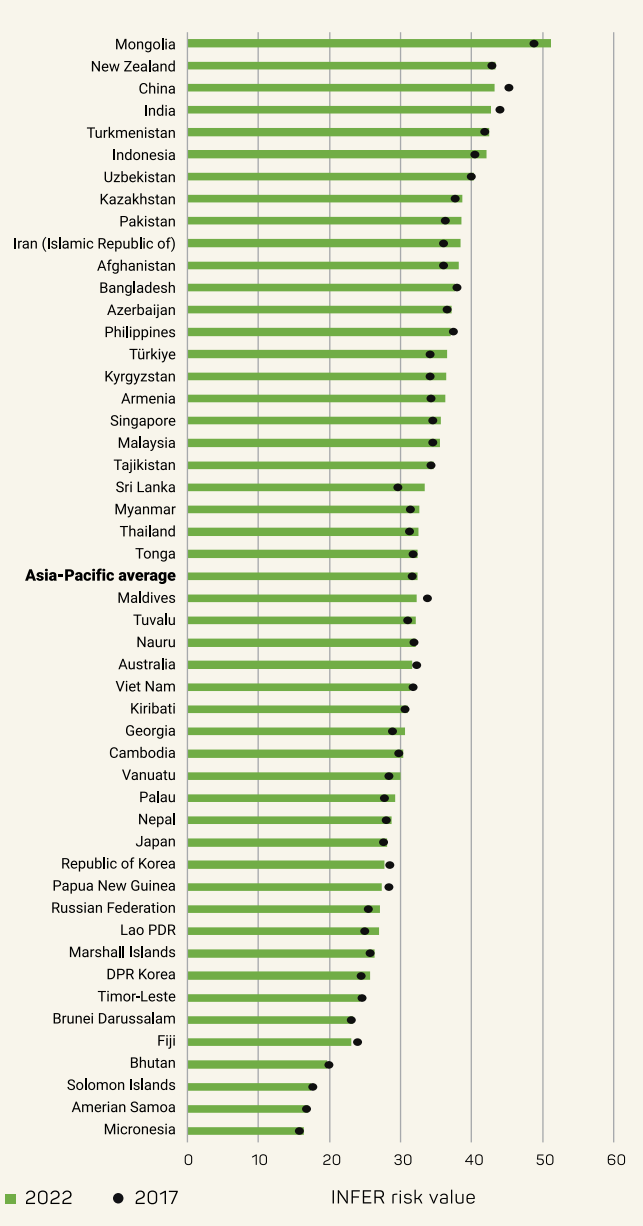


Figure 16. Risks to ecosystem health and sustainability



4.5 Country risk profiles, and applying INFER subnationally

The INFER framework can be used to generate risk profiles for each country to show risk trends, risk to food system outcomes and risk drivers. Annex 1 illustrates the application of the INFER framework to seven Asia-Pacific countries: Bangladesh, Fiji, Kazakhstan, Lao People's Democratic Republic, Pakistan, Sri Lanka and Uzbekistan.

These risk profiles can help to ensure that national food system transformation pathways and related strategies are appropriately risk-informed. Resilience-building and risk-management measures should also be tailored to each country's food system risk profile. including through national development strategies, national climate adaptation and disaster risk reduction and management plans. National entities responsible for agriculture, finance, health, environment, trade and labour, among others have an important role to play in food system risk management and resilience-building.

The country risk profiles in annex 1 build on international data sources rather than national data. The profiles are illustrative rather than prescriptive. They do not tell the story of subnational variability in risk, which can be considerable and requires spatially referenced data. In some cases, important data is missing – for example, regarding climate adaptation capacities. For these reasons, these risk profiles should be considered a starting point for further policy review and discussion at the national level. They may also contribute to strengthening institutional coordination and exchanges.

The national or subnational application of INFER requires a lead agency within a country that brings different stakeholders together to agree on how its results will be used, adapt the indicators and other aspects of the model to the national context, and to test and use the results in the business of government. The national application of INFER would use nationally approved and validated data, and engage a wide range of national entities in the process. It would also use geospatial data to map variations in risk across administrative regions.

Box 2 outlines some key enabling factors for adapting and localizing INFER.

Box 2. Enabling elements for an impactful INFER subnational model for sustainable food system transformations*

Political will and leadership, clear identification of users and relevant policy

- It is critical for leaders to adopt an anticipatory and multisectoral approach to food system risk planning, building on integrated data and interministerial collaboration. The leader's role could be taken on by national food system dialogue convenors, ministers or directors of national risk centres, disaster risk reduction departments, among others.
- The objectives of the INFER subnational model, including its linkages with specific policy processes or users need to be identified at the beginning of the model adaptation process.

Institutional arrangement, multisectoral and multi-stakeholder collaboration

- A lead agency, or institutional "home" for the INFER subnational model, should be identified. The lead agency will prepare a project plan in consultation with government departments and other partners, secure funds, and lead the INFER subnational model development, maintenance and usage.
- A technical working group should be established, building on existing or newly established interministerial collaboration networks, and include experts from development organizations, academia and other stakeholder groups. The group will provide insights, guidance and technical expertise, helping to ensure that the INFER subnational model has a balanced and robust incorporation of key data and views, and fits the needs of targeted sectors and stakeholders.
- Ensure balanced views across stakeholders.

Data and technology

- The INFER subnational model development process helps identify data gaps and enhance data transparency across food systems. It is critical to develop a data strategy to ensure continuing improvement of food system data and continued data updates.
- Given the sensitivity of some national data, development of two INFER versions for public and internal users, respectively, could be considered.
- Data should be harmonized across scales.
- Machine learning, artificial intelligence and other innovations can be explored to close data gaps and to extend the analytical power of the model.
- A process for validation and approval of the data for release by a responsible authority is needed.

Knowledge, skills and adaptive governance

- Continued research, education and training on multidimensional food system risk is needed for government officials and stakeholders.
- Continued strengthening capacity for evidence-based policymaking, as well as adaptive and risk-informed food system governance, is needed.
- Barriers in integrated data management and analytics, language barriers, differing terminologies and professional segregation, among others, should be addressed.

Funding and investments

- Financial resources need to be identified.
- Partnerships with development partners, research, academic or other organizations can be explored to ensure sustainability and improve data availability.

*Note: This box is informed by discussion during the expert group meeting on "Strengthening food system risk assessment: INFER and its application" held in September 2023 in Bangkok and online. National food system convenors, government experts and development partners participated.

5. Assessing near-term multidimensional food system risk

The INFER framework underlines that risk profiles develop over time. A complementary framework to monitor fast-changing near-term risk is also needed. Natural disasters, debt crises, currency devaluations and conflict can change the risk profile dramatically. These risk drivers should be carefully monitored in the countries with high food system risk and where high vulnerability and/or low adaptive capacity are major drivers of risk. An associate model for fast-moving indicators has therefore been proposed and requires further investment (Box 3).

Box 3: Associate model for fast-moving indicators

The INFER associate model aims to assess and monitor imminent risks to food insecurity, based on fast-moving indicators as well as selected indicators that indicate longer-term structural weakness. Capitalizing on the INFER main model structure and methodology, a country's or locality's risk score is calculated with a multiplicative equation of three dimensions – hazard and exposure, vulnerability and adaptive capacity – each of which is measured by food system and socioeconomic factors. The associate model aims to respond to the need for early warning and resource allocation, as socioeconomic shocks, including those due to the war in Ukraine and the COVID-19 pandemic, continue to trigger food insecurity crises.

Dimensions	Category	Indicators	Source	Frequency
Hazard and exposure	Food systems (50%)	• Trade balance (food categories) • International energy price • International fertilizer price • International food price inflation • Agricultural stress index – drought impact	Comtrade IMF IMF FAO FAO	Monthly/yearly Monthly Monthly Monthly Monthly
	Socioeconomic (50%)	• Conflicts (riots/protests) • Currency exchange rates • Inflation rates (CPI)	acleddata.com UN Treasury World Bank	Weekly Twice per month Monthly
Vulnerability	Food systems (50%)	• Insufficient food consumption (FCS) • Undernourishment prevalence • Average dietary energy supply adequacy	WFP Hunger Map FAO FAO	Irregular Yearly Yearly
	Socioeconomic (50%)	• Central government debt, total (% of gross domestic product [GDP]) • People affected by disasters (share of total population)	World Bank EMDAT	Yearly Yearly
Adaptive capacity	Food systems (50%)	• Without access to energy (%) (proxy for food storage) • Without access to improved water (%) • Without access to improved sanitation (%) • Prevalence of people with reduced coping strategies (RCSI) • Food insecurity experience (FIES) • Crisis or above-crisis food livelihood coping strategies (LCSI) • Food price anomaly (Indicator of food price anomalies [IFPA], CPI)	SDG data SDG data SDG data WFP Hunger Map FAO WFP Hunger Map FAO	Yearly Yearly Yearly Irregular Irregular Irregular Yearly
	Socioeconomic (50%)	• GDP per capita • Inequality-adjusted Human Development Index • People reporting challenges accessing health systems • People reporting challenges accessing markets	World Bank UNDP WFP Hunger Map WFP Hunger Map	Twice per year Yearly Daily Daily

6. Discussion

The application of the INFER framework to countries in the Asia-Pacific region reveals increasing risk in food systems in recent years. System vulnerability triggered by the 2007–2008 and 2010–2011 food–energy price crises has continued to rise, while hazard and exposure, following years of decline are on the rise again due to macroeconomic and climate dynamics. While other food security dimensions, such as food availability and utilization, have seen improvements, there is a considerable increase of risk in relation to stability and slow improvement in sustainability. This highlights the rising importance of risks beyond producing enough food, as well as the criticality of reducing risks of slow onset events related to climate change as well as vulnerabilities among the households and individuals most likely to be impacted by shocks.

INFER can support the development of risk-informed national food system transformation pathways by assisting policymakers in better understanding and targeting food systems' risk drivers and vulnerabilities. It also supports risk communication and transparency, and can help strengthen policy coherence and cross-sectoral collaboration on food system-related development strategies.

Significantly, INFER provides more comprehensive understanding and monitoring of food systems. The strength of the model relates to the comprehensive treatment of all six dimensions of food security and its emphasis on monitoring trends. It does not work well for prioritizing one issue over another, as it does not assess the starting point for changes in utilization or vulnerability, for example.

This application sought to cover as many Asia-Pacific countries as possible. Due to a lack of data appropriate for use in this application, key issues that influence food system risk have not been covered. These include anticipatory actions, multi-risk early warning systems and other resilience-boosting food system measures, such as climate adaptation, climate finance, diversification of food production and consumption, affordability of healthy diets, social protection measures and food reserves. Better data is also needed to capture issues related to agency and sustainability, such as land tenure, smallholder income, public participation, diet diversity, marine and freshwater ecosystem health, and animal and plant health. Some of these issues are captured by supplemental indicators listed in annex 3. As a policy support tool, INFER could be advanced by the following:

- Assessing the model further to understand the "predictive power" of INFER, i.e. assessing the extent to which the INFER risk score is related to specific food system outcomes.
- Identifying groups of countries with similar risk profiles to support exchange of experiences and identify useful policy interventions.
- Where INFER looks at the medium- to long-term trends, investing in understanding near-term risk via investment in the associate model (described in section 4).
- Adapting the model to better capture the risk faced by different population groups. INFER's risk score does not capture inequality within the country, or the situations of the populations who are the furthest behind, especially on vulnerability- and adaptive capacity-related indicators such as undernourishment, low birth weight, secondary education of females, access to water and electricity, among others. A lower bound to reflecting furthest behind groups, (as well as a higher bound) could be taken into account in subnational application of the model, particularly where better access to comparable data would be available in measuring risk.

- Applying the framework at the subnational level. This would include utilizing georeferenced data and locally adapted indicators and weights to support targeted resource allocation and planning within countries. Such application would help to highlight data gaps and food system elements, considering production, transformation, aggregation, transport, distribution, consumption, waste and the water–energy–food nexus.

- Integrating the INFER model with existing climate and food security risk assessment models to explore the impact of specific climate mitigation trajectories and risk scenarios (notably representative concentration pathways and shared socioeconomic pathways) on risk scores.

7. Conclusions

During the 2021 Food Systems Summit, countries acknowledged that food systems are essential for realizing a shared vision of a better world. Multidimensional, compounding and cascading risks to food systems threaten to fundamentally reverse the hard-won development gains and compromise the health and well-being of all stakeholders in food systems. Such risks therefore need to be identified and monitored in order to be addressed and mitigated. Policy measures and investments in building food system resilience should consider the risk profile of each country.

This study explored the application of a framework to assess and monitor multidimensional risks to food systems' outcomes, including those related to climate change, economic shocks, conflicts, epidemics, trade disruptions, poverty and inequality.

A risk index comprising the three dimensions of hazard and exposure, vulnerability and adaptive capacity assessed risk to six food security dimensions, and consequently to three food system outcomes: human health and nutrition, ecosystem health and sustainability, and shared prosperity.

The framework offers insights into various risk factors and supports prioritization of action as countries take policy decisions on the implementation of their national food systems transformation pathways and related resilience-building strategies. Its application reveals critical trends, including the rising instability of economic and market conditions impacting food systems, convergence of exposure to hazards across country income groups, the rising risks related to drought in high-income countries, and the compounding of risks in least developed, landlocked and low- and lower-middle-income economies by production factors and household vulnerabilities.

The risk profiles of seven countries presented in annex 1 illustrate the potential for applying INFER to ensure that strategies to build food systems resilience respond to the risk profile of each country and support strengthening risk perspectives in the implementation of national food system transformation pathways.

Several areas for improvement of the model have been noted. The application of INFER at the subnational level provides the opportunity to close data gaps, integrating spatial data and bringing risk insights together with other analyses, in particular climate and other threat scenarios. Engaging national stakeholders in the application of INFER at the subnational level, interpreting the results, and collaborating in their application is critical.

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Annex 1. Country risk profiles

This annex presents the INFER (INsights on Food SystEm Risks) country risk profiles for seven countries: Bangladesh, Fiji, Kazakhstan, Lao People's Democratic Republic (Lao PDR), Pakistan, Sri Lanka and Uzbekistan. The country profiles include a brief country overview followed by presentation of risk trends by risk dimension, by food security dimension, by food system outcomes and by risk components. Risk components for each country are compared with the average for countries in its income group, whether it is a lower-middle-income country (LMIC) or upper-middle-income country (UMIC).

The country risk profiles build on international data sources rather than national data. The profiles are illustrative rather than prescriptive. They do not tell the story of subnational variability in risk, which can be considerable and requires georeferenced data. In some cases, important data is missing (for example regarding anticipatory actions, climate adaptation, resilience and disaster risk reduction capacities).

For these reasons, these risk profiles should be considered starting points for further policy review and discussion at the national level and for the development of subnational food system risk models. Such a multi-stakeholder effort can contribute to strengthening institutional coordination for food system risk reduction and building resilience.

Data for each country can be explored at the INFER Dashboard at www.unescap.org/projects/infer

Bangladesh

Bangladesh is one of the world's most densely populated countries, with almost one quarter of the population living below the national poverty line in 2016. The agricultural sector accounts for 12 percent of GDP and employs 40 percent of the country's population (World Bank, 2022). Bangladesh is a leading producer of rice, jute, wheat, tea, pulses, oil-seeds, vegetables and fruits. Agricultural production is dominated by small-scale and subsistence farming, while the considerable economic growth of the past two decades is attributable to a large, productive population and thriving garment industry. Food systems have been subject to shocks ranging from the war in Ukraine and COVID-19 to seasonal floods and water stress. Undernourishment prevalence was reported at a high 11.4 percent in 2021. Compounded by the global food, fuel and financial crises following the war and pandemic, high inflation and depreciating local currency are important threats, alongside flooding, cyclones, landslides and rising sea levels. WFP surveys found that 12 percent of the population was acutely food insecure in December 2022. Populations most at risk include the 1 million Rohingya refugees in Cox's Bazar and the host community populations, smallholder farmers, and those living in low-lying flood-prone localities. Women are particularly vulnerable, with high levels of anaemia (36.7 percent) in women and girls of reproductive age, partly due to the high rates of early marriage in Bangladesh (ranked top ten globally).

Risk profile highlights

Overall risk in food systems is decreasing, but vulnerability is an increasingly influential risk driver for Bangladesh (Figure A1.1). While the risks of negative human health and nutrition outcomes have declined over time, risks to shared prosperity in food systems and to ecosystem health and sustainability have not changed significantly in the past 20 years (Figures A1.2 and A1.3). Lack of progress on these fronts compound the influence of rising vulnerability, noting the high proportion of smallholders, high poverty levels, climatic factors and increasing instability of market conditions. Water stress, socio-political conflict and floods, and vulnerabilities related to environmental pressures on production, household food acquisition and nutritional deficiencies, are much more significant risk drivers in Bangladesh than the average for LMICs (Figure A1.4).

On the other hand, many aspects of Bangladesh's adaptive capacity are stronger than the average for LMICs, supported by progress in economic growth, human capital development, agricultural productivity, strengthened infrastructure and health institutions (Figure A1.4).

Figure A1.1: Food system risk trends, Bangladesh

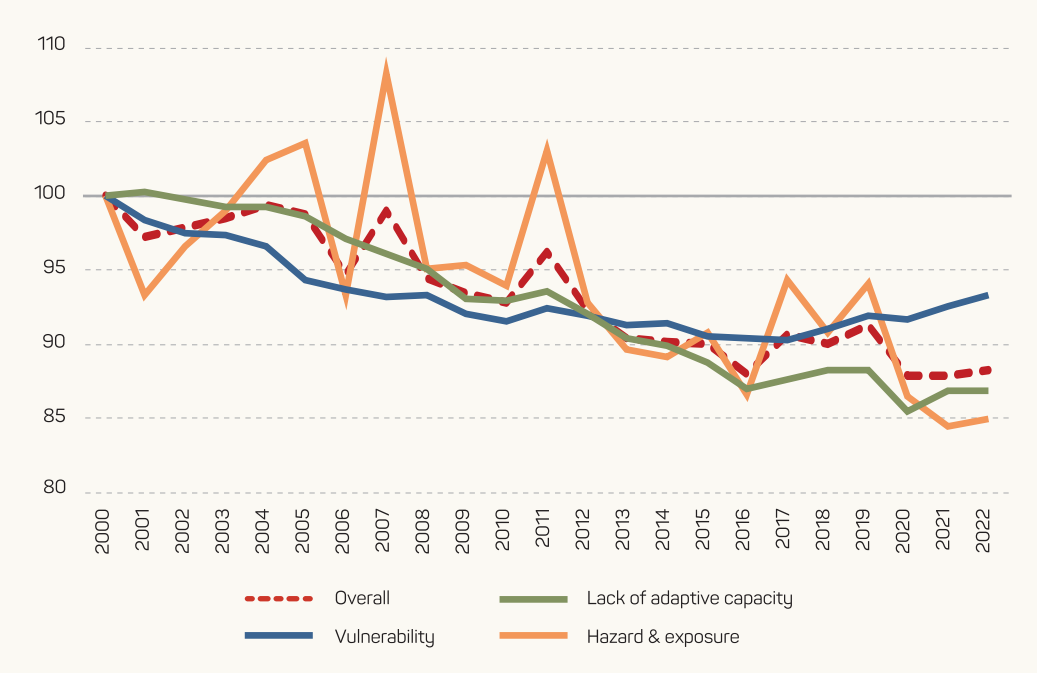


Figure A1.2: Risk to food security dimensions, Bangladesh

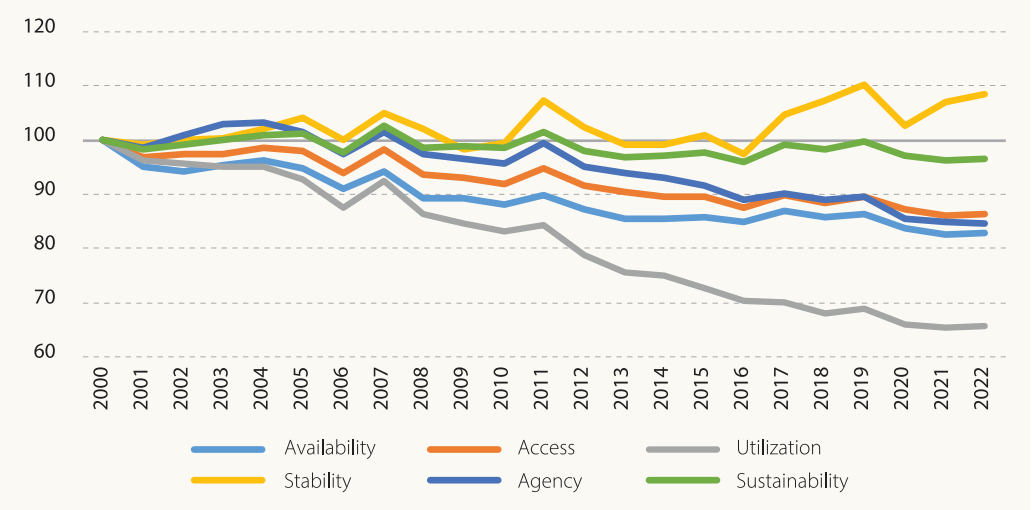


Figure A1.3: Risk to food system outcomes, Bangladesh

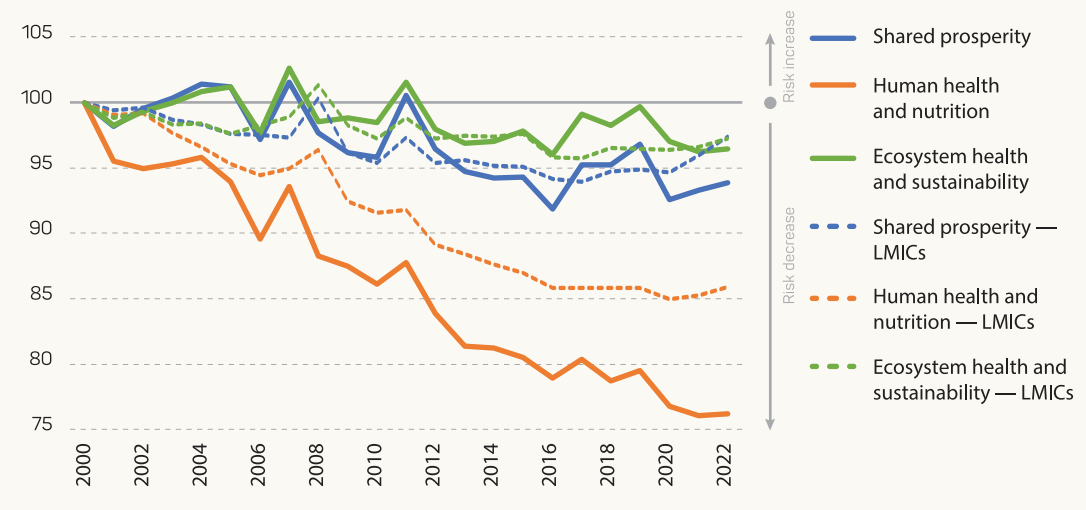
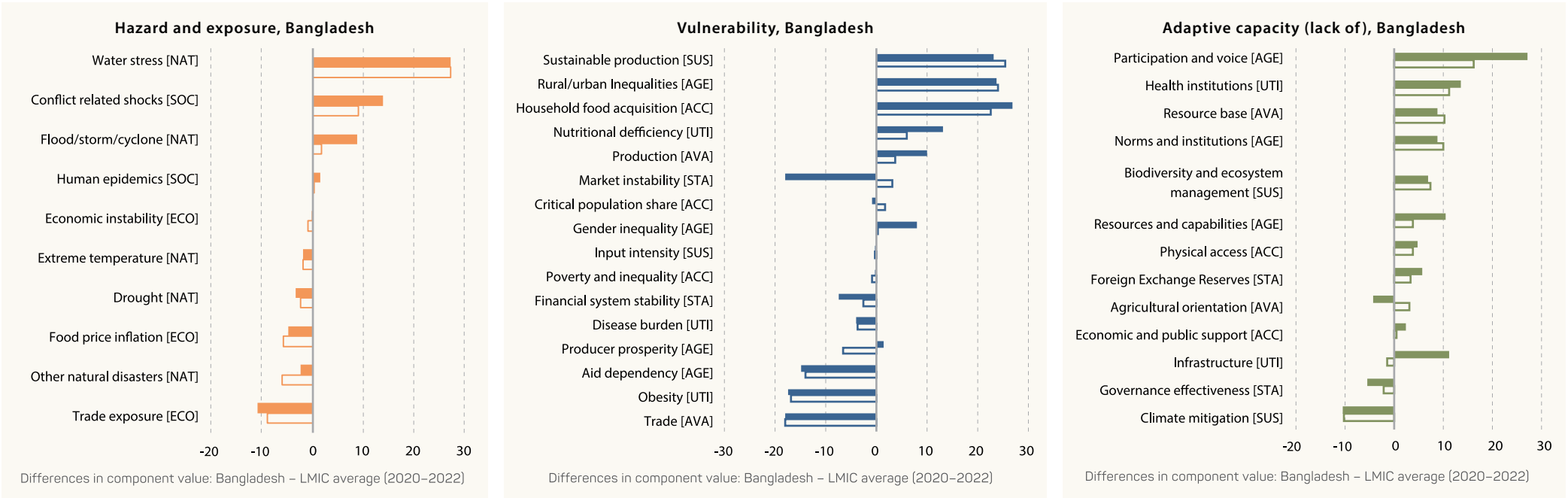


Figure A1.4: Risk components and change, Bangladesh



Fiji

Fiji, an archipelago of 300 islands with more than 900,000 inhabitants, is recognized for its thriving tourism industry in addition to its key agrifood economy, which includes production and export of processed brown sugar, kava, root crops, fish, ginger and coconut products. The agricultural sector accounts for 14.5 percent of GDP and employs 29 percent of the country's population (World Bank, 2022). Fiji has been subject to numerous multifaceted shocks in food systems, including from the war in Ukraine, COVID-19 and severe seasonal cyclones. As of 2019, 24.1 percent of the population lived below the national poverty line. With undernourishment prevalence reported at 5.7 percent in 2021, vulnerable groups in Fiji range from smallholder farmers, women and girls, and low-income households to rural, low-lying coastal and remote outer-island communities. Despite having relatively favourable local production conditions with around 28 percent arable land and more freshwater resources compared to other small island developing states, the country largely depends on food imports, especially in urban centres that have seen a rise in cheap, processed foods. In turn, Fiji is experiencing an increase in diabetes and obesity rates, particularly among Indigenous populations.

Risk profile highlights

Overall food systems risk has increased slightly in the past five years, while vulnerability has been rising since 2000. Despite improvements in adaptive capacity in that time, a change in direction has been noted in recent years (Figure A1.5). Risks to stability and availability have increased since 2000, with risks to stability declining again in recent years (Figure A1.6). Risks to food system outcomes of human health and nutrition, to shared prosperity and to ecosystem health have not changed significantly in the last 20 years (Figure A1.7). The most important threats are increased exposure to storms and cyclones, and trade disruption due to high food import dependency (Figure A1.8). Key vulnerabilities present in the food system include a lack of financial system stability, a highly concentrated trade network, heightened nutritional deficiency and a high disease burden, including increasing non-communicable diseases and lower national producer prosperity compared to five years ago (Figure A1.8). In addition to addressing these vulnerabilities, resilience must be built through increased adaptive capacity. The INFER model indicates that Fiji has made considerable progress in terms of government effectiveness and regulatory quality, physical access in terms of logistical connectivity in food systems and reduced food system emissions. However, rigorous adaptive capacity improvements in agricultural orientation, food infrastructure development (including enhanced access to water, sanitation and energy), health institution-building and human capital development are all required to strengthen food system resilience.

Figure A1.5. Food system risk trends, Fiji

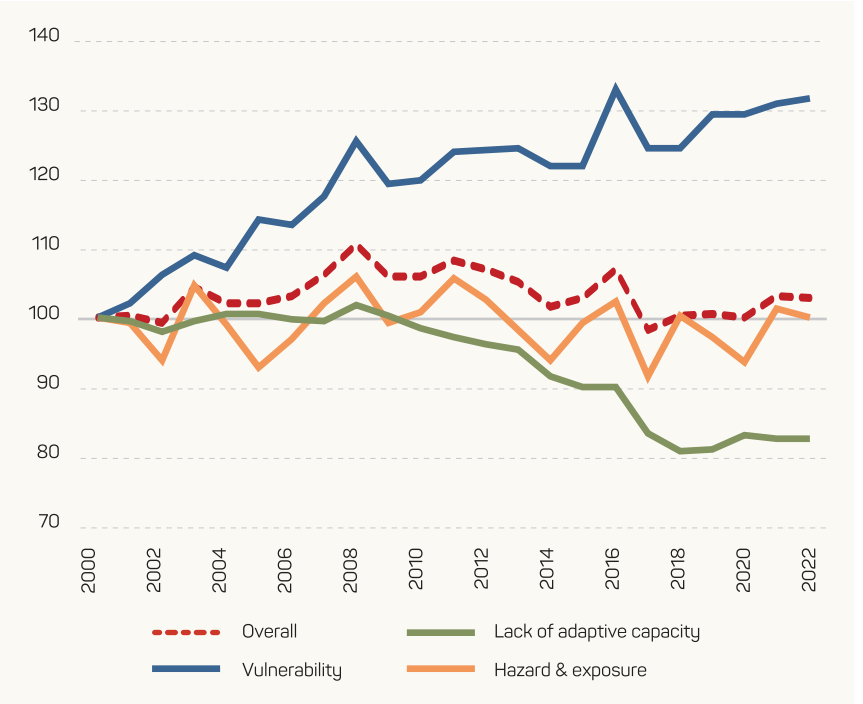


Figure A1.6. Risk to food security dimensions, Fiji

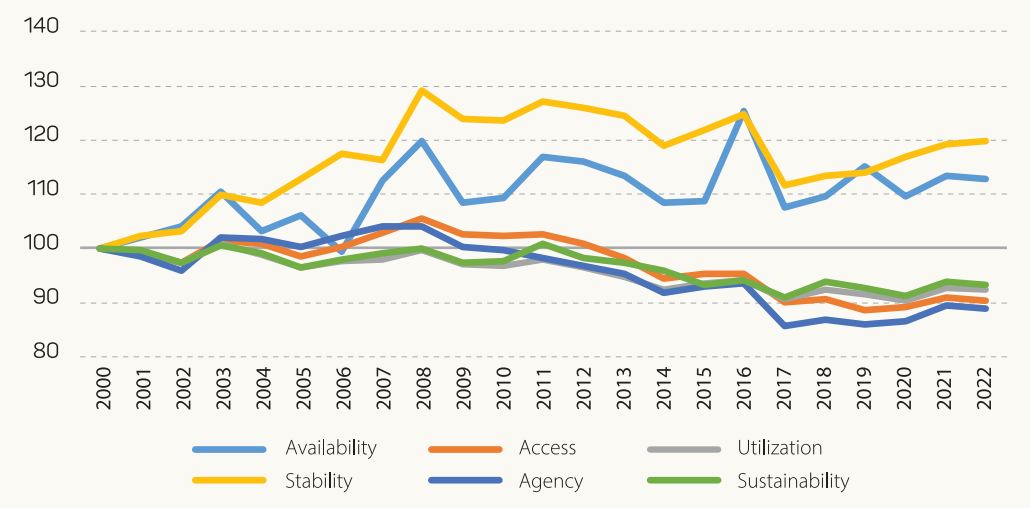


Figure A1.7. Risk to food system outcomes, Fiji

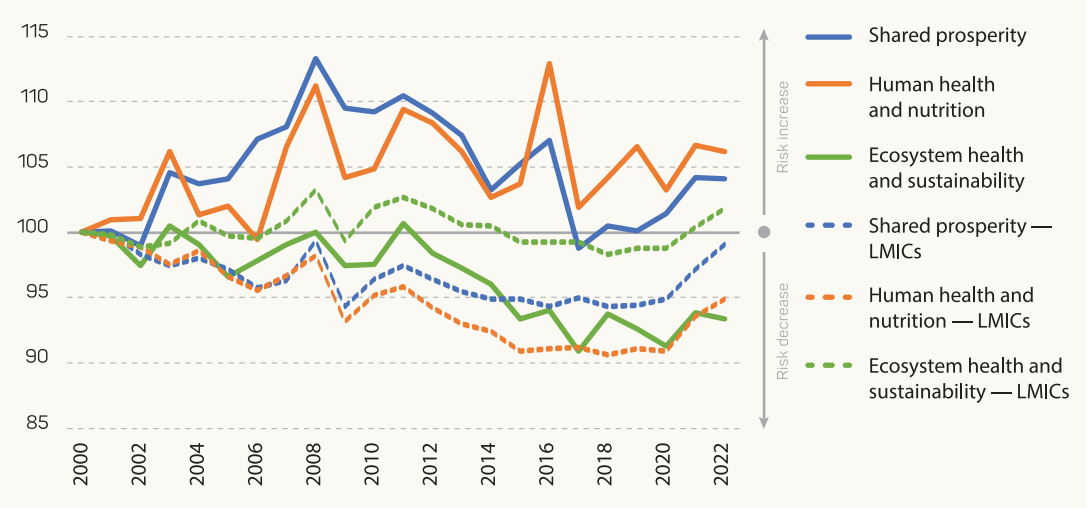
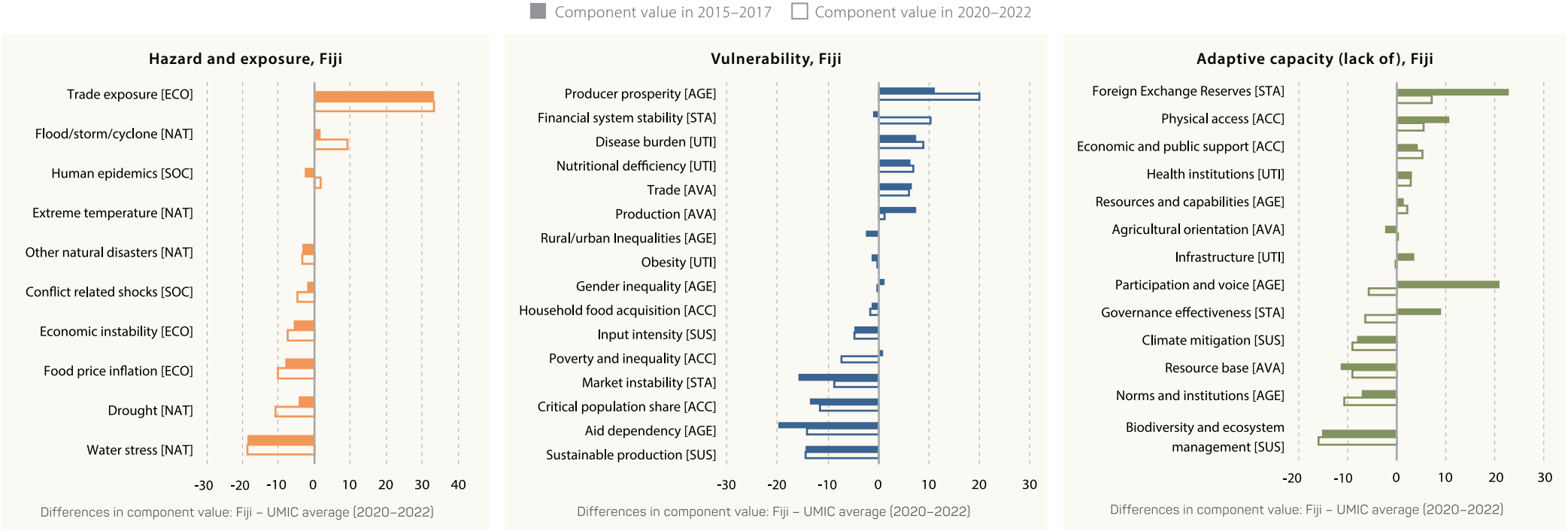


Figure A1.8. Risk components and change, Fiji



Kazakhstan

Kazakhstan is characterized by its significant role in global wheat and other grain production, its rich oil and natural gas reserves and its expansive land mass. Around 45 percent of its 19.4 million inhabitants live in rural areas and over one-third depend on agriculture for their livelihoods (World Bank, 2022). Seventy-five percent of all agricultural land is used for grazing, particularly of sheep. In 2021, agriculture contributed to around 5 percent of GDP, and in this oil-rich nation, as of 2021, 5.2 percent of the population live below the national poverty line. Kazakhstan is import dependent on food products and, despite having expansive land mass, the country suffers from drought, water stress and increasing climate impacts. Undernourishment prevalence was reported at less than 2.5 percent in 2021. Vulnerable groups in Kazakhstan range from smallholder farmers, women and girls, and low-income households to rural communities and those in water-scarce localities. The country's reliance on Russian economic infrastructure makes it vulnerable to supply chain disruptions. Compounded by the war in Ukraine and COVID-19, high domestic inflation poses great threats to food security and social stability, particularly for the most vulnerable populations.

Risk profile highlights

Overall risk has increased in the past five years, reflected in the increasing influence of hazards and exposure, vulnerability and lack of adaptive capacity. Vulnerability has been increasing over the last ten years. Recent changes in risk trends pre-date the COVID-19 epidemic (Figure A1.9). Risks in all food security dimensions have been rising recently, with particularly significant increases in risks related to stability and availability, driven by international and domestic markets and macroeconomic conditions, as well as drought and water stress (Figure A1.10). Risks to all three food system outcomes are increasing, with risks regarding human health and nutrition increasing most rapidly (Figure A1.11). The country's risk profile points to the need for more sustainable production methods and stronger measures for enhanced market stability (Figure A1.12). While various aspects of food system vulnerability are less influential risk drivers than the average for this income group (Figure A1.12), it is important to address increasing vulnerability in resilience-building efforts. Investments in adaptive capacity are also required. While Kazakhstan has made strides in government effectiveness compared to five years ago, a wide range of adaptive capacity improvements in sustainable ecosystem management, climate mitigation and institution strengthening, as well as more focus on the macroeconomic system's impact on food systems, might be targeted to strengthen food system resilience (Figure A1.12).

Figure A1.9. Food system risk trends, Kazakhstan

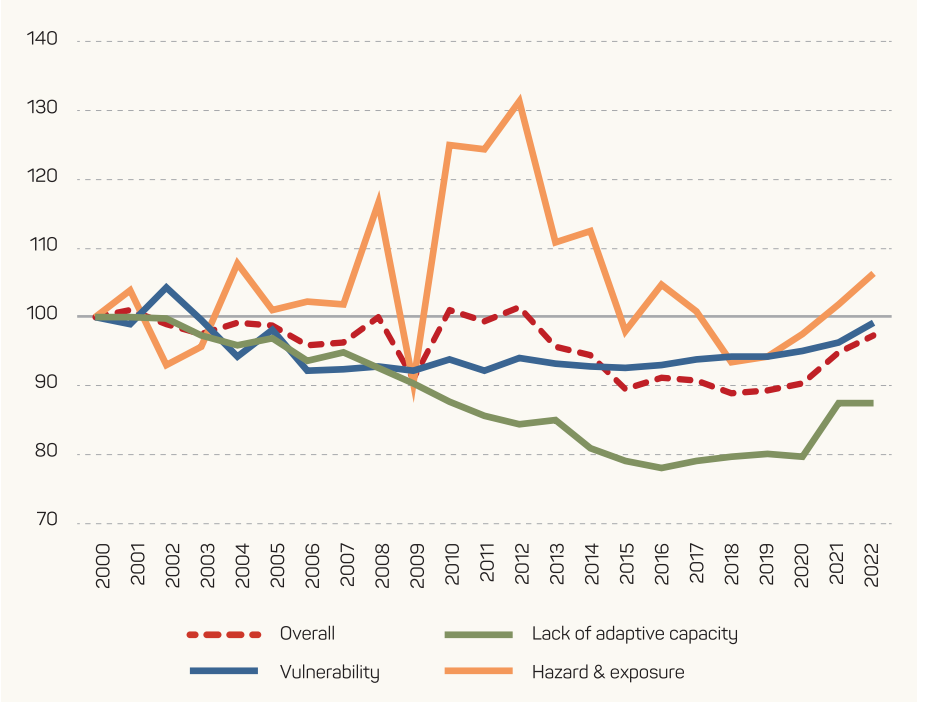


Figure A1.10. Risk to food security dimensions, Kazakhstan

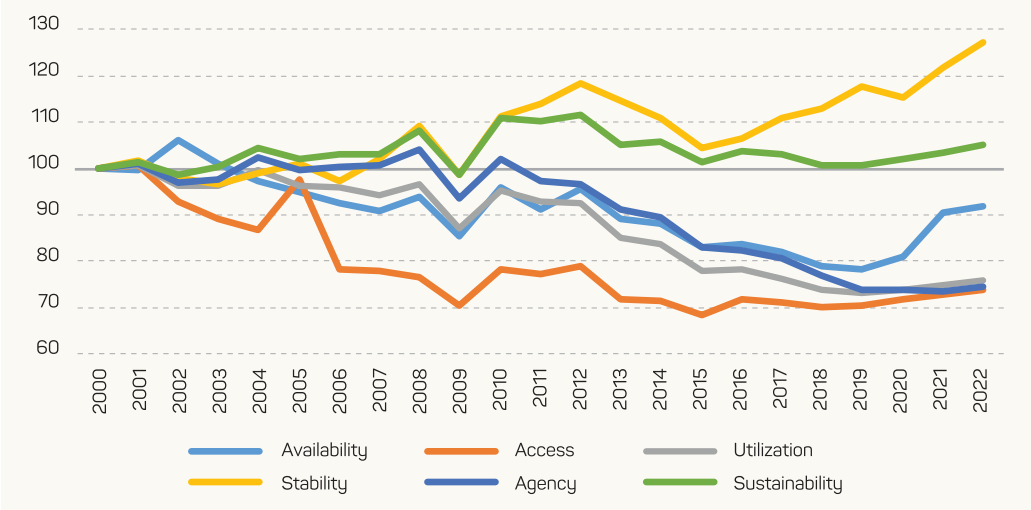


Figure A1.11. Risk to food system outcomes, Kazakhstan

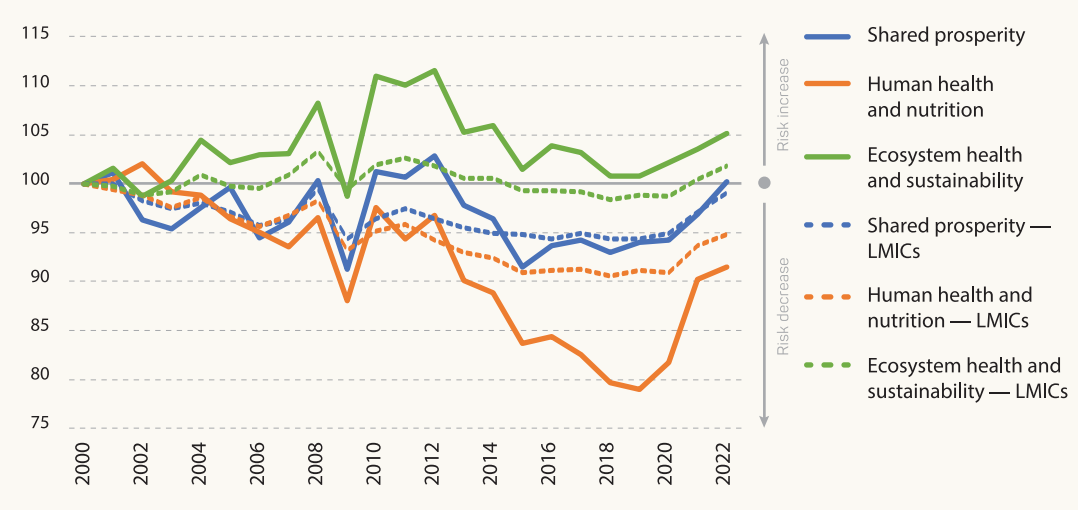
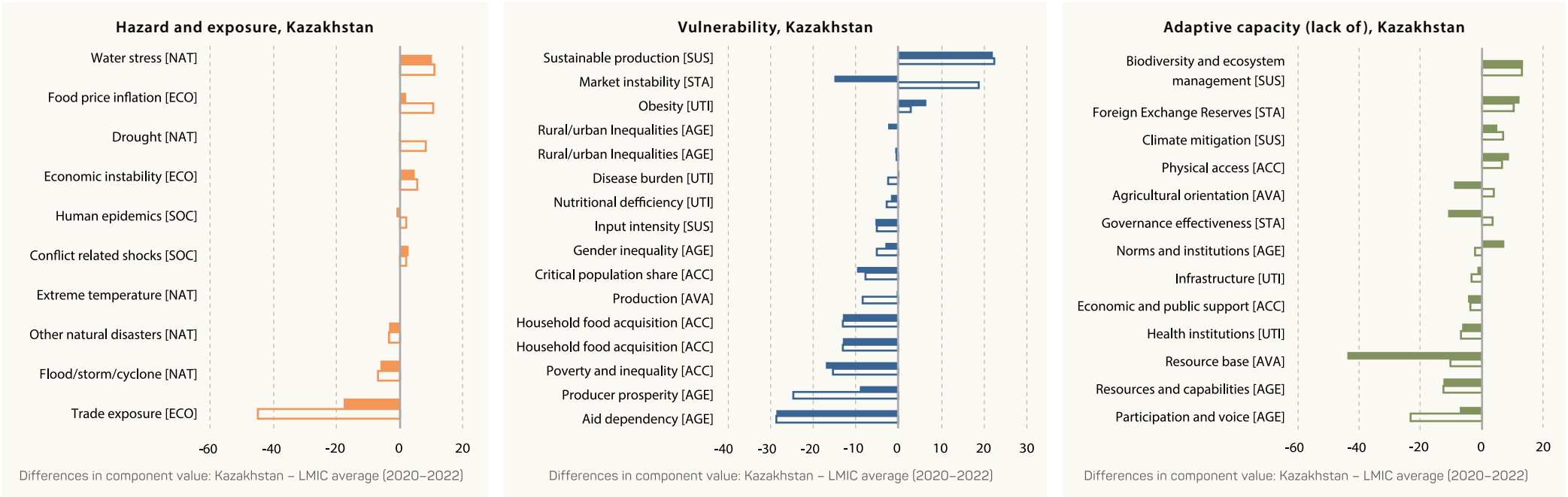


Figure A1.12. Risk components and change, Kazakhstan



Lao People's Democratic Republic

Lao PDR, the only landlocked country in South-East Asia, is recognized for its substantial agriculture-dependent population, rich mineral resources and expansive forest cover. Sixty percent of its 7.6 million inhabitants live in rural areas and 80 percent of households rely on subsistence farming, particularly small-scale rice farming (World Bank, 2022). As of 2018, 18.3 percent of the population lived below the national poverty line. Investments in the rural sector are hampered by unexploded ordinance. Undernourishment prevalence was reported at 5.1 percent in 2021. WFP estimated that 13.9 percent of the population, or 1.04 million people, were moderately or acutely food insecure as of March 2023, describing the country as being in a "slow-burning" food security crisis due to the compounding factors of COVID-19, the triple crises of high food, fuel and feed prices, climate shocks (including floods and dry weather conditions) and the expected lean season of May–October 2023. Stunting, wasting and micronutrient deficiencies are significant among children under 5 and women of reproductive age – particularly those from rural and remote households in northern and southern provinces – as well as among ethnic minorities and in households headed by a member with no education. High prevalence of unsafe food also presents a challenge in the country. Other vulnerable groups include smallholder farmers, women and girls, low-income households, rural communities and those in drought-prone localities.

Risk profile highlights

Overall risk has increased within the past five years after preceding years of decline. Declines in adaptive capacity have been exacerbated by increases in vulnerability (Figure A1.13). Increased risk to the stability dimension of food security is a major food system risk driver. On the other hand, there have been very significant reductions in risk related to utilization and only limited and slowing improvements in the other food security dimensions (Figure A1.14). Threats related to human epidemics, drought and water stress, and economic instability linked to inflation and currency depreciation intensify the vulnerabilities present in the country's food systems, including financial system instability, shortcomings in household food acquisition and lack of adequate nutritional intake, gender inequality, poverty and production challenges, which are all higher than the average for LMICs (Figure A1.15). Starting from a high level of food insecurity, the ability of food systems to cope with new and multiplying stressors is in serious question. Most aspects of adaptive capacity are lower than the average for this income group. However, there has been notable progress in terms of digital connectivity, infrastructure, government effectiveness and human capability development (Figure A1.16). Establishing effective arrangements for navigating periods of financial and market instability is among the measures required to strengthen the resilience of food systems in Lao PDR.

Figure A1.13. Food system risk trends, Lao PDR

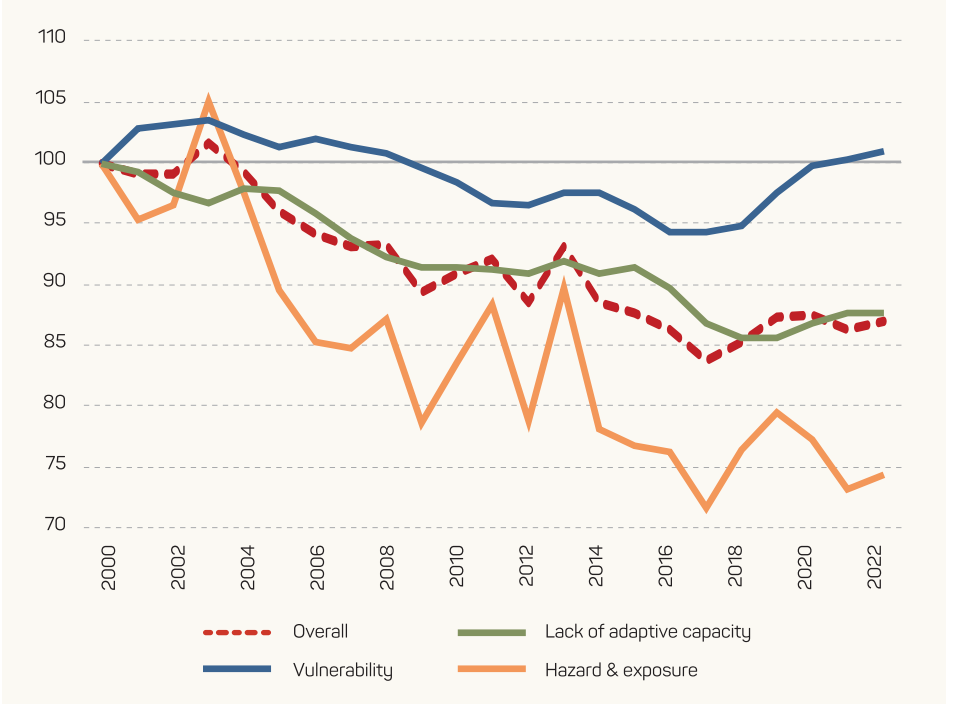


Figure A1.14. Risk to food security dimensions, Lao PDR

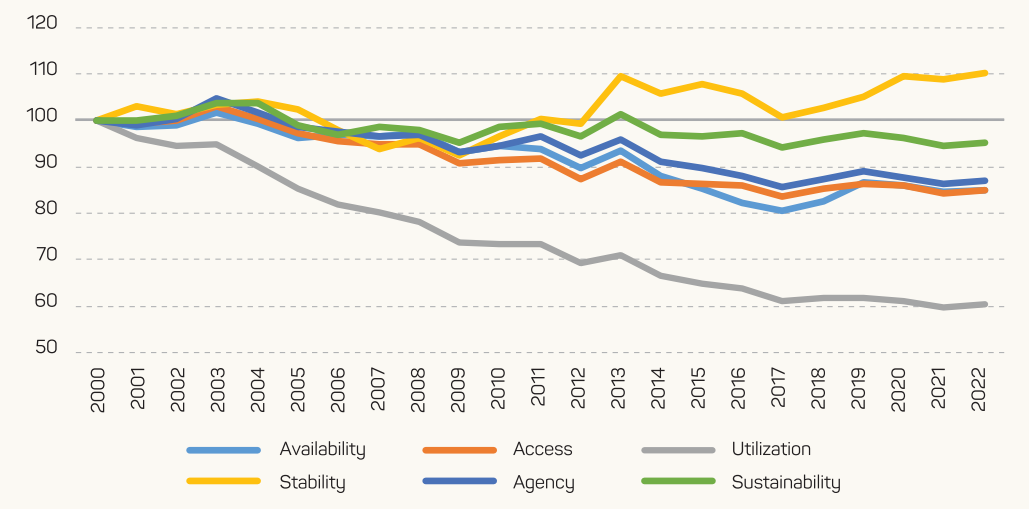


Figure A1.15. Risk to food system outcomes, Lao PDR

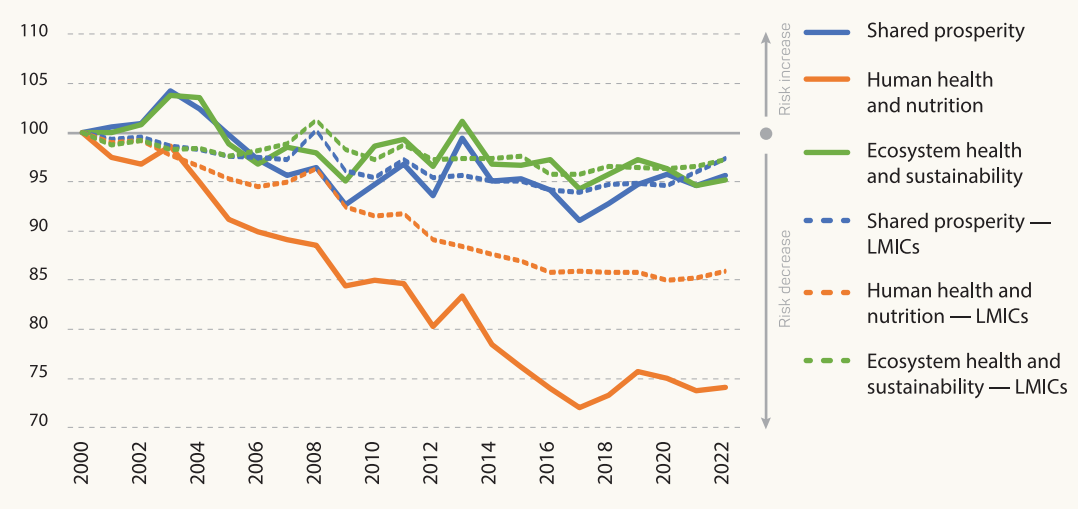
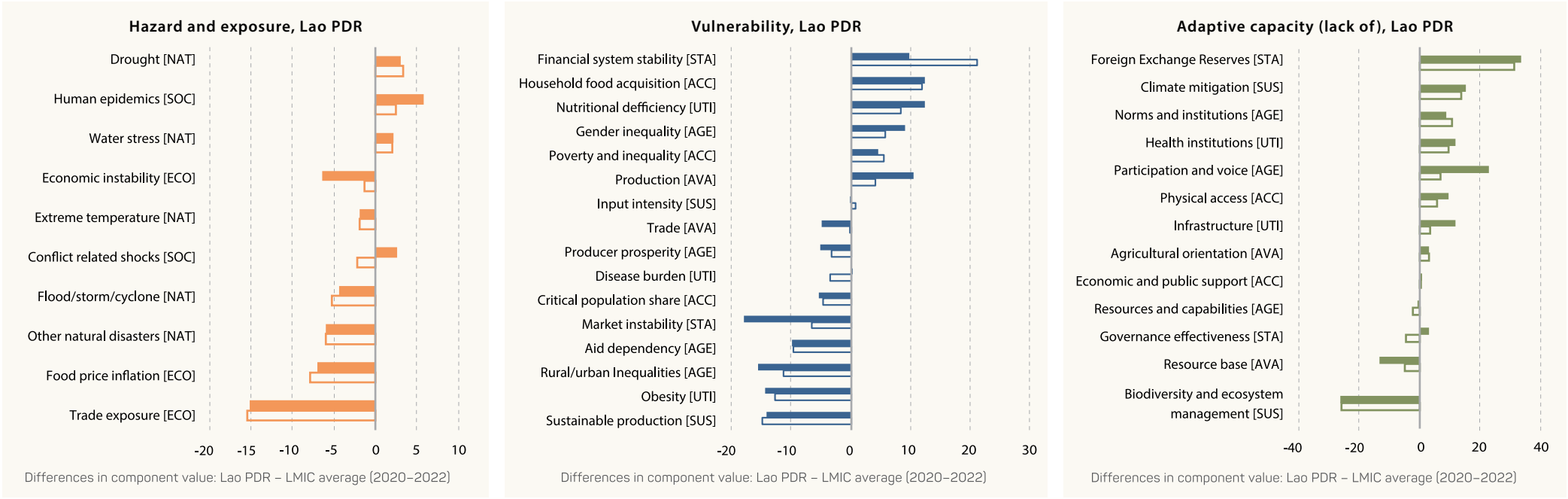


Figure A1.16. Risk components and change, Lao PDR



Pakistan

Pakistan is recognized for its vital role as a global producer of wheat, cotton, sugar, rice and fruit products. Thirty-eight percent of the population rely on agriculture for their livelihoods, and the agricultural sector accounts for 22 percent of the country's GDP. Livestock contributes to over 50 percent of agricultural value addition, while cotton production supports the country's textile industry (World Bank, 2022). However, despite this large-scale export-oriented production, Pakistan has been subject to numerous multifaceted shocks in food systems, ranging from the war in Ukraine and COVID-19 to floods, political upheaval, domestic conflicts and multiple bouts of macroeconomic and market instabilities. As of 2018, 21.9 percent of the population lived below the national poverty line. Pakistan has become a food surplus country over the years, but undernourishment prevalence is reported at an extreme 16.9 percent in 2021. WFP estimated that 36.9 percent of the population faced food insecurity as of 2018, mainly due to poor economic access to healthy, diverse and affordable food, particularly among the most vulnerable populations, including women and children, smallholder farmers, low-income households, low-lying flood-prone localities, rural communities, Afghan refugees and internally displaced persons. The same survey showed that around 40 percent of children under 5 are stunted and 29 percent underweight. Wheat is the country's main staple, contributing some 50 percent of the daily caloric intake, and relies heavily on imports from the Russian Federation. The average Pakistani household spend just over 50 percent of their monthly income on food, making them particularly vulnerable to price shocks. The unprecedented floods between June and October 2022 devasted food production, markets and livelihoods and had displaced around a million people as of January 2023. In addition, losses in agricultural inputs, including seed stocks, fertilizers, machinery and irrigation infrastructure, are impacting production systems.

Risk profile highlights

Overall risk has rapidly increased in the past five years. Sharp increases in hazard and exposure and vulnerability are observed (Figure A1.17), as well as risk across all food security dimensions (Figure A1.18). Pakistan is highly exposed to natural hazards, including severe water stress and extreme temperatures, compounded by food price inflation, currency depreciation, socio-political conflicts and human epidemics – and most recently, the flooding events of 2022 and 2023. As a consequence, risks to food systems outcomes of shared prosperity, ecosystem health and sustainability, and human health and nutrition have increased rapidly since 2021 (Figure A1.19). These disruptions aggravate vulnerabilities present in the country's food system, in particular, nutritional deficiencies, gender inequalities, finance and market instability, high disease burden, rural/urban divides in terms of access to infrastructure, and unsustainable production practices (Figure A1.20). Resilience-building requires these vulnerabilities to be reduced, and also investment in increased adaptive capacity. Here, progress on different aspects of adaptive capacity compared with five years ago has been limited, and shortcomings on most aspects of adaptive capacity are more influential as sources of risk than for the average LMIC (Figure A1.20).

Figure A1.17. Food system risk trends, Pakistan

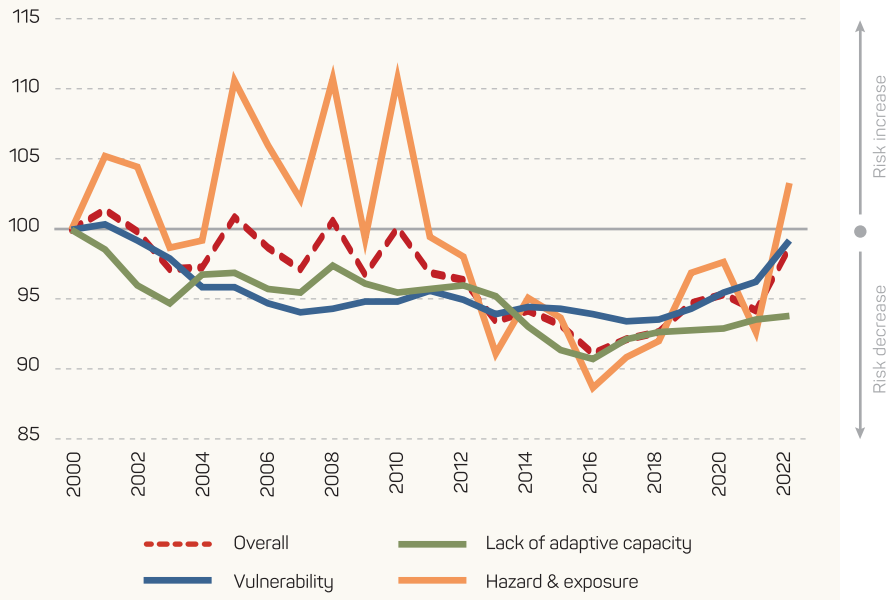


Figure A1.18. Risk to food security dimensions, Pakistan

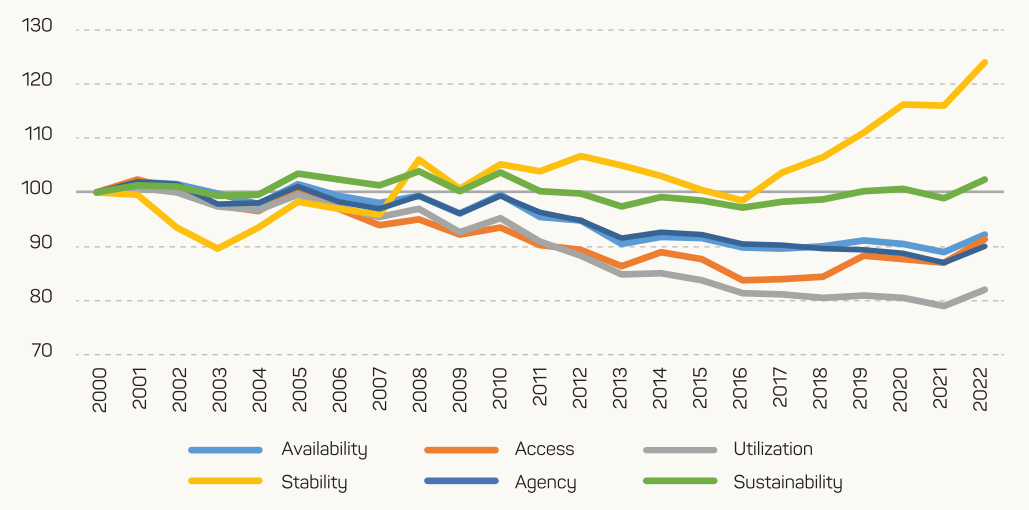


Figure A1.19. Risk to food system outcomes, Pakistan

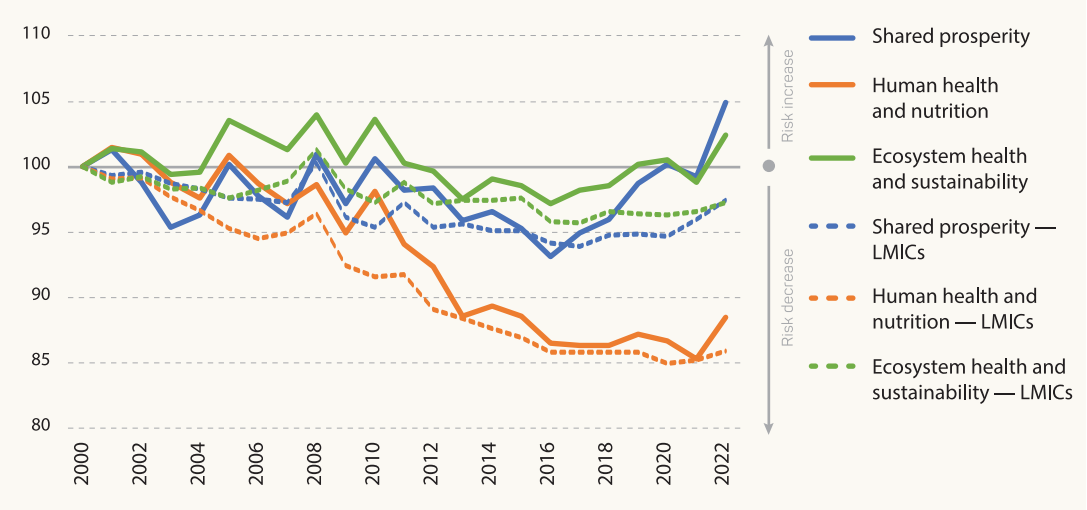
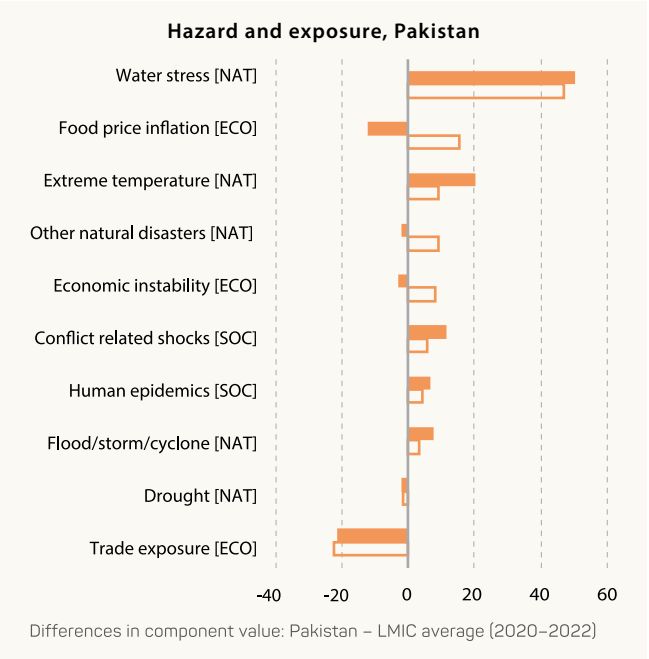
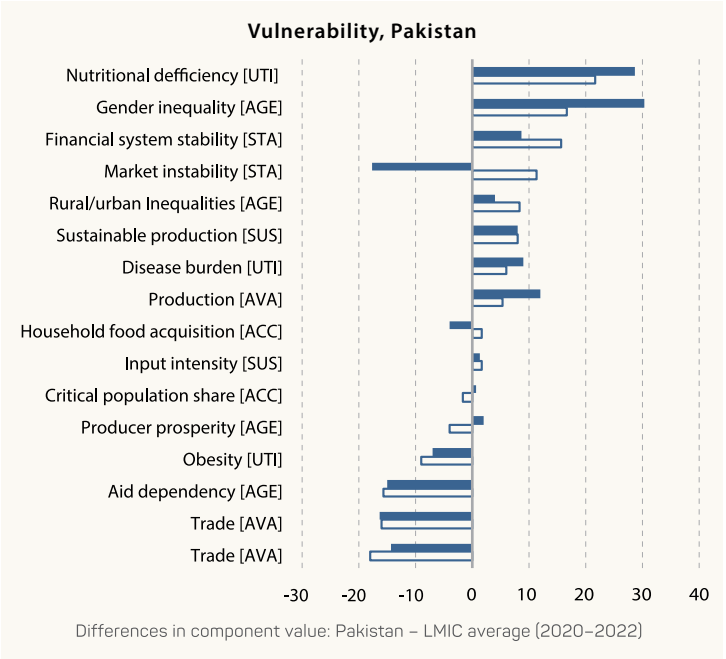
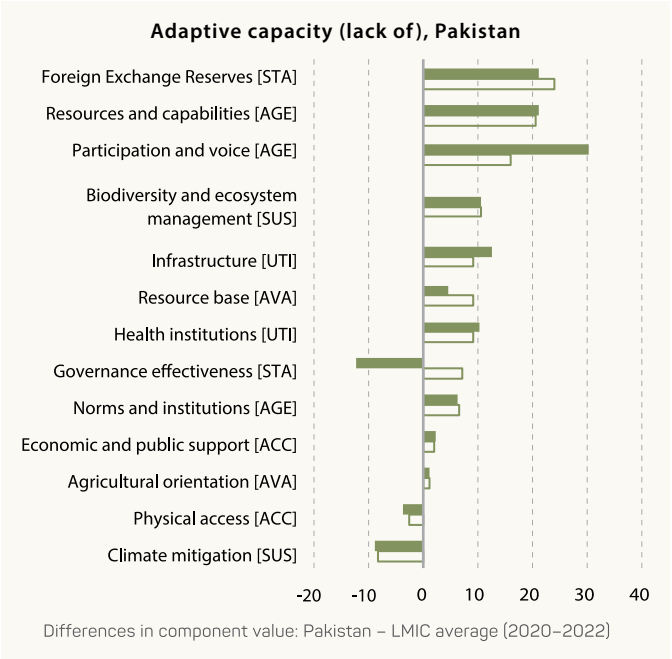


Figure A1.20. Risk components and change, Pakistan

Component value in 2015–2017 Component value in 2020–2022







Sri Lanka

Sri Lanka is recognized for its leading role as a global producer of tea, while other key pillars of its economy include rice, rubber, coconut products, spices, textiles and tourism. One quarter of the country's 21.4 million inhabitants are engaged in the agricultural sector. Agriculture contributes to only 8.7 percent of the country's GDP, with the fisheries sector contributing around 1.3 percent (World Bank, 2022). Imported food accounts for 22 percent of the country's food consumption. As of 2019, 14.3 percent of the population lived below the national poverty line, but undernourishment prevalence is reported at 3.4 percent for 2021, a dramatic decrease from 2000. Vulnerable groups in Sri Lanka range from smallholder farmers, women and girls, and low-income households to rural communities and those in coastal and low-lying flood-prone localities, who are disproportionately affected by shocks. In May 2022, Sri Lanka defaulted on debt for the first time, marking the country's worst economic crisis since it gained independence in 1948. A shortage of foreign exchange reserves, depreciation of local currency and subsequent shortage of foreign currency, compounded by reduced domestic agricultural production and disruptions in production – including shortages of fuel and an agrochemical import ban – resulted in soaring food prices, a cost-of-living crisis and severe food insecurity. WFP estimated that 6.2 million people (nearly 30 percent of the population) were moderately food insecure as of May–June 2022, especially among female-headed households (40 percent). Weather extremes, such as droughts and floods, and lack of fuel for pumping and irrigation add to the food system riskscape in the country.

Risk profile highlights

Overall risk has rapidly increased in the past five years. Limited and slow improvements in adaptive capacity are coupled with sharp increases in hazard and exposure and sustained increases in vulnerability over time (Figure A1.21). INFER points to negative risk trends in all food security dimensions – in particular stability (Figure A1.22). Key aspects of hazard and exposure include flooding and storms, water stress and socio-political conflict, while market and financial instability and a significant share of critical populations are more important risk drivers than for the average LMIC. The convergence of these negative risk trends is shown in the recent upturn in risks to shared prosperity, human health and nutrition, and ecosystem health and sustainability (Figure A1.23). The sustained increase in vulnerabilities present in the country's food systems are of note. Here, financial system instability, market instability and the share of critical populations are more influential sources of vulnerability than for the average LMIC, while foreign exchange reserve limitations constrain the ability of the country to adapt in a crisis situation (Figure A1.24).

Figure A1.21. Food system risk trends, Sri Lanka

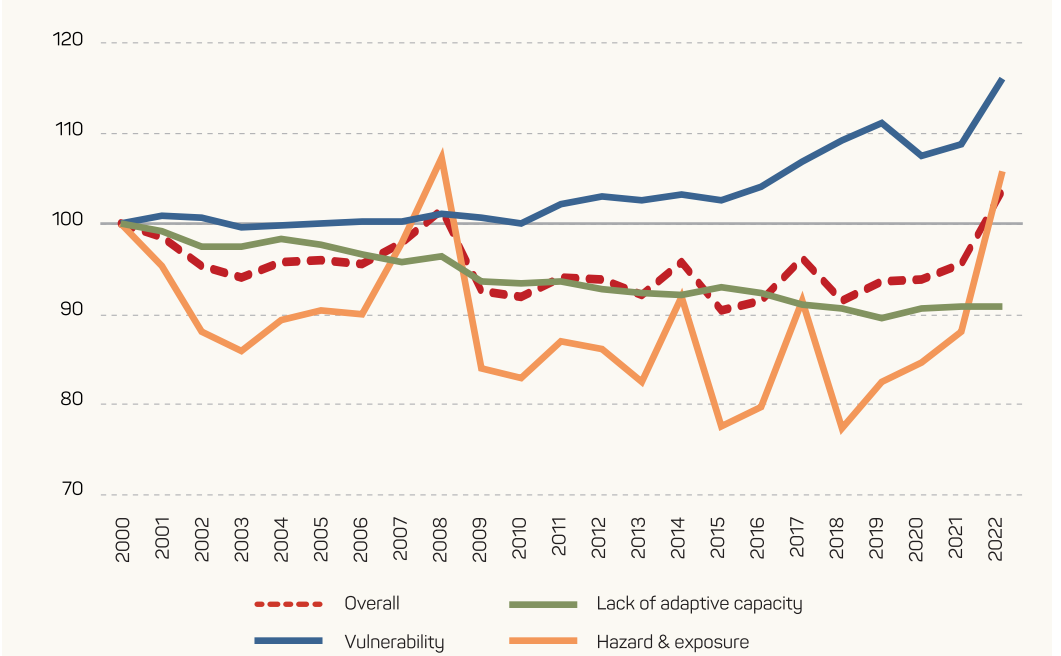


Figure A1.22. Risk to food security dimensions, Sri Lanka

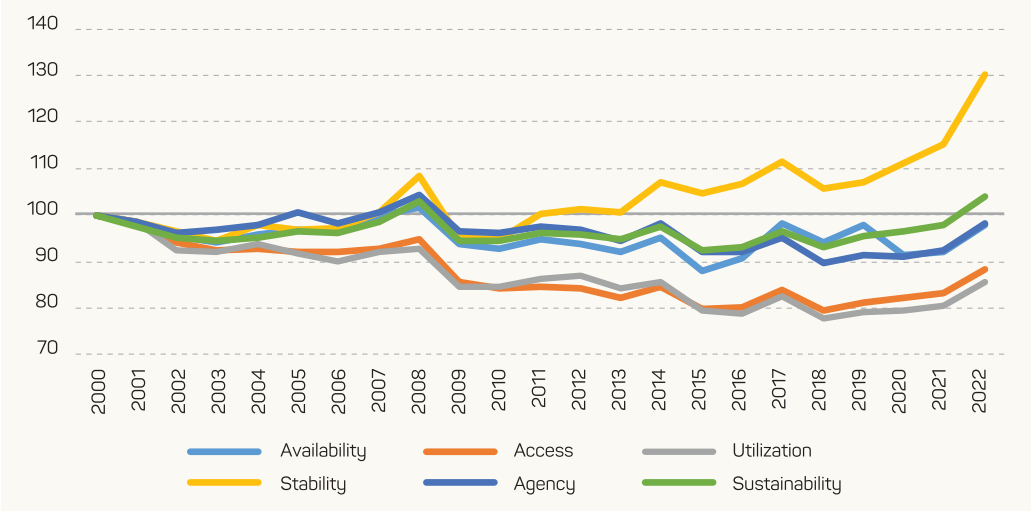


Figure A1.23. Risk to food system outcomes, Sri Lanka

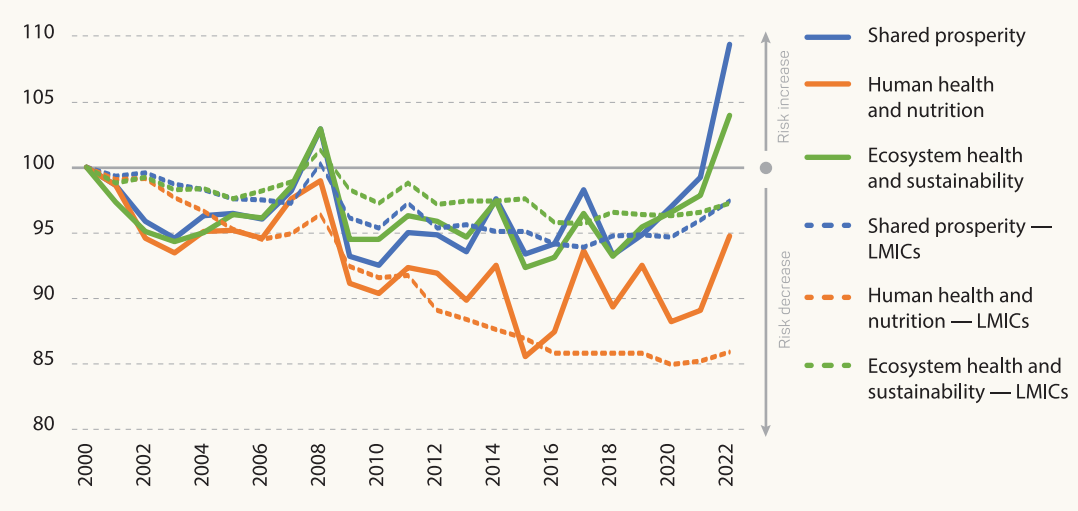
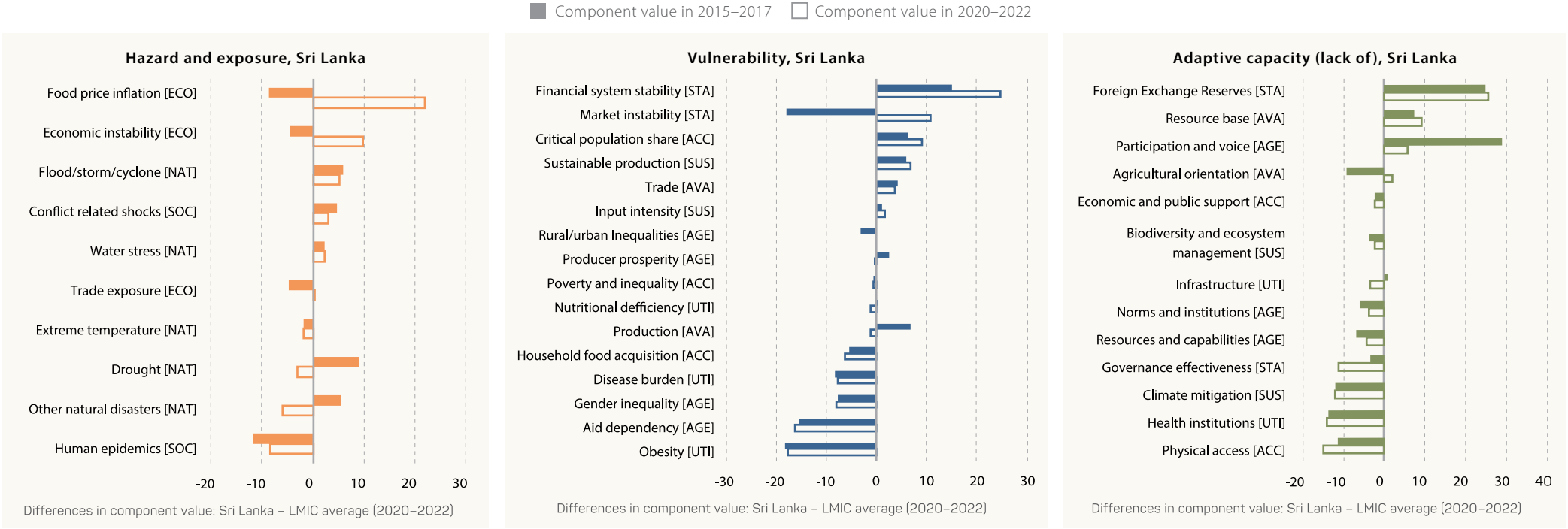


Figure A1.24. Risk components and change, Sri Lanka



Uzbekistan

Uzbekistan is recognized for its role as a critical player in global cotton production, its rich mineral resources and its place as the most populous country in Central Asia. Half of its 34.8 million inhabitants live in rural areas, while 17 percent lived below the national poverty line as of 2021, and over 25 percent depend on agriculture for their livelihoods (World Bank, 2022). Agriculture contributes to around 25 percent of GDP, with cotton and grain being the principal crops, as well as fruits, vegetables and oil-seeds. Agriculture consumes 90 percent of the water resources of Uzbekistan. At the same time, water scarcity and soil degradation continue to pose threats to food systems, compounded by limited access to inputs and modern technology in the agricultural sector. Uzbekistan shares strong food and agricultural trade relations with the Russian Federation, importing almost one third of its food from there. Factoring in these attributes, the war in Ukraine, compounded by the socioeconomic turmoil caused by COVID-19, have contributed to a cost-of-living crisis, rising poverty and food insecurity in Uzbekistan. Diet-related non-communicable diseases have increased in Uzbekistan, with around 22 percent of adult women and 16 percent of adult men being obese, and 13 percent of adult women and 12.8 percent of adult men having diabetes. Undernourishment prevalence was reported at less than 2.5 percent in 2021, however. Vulnerable groups in Uzbekistan range from smallholder farmers, women and girls, and low-income households to rural communities and those in drought-impacted and water-scarce localities. Water is a particular concern, given the high dependence on water from outside of the country and the glacial origins of this water being threatened by climate change. The precarious water supply for households and for agriculture and slow progress on agreed transboundary water management protocols are of concern.

Risk profile highlights

Overall risk has increased slightly in the last five years. The INFER model indicates increasing vulnerability as major driver of risk changes in the past ten years, mitigated by improvements in adaptive capacity and hazard and exposure (Figure A1.25). Risks have declined for all food security dimensions, except stability since 2000 (Figure A1.26). Rapid increases in risks to shared prosperity in the country's food system are notable (Figure A1.27). Threats such as water stress and food price inflation, and aspects of vulnerability, such as economic and market instability, poverty and inequality, input-intensive food production (in particular in relation to water) and increasing obesity play more influential roles as risk drivers in Uzbekistan than the average LMIC (Figure A1.28). Resilience-building measures should focus heavily on addressing the rapid increases in vulnerability. Over the past two decades, Uzbekistan has made notable advances in terms of state revenue generation, as well as logistical performance, including for rail connectivity and internet connectivity. Further adaptive capacity improvements, in particular to address water stress, are required to build further resilience.

Figure A1.25. Food system risk trends, Uzbekistan

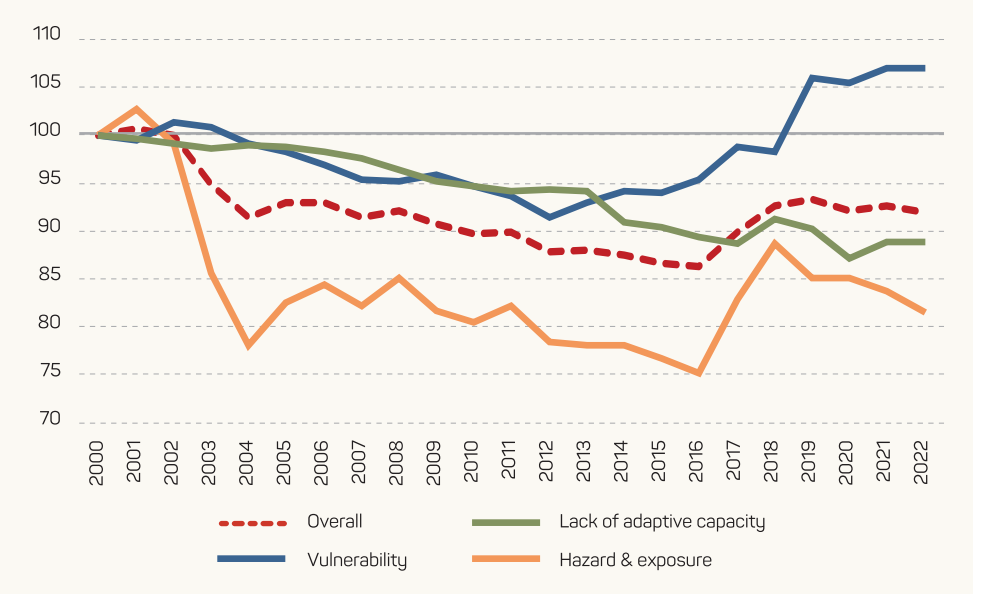


Figure A1.26. Risk to food security dimensions, Uzbekistan

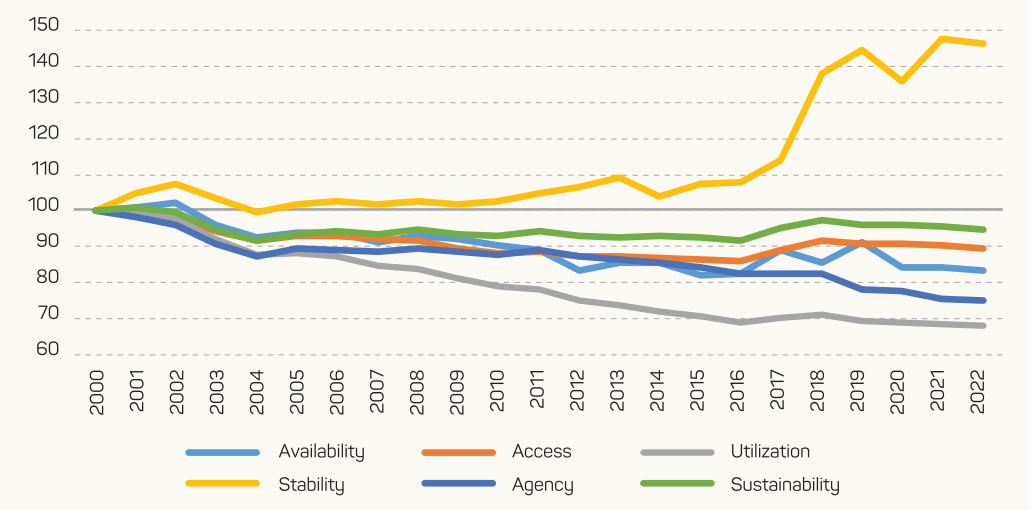


Figure A1.27. Risk to food system outcomes, Uzbekistan

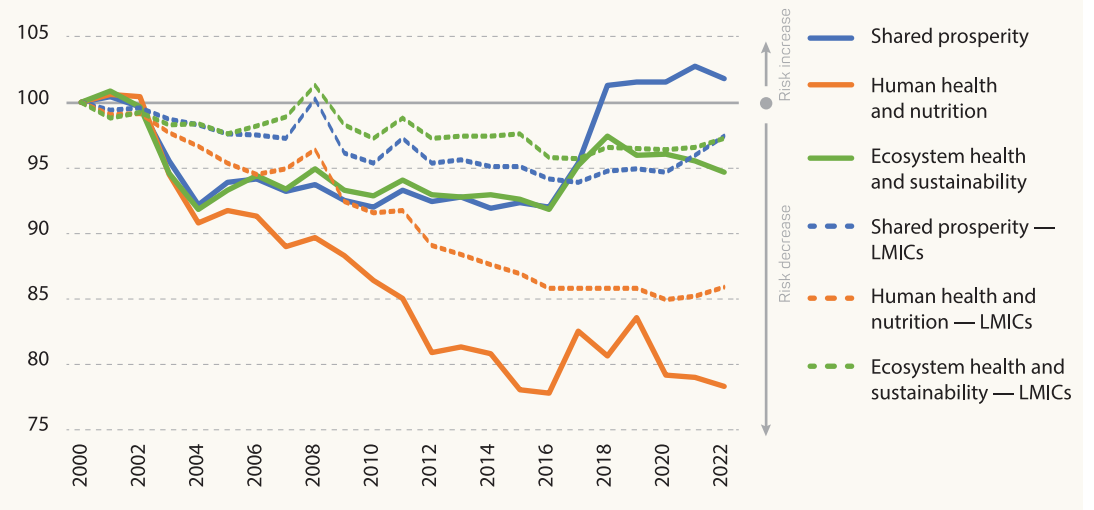
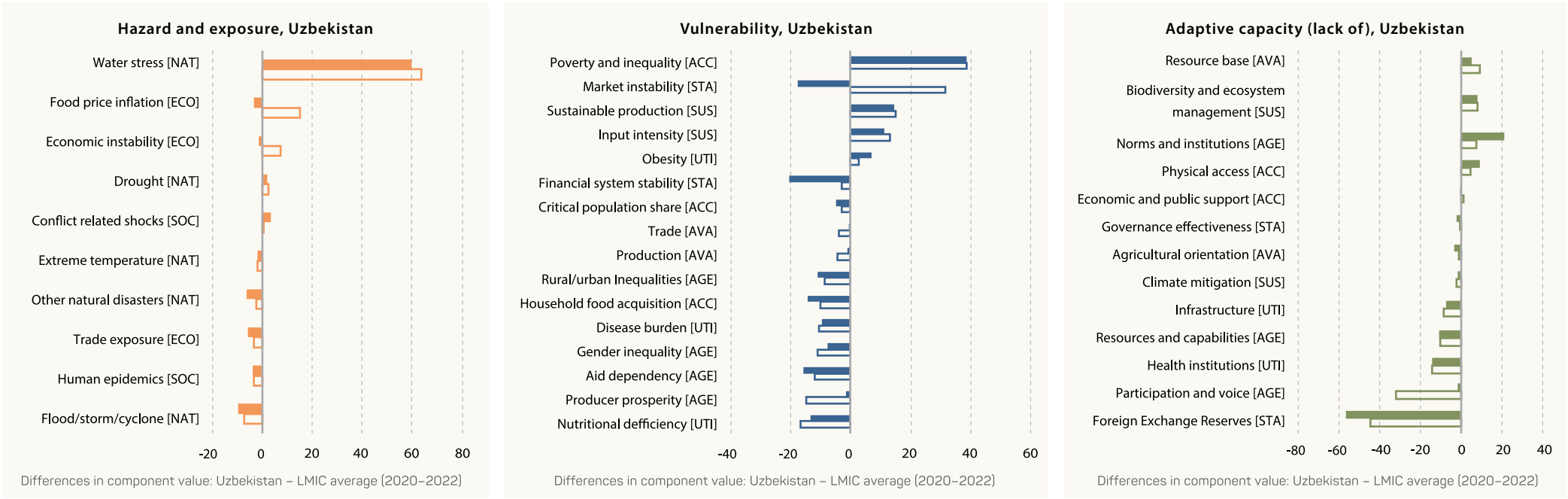


Figure A1.28. Risk components and change, Uzbekistan



Annex 2. Risk characteristics of country groups compared with Asia-Pacific average

Country income groups

Low- and lower-middle-income economies face higher threats in conflict-related shocks, trade exposure, food price inflation, epidemics and water stress, corresponding with these countries' notable risks in food production and increasing risks in agricultural orientation (the agricultural sector's share of government expenditures divided by the sector's share of GDP). Such risks are further compounded by risks in physical and economic access to food in these countries, which contribute to and are demonstrated by high levels of nutrition deficiency. On the other hand, adaptive capacity – including health institutions, food infrastructure (measured by access to improved sanitation, water and energy) and participation and voice – as well as gender equality have improved over the past five years, despite still lagging behind regional averages (Figure A2.1).

Upper-middle-income economies faces a higher threat of drought and **high-income economies** face a higher threat of extreme temperature than regional averages. At the same time, these countries perform relatively poorly in the sustainability dimension, with food systems in high-income economies generating large amounts of greenhouse gas emissions, and food systems in upper-middle-income economies contributing to biodiversity and ecosystem degradation, posing significant risks to food systems. Irresponsible consumption and production patterns in food systems are related to high rates of obesity in both country groups. While obesity decreased in upper-middle-income economies compared to five years ago, it continued to increase in high-income economies (Figures A2.2 and A2.3).

Exposure to hazards seems to be **converging** across income groups, as risk scores for all groups moved closer to the Asia-Pacific average over the last five years. Furthermore, **instability risks increased across all income groups**, with low- and lower-middle-income economies and upper-middle-income economies experiencing higher food and general price inflation and high-income countries experiencing higher financial instability.

Figure A2.1. Risk components and change, low- and lower-middle-income countries

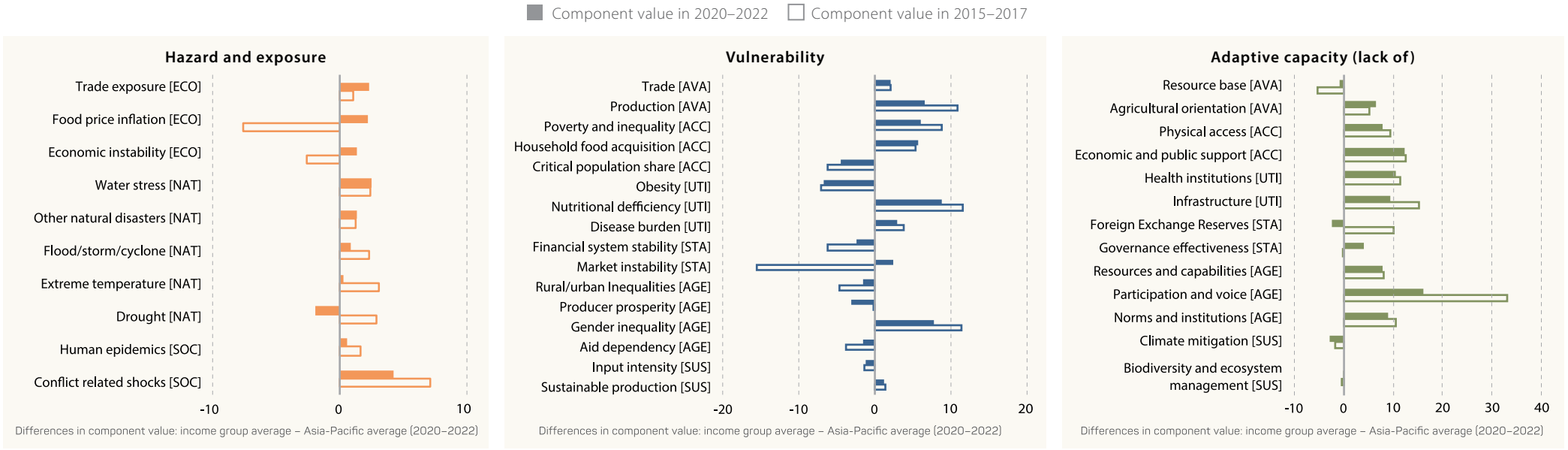


Figure A2.2. Risk components and change, upper-middle-income countries

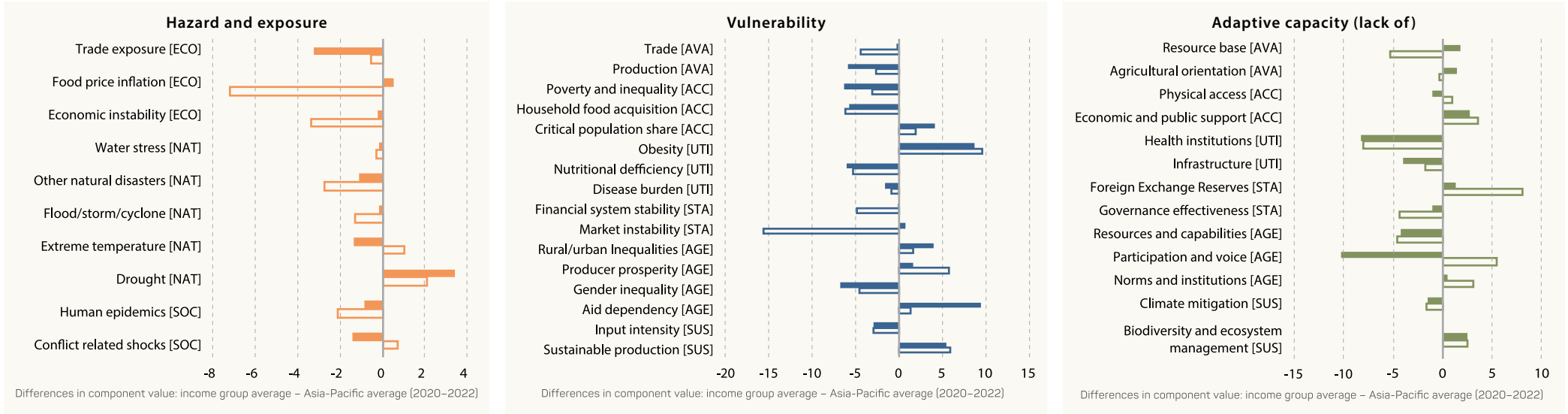
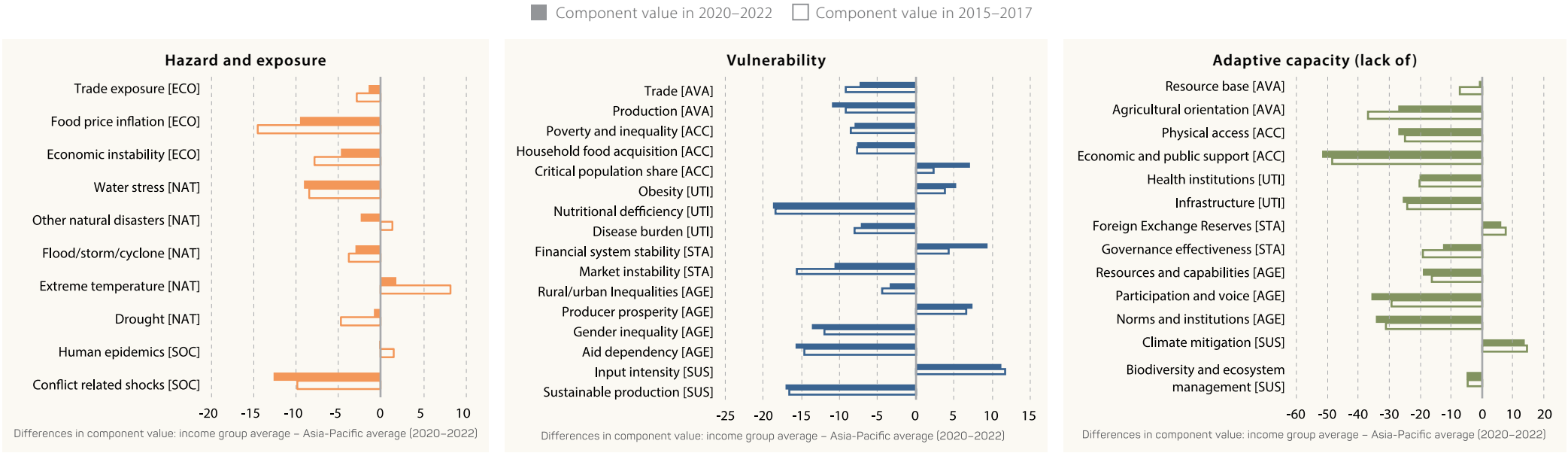


Figure A2.3. Risk components and change, high-income countries



Countries in special situations

Least developed countries (11 countries) face a similar set of risks compared to low- and lower-middle-income countries (26 countries), but with higher risk scores on average. These countries particularly lag behind in adaptive capacity, compounded by higher exposure to conflicts and human epidemics, and prevalence of underlying food insecurity, all posing great food system risks (Figure A2.4).

Landlocked developing countries face notably high and persistent threats of water stress, corresponding to relatively high levels of unsustainable food production, and compounded by risks in concentrated food trade networks, decreasing agricultural orientation, insufficient food infrastructure (including water, sanitation and energy), low logistic performance and weak regulatory quality. These contribute, to a certain degree, to high and increasing risks in food and general price inflation, compounding the impacts of the war in Ukraine. Sustainable production is another high-risk area showing little improvement in the last five years (Figure A2.5).

Small island developing states are characterized by persistent trade dependency (measured by dependency on imports of rice, wheat, soybean and maize) and aid dependency. They have high levels of obesity compounded by malnutrition and a high non-communicable disease burden. In addition, they have low producer prosperity (measured by producer price index, value added deflator, and proportion of women in agriculture and fisheries). An increasing risk of drought also adds to their riskscape, compounded by increasing likelihood of epidemics, urbanization and globalization. Adaptive capacity, however, has improved notably compared to five years ago (Figure A2.6).

Figure A2.4. Risk components and change, least developed countries

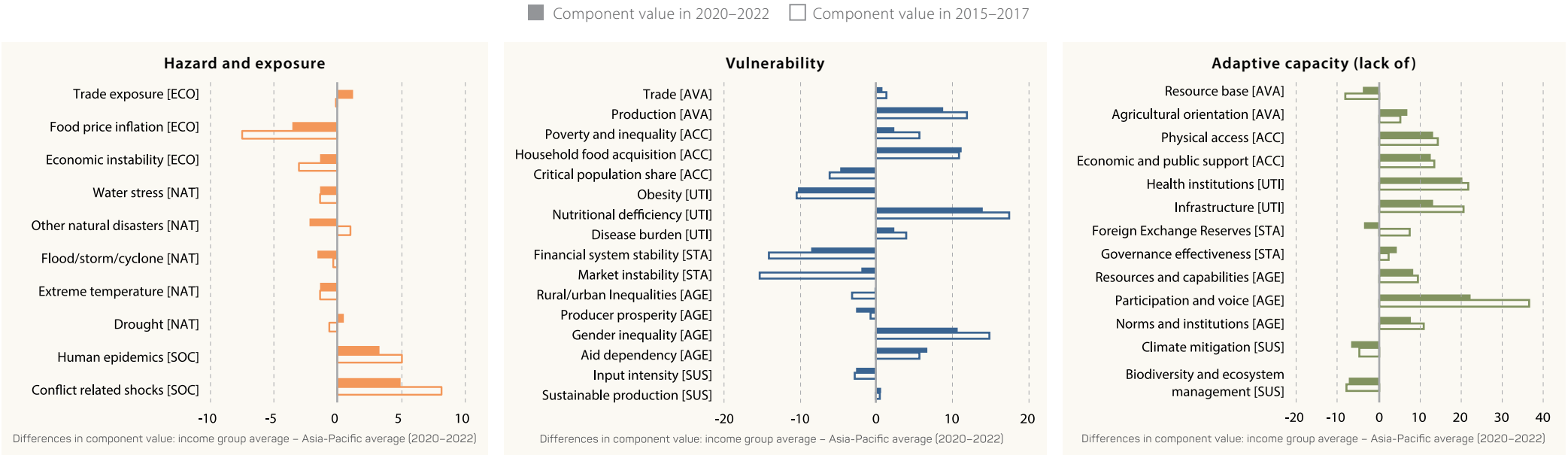


Figure A2.5. Risk components and change, landlocked developing countries

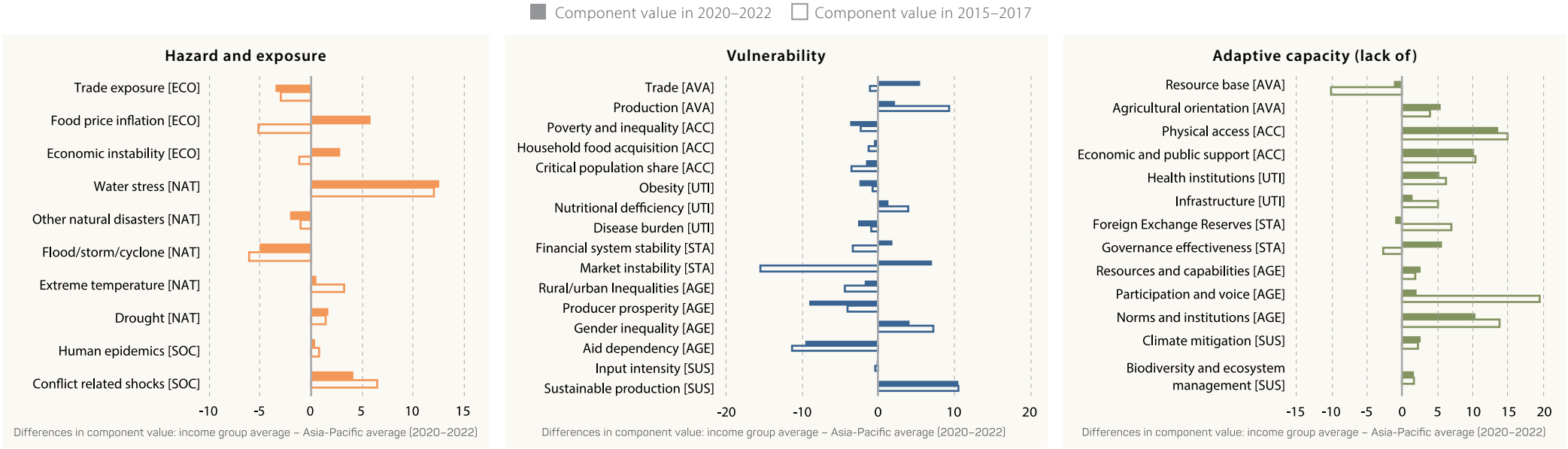
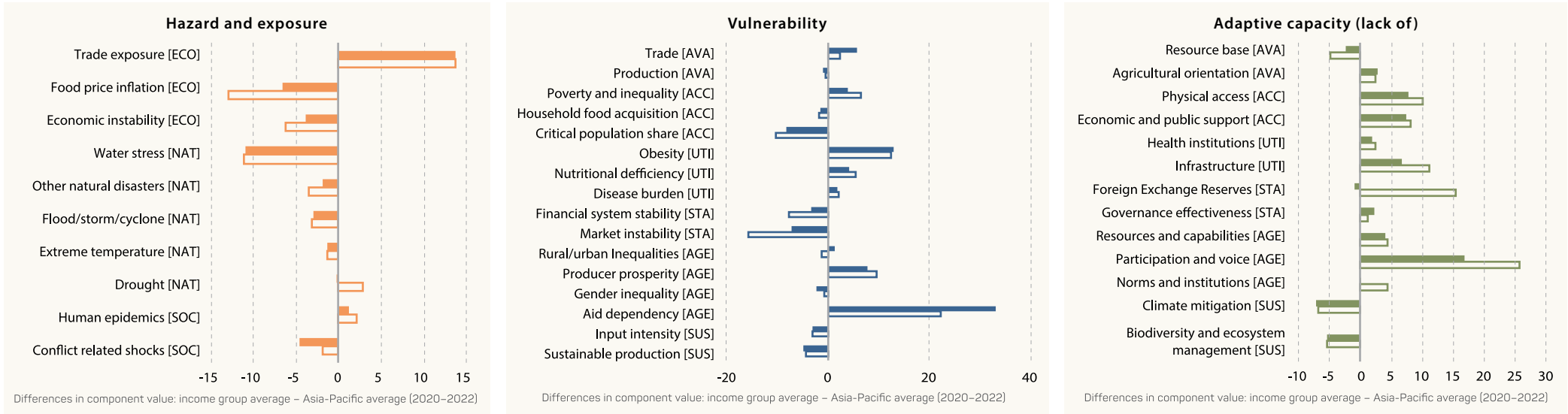


Figure A2.6. Risk components and change, small island developing states



Annex 3. Indicators, sources and coverage

Hazard and exposure								
Category	Component	Indicators	Framing	Source	First year	Latest year	% missing 2000–2020	Countries missing
Natural	Drought	Agricultural Stress Index	-	Adapted from FAO	2000	2022	0	0
		Population affected by drought events (%)	-	Adapted from EMDAT	2000	2022	0	0
	Extreme temperature	Extreme temperature frequency (events annually)	-	Adapted from EMDAT	2000	2022	0	0
		Population affected by extreme temperature events (%)	-	Adapted from EMDAT	2000	2022	0	0
	Flood	Flood frequency (events annually)	-	Adapted from EMDAT	2000	2022	0	0
		Population affected by flood events (%)	-	Adapted from EMDAT	2000	2022	0	0
	Storm	Storm frequency (events annually)	-	Adapted from EMDAT	2000	2022	0	0
		Population affected by storm events (%)	-	Adapted from EMDAT	2000	2022	0	0
	Other natural disasters	Other natural disaster frequency (events annually)	-	Adapted from EMDAT	2000	2022	0	0
		Population affected by other natural disaster events (%)	-	Adapted from EMDAT	2000	2022	0	0
	Water stress	Freshwater withdrawal as a proportion of available freshwater resources (%)	-	FAO	2000	2019	26.68	10
		Dependency ratio for water (%)	-	FAO	2000	2019	4.76	0
Economic	Economic instability	Percentage change in exchange rate value in past year	-	FAO	2000	2021	0	0
		Global inflation (CPI general) (% change)	-	FAO	2001	2022	13.75	5
	Food price inflation	Global food price inflation (Index % change)	-	FAO	2001	2022	13.75	5
	Trade exposure	Cereal import dependency ratio (%) (3-year average)	-	FAO	2002	2010	33.6	8
Socio-political	Conflict-related shocks	Global Peace Index	+	Institute for Economics and Peace	2008	2022	53.28	18
		Fragile States Index	-	Fragile States Index	2006	2022	38.63	7
		Political Stability and Absence of Violence/ Terrorism (Index)	+	World Bank	2000	2021	6.02	0
	Human epidemics	Respiratory infectious diseases — disability-adjusted life years (DALYs)	-	WHO	2000	2019	82.39	4
		Population density (people per sq. km of land area)	-	World Bank	2000	2020	0	0
		Urban population growth (annual %)	-	World Bank	2000	2021	0	0
		Urban population (% of total population)	-	World Bank	2000	2021	0	0
		Population practising open defecation (%)	-	UNSTATS	2000	2022	3.95	0
		Population under 5 years old (% of total population)	-	UN Population	2000	2021	0	0
		Confirmed COVID-19 deaths reported to WHO to date per 100,000 population	-	WHO	2020	2021	95.24	0
	Animal epidemics	*Avian influenza in poultry	-	Supplemental data	-	-	-	-

* Supplemental indicator not used in the current analysis, but may be considered by other applications of INFER.

Vulnerability								
Category	Component	Indicators	Framing	Source	First year	Latest year	% missing 2000–2020	Countries missing
Access	Critical population share	Uprooted people: Number of refugees + IDPs hosted and originating average	-	UNHCR	2000	2021	0	0
		Demographic structure – population share over 60 (% of population)	-	UN Population	2000	2021	0	0
		Share of people affected by natural disaster in the last 10 years (% of population)	-	EMDAT	2000	2022	1.89	1
		*Ageing in agri/forestry	-	Supplemental data	-	-	-	-
	Household food acquisition	Coefficient of variation of habitual caloric consumption distribution (Index)	+	FAO	2000	2021	18.87	10
		Prevalence of undernourishment (%)	-	FAO	2002	2021	24.89	9
		Prevalence of moderate or severe food insecurity in the total population (%)	-	FAO	2015	2020	83.56	16
		Prevalence of severe food insecurity in the total population (%)	-	FAO	2016	2021	86.88	16
		Prevalence of low birthweight (% of population)	-	UNICEF	2000	2015	48.25	17
		*WFP Food Consumption Score	+	Supplemental data	-	-	-	-
	Poverty and inequality	Gini Index	-	World Bank	2000	2021	65.95	7
		Poverty headcount ratio at $2.15 a day (2017 ppp) (% of population)	-	World Bank	2000	2021	65.95	7
Agency	Aid dependency	Net official development assistance (ODA) received per capita (current US$) + Total reported funding (US$) (past 2 years)	-	Adapted from World Bank & UNOCHA	2000	2022	24.35	3
		Net ODA received (% of GNI)	-	World Bank	2000	2022	11.5	2
	Gender inequality	Gender Inequality Index	-	UNDP	2000	2021	21.83	9
		Female lower secondary education completion rate compared to whole population (ratio)	+	Adapted from UNESCO	2000	2021	24.89	9
		Female mean years schooling 25+ compared to whole population (ratio)	+	Adapted from UNESCO	2000	2021	77.81	9
		*Female-headed households	+	Supplemental data	-	-	-	-
		*Prevalence of food insecurity by gender	-	Supplemental data	-	-	-	-
	Producer prosperity	Share of females in total employment in agriculture, forestry, and fisheries	+	FAO	2000	2021	48.88	3
		Value added deflator (agriculture, forestry and fishery) – value US$, 2015 prices	-	FAO	2000	2020	1.89	1
		Agriculture Producer Price Index	+	FAO	2000	2022	22.73	11
	Rural–urban inequalities	Percentage without access to improved drinking water (ratio rural–urban)	-	Adapted from UNSTATS	2000	2020	62.26	33
		Percentage with access to improved sanitation (ratio rural–urban)	-	Adapted from UNSTATS	2000	2020	66.31	35
Availability	Production	Average dietary energy supply adequacy (%) (3-year average)	+	FAO	2002	2021	24.89	9
		Agricultural water withdrawal as a % of total water withdrawals	-	AQUASTAT	2000	2019	26.86	10
		Agricultural production index value (2014-2016 = 100)	+	FAO	2000	2021	1.89	1

* Supplemental indicator not used in the current analysis, but may be considered by other applications of INFER.

Vulnerability								
Category	Component	Indicators	Framing	Source	First year	Latest year	% missing 2000–2020	Countries missing
Availability	Production	*Food loss %	-	Supplemental data	-	-	-	-
		*Diversity of staple foods produced	+	Supplemental data	-	-	-	-
		*Productivity of small-scale food producers	+	Supplemental data	-	-	-	-
Availability	Trade	Effectively applied (AHS) weighted average by country food products [Tariffs]	-	World Bank	2000	2022	0	0
		Fertilizer trade network concentrations	-	Adapted from UN-COMTRADE	2000	2021	0	0
		Cereals trade network concentrations	-	Adapted from UN-COMTRADE	2000	2021	0	0
Stability	Financial system	Central government debt, total (% of GDP)	-	IMF	2000	2021	24.53	12
		Total reserves (% of total external debt)	+	World Bank	2000	2021	40.79	18
	Markets	Consumer prices, food indices (2015=100)	-	FAO	2000	2022	9.43	5
		Consumer prices, general indices (2015=100)	-	FAO	2000	2022	9.43	5
Sustainability	Input Intensity	Fertilizer consumption (kg per ha of arable land)	-	World Bank	2000	2020	19.77	9
		Water intensity (withdrawals for agriculture per ha cultivated land)	-	FAO	2000	2019	26.68	10
		Energy intensity in agri-production (energy use per ha land under permanent crops, meadows and pastures)	-	Adapted from FAO	2000	2020	0.18	0
	Sustainable production	Agricultural land as percentage of total land area	-	World Bank	2000	2020	0	0
		Cropland area under organic agriculture (% of total agricultural land)	+	FAO	2004	2020	41.33	0
Utilization	Disease burden	Infectious diseases – disability-adjusted life years (DALYs)	-	WHO	2000	2019	82.39	4
		Non-communicable diseases – disability-adjusted life years (DALYs)	-	WHO	2000	2019	82.39	4
		Incidence of neglected tropical diseases (DALYs)	-	WHO	2000	2020	47.62	0
	Nutritional deficiency	Under 5 mortality rate (per 1,000 births)	-	UNICEF	2000	2021	0	0
		Wasting prevalence among children under 5 years of age (%)	-	WHO	2000	2020	82.12	6
		Proportion of children moderately or severely stunted (%)	-	WHO	2000	2020	13.21	7
		Prevalence of anaemia – women aged 15–49 (%)	-	WHO	2000	2019	6.56	1
		Nutritional deficiencies – disability-adjusted life years (DALYs)	-	WHO	2000	2019	82.39	4
	Obesity	Prevalence of obesity in the adult population (18 years and older) (%)	-	FAO	2000	2016	19.05	0
		Prevalence of obesity among children and adolescents aged 5 to 19 years (%)	-	WHO	2000	2020	0	0

* Supplemental indicator not used in the current analysis, but may be considered by other applications of INFER.

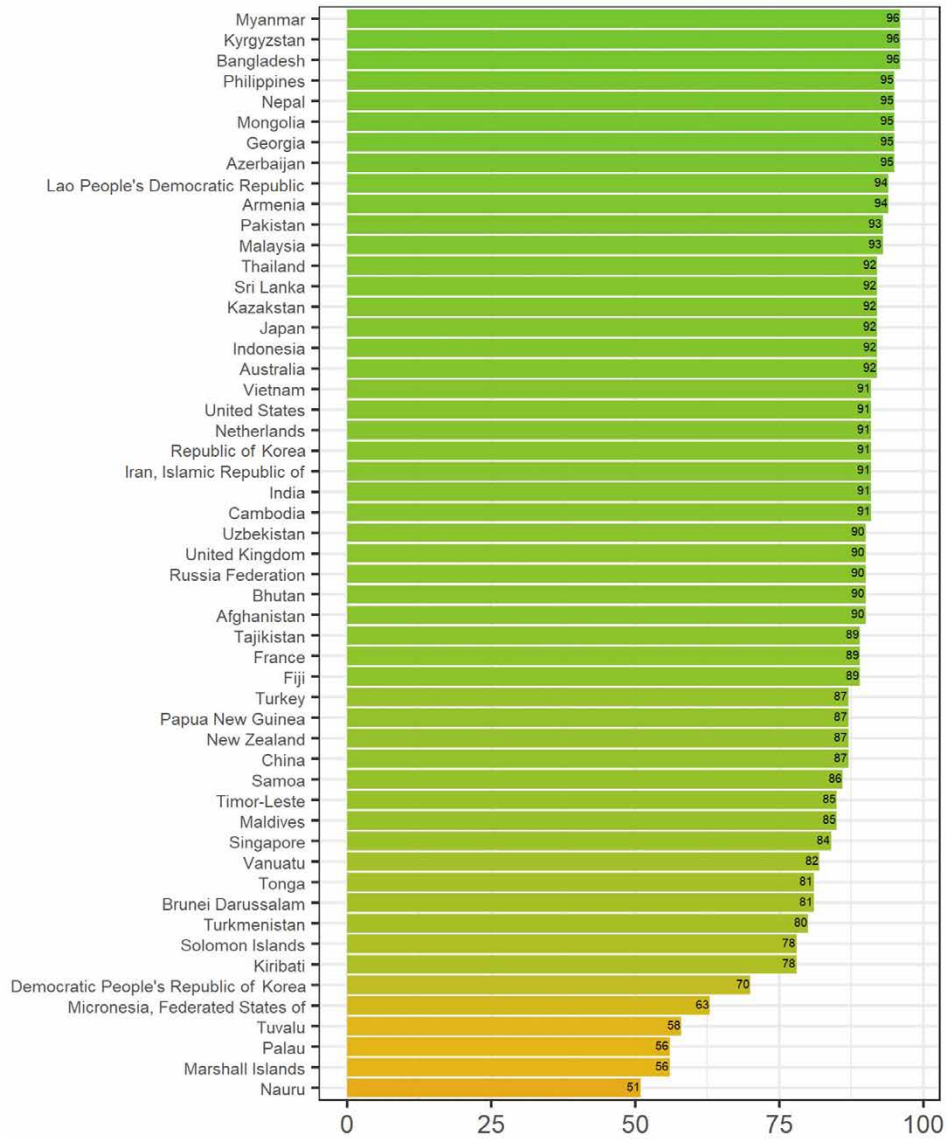
Lack of adaptive capacity								
Category	Component	Indicators	Framing	Source	First year	Latest year	% missing 2000–2020	Countries missing
Access	Economic and public support	GDP per capita	+	World Bank	2000	2021	3.05	1
		*School feeding programme coverage	+	Supplemental indicator	-	-	-	-
		*Food reserve	+	Supplemental indicator	-	-	-	-
	Physical	Logistics Performance Index	+	World Bank	2007	2018	78.62	11
		Government effectiveness (Index)	+	World Bank	2000	2021	8	0
		Liner Shipping Connectivity Index	+	UNCTAD	2006	2022	30.55	0
Agency	Norms and institutions	Control of Corruption (Index)	+	World Bank	2000	2021	7.46	0
		Regulatory quality (Index)	+	World Bank	2000	2021	8	0
	Participation and voice	Individuals using the internet (% of population)	+	ITU	2000	2020	16.71	4
		*Women's Political Power Index	+	V-Dem |Supplemental indicator	2000	2022	0	0
		*Deliberative Political Institutions Index	+	V-Dem |Supplemental indicator	2000	2022	0	0
		*Cooperatives	+	Supplemental indicator	-	-	-	-
		*Union membership	+	Supplemental indicator	-	-	-	-
		*Youth in agri/forestry	+	Supplemental indicator	-	-	-	-
	Rights and justice	*Human right to food/ environmental rights	+	Supplemental indicator	-	-	-	-
		*Sexual and reproductive health rights	+	UNFPA | Supplemental Indicator	-	-	-	-
	Resources and capabilities	Employment to population ratio (% of population)	+	ILO	2000	2022	18.87	10
		Lower secondary education completion rate (%)	+	UNESCO	2000	2021	24.62	9
		Human Development Index	+	UNDP	2000	2021	6.74	2
		*Prevalence of people with reduced Coping Strategy Index	+	WFP Supplemental data	-	-	-	-
		*% with ownership or secure rights over agricultural land	+	Supplemental data	-	-	-	-
		*% of women with secure rights over agricultural land	+	Supplemental data	-	-	-	-
Availability	Agricultural orientation	Agricultural value added per worker (Constant 2015 US$)	+	FAO	2000	2019	15.54	6
		Agricultural orientation index for government expenditures	+	FAO	2021	2020	6.56	1
	Resource base	Renewable internal freshwater resources per capita (m^3)	+	World Bank	2000	2019	17.34	7
		Arable land per capita (1000 ha/thousands of people)	+	Adapted from FAO & World Bank	2000	2021	0	0
	Climate adaptation and resilience	*Agricultural climate risk insurance	+		-	-	-	-

* Supplemental indicator not used in the current analysis, but may be considered by other applications of INFER.

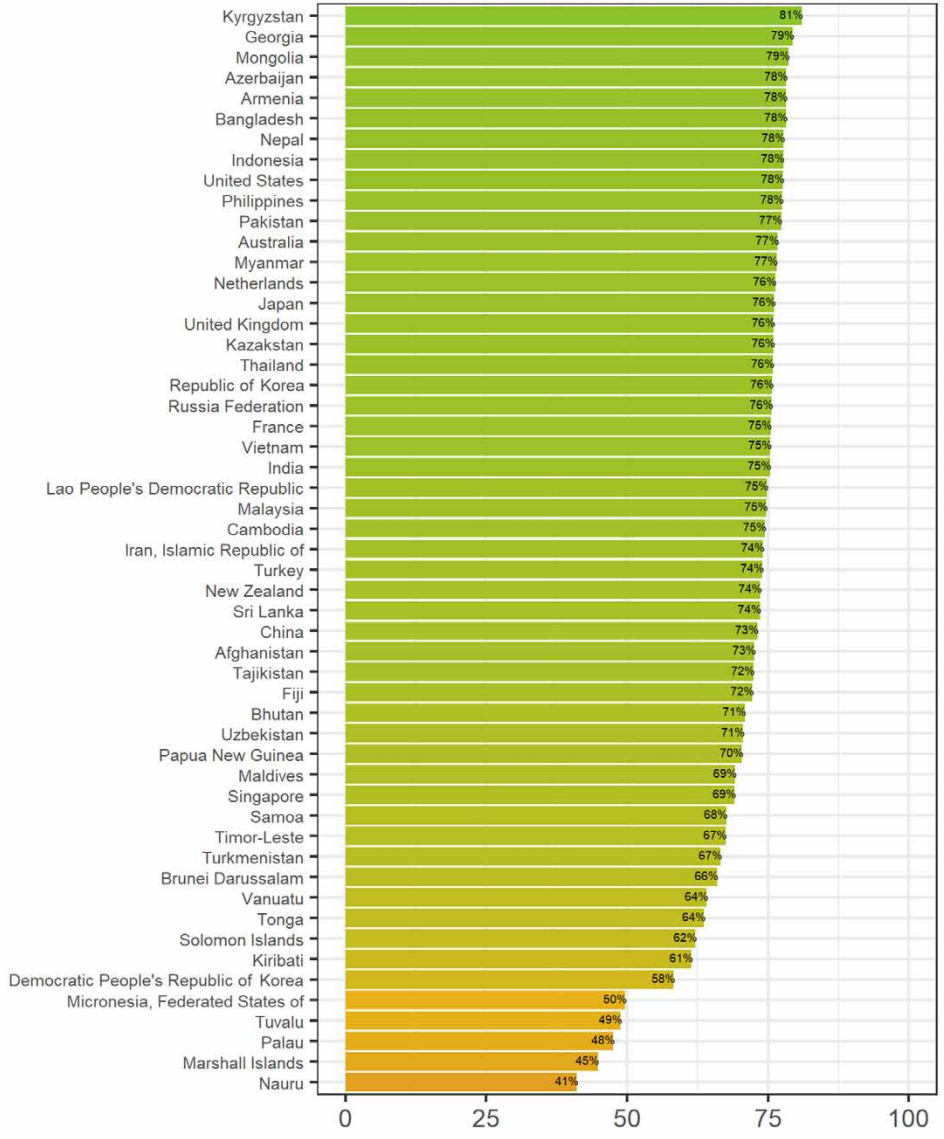
Lack of adaptive capacity								
Category	Component	Indicators	Framing	Source	First year	Latest year	% missing 2000–2020	Countries missing
Stability	Institutions	Government effectiveness (Index)	+	World Bank	2000	2021	8	0
	Markets	Indicator of food price anomalies (IFPA), applied to the Consumer Food Price Index	-	FAO	2012	2020	62.8	7
		Total reserves in months of imports	+	World Bank	2000	2021	20.4	7
Sustainability	Biodiversity and ecosystem management	Forest area (% of land area)	+	FAO	2000	2020	0	0
		Potential species loss from land use (fraction per year)	_	Life Cycle Initiative	2000	2018	31.72	13
	Climate	Greenhouse gas food system emissions per capita	_	EDGAR	2000	2018	9.52	0
Utilization	Infrastructure	Percentage with access to improved sanitation	+	UNSTATS	2000	2020	47.71	25
		Percentage with access to improved water	+	UNSTATS	2000	2020	36.48	19
		Access to electricity (% of population) (proxy for safe food storage)	+	World Bank	2000	2020	0.81	0
	Health Institutions	Health Care Access and Quality Index	+	Global Burden of Disease Study	2000	2015	82.03	3
		Maternal mortality rates (Maternal deaths per 100,000 live births)	-	World Bank	2000	2017	20.75	4
		*Breastfeeding rate	+	Supplemental indicator	-	-	-	-
		*Food safety mechanisms	+	Supplemental indicator	-	-	-	-

* Supplemental indicator not used in the current analysis, but may be considered by other applications of INFER.

Annex 4. INFER data coverage (all indicators) by country and correlation

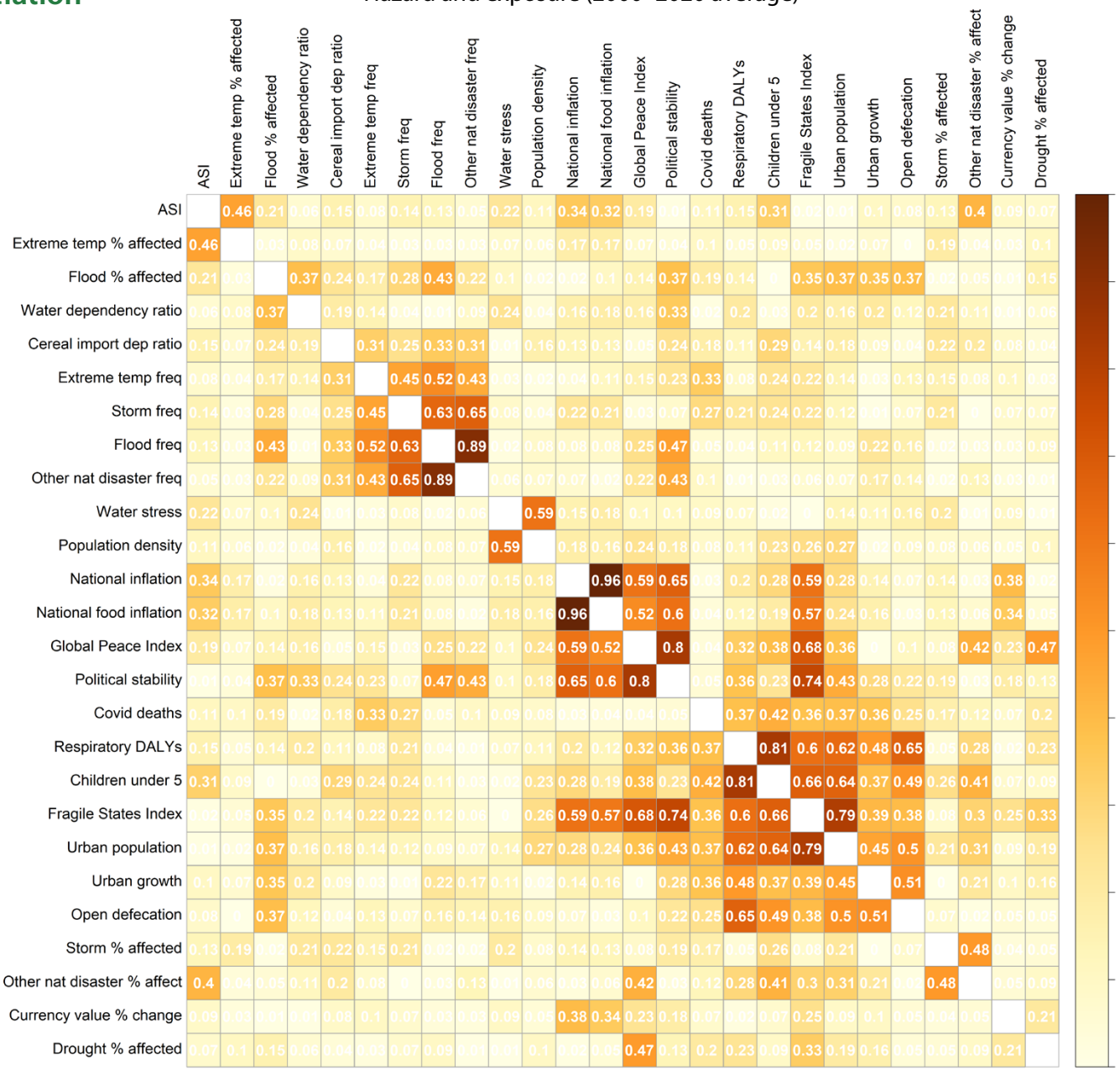


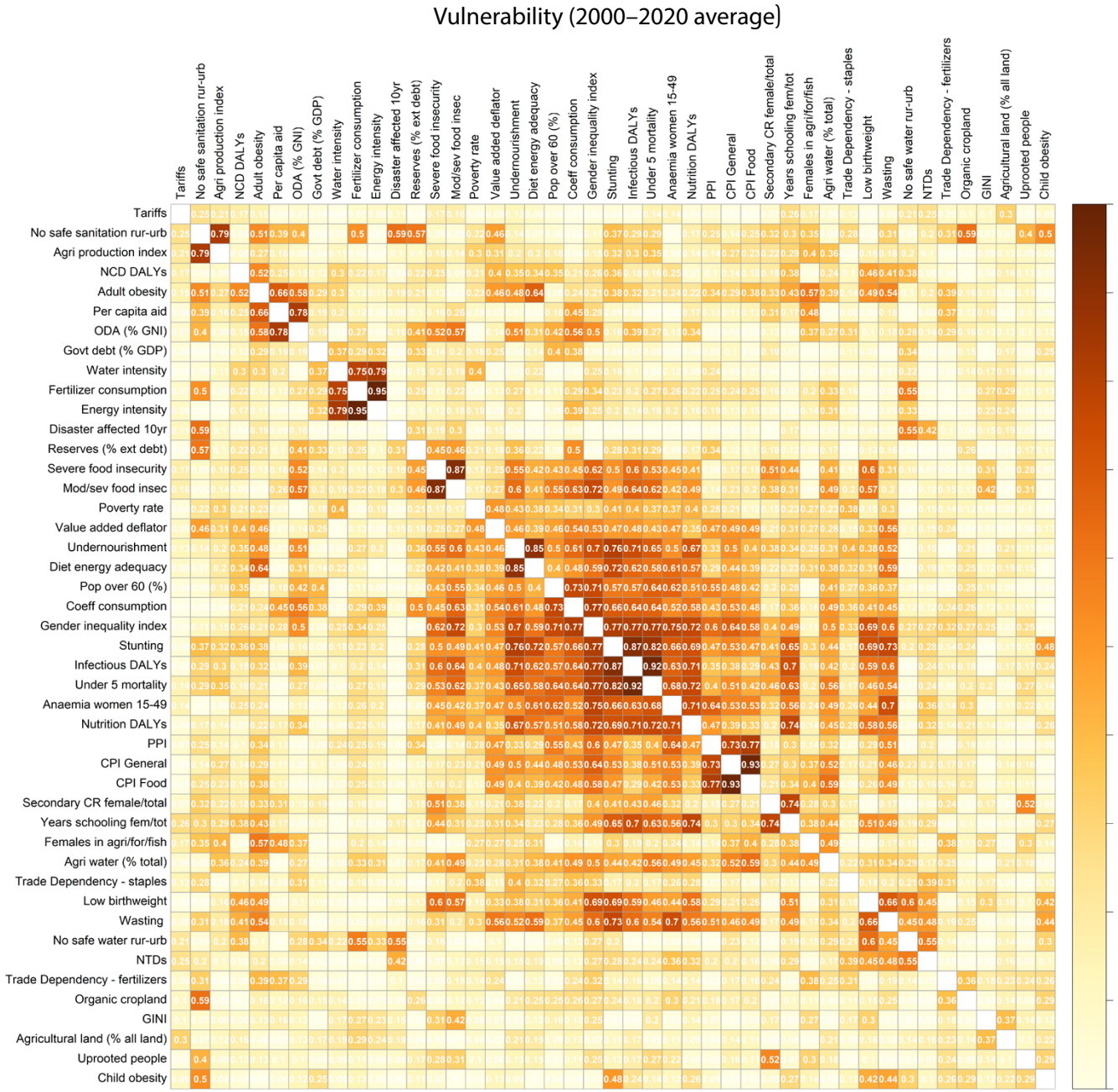
Available indicators 2000–2022 - total indicators: 96

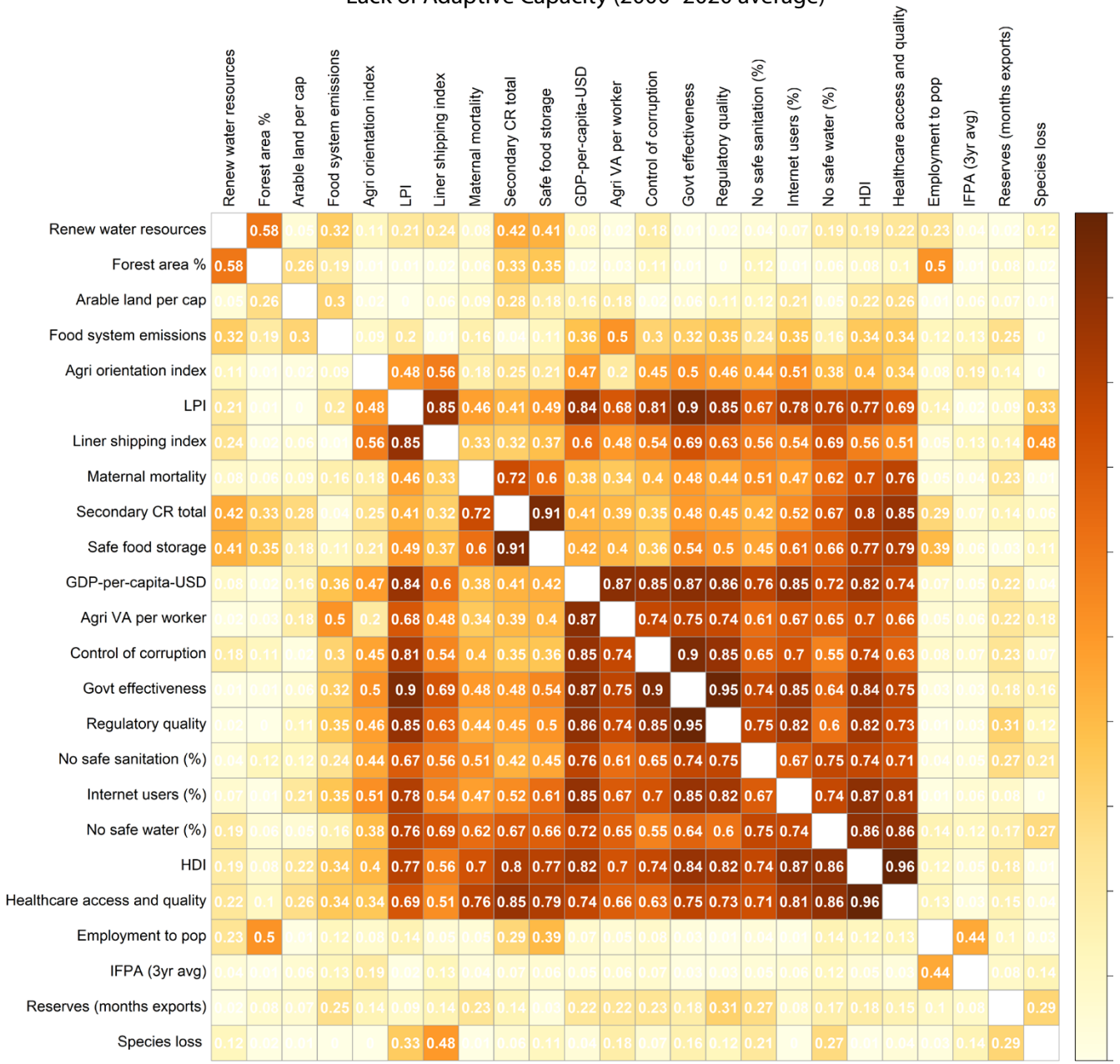


Percentage of data available 2000–2022

Heatmapping of correlation




Vulnerability (2000–2020 average)
Tariffs
No safe sanitation rur-urb
Agri production index
NCD DALYs
Adult obesity
Per capita aid
ODA (% GNI)
Govt debt (% GDP)
Water intensity
Fertilizer consumption
Energy intensity
Disaster affected 10yr
Reserves (% ext debt)
Severe food insecurity
Mod/sev food insec
Poverty rate
Value added deflator
Undernourishment
Diet energy adequacy
Pop over 60 (%)
Coeff consumption
Gender inequality index
Stunting
Infectious DALYs
Under 5 mortality
Anaemia women 15-49
Nutrition DALYs
PPI
CPI General
CPI Food
Secondary CR female/total
Years schooling fem/tot
Females in agri/for/fish
Agri water (% total)
Trade Dependency - staples
Low birthweight
Wasting
No safe water rur-urb
NTDs
Trade Dependency - fertilizers
Organic cropland
GINI
Agricultural land (% all land)
Uprooted people
Child obesity


Lack of Adaptive Capacity (2000–2020 average)
Renew water resources
Forest area %
Arable land per cap
Food system emissions
Agri orientation index
LPI
Liner shipping index
Maternal mortality
Secondary CR total
Safe food storage
GDP-per-capita-USD
Agri VA per worker
Control of corruption
Govt effectiveness
Regulatory quality
No safe sanitation (%)
Internet users (%)
No safe water (%)
HDI
Healthcare access and quality
Employment to pop
IFPA (3yr avg)
Reserves (months exports)
Species loss

Annex 5. INFER model weighting

Dimension	Dimension weight	Category	Category weight	Component (number of indicators)	Component weight	Indicator weight
Hazard and exposure	33%	Economic	11.1%	Economic instability (2)	3.70%	1.85%
				Food price inflation (1)	3.70%	3.70%
				Trade exposure (1)	3.70%	3.70%
		Natural	11.1%	Drought (2)	1.85%	0.93%
				Floods (2)	1.85%	0.93%
				Storms (2)	1.85%	0.93%
				Extreme temperatures (2)	1.85%	0.93%
				Water stress (2)	1.85%	0.93%
				Other natural disasters (2)	1.85%	0.93%
		Socio-political	11.1%	Conflict-related shocks (3)	5.56%	1.85%
				Human epidemics (7)	5.56%	0.79%
Vulnerability	33%	Access	5.6%	Critical population share (3)	1.85%	0.62%
				Household food acquisition (5)	1.85%	0.37%
				Poverty and inequality (2)	1.85%	0.93%
		Agency	5.6%	Aid dependency (2)	1.39%	0.69%
				Gender inequality (3)	1.39%	0.46%
				Producer prosperity (3)	1.39%	0.46%
				Rural–urban inequality (2)	1.39%	0.69%
		Availability	5.6%	Production (3)	2.78%	0.93%
				Trade (3)	2.78%	0.93%
		Stability	5.6%	Financial system (2)	2.78%	1.39%
				Markets (2)	2.78%	1.39%

Dimension	Dimension weight	Category	Category weight	Component (number of indicators)	Component weight	Indicator weight
Vulnerability	33%	Sustainability	5.6%	Input intensity (3)	2.78%	0.93%
				Sustainable production (2)	2.78%	1.39%
		Utilization	5.6%	Disease burden (3)	1.85%	0.62%
				Nutritional deficiency (5)	1.85%	0.37%
				Obesity (2)	1.85%	0.93%
Lack of adaptive capacity	33%	Access	5.6%	Economic and public support (1)	2.78%	2.78%
				Physical (3)	2.78%	0.93%
		Agency	5.6%	Norms and institutions (2)	1.85%	0.93%
				Participation and voice (1)	1.85%	1.85%
				Resources and capabilities (3)	1.85%	0.62%
		Availability	5.6%	Agricultural orientation (2)	2.78%	1.39%
				Resource base (2)	2.78%	1.39%
		Stability	5.6%	Institutions (2)	2.78%	1.39%
				Foreign exchange reserves (1)	2.78%	2.78%
		Sustainability	5.6%	Biodiversity and ecosystem management (2)	2.78%	1.39%
				Climate mitigation (1)	2.78%	2.78%
		Utilization	5.6%	Infrastructure (3)	2.78%	0.93%
				Institutions (2)	2.78%	1.39%

Annex 6. Country list and groupings

Asia-Pacific countries (ESCAP members)

Included in this study: Afghanistan, American Samoa, Armenia, Australia, Azerbaijan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, Fiji, Georgia, India, Indonesia, Iran (Islamic Republic of), Japan, Kazakhstan, Kiribati, Kyrgyzstan, Lao People's Democratic Republic, Malaysia, Maldives, Marshall Islands, Micronesia (Federated States of), Mongolia, Myanmar, Nauru, Nepal, New Zealand, Pakistan, Palau, Papua New Guinea, Philippines, Republic of Korea, Russian Federation, Singapore, Solomon Islands, Sri Lanka, Tajikistan, Thailand, Timor-Leste, Tonga, Türkiye, Turkmenistan, Tuvalu, Uzbekistan, Vanuatu, Viet Nam.

Not included in this study: Cook Islands, French Polynesia, Guam, Hong Kong (China), Macao (China), New Caledonia, Niue, Northern Mariana Islands, Samoa.

Income groupings*

Low-income economies	Lower-middle-income economies	Upper-middle-income economies	High-income economies
Afghanistan, Democratic People's Republic of Korea	Bangladesh, Bhutan, Cambodia, India, Indonesia, Iran (Islamic Republic of), Kiribati, Kyrgyzstan, Lao People's Democratic Republic, Micronesia (Federated States of), Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Tajikistan, Timor-Leste, Uzbekistan, Vanuatu, Viet Nam	American Samoa, Armenia, Azerbaijan, China, Fiji, Georgia, Kazakhstan, Malaysia, Maldives, Marshall Islands, Palau, Russian Federation, Thailand, Tonga, Türkiye, Turkmenistan, Tuvalu	Australia, Brunei Darussalam, Japan, Nauru, New Zealand, Republic of Korea, Singapore

Asia-Pacific countries in special situations*

Landlocked developing countries	Least developed countries	Small island developing states
Afghanistan, Armenia, Azerbaijan, Bhutan, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Mongolia, Nepal, Tajikistan, Turkmenistan, Uzbekistan	Afghanistan, Bangladesh, Bhutan, Cambodia, Kiribati, Lao People's Democratic Republic, Myanmar, Nepal, Solomon Islands, Timor-Leste, Tuvalu	American Samoa, Fiji, Kiribati, Maldives, Marshall Islands, Micronesia (Federated States of), Nauru, Palau, Papua New Guinea, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Vanuatu

*Only ESCAP Member states included in the study are listed. Groupings are as defined by the World Bank (World Bank, 2023)

Climate change, conflicts, epidemics, trade disruptions, price shocks, and other compounding crises have highlighted the multifaceted vulnerability of food systems. To ensure a resilient future, it is critical to systematically consider multidimensional risks to food system outcomes that impact people, planet and prosperity.

This working paper introduces INFER (INsights on Food SystEm Risks), a composite index that provides insights into multidimensional risks to three food system outcomes: human health and nutrition; ecosystem health and sustainability; and shared prosperity. It enables tracking of risk and comparison of risk drivers over time, within and across countries, contributing to the tools available for food systems monitoring and for ensuring that resilience-building strategies for food systems are risk-informed. The application of INFER at the Asia-Pacific regional and national levels, including risk profiles of Bangladesh, Fiji, Kazakhstan, Lao People's Democratic Republic, Pakistan, Sri Lanka and Uzbekistan, are also included in the working paper.

For more information, please visit:
https://www.unescap.org/projects/infer

ESCAP
Economic and Social Commission for Asia and the Pacific

WFP
World Food Programme