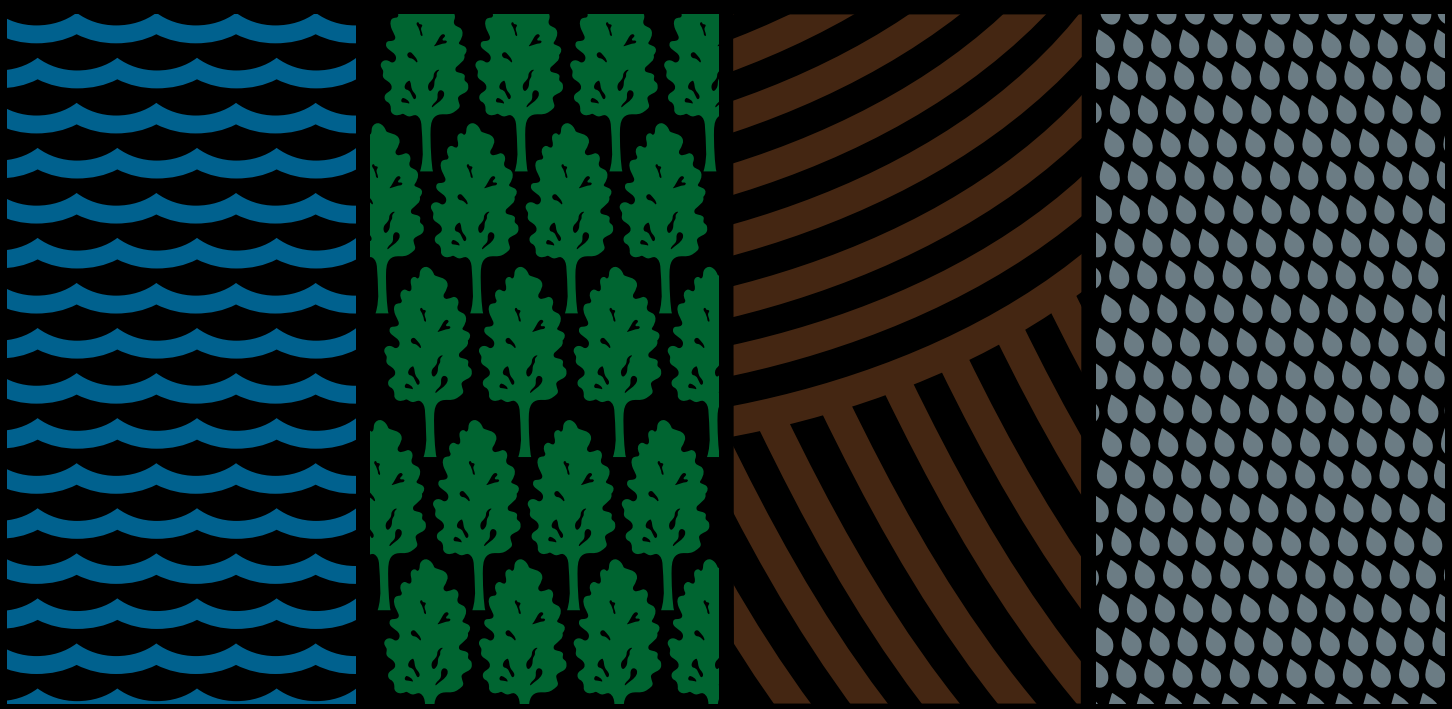
The Economist Intelligence Unit

A report from The Economist Intelligence Unit

GLOBAL FOOD SECURITY INDEX 2017

MEASURING FOOD SECURITY AND THE IMPACT OF RESOURCE RISKS



Sponsored by DUPONT®

Contents

Preface

The Global Food Security Index 2017: Measuring food security and the impact of resource risks is the sixth edition of an Economist Intelligence Unit study, commissioned by DuPont. This report discusses the key findings from the research and the benchmarking index. Katherine Stewart, Consulting Analyst, was the project manager. Robert Smith, Research Analyst, provided research and analytical support. Leo Abruzzese, Global Director of Public Policy, Lucy Hurst, EMEA Director of Public Policy, and Robert Powell, Senior Consultant, served as advisers. William Shallcross designed and constructed the benchmarking model and Mike Kenny was responsible for layout and design. We would like to extend our thanks to the many researchers who lent their expertise to this project. A full list of acknowledgements follows. ■

Acknowledgements

The following economists, researchers, country analysts, and food, climate, and natural resource specialists contributed to the report. We thank them for their participation.

Economist Intelligence Unit specialists and contributors

Diane Alarcon, Justin Alexander, Anwita Basu, Malini Bose, Nicholas Fitzroy, Andrei Franklin, Nadia Hasham, Tom Felix Joehnk, Charlotte King, Brendan Koch, Emily Mansfield, Eleanor Whitehead and Marcio Zanetti.

Peer panel members

The following experts on food security and agricultural policy contributed significantly to shaping the core index methodology and vetting the indicators. Their diverse backgrounds and extensive experience ensured that a wide variety of views were considered. The panel met as a group in February 2012 in Washington, DC to review an initial indicator list. The panel has also provided ongoing support, as needed, throughout all six editions of the index, as well as advising on the selection of weightings.

Ademola Braimoh (World Bank); Margaret Enis (US Agency for International Development); Craig Gundersen (National Soybean Research Laboratory, University of Illinois at Urbana-Champaign); Eileen Kennedy (Friedman School of Nutrition Science and Policy, Tufts University); Samarendu Mohanty (International Rice Research Institute); Prabhu Pingali (Gates Foundation); Pedro Sanchez (Earth Institute, Columbia University); David Spielman (International Food Policy Research Institute); Robert Thompson (Chicago Council on Global Affairs); Patrick Westhoff (Food and Agricultural Policy Research Institute, University of Missouri—Columbia).

For the latest iteration, The Economist Intelligence Unit convened an additional expert panel in March 2017 to assist in the development of a fourth index category, Natural Resources & Resilience, which captures climate-related and natural resource risks to global food security. The following experts on climate change and natural resources participated in the meeting.

Joe Glauber (IFPRI); Elise Golan (USDA); Susanna Hecht (UCLA); Karin Kemper (World Bank); Catie Lee (Land O'Lakes); Shaun Martin (World Wildlife Foundation); Dawn Rittenhouse (DuPont Pioneer); Allison Thomson (Field to Market); Sonja Vermeulen (independent consultant); Sara Walker (World Resources Institute) ■

Introduction

Global food security has generally improved over the past decade, in line with record agricultural production and lower food prices. But recent macroeconomic, socio-economic and political trends suggest that continued progress is not a foregone conclusion. Fluctuating global economic growth, increasing inequality, political instability and forced migration, among many other factors, also have a significant impact on whether populations remain well-fed. Climate change and natural resource depletion will only aggravate these trends, while severely threatening the United Nations' Sustainable Development Goals (UN SDGs) of ending hunger by 2030. According to a recent study from the UN Food and Agricultural Organisation (FAO), by 2030 an extra 35m to 122m people could fall into poverty and therefore become less food secure as a result of climate-related risks.[1]

Given the growing threats to food security posed by climate change and natural resource depletion, the 2017 iteration of the index includes a new category that seeks to understand the impact that these risks will have on global food security. More specifically, the category looks at a country's exposure, sensitivity and adaptive capacity to climate-related risks and the risks facing a country's key natural assets—land, water and oceans. The category was built into the index as an adjustment factor to demonstrate how overall food security changes when climate-related and natural resource risks are taken into account.

While the GFSI showed improvements in food security over the past four years, the most recent iteration has shown a decline, even without adjusting for climate-related and natural resource risks. The trends noted above—fluctuating global economic growth, increasing inequality, political instability and forced migration—are largely responsible for the deterioration. In an example of the interconnected nature of the challenge, the incidence of forced migration even exhibits a feedback loop with food insecurity. A new report from the World Food Programme (WFP) suggests that for every one percentage increase in food insecurity, an additional 1.9% of people are compelled to migrate. And as more people migrate, they may find little

1 FAO. "The State of Food and Agriculture: Climate Change, Agriculture and Food Security". 2016. URL: http://www.fao.org/3/a-i6132e.pdf

What is the GFSI?

The Economist Intelligence Unit's Global Food Security Index (GFSI), sponsored by DuPont, provides a common framework for understanding the root causes of food insecurity by looking at the dynamics of food systems around the world. It seeks to answer the central question: How food-secure is a country? Food security is a complex, multifaceted issue influenced by culture, environment and geographic location. While the index does not capture intra-country nuances, by distilling major food-security themes down to their core elements it provides a useful approach to understanding the risks to food security in countries, regions and around the world.

By creating a common framework against which to benchmark a country's food security, the GFSI has created a unique country-level food-security measurement tool that addresses the issues of affordability, availability and utilisation in 113 countries around the world. Since its inception, the GFSI has become a policy check for governments and a country diagnostic tool for investment. Non-governmental organisations and multilaterals have turned to the GFSI as a research tool to identify key countries in which to focus advocacy efforts for food-security policy changes and developments. The private sector uses the tool as a launch pad to make strategic decisions, explore food consumption trends and develop corporate social responsibility initiatives.

access to or have no means to purchase food on their journey, forcing them to continue moving.[2]

When climate-related and natural resource risks are taken into account, the results are even more discouraging. No country within the index performs better in terms of its overall food security score when adjusting for these risks. Clearly, moving forward, the discussion around global food security must include strategies to confront these risks.

2 World Food Programme. "At the root of exodus: Food security, conflict and international migration". May 2017. URL: https://docs.wfp.org/api/documents/WFP-0000015358/download/?_ga=2.24532794.1052841939.1505097217-860023768.1505097217

Key findings

Overall findings

The Global Food Security Index (GFSI) has recorded a slippage in global food security over the past year, after four years of consecutive food security gains. Migration is occurring at a rate that many countries' economies and infrastructure, already burdened with large and growing urban populations, are unable to sustainably accommodate; people are spending more of their household incomes on food as demand grows at a rate production cannot accommodate;[3] drought in Sub-Saharan Africa is putting strain on food safety nets and international food aid programmes; and political stability risk is threatening food security in almost every region. Just over three-fifths of countries experienced declines in their food security scores since the 2016 Index.

Ireland surpassed the United States to become the most food secure country in the Index. GDP per head has grown substantially since 2012 with the Irish economy rebounding strongly from the financial crisis and the large presence of multinationals inflating GDP in both nominal and real terms, although wealth distribution is still an area of concern in the country.[4] Consistently high public sector investment in agriculture (notwithstanding a slight slip in the past year) has also supported Ireland's progressive rise in the GFSI rankings.

Brexit poses an extreme risk to the United Kingdom's continued food security progress. The Economist Intelligence Unit forecasts that personal incomes through 2018 will fall 6%, impacting food affordability, while the weaker sterling is pushing up import costs: a major concern given that the United Kingdom is becoming increasingly reliant on foreign food imports.[5] About one quarter of the country's food is imported from the EU[6] and the EU's Common Agricultural Policy (CAP) accounted for over half of British farmers' incomes in 2015.[7] These generous subsidies will no longer exist once Brexit occurs. Though food self-sufficiency is an unrealistic goal, budgeting to account for the loss of CAP funding and attempting to maintain

3 C. Peter Timmer. "Food Security, Structural Transformation, Markets and Government Policy". 2017. URL: http://onlinelibrary.wiley.com/doi/10.1002/app5.161/full

4 The Irish Times. "Irish poverty rates for lone parents among highest in EU". 2016. URL: https://www.irishtimes.com/news/social-affairs/irish-poverty-rates-for-lone-parents-among-highest-in-eu-1.2888915

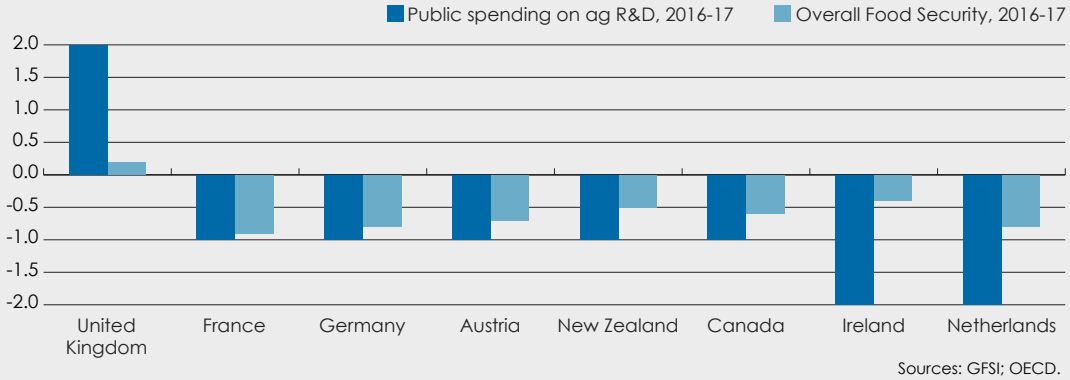
5 Bloomberg. "U.K.'s Self-Sufficiency in Food Is at Lowest in Decades: Chart". August 9th 2017. URL: www.bloomberg.com/news/articles/2017-08-09/u-k-s-self-sufficiency-in-food-is-at-lowest-in-decades-chart

6 QZ. "The British import a quarter of their food from the EU, and that's a problem". 2016. URL: https://qz.com/716156/the-british-import-a-quarter-of-their-food-from-the-eu-and-thats-a-problem/

7 Financial Times. "Britain's farmers will need help after Brexit". August 22nd 2016. URL: www.ft.com/content/df151906-6616-11e6-a08a-c7ac04ef00aa

Falling public investments in agriculture contribute to food security declines in high-income economies

Change in public spending on agricultural R&D (2016-17) v change in GFSI overall score (2016-17)



Sources: GFSI; OECD.

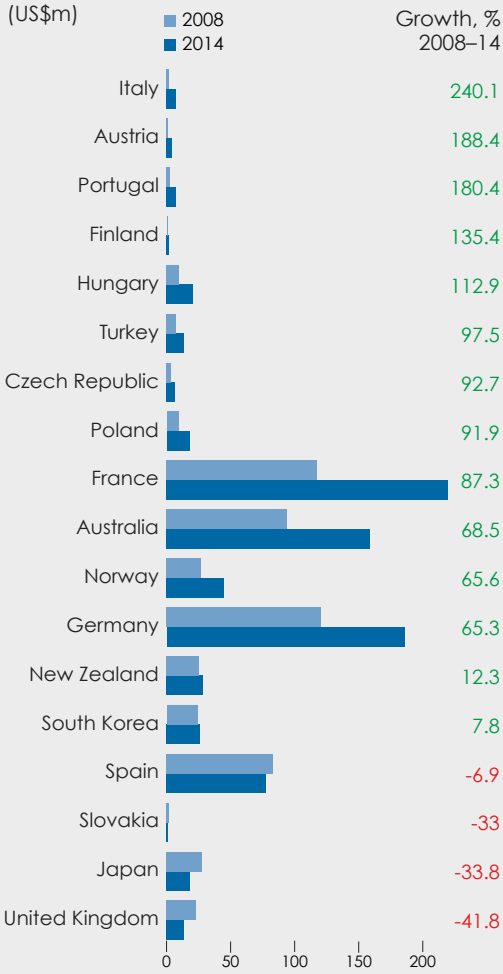
favourable trade relationships with the EU and other major agricultural exporters will be key to ensuring that the country is well fed.

Ending world hunger by 2030 is expected to cost an extra US$11bn a year,[8,9] but persistent austerity across the advanced economies is threatening this target. Notably, falls in public sector investment in the agriculture sector are increasingly putting strains on globalised food systems. Five of the ten most food-secure countries—Canada, France, Germany, Ireland and the Netherlands—saw their food security scores fall this year as a result of their reduced public expenditure on agricultural R&D (see chart). Though private sector investment in agriculture has grown in most high-income countries in the past few years (see chart), there remains a large funding gap across the globe.

National nutrition monitoring provides an avenue for governments to assess and address malnutrition problems across populations. The Sustainable Development Goals' emphasis on ensuring healthy

Growth in private sector agriculture investment

Private enterprise spending on agriculture, forestry and fishing R&D, select countries



Where 2008 data was unavailable, 2007 or 2009 data was used. Where 2014 data was unavailable, 2013 data was used.
Source: OECD.

8 Sara Gustafson. "How much would it cost to end hunger worldwide by 2030?". 2016. URL: http://www.ifpri.org/blog/how-much-would-it-cost-end-hunger-worldwide-2030

9 International Food Policy Research Institute and International Institute for Sustainable Development estimate.

populations and ending hunger has made monitoring a critical issue. Regular government monitoring of nutrition is particularly weak in the Middle East & North Africa and in South America. Israel's most recent national nutrition survey that covered the entire population occurred at the turn of the century, while Qatar[10] and Saudi Arabia have not had surveys since 2005. Almost half of the Central & South American countries in the GFSI—including Bolivia, the Dominican Republic, Haiti and Panama—have no national nutrition surveillance programmes.

Economic recovery and double digit growth in personal incomes across lower- and middle-income countries are helping with food affordability, but more efficient and innovative food production and sustainable supply chains are needed to support shifting food preferences and growing demand. China has experienced a 54% increase in GDP per head since 2012, while economies in Sub-Saharan Africa and Southeast Asia have also grown rapidly. However, by 2050, a 50% boost in agricultural production will be needed to satisfy the world's 10bn people, and increased consumption of fruits, vegetables and meat will necessitate shifts in agricultural outputs, taxing already strained natural resources.[11]

Disaster and crisis related hunger will continue to increase populations' dependency on food safety net programmes unless emphasis is placed on adaptation and building resilience. Drought across Eastern and Southern Africa are overtaxing multilateral and NGO-run food aid programmes and shifting fund allocation from developing structurally sound food systems and fixing dysfunctional markets to crisis alleviation.

- Since 2012, dependency on chronic food aid has increased in 20 countries in the GFSI. Three-quarters of those countries have seen their chronic dependency rise in the past year as drought and extreme weather events have affected production. For example, drought in Ethiopia has forced the United Nations World Food Programme (WFP) to start cutting its food rations in the country by 20% as it faces a budget gap of US$121m.[12]

10 Qatar's Supreme Council of Health rolled out the Gulf's first nutrition guide in 2015. The rollout was supposed to include a consumption and nutrition survey, but there is no public evidence that this survey has been conducted yet.

11 FAO. "The Future of Food and Agriculture: Trends and Challenges". 2017. URL: http://www.fao.org/3/a-i6583e.pdf

12 Washington Post. "Ethiopia is facing a killer drought. But it's going almost unnoticed". 2017. URL: https://www.washingtonpost.com/news/worldviews/wp/2017/05/01/ethiopia-is-facing-a-killer-drought-but-its-going-almost-unnoticed/?utm_term=.a1f918ab3ddc

2017 GFSI overall rankings table

Weighted total of all category scores (0-100 where 100=most favourable)

Rank		Score /100
1	Ireland	85.6
2	United States	84.6
3	United Kingdom	84.2
4	Singapore	84.0
5	Australia	83.3
6	Netherlands	82.8
7	Germany	82.5
8	France	82.3
9	Canada	82.2
10	Sweden	81.7
11	Austria	81.6
11	Switzerland	81.6
13	Norway	81.4
14	Finland	81.0
14	New Zealand	81.0
16	Denmark	80.3
17	Belgium	79.8
18	Japan	79.5
19	Israel	79.2
20	Portugal	79.0
21	Spain	78.1
22	Italy	75.9
23	Czech Republic	75.8
24	Chile	74.7
24	South Korea	74.7
26	Kuwait	74.6
27	Poland	74.1
28	Oman	73.9
29	Qatar	73.3
30	Hungary	72.2
31	Greece	71.9
32	Saudi Arabia	71.0
33	United Arab Emirates	70.9
34	Slovakia	70.0
35	Uruguay	69.7
36	Costa Rica	69.3
37	Bahrain	68.6
38	Brazil	67.7

Rank		Score /100
38	Romania	67.7
40	Argentina	67.3
41	Malaysia	66.2
41	Russia	66.2
43	Mexico	65.8
44	South Africa	64.0
45	China	63.7
46	Belarus	63.0
47	Bulgaria	62.9
48	Panama	62.5
49	Turkey	61.1
50	Serbia	60.6
51	Colombia	60.1
52	Botswana	59.4
53	Peru	59.2
54	Tunisia	58.8
55	Jordan	58.3
55	Thailand	58.3
57	Azerbaijan	57.8
58	Egypt	56.6
59	Paraguay	56.5
60	Kazakhstan	56.0
61	Ecuador	55.2
62	Dominican Republic	54.8
63	Ukraine	54.1
64	Vietnam	54.0
65	El Salvador	53.1
66	Sri Lanka	53.0
67	Morocco	52.8
68	Algeria	51.5
69	Bolivia	51.3
69	Indonesia	51.3
71	Venezuela	50.2
72	Nicaragua	50.0
73	Guatemala	49.6
74	India	48.9
75	Honduras	48.6
76	Ghana	47.9

Rank		Score /100
77	Pakistan	47.8
78	Uzbekistan	47.5
79	Philippines	47.3
80	Myanmar	44.8
81	Nepal	44.5
82	Senegal	44.2
83	Cambodia	43.3
83	Uganda	43.3
85	Cote d'Ivoire	42.5
86	Kenya	42.2
87	Cameroon	41.6
88	Rwanda	39.8
89	Bangladesh	39.7
90	Benin	39.6
91	Mali	39.4
92	Nigeria	38.4
93	Togo	37.2
94	Tajikistan	35.9
95	Tanzania	35.4
96	Sudan	34.8
97	Guinea	34.0
98	Mozambique	33.7
99	Ethiopia	33.3
99	Syria	33.3
101	Angola	33.2
102	Burkina Faso	33.1
102	Laos	33.1
104	Zambia	32.4
105	Malawi	31.3
106	Niger	29.5
107	Haiti	29.1
108	Yemen	28.8
109	Sierra Leone	28.7
110	Chad	28.3
111	Madagascar	27.2
112	Congo (Dem. Rep.)	25.5
113	Burundi	25.1

Score changes

(Net change in overall score, 2017 v 2016)

Score improved

Score declined

	Score change
Sierra Leone	+2.6
Paraguay	+2.0
Ecuador	+1.4
Bangladesh	+1.3
Nicaragua	+1.3
Ghana	+1.2
Colombia	+1.1
Jordan	+1.1
Peru	+1.1
Finland	+0.9
El Salvador	+0.8
Togo	+0.8
Czech Republic	+0.7
Pakistan	+0.7
Kazakhstan	+0.6
Slovakia	+0.6
Tunisia	+0.6
Costa Rica	+0.5
Haiti	+0.5
Hungary	+0.5
Laos	+0.4
Mozambique	+0.4
Japan	+0.3
Azerbaijan	+0.2
Botswana	+0.2
Burkina Faso	+0.2
Indonesia	+0.2
Mexico	+0.2
Oman	+0.2

	Score change
Poland	+0.2
South Africa	+0.2
United Arab Emirates	+0.2
United Kingdom	+0.2
Cote d'Ivoire	+0.1
Kuwait	+0.1
Nepal	+0.1
Norway	+0.1
Cambodia	0.0
Nigeria	0.0
Tajikistan	0.0
Cameroon	-0.1
Greece	-0.1
Australia	-0.2
Brazil	-0.2
Chile	-0.2
Ireland	-0.2
Senegal	-0.2
Serbia	-0.2
Denmark	-0.3
Sweden	-0.3
Belarus	-0.4
Russia	-0.4
Belgium	-0.5
Benin	-0.5
Guatemala	-0.5
New Zealand	-0.5
Thailand	-0.5

	Score change
Turkey	-0.5
Bulgaria	-0.6
Canada	-0.6
Rwanda	-0.6
Singapore	-0.6
United States	-0.6
Argentina	-0.7
Austria	-0.7
Guinea	-0.7
Italy	-0.7
Morocco	-0.7
Myanmar	-0.7
Uruguay	-0.7
Bolivia	-0.8
Germany	-0.8
Netherlands	-0.8
Saudi Arabia	-0.8
South Korea	-0.8
Switzerland	-0.8
France	-0.9
India	-0.9
Panama	-0.9
Spain	-0.9
Sri Lanka	-0.9
Israel	-1.0
Kenya	-1.0
Philippines	-1.0
Sudan	-1.1
Tanzania	-1.1

	Score change
Uganda	-1.1
China	-1.2
Egypt	-1.2
Uzbekistan	-1.2
Bahrain	-1.3
Portugal	-1.3
Syria	-1.3
Romania	-1.4
Honduras	-1.6
Burundi	-1.7
Niger	-1.7
Ukraine	-2.1
Dominican Republic	-2.2
Malawi	-2.2
Vietnam	-2.2
Mali	-2.3
Algeria	-2.7
Chad	-3.0
Zambia	-3.1
Angola	-3.2
Malaysia	-3.2
Ethiopia	-3.3
Yemen	-3.4
Congo (Dem. Rep.)	-3.8
Madagascar	-4.7
Qatar	-6.0
Venezuela	-7.1

Natural Resource & Resilience findings[13]

The developed countries of Austria (which moves from 11th to second) and Denmark (16th to ninth) see the greatest rank improvements when the new Natural Resources & Resilience adjustment factor is applied to the Index. Denmark's resilience, low sensitivity to the impacts of climate exposure, and management of both salt and freshwater resources—rare among the Index's coastal countries—push it to the fore, while Austria's landlocked geography (and consequent low exposure), high adaptive capacity and low soil erosion drive its strong performance.

Singapore's dependence on food imports and its susceptibility to rising sea levels and extreme weather events make it most vulnerable to natural resources and climate risks. The country drops 15 spots in the rankings (from fourth to 19th) when the adjustment factor is applied.

- Australia and the United Arab Emirates are also negatively affected, falling nine and eight places respectively. Both countries have few structures in place to manage exposure, while Australia is also highly sensitive to agricultural freshwater risk, soil erosion and ocean eutrophication. The UAE's susceptibility to drought, storm severity and rising sea levels—a common vulnerability across the six-member Gulf Cooperation Council (GCC)—put it at risk.

Urbanisation-related land-use change and high concentrations of fertiliser nitrates have contaminated almost half of Europe's freshwater bodies, according to the European Environmental Agency.[14] [15] Although the region has made substantial commitments to manage climate exposure and resource-related risk—Europe has curbed the dumping of untreated urban and industrial wastewater into rivers and has comprehensive national agriculture risk management systems—minimal attention has been devoted to lowering fertiliser use or developing alternative fertilisers with fewer contaminants.

Countries in Sub-Saharan Africa are in a unique position to grow their relatively nascent agricultural sectors using sustainable agricultural practices instead of more traditional resource-intensive ones. Comparative underdevelopment across the region means that resource intensity (ie, water withdrawals, soil erosion) in agriculture is much lower than in regions with extensive access to irrigation and other resource-intensive technologies. However, limited financial resources and the need to increase productivity rapidly could offset interest in or commitment to sustainable agriculture.

In the lower-middle income countries that are transitioning from agricultural- to manufacturing-led economies, climate exposure or natural resource shocks threaten to undermine their economic systems, potentially forcing them back to low-income status. Projected rising sea levels and temperatures, freshwater depletion and contamination, deforestation, and poor disaster risk

13 This category assesses a country's exposure to the impacts of a changing climate; its susceptibility to natural resource risks; and how the country is adapting to these risks. When applied, the Natural Resources & Resilience category acts as an adjustment factor on countries' food security scores. This section looks at how countries' food security scores shift after the adjustment factor is applied, while the findings above focused on the baseline index (Affordability, Availability and Quality & Safety).

14 Nature. "Europe sounds alarm over freshwater pollution". 2015. URL: http://www.nature.com/news/europe-sounds-alarm-over-freshwater-pollution-1.17021

15 European Environment Agency. "SOER 2015 – The European Environment – state and outlook 2015". 2015. URL: https://www.eea.europa.eu/soer

management result in high sensitivity across this income group. This is further exacerbated by low adaptive capacity, especially around agricultural risk management.

The high-income economies of North America with their resource intensive agriculture sectors are particularly vulnerable to water-related resource risks. Even though the Great Lakes hold 20% of the world's freshwater (most of which is non-renewable water left-over from melted glaciers),[16] Canada and the United States are particularly susceptible to agriculture-related droughts: in Canada, agriculture consumed 80% of water withdrawn from water sources in 2013.[17] Focusing on more efficient water use technologies can help mitigate these risks.

Being landlocked confers both advantages and disadvantages when natural resources and resilience are considered. Though on average less food secure than coastal countries—with lack of direct access to coasts, poor infrastructure, long supply chains and high tariffs impacting trade volumes—landlocked countries show lower susceptibility to the harmful effects of rising temperatures, storms, rising sea levels and depletion of freshwater resources. However, as countries that are often dependent on natural capital, droughts, flooding and soil erosion pose very tangible threats to landlocked economies' agricultural sectors and food systems. And these countries often do not have the structures in place to manage disasters and adapt to climate- and resource-related risks.

16 Toronto Sun. "Fresh water scarcity is an issue in Canada too". 2016. URL: http://www.torontosun.com/2016/09/24/fresh-water-scarcity-is-an-issue-in-canada-too

17 Government of Canada, Environment and Climate Change Canada. "Water Withdrawal and Consumption by Sector". 2017. URL: https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=5736C951-1

2017 GFSI Natural Resources & Resilience rankings table

Weighted total of all Natural Resources & Resilience indicator scores (0-100 where 100=most favourable)

Rank		Score /100
1	Denmark	82.1
2	Slovakia	81.1
3	Austria	80.3
3	Czech Republic	80.3
5	Hungary	79.0
5	Switzerland	79.0
7	Poland	78.8
8	France	76.5
9	Uruguay	75.9
10	Romania	75.2
11	Bulgaria	75.1
12	Germany	74.9
13	Sweden	74.8
14	Greece	74.4
15	Canada	74.0
16	Ireland	73.4
17	Italy	72.9
18	Spain	72.5
19	New Zealand	72.3
20	Portugal	71.6
21	Finland	71.5
22	Uganda	71.3
23	Russia	71.0
24	Japan	70.4
25	Malawi	70.1
26	Cote d'Ivoire	69.9
27	Belgium	69.5
27	Burkina Faso	69.5
27	Myanmar	69.5
30	Serbia	69.0
31	Burundi	68.8
32	Laos	68.7
33	Netherlands	68.6
34	Rwanda	68.4
35	Kazakhstan	67.7
36	Tanzania	67.5
37	Zambia	67.3
38	Niger	67.0

Rank		Score /100
38	Turkey	67.0
38	United Kingdom	67.0
41	Paraguay	66.7
42	Norway	66.6
43	Madagascar	66.2
44	United States	65.8
45	Thailand	64.3
46	Argentina	64.2
47	Mali	63.8
48	Kenya	63.7
49	Cambodia	63.1
50	Jordan	62.8
51	Honduras	62.7
52	Belarus	62.6
52	Botswana	62.6
52	Chile	62.6
55	Pakistan	62.5
56	Bolivia	62.1
57	Guatemala	61.8
57	Nicaragua	61.8
57	Senegal	61.8
60	Ethiopia	61.1
61	Nigeria	60.7
62	Brazil	60.6
62	Venezuela	60.6
64	Togo	60.5
65	Haiti	60.4
66	Australia	60.1
66	China	60.1
68	Azerbaijan	59.8
69	Chad	59.0
70	Costa Rica	58.5
70	Nepal	58.5
72	El Salvador	58.4
72	Sri Lanka	58.4
74	Ukraine	58.2
75	Vietnam	58.1
76	South Africa	57.7

Rank		Score /100
77	Sierra Leone	57.5
78	Ghana	57.4
79	Cameroon	57.3
80	Egypt	57.0
80	Sudan	57.0
82	Angola	56.8
83	Tunisia	56.6
84	Benin	56.5
85	Bangladesh	56.2
86	Guinea	56.0
87	Morocco	55.1
88	Uzbekistan	54.7
89	Mexico	54.4
90	Mozambique	54.3
91	Panama	54.1
92	South Korea	53.9
93	Colombia	53.8
94	India	53.7
94	Tajikistan	53.7
96	Dominican Republic	53.6
97	Algeria	53.5
98	Bahrain	53.0
99	Ecuador	52.4
100	Malaysia	52.1
101	Philippines	52.0
102	Israel	51.3
103	Kuwait	51.1
104	Syria	50.7
105	Qatar	49.9
106	Oman	49.2
106	Singapore	49.2
108	Yemen	47.5
109	Indonesia	46.5
110	Congo (Dem. Rep.)	46.3
110	Saudi Arabia	46.3
112	Peru	45.4
113	United Arab Emirates	40.0

2017 adjusted overall GFSI score

Overall GFSI score adjusted by the Natural Resources & Resilience overall score (0-100 where 100=most favourable)

Rise in ranking
Decline in ranking

Rank		Score /100	Rank*
1	Ireland	79.9	0
2	Austria	77.6	9
3	France	77.5	5
4	United States	77.4	-2
5	Germany	77.3	2
5	Switzerland	77.3	6
5	United Kingdom	77.3	-2
8	Canada	76.9	1
9	Denmark	76.7	7
10	Sweden	76.6	0
11	Netherlands	76.3	-5
12	New Zealand	75.4	2
13	Finland	75.2	1
14	Australia	75	-9
15	Norway	74.6	-2
16	Belgium	73.7	1
17	Japan	73.6	1
18	Portugal	73.4	2
19	Singapore	73.3	-15
20	Spain	72.7	1
21	Czech Republic	72.1	2
22	Italy	70.8	0
23	Poland	70.2	4
24	Israel	69.6	-5
25	Hungary	68.4	5
26	Chile	67.7	-2
27	Greece	67.3	4
28	Slovakia	66.7	6
29	South Korea	66.1	-5
30	Kuwait	65.5	-4
30	Uruguay	65.5	5
32	Oman	64.5	-4
33	Qatar	64.1	-4
34	Romania	63.5	4
35	Costa Rica	62.1	1
36	Saudi Arabia	61.5	-4
37	Russia	61.4	4
38	Argentina	61.3	2
39	Brazil	61	-1
40	Bahrain	60.5	-3
41	United Arab Emirates	60.3	-8
42	Bulgaria	59	5
43	Malaysia	58.3	-2
43	Mexico	58.3	0
45	China	57.3	0
46	South Africa	57.2	-2
47	Belarus	57.1	-1
48	Turkey	56.1	1
49	Serbia	55.9	1
50	Panama	55.3	-2
51	Botswana	53.8	1
52	Colombia	53.2	-1
53	Thailand	53.1	2
54	Jordan	52.9	1
55	Tunisia	52.4	-1
56	Azerbaijan	52	1
57	Paraguay	51.8	2
58	Kazakhstan	51.5	2
59	Peru	51.1	-6
60	Egypt	50.5	-2
61	Ecuador	48.6	0
62	Dominican Republic	48.4	0
62	Ukraine	48.4	1
64	Vietnam	48.3	0
65	El Salvador	47.6	0
66	Sri Lanka	47.5	0
67	Morocco	46.9	0
68	Bolivia	46.4	1
69	Algeria	45.5	-1
70	Venezuela	45.3	1
71	Nicaragua	45.2	1
72	Guatemala	44.9	1
73	Indonesia	44.4	-4
74	Honduras	44.1	1
75	Pakistan	43.3	2
76	India	43.2	-2
77	Ghana	42.8	-1
78	Uzbekistan	42.1	0
79	Philippines	41.6	0
80	Myanmar	41.4	0
81	Uganda	40.2	2
82	Senegal	40	0
83	Nepal	39.9	-2
84	Cambodia	39.3	-1
84	Cote d'Ivoire	39.3	1
86	Kenya	38.4	0
87	Cameroon	37.2	0
88	Rwanda	36.7	0
89	Mali	35.8	2
90	Bangladesh	35.4	-1
91	Benin	35.3	-1
92	Nigeria	34.6	0
93	Togo	33.5	0
94	Tanzania	32.5	1
95	Tajikistan	31.7	-1
96	Sudan	31.1	0
97	Burkina Faso	30.6	5
98	Laos	30.5	4
99	Guinea	30.3	-2
100	Ethiopia	30.1	-1
101	Mozambique	29.8	-3
101	Zambia	29.8	3
103	Angola	29.6	-2
104	Syria	29.2	-5
105	Malawi	29	0
106	Niger	27.1	0
107	Haiti	26.2	0
108	Sierra Leone	25.7	1
109	Chad	25.4	1
110	Yemen	25	-2
111	Madagascar	24.9	0
112	Burundi	23.1	1
113	Congo (Dem. Rep.)	22.1	-1

Global Food Security Index (Affordability, Availability, Quality & Safety)

Overview

The baseline Global Food Security Index (GFSI) considers the core issues of food affordability, availability, and quality and safety in 113 countries (natural resources and resilience are covered later in the report). Affordability, or the capacity to afford good-quality food without undue stress, is a crucial aspect of food security. This category explores the capacity of a country's people to pay for food, and their ability to cope with food-related price shocks.

Affordability is measured across six indicators:

- Food consumption as a share of household expenditure
- Proportion of the population under the global poverty line (% of population with income under US$3.10/day at 2011 purchasing power parity, or PPP, exchange rates)
- GDP per head at PPP exchange rates
- Agricultural import tariffs
- Presence of food safety-net programmes
- Access to financing for farmers

The Availability category assesses factors that influence the supply of food and the ease of access to food. It examines how structural aspects determine a country's capacity to produce and distribute food, and explores elements that might create bottlenecks or risks to accessibility.

Availability is measured across eight indicators:

- Sufficiency of supply
- Public expenditure on agricultural research and development (R&D)
- Agricultural infrastructure
- Volatility of agricultural production
- Political stability risk
- Corruption
- Urban absorption capacity
- Food loss

The Quality & Safety category moves beyond traditional welfare metrics, such as poverty and issues of access and supply, and explores the nutritional quality of average diets and the food safety environment in each country.

Food quality and safety is measured across five indicators:

- Diet diversification
- Nutritional standards
- Micronutrient availability
- Protein quality
- Food safety

Top performers and trends

Ireland is at the top. GDP per head has risen more than half since 2012, rebounding strongly from the Irish banking crisis of 2008-10 and boosted by the large number of multinational companies who have established their European headquarters in Ireland. Investment in agriculture is a priority for the government[18] and consistently high public sector investment in agriculture (even with the slight drop in 2016) has supported Ireland's progressive rise. However, despite Ireland's strong performance, wealth distribution at the national level remains a concern.

The United Kingdom's five-year gains are at risk. Rising personal incomes, investment in agricultural R&D, and lower import tariffs for agricultural goods have pushed the United Kingdom into 3rd place from 16th spot in 2012. Brexit, however, poses a risk to the country's continued progress, with The Economist Intelligence Unit forecasting that personal incomes will fall 6% through 2018. The UK produced only 60% of its food in 2016 and is leaving the European Union (EU) at a time when it relies on imported food more than any time in the past five decades.[19] Once Britain leaves the EU, it will have to do without billions of pounds in subsidies under the EU's Common Agricultural Policy, direct access to European markets and unrestricted access to cheap agricultural laborers from Europe.[20]

Paraguay progresses, but hunger lingers. Paraguay's ranking saw the biggest improvement over the past year, moving from 67th place to 59th this year. The improvement occurred as a result of rising incomes, greater political stability and falling corruption. While graft in the country remains widespread, Transparency International's Corruption Perception Index 2016 shows some progress in preventing public malfeasance.[21] New anti-corruption hotlines and a crackdown on public-sector inefficiency have helped in this regard, while civil society is increasingly demanding a better and more transparent government, both of which have created an opportunity to develop and improve food distribution systems in the country. About a tenth of Paraguay's population, however, faces hunger and malnutrition despite a decade of impressive economic growth, a burgeoning agriculture sector and corruption crackdowns, indicating that there are still substantial food security challenges in the country.[22]

Upper-middle income Ecuador moves forward. Ecuador's improvement has been underpinned by a reduced dependency on chronic food aid, greater access to credit for farmers and an easing of political stability risk. Meanwhile, multilaterals have made a concerted effort to modernise agriculture, promote crop diversification and improve market access for small-holders, showcasing the impact that investments in agricultural development and a functional government system can have in supporting economic growth.[23]

18 European Commission, Representation in Ireland. "Agriculture". URL: http://ec.europa.eu/ireland/news/key-eu-policy-areas/agriculture_en

19 Bloomberg. "U.K.'s Self-Sufficiency in Food Is at Lowest in Decades: Chart". August 9th 2017. URL: www.bloomberg.com/news/articles/2017-08-09/u-k-s-self-sufficiency-in-food-is-at-lowest-in-decades-chart

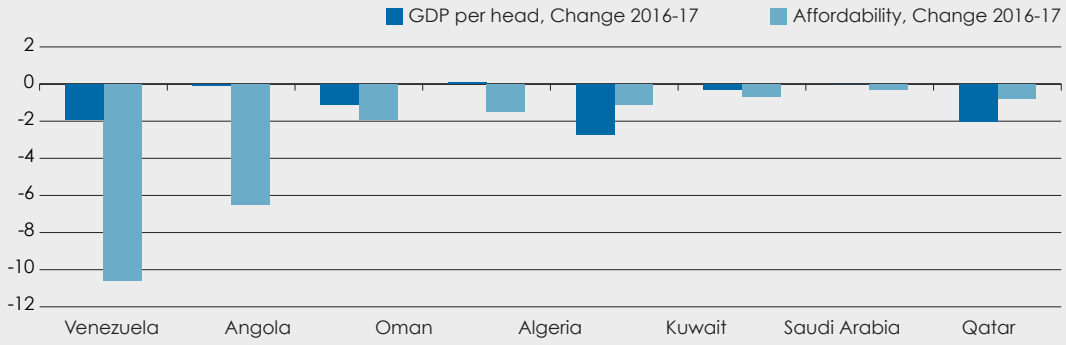
20 Financial Times. "Britain's farmers will need help after Brexit". August 22nd 2016. URL: www.ft.com/content/df151906-6616-11e6-a08a-c7ac04ef00aa

21 Transparency International. "Corruption Perception Index 2016: Paraguay". URL: www.transparency.org/country/PRY

22 Office of the United Nations High Commissioner for Human Rights. "Paraguay produces food for 60 million people, yet parts of its own population face hunger and malnutrition". November 10th 2016. URL: http://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=20843&LangID=E

23 The World Bank. "Sustainable Family Farming Modernization Project, Ecuador". June 10th 2017. URL: http://proyectos.agricultura.gob.ec:1010/pit/documentos/Documento%20de%20Evaluación%20de%20Proyecto%20%28Oficial%20-%20versión%20en%20inglés%29.pdf

Falling oil prices reduce affordability in oil exporting countries
Falling oil prices reduce affordability in oil exporting countries



Sources: EIU; GFSI.

Opportunities for improvement

Economic collapse in Venezuela is mirrored in its GFSI score. Venezuela is experiencing the steepest economic collapse in modern Latin American history. Weak oil prices and inept government management have led to a sharp decline of average incomes back to where they were in the 1950s. Survey results show that 93% of citizens say they cannot afford the food they need.[24] As a consequence, the GFSI shows a steep decline in Venezuela's score in the Affordability and Availability categories. More broadly, in the past year, falling oil prices have contributed to reduced food affordability in most of the GFSI oil exporting countries, including Angola, Ecuador, Kuwait, Nigeria, and Oman.

Drought in Sub-Saharan Africa worsens food insecurity. The Sub-Saharan countries, which are the most food insecure countries globally, have been hit by the worst drought since 1985.[25] This has increased populations' dependency on already overburdened multilateral and NGO-run food safety net programmes in Eastern and Southern Africa. The UN noted that, given the range of food crises around the globe, finding the funds to feed some 50m Africans would be extremely difficult.[26] The GFSI score breakdown mirrors the food security crisis in Sub-Saharan Africa. Ethiopia's scores for overall food security and food availability fell to their lowest since the Index was launched in 2012, as the country faces one of the most severe droughts since the 1980s with millions of people requiring emergency food aid.[27] In Madagascar, Africa' biggest island, a three-year drought, made worse by last year's El Niño, has caused harvests to fail.[28] As a result, the country's baseline GFSI score fell to an all-time low as availability and affordability plummeted.

Weak nutritional standards persist across the Middle East & North Africa. The oil rich Gulf States are countries where high average incomes and relatively low nutritional outcomes persist. National nutrition monitoring is an important tool for

24 The Economist. "How to deal with Venezuela". July 29th 2017. URL: www.economist.com/news/leaders/21725559-sanctions-should-target-officials-not-country-how-deal-venezuela

25 The Guardian. "Across Africa, the worst food crisis since 1985 looms for 50 million". May 22nd 2016. URL: https://www.theguardian.com/global-development/2016/may/22/africa-worst-famine-since-1985-looms-for-50-million

26 Ibid.

27 Washington Post. "Ethiopia is facing a killer drought. But it's almost going unnoticed." May 1st 2017. URL: www.washingtonpost.com/news/worldviews/wp/2017/05/01/ethiopia-is-facing-a-killer-drought-but-its-going-almost-unnoticed/?utm_term=.a1f918ab3ddc

28 NPR. "Drought-Stricken Southern Madagascar Teeters On The Edge Of Famine". December 5th 2016. URL: http://www.npr.org/sections/thesalt/2016/12/05/504164887/drought-stricken-southern-madagascar-teeters-on-the-edge-of-famine

governments to assess malnutrition and shape health policies that address it. Yet, in some of the region's most prosperous countries, such as Saudi Arabia and Qatar, monitoring is particularly weak, and about half of the region's fifteen high-income countries do not have national dietary guidelines. For example, there is no evidence of a current national nutrition strategy in the UAE, which has one of the world's highest incidents of diabetes[29], and whose strategy expired in 2015.[30]

Other noteworthy findings

Food security has slipped. More than three-fifths of the 113 countries in the Global Food Security Index have experienced declines in their food security scores since 2016. The decline comes amidst the slowest world GDP growth since 2009,[31] and more people are spending a greater share of their household incomes on food as demand exceeds production. Socio-demographics have also played a role, with migration occurring at a rate that many countries' economies and infrastructure––already burdened with large and growing urban populations––are unable to sustainably accommodate.

Political instability threatens food systems. Across most regions, rising international tensions and social unrest have negatively affected food systems. In Mexico internal protests against corruption have undermined confidence in the political establishment and the United States' hostile policy towards immigration and trade has dampened the foreign policy outlook.[32] In Myanmar, which is only emerging from half a century of military rule, insurgencies are rumbling on along its northern borders and state-led atrocities in Western Myanmar have undermined political stability.[33] Romania saw its political stability score fall as a result of the biggest protests since the fall of communism against a decree designed

29 GulfNews. "Fast food ingredients under health scanner in UAE nutrition strategy". May 26th 2010. URL: http://gulfnews.com/news/uae/health/fast-food-ingredients-under-health-scanner-in-uae-nutrition-strategy-1.632306

30 FAO. "The Second International Conference on Nutrition. Better Nutrition Better Lives." November 19th-21st 2014. URL: www.fao.org/fileadmin/user_upload/icn2/media/statements/doc/211114_United_Arab_Emirates.pdf

31 OECD-FAO. "Agricultural Outlook 2017-2015". URL: http://www.keepeek.com/Digital-Asset-Management/oecd/agriculture-and-food/oecd-fao-agricultural-outlook-2017-2026_agr_outlook-2017-en#page20

32 EIU Risk Briefing.

33 Ibid.

to weaken anti-graft legislation.[34] While ethnic tensions reemerged in Serbia as borders in the Balkans are again being questioned.[35]

Double-digit rises in incomes have in some cases boosted affordability rankings. China has recorded the biggest rise in incomes (up 54% in GDP per head since 2012) among the countries within the GFSI, followed by the lower-middle income economies in Sub-Saharan Africa and Southeast Asia. However, this growth has occurred as burgeoning populations and rapid urbanisation further strain food production, push up demand and change food consumption patterns. The strain will continue to grow, especially in Africa where the number of cities with a population of 5m-10m will rise from three in 2017 to 12 by 2030, and another 67 cities will house between 1m and 5m people.[36] Failing government intervention and a lack of private sector investment to increase the absorptive capacity of cities will lead to a greater number of people concentrated in poor urban areas, and therefore threaten food security given that these people tend to be net buyers of food.[37]

34 The Conversation. "Romania protests: what caused the biggest uprising since the fall of communism?" February 8th 2017. URL: http://theconversation.com/romania-protests-what-caused-the-biggest-uprising-since-the-fall-of-communism-72549

35 The Guardian. "Rumbling Balkans threaten foreign policy headache for Trump". February 27th 2017. URL: https://www.theguardian.com/world/2017/feb/27/balkans-foreign-policy-headache-trump-kosovo-serbia-bosnia-montenegro

36 Brookings Institute. "Urbanization in sub-Saharan Africa: Leveraging the opportunities". December 12th 2016. URL: https://www.brookings.edu/events/urbanization-in-sub-saharan-africa-leveraging-the-opportunities/

37 FAO. "Rapid urbanization and food security: Using food density maps to identify future food security hotspots". 2009. URL: www.fao.org/fileadmin/user_upload/esag/docs/RapidUrbanizationFoodSecurity.pdf

Natural Resources & Resilience

Category overview

The global agricultural sector, and in turn its ability to meet the dietary needs of a growing population, is further threatened by the sustainability of countries' natural assets and the threat of climate change. Higher temperatures, droughts, floods and rising seas necessitate building resilience in the agriculture sector and managing disaster risk. Innovations in inputs will allow farmers to adapt to some of the changing conditions, but without public and private sector commitment to conserving water and land resources and investment in sustainable agriculture development, the longer-term outlook for global food security would be bleak.

Exposure

Brief overview

Climate-related risks threaten food security. Managing them is critical to protect the agricultural sector. Rising temperatures, drought, flooding and other climate change impacts disproportionally affect food-insecure regions, hindering crop and livestock production, fish stocks and fisheries[38]. The Exposure indicator explores how susceptible national economies are to climate-related risks and how well equipped they are to mitigate and adapt, specifically in the agriculture sector.

Exposure is measured across six sub-indicators:

- Temperature rise
- Drought
- Flooding
- Storm severity (AAL)[39]
- Sea level rise
- Commitment to managing exposure

Top performers

Amongst European countries, Portugal and Spain are the least exposed. As EU member states they have comprehensive regulations addressing agriculture-related climate exposure and natural resource management. They have lower exposure to severe storms and flooding compared to most other European countries. However, both rank in the middle of the pack in Europe in terms of temperature rise and the large wildfires in northern and central Portugal that decimated almost 1m acres in 2017 suggest that climate-related risks are still great.[40]

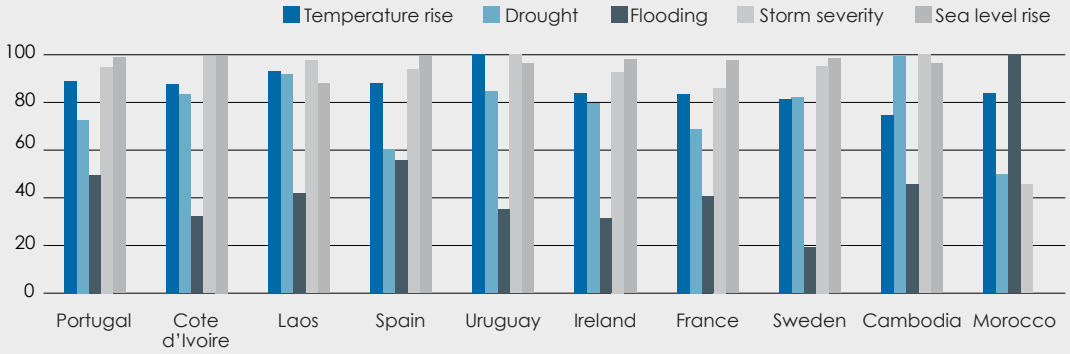
Landlocked Laos is least susceptible among its Asia Pacific peers. But despite its high ranking (third in the Exposure indicator), the country still faces climate-related risks. While 81% of the country remains under forest cover, thus helping to prevent flooding by allowing water to be drained into the

38 BioSafety Information Centre. "Challenges for Food and Agriculture in the 21st Century". March 27th 2017. URL: www.biosafety-info.net/article.php?aid=1368

39 AAL refers to average annual losses.

40 The Telegraph. "Wildfires rage across Portugal". August 10th 2017. URL: http://www.telegraph.co.uk/news/2017/08/10/wildfires-rage-across-portugal/

Countries with low exposure are generally still susceptible to flooding
Exposure indicator performance by type of risk



Source: GFSI calculation.

ground,[41] this figure masks the rapid changes in land use occurring in the country. Substantial agricultural investment in the country is funneling into rubber plantations. Though still considered forests, rubber plantations are threatening forest ecosystems and having a negative impact on soil quality, biodiversity and food security, while also heightening the risk of floods.[42]

Cote d'Ivoire stands out among lower-income countries. It is the only lower-income country with a commitment to managing exposure in the agricultural sector. This, along with lower risk of sea level rise and severe storms, puts it 2nd globally in the Exposure indicator. The country is the least susceptible to temperature rise in Sub-Saharan Africa, and risk exposure to earthquakes, wind and storm surges and tsunamis is small. Similar to most top performers in this category, exposure to flooding is a much higher risk than other impacts. This is understandable because storms and floods account for almost three-quarters of weather-related disasters. According to Munich Re, a reinsurer, globally the number of major storms and floods has increased from about 200 in 1980 to over 600 last year.[43]

Opportunities for improvement

Temperature rise and drought plague Ecuador and Peru. In these countries where crops are already close to their limits in tolerating extreme temperatures, rising temperatures are a real risk.[44] Ecuador's Nationally Determined Contribution under the Paris Agreement limits its agriculture-related adaptation plan to crop diversification and livestock, making it one of the countries with the most rudimentary exposure management plans. Projections by the Inter-American Development Bank show that Latin American countries will suffer widespread flooding and coastal damage, an increase in tropical diseases and climate change-related losses of US$30bn-52bn in agricultural exports by 2050.[45]

41 Sustainable Green Initiative. "How trees help in preventing floods". May 2013. URL: http://www.greening.in/2013/05/how-trees-help-in-preventing-floods.html

42 The Economist. "A bleak landscape". URL: https://www.economist.com/news/asia/21588421-secretive-ruling-clique-and-murky-land-grabs-spell-trouble-poor-country-bleak-landscape

43 The Economist. "How government policy exacerbates hurricanes like Harvey". URL: https://www.economist.com/news/leaders/21727898-if-global-warming-were-not-enough-threat-poor-planning-and-unwise-subsidies-make-floods

44 InsideClimateUse. "Climate Change Could Devastate Latin America's Agriculture". March 6th 2009. URL: https://insideclimatenews.org/news/20090306/climate-change-could-devastate-latin-americas-agriculture

45 Inter-American Development Bank. "Latin America and the Caribbean face massive economic damages from global warming, report warns". June 5th 2015. URL: http://www.iadb.org/en/news/webstories/2012-06-05/latin-america-and-the-caribbean-global-warming,10011.html

The countries of the GCC—Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and the UAE—are exceptionally vulnerable. The oil-rich area is the most susceptible of all regions to losses from storms, sea level rise and drought. Though the GCC countries' agricultural sectors are small—less than 2% of the total land area is arable—heightened exposure threatens to increase dependency on imports. On average they already import 60-80% of their food from abroad.[46] Furthermore, management of risks is particularly weak: for example, Qatar, ranked 110th out of 113 countries in this category, has no exposure management measures in place.

Singapore may be rich, but it too is extremely exposed. Island-city state Singapore's liability to rising sea levels and extreme weather events make it especially vulnerable to natural resources and climate risks. Singapore is ranked 4th globally on the unadjusted GFSI, but once natural resource and climate risks are factored in its rank drops to 19th. Singapore is not alone in having no adequate farmland to support its population—some 66 countries share this feature according to one study.[47] But as a global trading hub for many commodities, including food, high-income Singapore is well placed to support the region's efforts to adapt to and mitigate the effects of exposure on food security.

Other noteworthy findings

Rising seas threaten the Netherlands and Bangladesh. A quarter of the Netherlands' territory is below the mean sea level and 35% of its 17m population lives in flood-prone areas.[48] [49] The urban area in the flood-prone Dutch delta has increased six-fold in the 20th century. More positively, while exposure has grown by a factor of sixteen, the capacity to deal with catastrophic floods has concomitantly improved, as the Dutch have constructed lakes, parks and plazas designed to act as enormous reservoirs when flooding occurs.[50] [51] In low-lying Bangladesh, the world's most densely populated big country, scientists estimate that a three-foot sea level rise would submerge almost 20% of low-lying delta and displace more than 30m people.[52] Exacerbating the burden of having to feed these 30m people, the loss of agricultural land owing to the flooding would also threaten the country's food self-sufficiency.

46 NCB Capital. "Bridging the food gap". March 2010. URL: https://www.gulfbase.com/ScheduleReports/GCC_Agriculture_Sector_March2010.pdf

47 FAO. "Food security and international trade". 2015-16. URL: http://www.fao.org/3/a-i5160e.pdf

48 ClimateChangePost.com. "Coastal flood risk: The Netherlands". URL: www.climatechangepost.com/netherlands/coastal-floods/

49 WorldPoliticsReview. "Threat of Rising Sea Levels Drives the Netherland's Climate Policy". September 30th 2016. URL: www.worldpoliticsreview.com/trend-lines/20071/threat-of-rising-sea-levels-drives-the-netherland-s-climate-policy

50 ClimateChangePost.com. "Coastal flood risk: The Netherlands". URL: www.climatechangepost.com/netherlands/coastal-floods/

51 The New York Times. "The Dutch Have Solutions to Rising Seas. The World Is Watching." June 15th 2017. URL: https://www.nytimes.com/interactive/2017/06/15/world/europe/climate-change-rotterdam.html

52 Scientfic American. "The Unfolding Tragedy of Climate Change in Bangladesh". April 21st 2017. URL: https://blogs.scientificamerican.com/guest-blog/the-unfolding-tragedy-of-climate-change-in-bangladesh/

Grappling with unprecedented climate-related displacement

Rising sea levels could strain food security across India and Bangladesh

It could be the largest migration in human history: 8m Bangladeshis and 5m Indians who live in the Sundarbans[53]—a group of 200 islands in the world's largest river delta in the Bay of Bengal—are at risk of losing their homes, livelihoods and even lives to rising seas and swelling rivers. Rising temperatures and melting glaciers in the Himalayas[54] (where two major rivers[55] that ultimately empty into the Bay of Bengal originate) could submerge the islands within two decades.[56]

Extreme weather and climate change are already affecting both countries: The Indian Sundarbans have lost almost 10,000 ha (or 2.5% of total land area) in recent decades.[57] Meanwhile, uncharacteristically high pre-monsoon rainfall in Bangladesh this year flooded 400,000 ha of land across the country (including in the Sundarbans), and destroyed 2m tonnes of rice, forcing the country to put out a tender for imports from India and Thailand for the first time in six years.[58] This has made a country that is already dependent on food aid—it received over US$350m in emergency food aid between 2007-2015[59]—even more so, especially since the price of rice has increased by 57% since 2016[60].

As Indians and Bangaldeshis in the Sundarbans struggle with flooding, communities in mainland India, particularly West Bengal (the 100m people-strong state that shares a border with Bangladesh), should also be preparing to tackle the challenges of reduced agricultural yields and increased price volatility. Agriculture across West Bengal is already vulnerable to the vagaries of monsoons[61] and rising temperatures.[62] And this vulnerability is compounded by the potential large-scale climate-driven migration of Indians and Bangladeshis from the Sundarbans into the state's already over-stretched towns. According to officials, by 2015, over 10,000 people in 60 island villages—a fraction of the number that might be forced to migrate as sea levels continue to rise—had left the Sundarbans.[63] Partially as a consequence, in the period from 2001-11, one township alone (Patharptatima, in West Bengal) witnessed a 51% population increase.[64]

Though climate-related migration accounts for only a portion of the population growth in Patharptatima, and it is impossible to anticipate where climate refugees will migrate to over the next few decades,[65] the potential impact could clearly be extreme. A quarter of West Bengal's population currently lives below the poverty line,[66] a share that is likely to increase if climate refugees flood the state. Food safety net programmes like the West Bengal chief minister's food security scheme, which subsidise grains for 70m people (the equivalent of the entire population of the United Kingdom), and costs over US$1.25bn, would require substantial additional investment to accommodate the rapidly expanding population.[67] And, while food distribution in West Bengal has improved rapidly in the past few years,[68] risks to agricultural performance already threaten additional progress on improving access in the state. As is the case with most large-scale migration, an inflow of "climate refugees" could exert tremendous pressure on food systems and limit the government's ability to target those most in need.

There is opportunity to collaboratively pre-empt the more severe consequences of this climate-related crisis if national and state-level governments in India and Bangladesh focus on short-term adaptation measures like sandbag levees and cyclone shelters, while also investing in long-term strategies such as co-ordinated rehabilitation and disaster risk reduction policy.[69] That being said, the most effective solution continues to be global cohesive climate change mitigation efforts designed to prevent further temperature and sea level rises that threaten the populations, economies and geographies of low-lying, densely populated countries and regions.

53 Huffington Post. "Between The Dark Seas And Living Hell: Women refugees from Sundarbans, the world's most vulnerable climate hotspot, are trapped in a nightmare". July 1st 2016. URL: http://projects.huffingtonpost.in/articles/sundarbans/

54 News Nation. "Climate change strikes Gangotri glacier, retreated by 0.15 sq km between 2007-16". 2017. URL: http://www.newsnation.in/science-news/climate-change-strikes-gangotri-glacier-retreated-by-0-15-sq-km-between-2007-16-article-177734.html

55 The Ganges and the Brahmaputra rivers.

56 Centre for Science & Environment. "Living with Changing Climate: Indian Sundarbans". URL: http://www.cseindia.org/userfiles/adaptation_paradigm.pdf

57 Huffington Post. "Between The Dark Seas And Living Hell: Women refugees from Sundarbans, the world's most vulnerable climate hotspot, are trapped in a nightmare". July 1st 2016. URL: http://projects.huffingtonpost.in/articles/sundarbans/

58 Climate Home. "Bangladesh faces food supply crunch after flash floods". 2017. URL: http://www.climatechangenews.com/2017/05/15/bangladesh-faces-food-supply-crunch-flash-floods/

59 OECD. "Food aid". URL: https://data.oecd.org/oda/food-aid.htm

60 Climate Home. "Bangladesh faces food supply crunch after flash floods". 2017. URL: http://www.climatechangenews.com/2017/05/15/bangladesh-faces-food-supply-crunch-flash-floods/

61 The Hindu Business Line. "Bihar, Bengal grapple with fresh flooding". August 14th 2017. URL: http://www.thehindubusinessline.com/news/bihar-bengal-grapple-with-fresh-flooding/article9818231.ece

62 Hindustan Times. "Sharp spike in natural disasters impacting agriculture, data shows". July 31st 2017. URL: http://www.hindustantimes.com/india-news/sharp-spike-in-natural-disasters-impacting-agriculture-data-shows/story-Wv5ywWXx6U1X4hwVjnVFZK.html

63 Reuters. "'Everyday disasters' driving flight from Subdarbans". April 7th 2015. URL: http://www.reuters.com/article/us-india-sundarbans-migration-idUSKBN0MY0AW20150407

64 Ibid.

65 There is no international definition for "climate refugees" and migration from Bangladesh into India is a politically fractious issue at both the federal and state level. This makes it difficult to forecast the number of people who will migrate because of climate change.

66 Ministry of Social Justice and Empowerment. URL: http://socialjustice.nic.in/UserView/index?mid=76672

67 Deccan Herald. "Mamata launches food security scheme". December 20th 2015. URL: http://www.deccanherald.com/content/518531/mamata-launches-food-security-scheme.html

68 The Indian Express. "PDS has improved in West Bengal, but it's still not up to the mark". September 16th 2016. URL: http://indianexpress.com/article/opinion/columns/mamata-banerjee-public-distribution-system-west-bengal-food-security-act-3033234/

69 Scientific American. "The Unfolding Tragedy of Climate Change in Bangladesh". April 21st 2017. URL: https://blogs.scientificamerican.com/guest-blog/the-unfolding-tragedy-of-climate-change-in-bangladesh/

Flood risk is high for big food producers. China, India, Canada and Ukraine are among the countries most susceptible to flooding, and the potential impacts for global food supplies are extreme. In 2016, these four countries produced over 270m tonnes of wheat,[70] with Canada and Ukraine alone accounting for 12.4% and 7.2% of global wheat exports respectively.[71]

Water

Brief overview

Water security and food security are inextricably linked. Agriculture accounts for 70% of water withdrawals worldwide, and 1.5bn people work in water related sectors (agriculture, energy and environmental protection, among others). Freshwater is the backbone of food security, yet many freshwater resources are at risk of being overused and polluted. Threats to freshwater quantity and quality can be attributed to agricultural practices (eg, overuse of resources, fertilisers, nitrogen runoff). The Water indicator explores the risks facing freshwater resources in each country as a result of agricultural water withdrawals.

Water risk is measured across two sub-indicators:

- Agricultural water risk—quantity
- Agricultural water risk—quality

Top performers

Sub-Saharan Africa is at the top. Thirteen countries in the region rank in the top 20 globally in terms of the quality and quantity of freshwater. Since the GFSI measures the impact of freshwater withdrawals by agriculture on the renewable water supply in a country, arid areas with low water use and withdrawals perform well. In top-ranked Uganda, some 84% of people live in rural areas and rely on subsistence farming,[72] but freshwater withdrawals allocated to agriculture in the water-stressed country are small. Water intensive, industrialised agriculture is rare in the region. South Africa, which has the region's most developed agriculture sector, ranks lowest among SSA countries. Despite the region's high ranking within the category, the use of water for agriculture will only rise as it develops and irrigation expands. Conservation-conscious water management policies and innovative technologies will be needed to help the region use water more efficiently and still meet the food demand of Africa's growing population.[73]

Second-ranked Denmark has made major progress in improving water resources. Early public awareness of environmental issues and government action—the country was one of the first to create a ministry dedicated to environmental issues—have put Denmark at the forefront of sustainably managing its significant quantities of freshwater resources.[74] Danish companies have established a strong foothold in technologies used to treat and conserve water and map groundwater,[75] and, as a result, only 7.8% of water is lost before it reaches the consumer, compared with 30-60% in many other countries.[76] A mix of strict water regulations and smart

70 "World Map with Top Ten Countries by Wheat Production". URL: https://www.mapsofworld.com/world-top-ten/world-map-countries-wheat-production.html

71 World's Top Exports. "Wheat Exports by Country". May 10th 2017. URL: http://www.worldstopexports.com/wheat-exports-country/

72 FarmAfrica. URL: www.farmafrica.org/uganda/uganda

73 Journal of Water Resource and Protection. "The Need for Agricultural Water Management in Sub-Saharan Africa". 2016, 8, 835-843. Published Online. August 2016. in SciRes. URL: http://www.scirp.org/journal/jwarp http://dx.doi.org/10.4236/jwarp.2016.89068

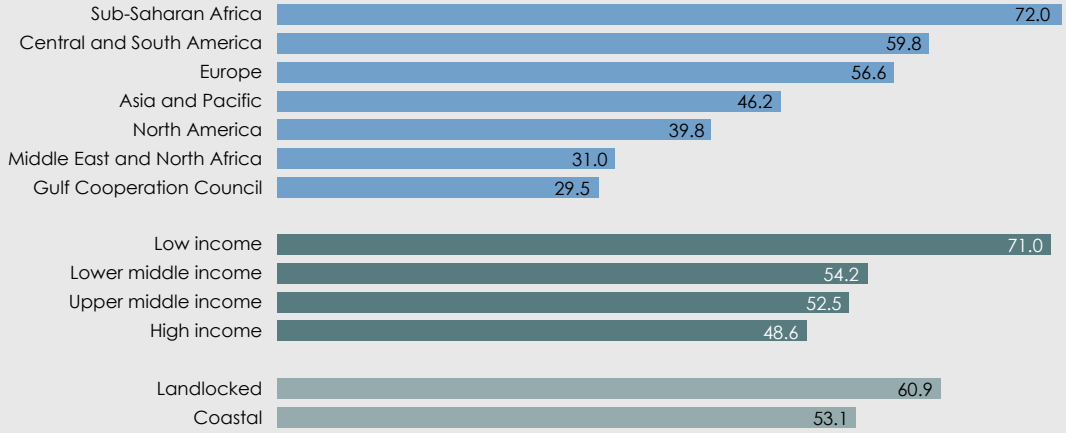
74 Eco-Business. "Denmark's Vision for solving the world's water woes". March 25th 2015. URL: http://www.eco-business.com/news/denmarks-vision-for-solving-the-worlds-water-woes/

75 Ibid.

76 Ministry of Environment and Food of Denmark. "Identity source of water loss". URL: http://eng.mst.dk/nature-water/water-at-home/water-loss/

Freshwater resources risk

Average Water indicator scores by region / group



Note: The Water indicator is a composite indicator that measures the health of fresh-water resources and how depletion might impact agriculture. Subindicators include water quantity and water quality risks based on agricultural water withdrawals. A higher score equals lower risk.

Sources: GFSI; WRI Aqueduct.

technologies also ensure extremely high water quality. Denmark's water policies point the way to sustainable food production under growing water scarcity, and can provide an example of successful water management strategies that could be applied to food insecure regions.

The Mekong River Basin boasts ample freshwater resources. The Mekong sits at the heart of six countries'[77] food, energy and water supply.[78] Yet poor water governance and rapid economic development pose significant challenges, with hydropower and industrial contamination threatening the health of the basin's ecosystems, its water quality and fish stocks, according to a recent report from The Economist Intelligence Unit.[79] The food security and livelihoods of millions in the basin are dependent on the Mekong, especially those in the mountainous regions in northern Laos and Vietnam, Cambodia's north-west and areas around the Tonlé Sap, and parts of north-eastern Thailand—all of which are regularly affected by drought.[80]

Opportunities for improvement

North American water is vulnerable to over-withdrawal. The United States, the third largest producer of food after China and India, ranks in the bottom twenty countries in our rankings on exposure to water-related risks. Its northern neighbor, Canada, ranks 58th. The Great Lakes, which border Canada and the US, hold 20% of the world's freshwater (most of which is non-renewable water left-over from melted glaciers),[81] but both countries' large, water-intensive agricultural sectors are susceptible to changes in the availability and quality of water. In Canada, agriculture consumes about 80% of water

77 The lower 86% of the Mekong River Basin, which falls within Myanmar, Laos, Thailand, Cambodia and Vietnam, is known as the Lower Mekong Basin; the northern portion of the river basin lying within China is known as the Upper Mekong Basin, or the Lancang River Basin (in reference to the river's Chinese name).

78 The Economist Intelligence Unit. "Water security threats demand new collaborations: Lessons from the Mekong River Basin". 2017. URL: http://foodsecurityindex.eiu.com/Resources

79 Ibid.

80 Ibid.

81 Toronto Sun. "Fresh water scarcity is an issue in Canada too". 2016. URL: http://www.torontosun.com/2016/09/24/fresh-water-scarcity-is-an-issue-in-canada-too

withdrawn from freshwater sources.[82] The impacts of climate change are expected to shift the area of crop productivity north, increase the reliance on irrigation and pesticides and herbicides.[83] To sustain food output and long-term food security, programmes that promote efficient irrigation, climate-resistant crops and efficient water pricing will be needed.[84]

Wastewater discharges threaten Europe's water. Aside from the Scandinavian countries—Denmark, Norway, Finland and Sweden—other European countries struggle with freshwater resources. The region's top performer is landlocked Switzerland, which ranks 41st (compared with 5th in the Natural Resources & Resilience category overall). The results are consistent with findings by the European Environmental Agency, which show that only 53% of Europe's fresh-water bodies remained in good ecological condition in 2015.[85] [86] The remaining bodies have suffered from urbanisation, agriculture, changes in land use and rising pollution from nitrates in fertilisers. The European Environmental Agency commends the region's progress in curbing the dumping of untreated urban and industrial wastewater into rivers, but argues that more needs to be done to reduce fertiliser use in agriculture.[87] [88]

82 Government of Canada, Environment and Climate Change Canada. "Water Withdrawal and Consumption by Sector". 2017. URL: https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=5736C951-1

83 Center for Water Policy. "Climate change impacts on Agriculture in the Great Lakes Basin". 2013.URL: http://uwm.edu/centerforwaterpolicy/wp-content/uploads/sites/170/2013/10/Great-Lakes_Agriculture_Final.pdf

84 Ibid.

85 Nature. "Europe sounds alarm over freshwater pollution". March 2nd 2015. URL: http://www.nature.com/news/europe-sounds-alarm-over-freshwater-pollution-1.17021

86 European Environment Agency. "SOER 2015 – The European Environment – state and outlook 2015". 2015. URL: https://www.eea.europa.eu/soer

87 Nature. "Europe sounds alarm over freshwater pollution". March 2nd 2015. URL: www.nature.com/news/europe-sounds-alarm-over-freshwater-pollution-1.17021

88 European Environment Agency. "SOER 2015 — The European environment — state and outlook 2015". URL: www.eea.europa.eu/soer

Other noteworthy findings

Middle East & North Africa are most vulnerable to agricultural water risk. These findings mirror results of a World Resources Institute study on the world's most water stressed countries by 2040, which projects that 14 out of 33 countries that will be most water stressed are in the Middle East.[89] As these countries continue to focus on driving economic growth, additional burden will be placed on already stressed freshwater resources. Some of this stress can be alleviated by innovation: though Israel is the most at risk country in the region, it is among the most innovative countries in developing man-made water resources. Its Sorek desalination plant, near Tel Aviv, is the world's largest reverse-osmosis desalination facility. It transforms seawater of the Mediterranean into drinking water for 1.5m people.[90]

China's and India's water withdrawals are unsustainable. These two largest food-producing countries globally rank 99th and 108th out of 113 countries respectively in terms of water-related risks. In India, water stresses will rise as the population approaches 1.7bn by 2050. Largely rain-fed agriculture makes the country especially vulnerable to climate-related fluctuations in the annual monsoon and changes in energy prices that impact the cost of ground water extraction.[91] India is home to a quarter of the world's undernourished people—more than any other country—and is at the heart of the global food

89 The Jerusalem Post. "Israel likely to be water-stressed in 2040, study finds". URL: http://www.jpost.com/Business-and-Innovation/Environment/Israel-likely-to-be-water-stressed-in-2040-study-finds-413404

90 Scientific American. "Israel Proves the Desalination Era Is Here". July 26th 2016. URL: https://www.scientificamerican.com/article/israel-proves-the-desalination-era-is-here/

91 Hindu Business. "Food, energy, water security go together". March 14th 2017. URL: http://www.thehindubusinessline.com/opinion/food-energy-water-security-go-together/article9583819.ece

security challenge,[92] making policymakers particularly concerned about the lack of long-term replenishable water resources.[93] In China, scientists estimate that 678m people now live in areas that are facing high and extremely high water stress.[94] Agricultural freshwater withdrawals as a percentage of total freshwater withdrawals are lower than in India (64% versus 87%). As China's population is likely to start shrinking after 2030, experts anticipate that overall food security in the country is unlikely to be highly compromised by climate change, though considerable uncertainty exists around the capacity of some of China's regions to adapt to water stresses and the potential agricultural impacts.[95]

Land

Brief overview

The competition for natural resources in agriculture can lead to overexploitation and unsustainable usage.[96] The management of agricultural land and forests and nefarious impacts of land use change affect the extent to which greenhouse gases are emitted into or removed from the atmosphere. Soil quality, the extent of grasslands that can act as carbon sinks, and changes in the health and extent of forest cover are all intrinsically linked to food security. The Land indicator measures the health of land in the country and its impact on agriculture.

Land is measured across three sub-indicators:

- Soil erosion/organic matter
- Grassland
- Forest change

Top performers

Forest recovery in the Dominican Republic and Vietnam is encouraging.[97] Forests are critical for maintaining the health of soil and storing groundwater, which in turn improve agricultural productivity. In the Dominican Republic, high rates of deforestation have in effect been halted, but only after the share of the country's land area accounted for by forest had been reduced to around 41% from 70% in the 1980s.[98] Similarly, after losing a third of its forest between 1943 and the early 1990s, Vietnam has curbed deforestation and accelerated reforestation.[99] A policy of devolution of forest control, which incentivises locals to look after "their" forests, has been an important driver of reduced deforestation,[100] and consequently supported longer-term food security efforts.

Europe boasts fertile soil. More than half of the 25 countries that receive the highest possible score on the Soil erosion / organic matter sub-indicator are in Europe. The productivity and fertility of soils—though changing—remains relatively high. However, while European countries perform well in terms of soil quality, they tend to rank in the lower half of the index in terms of

92 World Food Programme. "Food Security in India Quarterly Bulletin". URL: https://www.wfp.org/content/food-security-india-quarterly-bulletin

93 The Water Project. "Water in Crisis – India". URL: https://thewaterproject.org/water-crisis/water-in-crisis-india

94 World Resources Institute. "China's Water Stress Is on the Rise". January 10th 2017. URL: http://www.wri.org/blog/2017/01/chinas-water-stress-rise

95 EconomicsEjournal. "Chinese Food Security and Climate Change: Agriculture Futures". January 7th 2017. URL: http://www.economics-ejournal.org/economics/discussionpapers/2013-2/file

96 FAO. "The future of food and agriculture: Trends and Challenges". 2017. URL: www.fao.org/3/a-i6583e.pdf

97 The reddeesk.org. "REDD in Dominican Republic". URL: http://theredddesk.org/countries/dominican-republic

98 Ibid.

99 Hoan, D.T. and Catacutan, D. "Beyond reforestation: An assessment of Vietnam's REDD+ Readiness". 2014. Working Paper 180. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. URL: http://www.worldagroforestry.org/sea/Publications/files/workingpaper/WP0183-14.pdf

100 Mongabay. "Vietnam's forests on the upswing after years of recovery". December 11th 2016. URL: https://news.mongabay.com/2016/12/vietnams-forests-on-the-upswing-after-years-of-recovery/

greenhouse gas (GHG) emissions from grasslands. Grasslands, which cover 37% of the earth's surface, are an important store of carbon and important for global food supply, especially animal milk and meat production.[101]

Opportunities for improvement

Botswana and Indonesia face land degradation risks. Steady decline in forest cover, soil quality constraints and erosion drive Botswana's poor performance, while Indonesia's rapid deforestation and poorly preserved grasslands undermine the country's agricultural productivity. Experts agree that Indonesia needs to develop more effective agrarian policies, including raising yields of subsistence crops, reconstructing irrigation systems and instituting land policies and enforcement that protect land-grabbing from industrialised agriculture.[102]

Venezuela, Brazil and Paraguay are at the bottom. These three Latin American countries are particularly affected by deforestation and soil quality constraints. The loss of Brazil's Amazon rainforest presents significant environmental challenges ranging from soil erosion and water quality problems to a loss of biodiversity and social conflict. The resulting erosion and loss of top soil often force farmers to use fertilisers to boost yields on poor soils, which can result in high agriculture emissions and contaminate freshwater resources.[103] [104] As Brazil's agricultural area expands, more robust deforestation and national soil policies are needed to support sustainable agriculture.[105] After losing about 500,000 sq. km of forest from 1990-2015, Brazil's Ministries of Agriculture and the Environment committed to restoring 12m hectares of deforested and degraded forest land by 2030.[106] [107]

Other noteworthy findings

Rapid deforestation in Myanmar poses risks to food security. This Southeastern Asian country has undergone a remarkable opening and a return to civilian rule. Yet governance remains extremely weak and, despite an official ban on logging, deforestation continues at a rapid pace. Myanmar's fertile land and endowment of natural resources should ensure robust food security and agricultural development in the country, but a further loss of forest could have troubling effects on food security.

Asia-Pacific faces pressure on land resources. Among the regions with sizable agricultural sectors, the countries in Asia-Pacific struggle most with land resources, especially with land degradation and emissions from drainage of organic soils under grassland. An intensification of agriculture is likely in Asia as the demand for food rises, but the potential for adding crop area is very limited, which exacerbates existing food security concerns in the region.[108]

101 O'Mara, F.P. "The role of grasslands in food security and climate change". 2012. URL: https://www.ncbi.nlm.nih.gov/pubmed/23002270

102 Inside Indonsia. "Food Security in Indonesia". October 25th 2017. URL: www.insideindonesia.org/food-security-in-indonesia-2

103 WWF. "Soil Erosion and Degradation". URL: https://www.worldwildlife.org/threats/soil-erosion-and-degradation

104 Science Daily. "Devastating human impact on the Amazon rainforest revealed". May 2014. URL: https://www.sciencedaily.com/releases/2014/05/140522104856.htm

105 International Soil and Water Conservation Research. "The expansion of Brazilian agriculture: Soil erosion scenarios". December 2013. URL: http://www.sciencedirect.com/science/article/pii/S2095633915300290

106 The World Bank SDG Atlas 2017, "Life on land". URL http://datatopics.worldbank.org/sdgatlas/SDG-15-life-on-land.html

107 WRI, "STATEMENT: Brazil Announces Goal of Restoring 22 Million Hectares of Degraded Land by 2030", 2016. URL: http://www.wri.org/news/2016/12/statement-brazil-announces-goal-restoring-22-million-hectares-deg raded-land-2030

108 Pugh, T.A.M et al. "Climate analogues suggest limited potential for intensification of production on current croplands under climate change". 2016. URL: https://www.nature.com/articles/ncomms12608

The outlook in low-income economies is bleak. While the underdeveloped agricultural economies performed well in quantity and quality of freshwater resources, not a single low-income country makes it into the top 20 in the Land indicator. The World Bank notes that land is at the heart of development challenges and our ranking in the category mirrors this assessment.[109] Investment in agriculture is needed to reduce poverty and enhance food security, as such investment can be four times more effective in raising incomes of the poor than growth in other economic sectors.[110] The FAO reckons that global agricultural investment by the private sector must increase from US$142bn a year to US$209bn to feed a growing population. But if that investment is not channelled into sustainable agriculture and conservation measures, the potential natural resource risks could threaten long-term food security.

Oceans

Brief overview

Oceans occupy nearly three-quarters of the earth's surface area, provide over half of the oxygen we breathe, absorb massive amounts of earth-warming greenhouse gases and are a fundamental component of the global weather system. They are also the primary source of protein for over 3bn people around the world.[111] Ensuring their health is thus key to food security. The Oceans indicator measures the health of oceans, exploring the threat of nutrient over-enrichment, the overexploitation and collapse of fish stocks, and the protection and preservation of marine ecosystems.

The Oceans indicator is measured across three sub-indicators:

- Eutrophication and hypoxia (richness of nutrients and oxygen depletion)
- Marine biodiversity
- Marine protected areas

(Landlocked countries receive the highest possible scores across each sub-indicator, as they rely less on oceans as a protein source).

Top performers

Among coastal countries, Denmark is at the top. Denmark has successfully reduced agriculture run-off into and nitrogen levels in its coastal waters by limiting the density of livestock on land, improving storage capacity for manure and increasing the utilisation of catch crops[112] between planting seasons of main crops.[113] The country's waters were once much more polluted, but awareness and government action have significantly changed the environmental status of coastal waters. Although Danish waters are not yet classified by the EU as unaffected by eutrophication,[114] Denmark is held up as a model of food security and sustainability.[115]

109 World Bank. "Land". April 17th 2017. URL: http://www.worldbank.org/en/topic/sustainabledevelopment/brief/land

110 World Bank. "Land and Food Security". URL: http://www.worldbank.org/en/topic/agriculture/brief/land-and-food-security1

111 United Nations, Sustainable Development Goals. "Goal 14: Conserve and sustainably use the oceans, seas and marine resources". URL: http://www.un.org/sustainabledevelopment/oceans/

112 Catch crops are fast-growing crops grown between plantings of main crops.

113 Nørring, N.P. and Jørgensen, E. "Eutrophication and agriculture in Denmark: 20 years of experience and prospects for the future". Hydrobiologia (2009). URL: https://link.springer.com/article/10.1007/s10750-009-9772-2

114 Ambio. "Nitrogen inputs from agriculture: towards better assessments of eutrophication status in marine waters". 2014. URL: https://www.ncbi.nlm.nih.gov/pubmed/24715386

115 Coleen Slebzak. "Food Security: Denmark Personifies the Perfect Economic Example of Sustainability". URL: https://colleenslebzak.wordpress.com/2013/06/05/food-security-denmark-personifies-the-perfect-economic-example-of-sustainability/

Assessing the potential impact of rising sea levels and the degradation of oceans in land-locked economies

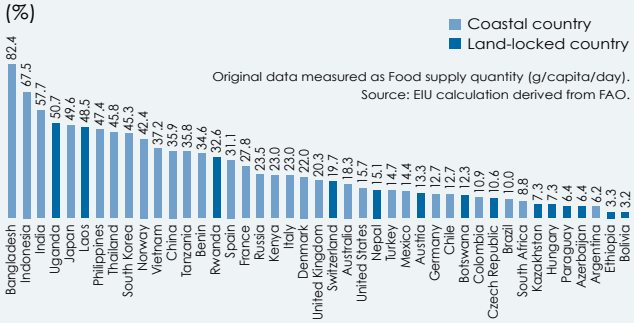
The 27 land-locked countries[116] in the Global Food Security Index posed a research challenge for the Exposure (4.1) and Oceans (4.4) indicators in the new Natural Resources & Resilience category. The data sources used to assess the potential impacts of sea level rise (4.1.5), ocean eutrophication and hypoxia (4.4.1), marine biodiversity (4.4.2) and marine protected areas (4.4.3) do not include land-locked countries. The Economist Intelligence Unit took a two-fold approach to assessing the potential risks that climate change and natural resource depletion pose to oceans for land-locked economies.

When estimating the future impact of rising sea-levels—which, in addition to threatening agricultural land and crops in coastal areas, can jeopardise food and agriculture supply chains and impact food accessibility and affordability (and farmer incomes) across countries—we considered the potential risks of rising sea levels in coastal trading partners and across supply chain routes. If rising seas pose extreme risks to a land-locked country's primary coastal access routes and suppliers, the likelihood that there could be trickle-down effects in the land-locked country itself is higher.

In addition, we considered how critical ocean-based food sources are to land-locked countries diets. Countries without coastlines, especially those with higher incomes, generally consume less fish than their coastal counterparts: on average fish consumption comprises about a third (30.2%) of total fish and meat supply in coastal GFSI countries compared with less than a fifth (17.8%) in land-locked ones.[117] To account for this lower dependence on fish-based protein, the GFSI model assumes that ocean resource depletion will affect inland countries, but that the effect will be comparatively low. Land-locked countries, therefore, receive the highest score across the Oceans indicator (4.4), reflecting relative protection and innate resilience to potential risks.

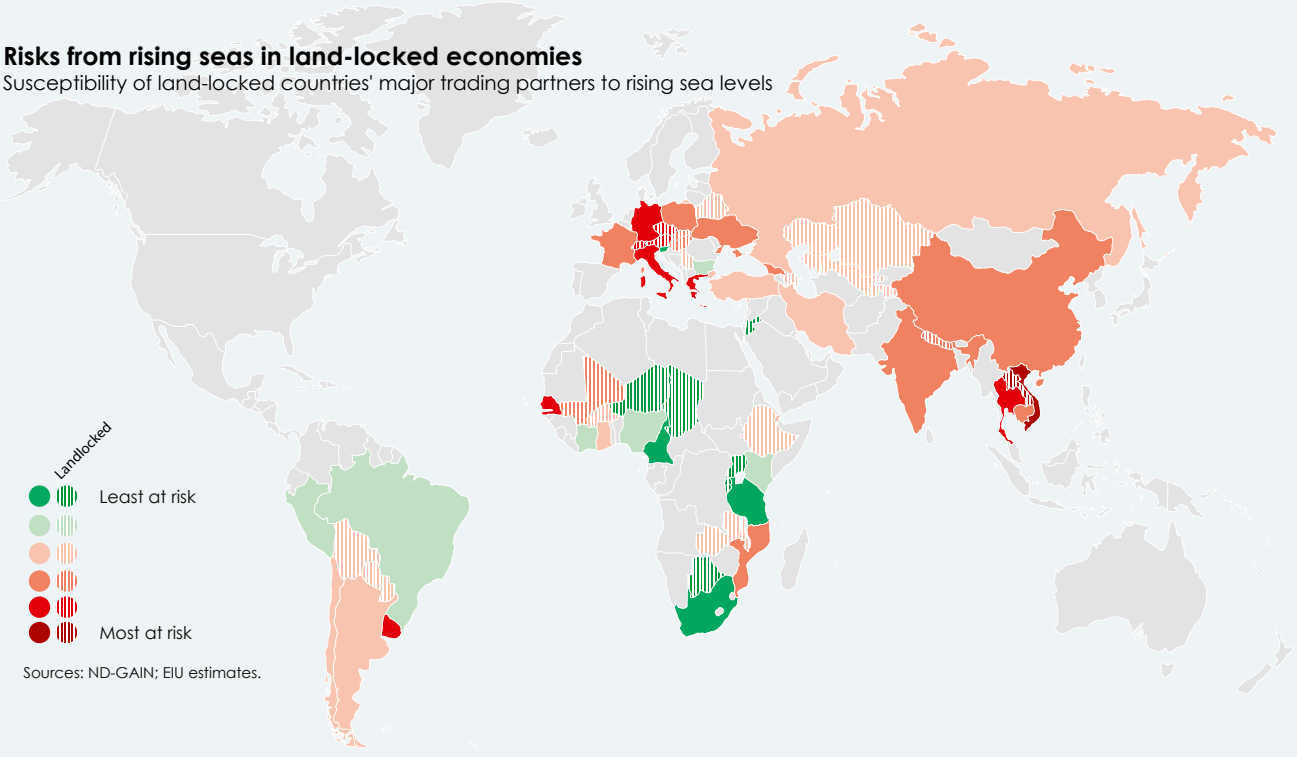
Prevalence of fish consumption in land-locked diets

Fish supply as a share of total fish and meat supply (%)



Risks from rising seas in land-locked economies

Susceptibility of land-locked countries' major trading partners to rising sea levels



Sources: ND-GAIN; EIU estimates.

116 Austria, Azerbaijan, Belarus, Bolivia, Botswana, Burkina Faso, Burundi, Chad, Czech Republic, Ethiopia, Hungary, Jordan, Kazakhstan, Laos, Malawi, Mali, Nepal, Niger, Paraguay, Rwanda, Serbia, Slovakia, Switzerland, Tajikistan, Uganda, Uzbekistan and Zambia.

117 FAO Food Balance Sheets; EIU calculation.

Marine Protected Areas (MPAs) in European territorial waters are encouraging. Germany, France, Norway, the Netherlands and Belgium have the highest share of protected territorial waters. MPAs create space for the conservation of species and ecosystems, and protect the ocean's capacity as a carbon sink. The percentage of territorial waters that are protected is still small, and marine protection is not in any case a panacea for rebuilding the ecological capacity of the sea. Nevertheless, some countries have had success with marine conservation: across the developed world, Belgium's marine spatial planning (MSP) process is held up as a success story where political leadership, public participation, science and effective communication have allowed the country to create a vision of how to manage competing uses of its small, but very busy, part of the North Sea.[118]

Indonesia leads among developing countries. Indonesia has committed to establish 20m hectares of marine protected areas by 2020.[119] This effort stands out, as most attempts to improve and protect ocean ecosystems are occurring in advanced economies, highlighting the need for large-scale interventions that both benefit ocean health and impose limited costs on local populations.

Opportunities for improvement

Mediterranean countries lag behind. Greece has a middling performance in the Oceans indicator, but Italy (ranked 73rd), France (85th), Turkey (97th), Egypt (103rd) and Spain (106th) fare poorly. Fish catches in the Mediterranean have dropped by one-third since 2007 as a result of eutrophication, hypoxia and overfishing. The European Commission estimates that 91% of Mediterranean stocks are overfished.[120] Overfishing, illegal fishing activities and overcapacity must be addressed, which includes efforts around better management and monitoring of spawning grounds.[121]

Norway ranks last. Although the country ranks in the top three for coastal countries in terms of its size of marine protected area, overfishing and eutrophication and hypoxia push the country to the bottom of the Oceans indicator. North Sea cod stocks are a quarter of the size they were in the 1970s.[122] Norway has, however, made a vigorous attempt to manage its fisheries sustainably including limiting access to new offshore fishing entities, ending subsidies to the fishing sector, and facilitating discussions among stakeholders to enforce a national distribution of quotas among fleet groups and vessels.[123]

China's oceanic waters face serious risks. In China, the demand for marine goods and services is growing faster than in any other country. Some 60% of the world's fish

118 Marine Policy. "Implementing marine spatial planning: A policy perspective". Ir. Cathy Plasman. 32 (2008) pp. 811-815. URL: http://www.unesco-ioc-marinesp.be/uploads/documentenbank/70c1177458b135f6ddad8d6ba608a623.pdf

119 Mongabay. "Photos: the people of Indonesia's marine protected areas". 2016. URL: https://news.mongabay.com/2016/06/photos-the-people-of-indonesias-marine-protected-areas/

120 OCEANA. "European Commission confirms 91% of Mediterranean stocks are overfished". June 27th 2014. URL: http://eu.oceana.org/en/press-center/press-releases/european-commission-confirms-91-mediterranean-stocks-are-overfished

121 FAO. "The State of World Fisheries and Aquaculture". 2016. URL: http://www.fao.org/3/a-i5555e.pdf

122 ICES Journal of Marine Science. "Changing attitudes 1970–2012: evolution of the Norwegian management framework to prevent overfishing and to secure long-term sustainability". Volume 71, Issue 2, January 1st 2014, Pages 173–182. URL: https://academic.oup.com/icesjms/article/71/2/173/778852/Changing-attitudes-1970-2012-evolution-of-the

123 Ibid.

farms are in Chinese waters.[124] China's oceanic waters are becoming more susceptible to eutrophication and hypoxia due to the rapid growth of intensive farming methods, industrial development and growing populations.[125] For decades, economic development has trumped environmental priorities, but more recently the tone of policy and planning suggests some evolution. China's ocean economy accounting system launched in 2006 includes a "Gross Ocean Product" as well as a "Green Ocean Account" that quantifies the ocean's benefits that are not counted in the national income.[126]

Other noteworthy findings

Sharing the oceans is critical. As an important link between resources, countries are increasingly looking to expand the potential of the ocean to support their populations' search for food, water and energy security. Drawing upon the sea for resources can be a less detrimental alternative to relying on land. For example, fish consume less than two pounds of feed to produce an additional pound of fish (compared with seven for beef).[127] Yet managing a common pool resource remains complex. The World Bank has estimated the lost economic output from mismanaging marine fisheries to amount to an annual US$50bn,[128] with the accumulative loss of potential economic benefits over the last three decades at around US$2trn.[129] It is essential that countries and stakeholders work together to improve the health of oceans.

The challenge to achieving resilient oceans lies in developing Asia. Asia is at the epicenter of seafood production and consumption: it is responsible for more than half of global fisheries landings and 90% of aquaculture production, but the three most populous Asian countries (China, India and Indonesia) all sit firmly in the bottom half of the rankings for this indicator. Future patterns in the consumption of ocean resources—especially in China and India—will greatly determine longer-term ocean health.

Sensitivity

Brief overview

This indicator assesses how sensitive countries are to climate change and natural resource depletion. It examines food import dependency, which in the event of crisis can leave countries vulnerable as other countries restrict exports to ensure the food security of their own populations. The indicator also looks at how dependent a country is on its endowment of natural resources to generate economic activity. Finally, it looks at national governments' disaster risk management capacity in agriculture to evaluate the extent to which the authorities are proactively addressing potential climate and resource-related concerns.

Sensitivity is measured across three sub-indicators:

- Food import dependency
- Dependence on natural capital[130]
- Disaster risk management

124 FAO. "The State of World Fisheries and Aquaculture". 2016. URL: http://www.fao.org/3/a-i5555e.pdf

125 World Resources Institute. "Coastal Eutrophic and Hypoxic Areas of Asia". URL: http://www.wri.org/resources/maps/coastal-eutrophic-and-hypoxic-areas-asia

126 Marine Policy. "Defining and quantifying China's ocean economy". Rui Zhao, Stephen Hynes , Guang Shun He. 43 (2014) 164-173. URL: https://webcache.googleusercontent.com/search?q=cache:smaH5rWCEK8J:https://www.dimar.mil.co/sites/default/files/atach/10.defining_and_quantifying_chinas_ocean_economy.pdf+&cd=2&hl=en&ct=clnk&gl=th&client=safari

127 Earth Policy Institute. "Farmed Fish Production Overtakes Beef". June 12th 2013. URL: www.earth-policy.org/plan_b_updates/2013/update114

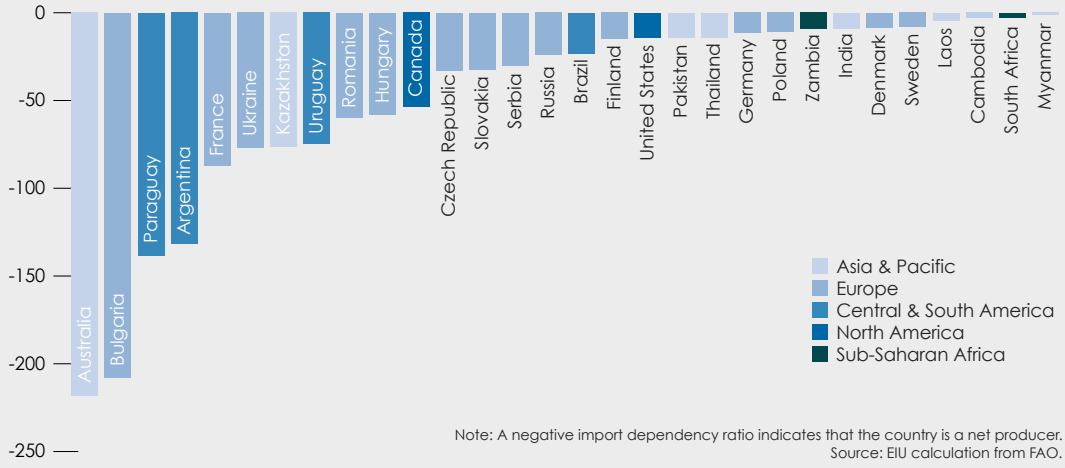
128 The World Bank. "The sunken billions. The Economic Justification for fisheries reform". 2008. URL: http://siteresources.worldbank.org/EXTARD/Resources/336681-1224775570533/SunkenBillionsFinal.pdf

129 Ibid.

130 Natural capital refers to the world's stock of natural assets. For the purposes of this sub-indicator, it refers specifically to a country's economic dependence on forests and minerals (the percentage of GDP derived from forests and minerals).

Countries with low food import dependency are often better placed to adapt to resource risks

Cereal import dependency ratio



Note: A negative import dependency ratio indicates that the country is a net producer.
Source: EIU calculation from FAO.

Top performers

North America performs best. The US and Canada are among the world's top producers of cereals, and their cereal imports are quite small.[131] Both countries' economies are highly diversified and their limited dependence on natural resources makes them more resilient to resource depletion. However, the depletion of natural resources such as forests, which play a key role in developing sustainable agriculture, mitigating climate change risks, and supporting soil conservation and carbon sequestration, could threaten long-term adaptation and mitigation efforts.[132] Additionally, Mexico and Canada are among the six countries with the highest performance in agricultural disaster risk management. Though the US has developed policies to help farmers protect against the fall-out from disasters[133] [134] that range from crop insurance schemes to emergency loans, there is no legislation in the country specifically devoted to disaster risk reduction in agriculture.

Big agricultural producers top the rankings. Low food import dependency in Australia (1st), France (3rd) and Argentina (7th) drive performance across this indicator. However, falling wheat prices and changing weather patterns pose risks to these countries' production. Australia's wheat crop this year is estimated to have slumped by nearly a third compared with 2016 (to 24m metric tonnes down from 35m tonnes) as a result of lower cereal prices and drier and warmer than average seasonal conditions.[135] Argentina, by contrast, is expecting to harvest 17m tonnes of wheat—its biggest crop since 2008/09. Though the country's yields fell slightly compared with the 2016 harvest season, area under cultivation rose.[136]

131 USDA Economic Research Service. "Trade". URL: https://www.ers.usda.gov/topics/crops/wheat/trade/

132 FAO. "Bridging the gap between forestry and agriculture to improve food security". URL: www.fao.org/news/story/en/item/425048/icode/

133 USDA. "Government Programs & Risk: Major Risk Management Programs". URL: www.ers.usda.gov/topics/farm-practices-management/risk-management/government-programs-risk.aspx

134 Ibid.

135 Grain Central. "Australian 2017 wheat crop forecast to reach 24m tonnes: USDA report". URL: https://www.graincentral.com/cropping/grains/usda-report-forecasts-australian-2017-wheat-crop-at-24m-tonnes/

136 USDA Gain Report. "Argentina: Grain and Feed Annual". 2017. URL: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Buenos%20Aires_Argentina_4-21-2017.pdf

Opportunities for improvement

Sensitivity in Sub-Saharan Africa is high. Nine countries most sensitive to climate and resource risks are in Africa: the Democratic Republic of Congo, Sierra Leone, Guinea, Malawi, Sudan, Mozambique, Togo, Burkina Faso and Burundi. Though not as dependent on grain imports as the Middle East and North Africa (especially the GCC countries), their economies are highly dependent on their natural capital.[137] With the exception of Chile and Laos, the 20 worst performers in the Dependence on natural capital sub-indicator are lower-income Sub-Saharan countries where depletion of natural resources threatens longer-term economic development and income growth.

Other noteworthy findings

Comprehensive disaster risk mechanisms are lacking. Only six countries in the GFSI—Australia, Costa Rica, Czech Republic, Mexico, South Africa and Thailand—have complete agriculture disaster risk management mechanisms and policies in place. The GFSI's Disaster risk management sub-indicator considers whether the country has:

- legislation for disaster risk reduction (DRR) in the agriculture sector;
- specific action plan or strategy for addressing DRR in agriculture;
- commitment to the Hyogo Framework for DRR;
- societal vulnerability to disasters (taking into account a country's governmental, demographic, economic and infrastructural pillars).

Together these elements measure whether or not countries are proactively addressing agricultural sector disaster risks and if they have the social structure in place to respond to such disasters effectively. The vulnerability and exposure of individuals and their communities to the impacts of natural disasters depends on a range of socio-economic and demographic factors. In most countries, specific action plans or strategies for addressing disaster risk reduction in agriculture are either absent or underdeveloped. And in most low-income countries the shift from disaster response to preparedness needs to accelerate in order to strengthen the resilience of their agricultural sectors.

Landlocked countries are less dependent on food imports. The absence of direct port access and their reliance on their agricultural sectors and natural capital have resulted in the creation of more self-sufficient food systems in land-locked economies than coastal ones. However, given inland economies' dependence on natural assets, droughts, flooding and soil erosion pose a particular threat to these countries' agricultural sectors and, consequently, food security. The low-income countries among them often do not have the institutional structures in place to manage disasters and adapt to climate- and resource-related risks.

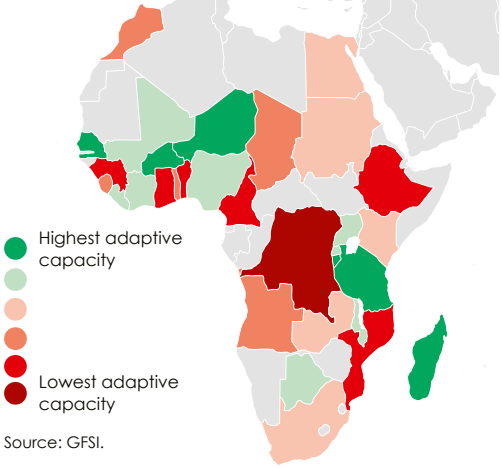
Adaptive capacity

Brief overview

Countries can make their agricultural sectors more resilient against climate change risk and related shocks, such as diseases, storms, drought and flooding. Those with early warning systems and policies focusing on preparedness rather

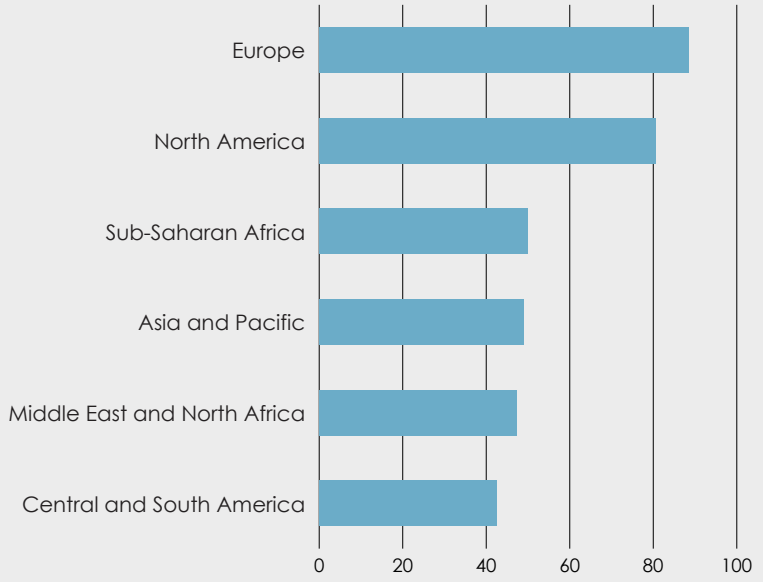
137 See footnote 131.

Sub-Saharan African countries have focused on developing climate smart agriculture and risk management systems
17 out of 28 countries in the region score in the upper half of the Adaptive capacity indicator



Source: GFSI.

Sub-Saharan Africa has focused on building resilience more than other lower-income regions
Regional performance on 4.6 Adaptive capacity



Source: GFSI.

than just response are better suited to manage risks to their agriculture sectors.

Adaptive capacity is measured across two indicators:

- Early warning measures/climate smart agriculture
- National agricultural risk management systems

Top performers

High-income economies top the rankings. These countries have the financial resources and technical adoption and innovation capacity to invest in early warning measures, pest and disease control and in climate smart agriculture systems. In Europe, "digital agriculture"–the use of information technology to make farming more efficient and climate friendly–is a popular concept. Popular tools of digital farming range from automatic machine settings and machine monitoring to yield mapping, nitrogen sensors and soil sampling.[138] The European Commission also has initiatives on precision farming and smart machinery in agriculture to improve sustainability, including the Farm Advisory Services, activities under Europe's current science programme (Horizon 2020), and the European Innovation Partnership on 'Agricultural Productivity and Sustainability'.[139]

Myanmar surprises. Myanmar is one of the top performers among low-income countries where risks are high. The private sector and industry organisations in the country are driving much of the progress on building adaptive capacity in the country. For example in 2015, an Indian warehouse service provider signed a memorandum of understanding with a

138 FTI Consulting. "Europe's Opportunity in Digital Agriculture". November 29th 2016. URL: http://fticommunications.com/2016/11/europes-opportunity-digital-agriculture/

139 European Commission, Agriculture and Rural Development. "European Innovation Partnership 'Agricultural productivity and Sustainability' EIP-AGRI". URL: https://ec.europa.eu/agriculture/research-innovation/eip-agriculture_en

local Myanmar bank to implement a standard warehouse receipts system that will allow the bank to use the stored crops as loan collateral.[140] And in May 2017, the Ministry of Agriculture, Livestock and Irrigation launched a pilot weather-index based crop insurance in selected townships.[141]

Opportunities for improvement

Vietnam and Indonesia lack capacity. Neither country has developed policies that focus on early warning measures or climate smart agriculture, nor have they implemented systems to help manage agricultural risk. According to the World Bank's Climate Smart Agriculture Indicators, Vietnam does not have grain stock management systems, such as grain stock reserve access, grain stock management receipts, agricultural insurance measures or agricultural information systems in place.[142] Indonesia has only one of these components in place. Local level initiatives to introduce innovations (eg, methods for measuring river sediment) to farmers do however exist.[143]

Other noteworthy findings

Sub-Saharan Africa stands out. The Sub-Saharan Africa countries, with the exception of the Western Africa countries of Benin, Ghana and Guinea, Central African Democratic Republic of the Congo, and East African Mozambique, perform better than other developing regions. This is primarily a result of a focus on adaptive measures like early warning systems and climate smart agriculture developments in their Nationally Determined Contributions (NDCs).[144]

Demographic stresses

Brief overview

Growing populations and urbanisation will significantly affect consumption patterns and availability of food around the globe. It is therefore essential to include demographic changes to any discussion around food security. This indicator measures how demographic stresses might increase a country's sensitivity to agriculture-related climate exposure and natural-resource risks.

Demographic stresses are measured along two sub-indicators:

- Population growth (2015-20)
- Urbanisation (2015-20)

Top performers

Eastern European countries rank highest. Bulgaria, Ukraine, Serbia and Romania share common characteristics beyond their geographic location. Already sparsely populated, they have shrinking populations and are less urbanised than most advanced economies, which puts less strain on food systems and stems the need for increased production to accommodate population growth. The total fertility rate across all four countries is far below the replacement level of 2.1 children per women. Bulgaria tops the ranking: on average women have 1.5 children in the

140 Myanmar Times. "Yoma Bank, Indian firm plan warehouse receipt financing". URL: www.mmtimes.com/index.php/business/12884-yoma-bank-indian-firm-plan-warehouse-receipt-financing.html

141 Myanmar Times. "Insurance to protect crop changes". May 3rd 2017. URL: https://www.pressreader.com/myanmar/the-myanmar-times/20170503/281522225989121

142 World Bank. "Climate Smart Agricultural Indicators". URL: https://csai.worldbank.org

143 AgroforestryWorld. "Sharing innovations in climate-smart agriculture". July 12th 2017. URL: http://blog.worldagroforestry.org/index.php/2017/07/12/sharing-innovations-climate-smart-agriculture/

144 NDCs refer to the steps that governments will take to address climate change in their own countries.

country.[145] Furthermore, the fact that these are relatively large agricultural producers means that domestic food supplies are secure.

Migration could increase strain in Europe. Though most of Europe is shielded from demographic stresses that might increase its sensitivity to agricultural-related climate exposure and resource risks, food security and conflict are at the root of international migration. With high migrant inflows from the Middle East & North Africa into the European Union,[146] immigration could drive food demand upward, which in turn would threaten this currently comparatively food secure and demographically unstressed region.

Opportunities for improvement

Gulf states are at the bottom. A key challenge in the decades ahead for the three bottom performers in the Demographic stresses indicator—Kuwait, Qatar and Oman—and the GCC more broadly will be managing energy, water and food resources to ensure both high living standards and sustainable growth.[147] Some 90% of inhabitants in the GCC live in cities.[148] By 2020 the GCC population is forecast to reach 53.5m, a 30% increase from 2000.[149] Water resources are already strained and keeping food affordable in this import-dependent region will be challenging. Through 2020, the GCC's food imports are projected to grow to US$53.1bn (or 8% of all imports in value terms) compared to US$42.6bn today.[150]

Public funding falls threaten European social services. Europe's population is expected to fall from 742m in 2017 to 739m in 2030.[151] Europe's demographics are a double-edged sword: while the stress on resources will not rise, in many European countries tax revenues are expected to fall. It will be up to policymakers to direct resources into ensuring that food safety net programmes do not suffer and that investment into agriculture adaptation and mitigation continues. The European Union has undertaken a comprehensive review of its policies to ensure that it will be able to provide EU citizens with safe, nutritious and affordable food in future decades.[152]

Other noteworthy findings

Emerging markets face the most strain. Rising incomes, growing populations, increasing urbanisation and the associated changes in land use will burden food systems in Sub-Saharan Africa and Southeast Asia. This pressure will continue to grow, especially across Sub-Saharan Africa where most countries are expected to experience 2-3% population growth through 2020 with a substantial portion of that growth in cities.[153] And by 2030 Southeast Asia's urban population is

145 CIA Factbook.

146 European Commission. "At the root of exodus: Food security, conflict and international migration". June 28th 2017. URL: https://ec.europa.eu/europeaid/root-exodus-food-security-conflict-and-international-migration_en

147 The Economist Intelligence Unit. "The GCC in 2020: Resources for the future". 2010. URL: http://graphics.eiu.com/upload/eb/GCC_in_2020_Resources_WEB.pdf

148 Ramadan, E. "Sustainable Urbanization in the Arabian Gulf Region: Problems and Challenges". Arts Social Sci J 6:109. doi:10.4172/2151- 6200.1000109. 2015. URL: www.omicsonline.org/open-access/sustainable-urbanization-in-the-arabian-gulf-region-problems-and-challenges-2151-6200-1000109.php?aid=57134

149 The Economist Intelligence Unit. "The GCC in 2020: Resources for the future". 2010. URL: http://graphics.eiu.com/upload/eb/GCC_in_2020_Resources_WEB.pdf

150 Ibid.

151 World Economic Forum. "More people live inside this circle than outside it – and other demographic data you should know". 2017. URL: https://www.weforum.org/agenda/2017/07/more-people-live-inside-this-egg-than-outside-of-it-and-other-overpopulation-data/

152 European Commission. "Delivering on EU Food Safety and Nutrition in 2050 - Future challenges and policy preparedness". 2016. URL: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/delivering-eu-food-safety-and-nutrition-2050-future-challenges-and-policy-preparedness

153 Bongaarts, John, and John Casterline. "Fertility Transition: Is Sub-Saharan Africa Different?" Population and development review 38.Suppl 1 (2013): 153–168. PMC. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4011385/

forecast to grow by almost 100m, from 280m to 373m people.[154] Where infrastructure investment in cities fails to keep up with rapid urbanisation, city dwellers will be particularly susceptible to climate change and natural disaster risks unless adaptation and risk management becomes the priority.

154 CityLab. "Does Urbanization Drive South-East Asia's Development?" January 18th 2017. URL: https://www.citylab.com/life/2017/01/southeast-asia-martin-prosperity-institute/511952/

Conclusion

For the first time in four years, global food security has experienced a decline. As noted, key factors contributing to this deterioration include urban growth and migration, greater household expenditures on food, pressure on food safety nets and international food aid programmes, and political instability. The decline in global food security is even more concerning given climate-related and natural resource risks facing countries around the globe, which we expect to intensify in the near future. Facing up to these risks will require significant collaborative efforts by governments, the private sector, non-profit organisations and other stakeholders.

Affordability and access to food have declined, while quality and safety standards have improved. Despite rising incomes in most countries in the GFSI, food affordability has lessened. Populations are spending a greater portion of their household income on food, and food safety net programmes in the countries that most need them are being strained by climate-related impacts (eg, drought). Availability of food has also fallen, driven largely by rising political instability and rapid urbanisation, which have strained food supply chains. The quality and safety of food has improved, but the difference between this year and the previous is insignificant.

Current threats to global food security are exacerbated by climate-related and natural resource risks. Political stability and demographic changes are only a small part of the food security equation. Climate change and natural resource depletion could pose even greater risks in the long term. Rising temperatures could destroy crop yield gains made over the past century, with the threat of damaging weather events—torrential rainfalls, flooding or drought—and insect pests becoming more prevalent. Bees and other pollinators, essential to approximately three-quarters of global food crop production, are becoming more affected by the mismatch in flowering periods that they rely on due to rising temperatures—adding to the ongoing dangers they face from significant habitat loss, disease and pesticide use.[155] Ocean acidification, the result of CO2 from the atmosphere dissolving into the oceans, could significantly reduce the productivity of ocean fisheries and marine-based aquaculture.

Collaborative efforts on the part of governments, the private sector, non-profit organisations and other stakeholders are therefore key to mitigating and adapting to these risks. Efforts include developing more sustainable food production systems, with the caveat that there must also be increased yields to meet the expected

155 The Guardian. "Climate change is disrupting flower pollination, research shows". November 6th 2014. URL: https://www.theguardian.com/environment/2014/nov/06/climate-change-is-disrupting-flower-pollination-research-shows

food demands of a growing population. Efforts also include ensuring that the most vulnerable populations are prepared to adapt to the effects of climate change, as they tend to be the most reliant on agriculture for their livelihoods.[156] As stakeholders step up to the plate, they need data and analysis to be able to prioritise effective investments and drive impacts. The Global Food Security Index can provide the first step into identifying food security gaps and creating solutions.

156 FAO. "The State of Food and Agriculture: Climate Change, Agriculture and Food Security". 2016. URL: http://www.fao.org/3/a-i6132e.pdf

Case study

Achieving the Sustainable Development Goals: Alternative measurements to assess progress

The United Nations' Sustainable Development Goals (SDGs) lay out an agenda to end poverty, protect the planet and ensure prosperity for all by 2030.[157] They are intended to mobilise efforts to eradicate poverty, build economic growth, provide social needs and preserve natural resources. The UN has identified a list of targets and indicators to help track progress towards the SDGs, but these indicators are primarily output oriented.

What are the drivers of progress that will allow countries and stakeholders to advance towards the SDGs? How can we create a roadmap for action that ensures that the world meets the SDGs?

Alternative metrics and data sets can be useful tools for assessing progress. Research initiatives like the Global Food Security Index dig deep into the underlying factors that impact outcomes and help identify gaps in political, economic and social systems that must be addressed to ensure we meet the SDGs. SDG 2 aims to end hunger by 2030, calling for access to safe, nutritious and sufficient food for everyone at all times. This definition of "Zero Hunger" also forms the base of the GFSI framework, which measures whether "people at all times have physical, social and economic access to sufficient and nutritious food to meet their dietary needs for a healthy and active life."[158] The GFSI looks at the inputs and food system structures that support and drive food security, providing an actionable way of achieving the Zero Hunger Target.

157 UN. "Sustainable Development Goals: 17 Goals to Transform Our World." URL: http://www.un.org/sustainabledevelopment/sustainable-development-goals/#

158 1996 World Food Summit.

Appendix: Methodology

The objective of the Global Food Security Index (GFSI) is to determine which countries are most and least vulnerable to food insecurity. The GFSI is a dynamic quantitative and qualitative benchmarking model that measures drivers of food security across 113 countries. The methodology The Economist Intelligence Unit used, including category and indicator definitions, scoring criteria, country selection, weightings, and sources, is provided below.

Scoring criteria and categories

Categories and indicators were selected on the basis of Economist Intelligence Unit expert analysis and consultation with a panel of food-security specialists. We convened the panel in February 2012 to help select and prioritise food-security indicators using a transparent and robust methodology. The goal of the meeting was to review the framework, selection of indicators, weighting and overall construction of the index.

A fourth category was added to the 2017 iteration of the index to capture the impact of climate-related and natural resource risks. We convened a new expert panel in March 2017 to assist in the development of this new category.

The four category scores are calculated from the weighted mean of underlying indicators and are scaled from 0 to 100, where 100=most favourable. These categories are: Affordability, Availability, Quality & Safety, and Natural Resources & Resilience. The overall score for the GFSI (on a range of 0-100) is calculated from a simple weighted average of the first three category scores (Affordability, Availability and Quality & Safety). The Natural Resources & Resilience category is an adjustment factor that serves as a lens through which overall food security can be viewed to demonstrate changes to the overall score when climate-related and natural resource risks are taken into account (See *Natural Resources & Resilience: Adjustment factor* below for more detail).

The categories and indicators are:

1. Affordability

1.1 Food consumption as a share of household expenditure
1.2 Proportion of population under the global poverty line
1.3 Gross domestic product per capita (PPP)
1.4 Agricultural import tariffs
1.5 Presence of food safety-net programmes
1.6 Access to financing for farmers

2. Availability

2.1 Sufficiency of supply
2.1.1 Average food supply

2.1.2 Dependency on chronic food aid
2.2 Public expenditure on agricultural R&D
2.3 Agricultural infrastructure
2.3.1 Existence of adequate crop storage facilities
2.3.2 Road infrastructure
2.3.3 Port infrastructure
2.4 Volatility of agricultural production
2.5 Political stability risk
2.6 Corruption
2.7 Urban absorption capacity
2.8 Food loss

3. Quality & Safety

3.1 Diet diversification
3.2 Nutritional standards
3.2.1 National dietary guidelines
3.2.2 National nutrition plan or strategy
3.2.3 Nutrition monitoring and surveillance
3.3 Micronutrient availability
3.3.1 Dietary availability of vitamin A
3.3.2 Dietary availability of animal iron
3.3.3 Dietary availability of vegetal iron
3.4 Protein quality
3.5 Food safety
3.5.1 Agency to ensure the safety and health of food
3.5.2 Percentage of population with access to potable water
3.5.3 Presence of formal grocery sector

4. Natural Resources & Resilience

4.1 Exposure
4.1.1 Temperature rise
4.1.2 Drought
4.1.3 Flooding
4.1.4 Storm severity (AAL)
4.1.5 Sea level rise
4.1.6 Commitment to managing exposure
4.2 Water
4.2.1 Agricultural water risk - quantity
4.2.2 Agricultural water risk - quality
4.3 Land
4.3.1 Soil erosion / organic matter
4.3.2 Grassland
4.3.3 Forest change
4.4 Oceans
4.4.1 Eutrophication and hypoxia
4.4.2 Marine biodiversity
4.4.3 Marine protected areas
4.5 Sensitivity
4.5.1 Food import dependency
4.5.2 Dependence on natural capital
4.5.3 Disaster risk management
4.6 Adaptive capacity
4.6.1 Early warning measures / climate smart ag
4.6.2 National agricultural risk management systems
4.7 Demographic stresses
4.7.1 Population growth (2015-20)
4.7.2 Urbanisation (2015-20)

Data for the quantitative indicators are drawn from national and international statistical sources. Where there were missing values in quantitative or survey data, we have used estimates. Estimated figures have been noted in the model workbook. We created some of the qualitative indicators, based on information from development banks and government websites, while others have been drawn from a range of surveys and data sources and adjusted by us. The main sources used in the GFSI are the The Economist Intelligence Unit, the World Bank Group, the International Monetary Fund (IMF), the UN Food and Agriculture Organisation (FAO), the UN Development Programme (UNDP), the World Health Organisation (WHO), the World Trade Organisation (WTO), Organisation for Economic Cooperation and Development (OECD), Agricultural Science and Technology Indicators (ASTI), ND-GAIN, the World Resources Institute (WRI) and national statistical offices.

Country selection

The 113 countries in the index were selected by The Economist Intelligence Unit based on regional diversity, economic importance, population size (countries with larger populations were chosen so that a greater share of the global population is represented) and the goal of including regions around the globe. The countries included in the 2017 index are:

Asia & Pacific	Central & South America	Europe	Gulf Cooperation Council	Middle East & North Africa	North America	Sub-Saharan Africa
Australia	Argentina	Austria	Bahrain	Algeria	Canada	Angola
Azerbaijan	Bolivia	Belarus	Kuwait	Egypt	Mexico	Benin
Bangladesh	Brazil	Belgium	Oman	Israel	United States	Botswana
Cambodia	Chile	Bulgaria	Qatar	Jordan		Burkina Faso
China	Colombia	Czech Republic	Saudi Arabia	Morocco		Burundi
India	Costa Rica	Denmark	United Arab Emirates	Syria		Cameroon
Indonesia	Dominican Republic	Finland		Tunisia		Chad
Japan	Ecuador	France		Turkey		Congo (Dem. Rep.)
Kazakhstan	El Salvador	Germany		Yemen		Côte d'Ivoire
Laos	Guatemala	Greece				Ethiopia
Malaysia	Haiti	Hungary				Ghana
Myanmar	Honduras	Ireland				Guinea
Nepal	Nicaragua	Italy				Kenya
New Zealand	Panama	Netherlands				Madagascar
Pakistan	Paraguay	Norway				Malawi
Philippines	Peru	Poland				Mali
Singapore	Uruguay	Portugal				Mozambique
South Korea	Venezuela	Romania				Niger
Sri Lanka		Russia				Nigeria
Tajikistan		Serbia				Rwanda
Thailand		Slovakia				Senegal
Uzbekistan		Spain				Sierra Leone
Vietnam		Sweden				South Africa
		Switzerland				Sudan
		Ukraine				Tanzania
		United Kingdom				Togo
						Uganda
						Zambia

Weightings

The weighting assigned to each category and indicator can be changed by users to reflect different assumptions about their relative importance. Two sets of weightings are provided in the index. One possible option, known as neutral weights, assumes that all indicators are equally important and distributes weightings evenly. The second available option, known as peer panel recommendation, averages the weightings suggested by five members of the 2012 expert panel. The expert weightings are the default weightings in the model. The model workbook also enables users to create customised weightings to allow them to test their own assumptions about the relative importance of each indicator.

Data modelling

Indicator scores are normalised and then aggregated across categories to enable a comparison of broader concepts across countries. Normalisation rebases the raw indicator data to a common unit so that it can be aggregated. The indicators for which a higher value indicates a more favourable environment for food security—such as GDP per head or average food supply—have been normalised on the basis of:

x = (x - Min(x)) / (Max(x) - Min(x))

where Min(x) and Max(x) are, respectively, the lowest and highest values in the 113 economies for any given indicator. The normalised value is then transformed from a 0-1 value to a 0-100 score to make it directly comparable with other indicators. This in effect means that the country with the highest raw data value will score 100, while the lowest will score 0.
For the indicators for which a high value indicates an unfavourable environment for food security—such as volatility of agricultural production or political stability risk—the normalisation function takes the form of:

x = (x - Max(x)) / (Max(x) - Min(x))

where Min(x) and Max(x) are, respectively, the lowest and highest values in the 113 economies for any given indicator. The normalised value is then transformed into a positive number on a scale of 0-100 to make it directly comparable with other indicators.

Natural Resources & Resilience: Adjustment factor

The Natural Resources & Resilience category is designed so that the user can opt to view the results with climate-related and natural resource risks taken into account or not taken into account. Indicator scores follow the same methodology as noted above (see *Data modelling*), while the formula for the adjusted overall score is as follows:

Adjusted overall score =
X * (1 - Z) + (X * (Y / 100) * Z)

where X is the original overall score, Y is the Natural Resource & Resilience score, and Z is the adjustment factor weighting (where 0 = 0% adjustment, 0.5 = 50% adjustment and 1 = 100% adjustment). The default setting for the adjustment factor weighting is 0.25 = 25%.

Sources and definitions

In the 2017 version of the index, we replaced the WFP data for indicator (2.1.2) with more up-to-date OECD sources. Across all indicators, where the quantitative or survey data have missing values, we have estimated the scores.

Indicator	Primary source(s)	Year	Indicator definitions and construction
1) Affordability			
Food consumption as a share of household expenditure	National accounts; UN	Latest available year in 2009-17	A measure of the national average percentage of household expenditure that is spent on food.
Proportion of population under global poverty line	World Bank, World Development Indicators	Latest available year in 2007-16	A measure of the prevalence of poverty, calculated as the percentage of the population living on less than US$3.10/ day at 2011 purchasing power parity (PPP) exchange rates.
GDP per capita at PPP	The Economist Intelligence Unit (EIU)	2016	A measure of individual income and, hence, the affordability of food, calculated in US dollars at PPP.
Agricultural import tariffs	World Trade Organisation (WTO)	Latest available year in 2012-15	Measured as the average applied most-favoured nation (MFN) tariff on all agricultural imports.
Presence of food safety-net programmes	Qualitative scoring by EIU analysts	Based on data availability, 2011-17	A measure of public initiatives to protect the poor from food-related shocks. This indicator considers food safety-net programmes, including in-kind food transfers, conditional cash transfers (e.g. food vouchers) and the existence of school feeding programmes provided by the government, non-governmental organisations (NGOs) or the multilateral sector. Measured on a 0-4 scale based on the prevalence and depth of food safety-net programmes: 0 = No evidence of food safety-net programmes or very minimal presence of ineffective programmes run by NGOs or multilaterals only. 1 = Minimal presence of food safety-net programmes run by NGOs and multilaterals only or very rudimentary, ineffective government-run programmes. 2 = Moderate prevalence and depth of food safety-net programmes run by government, multilaterals or NGOs. 3 = National coverage, with very broad, but not deep, coverage of food safety-net programmes. 4 = National government-run provision of food safety-net programmes. Depth indicates the quantity of funds available to recipients; breadth indicates the range of services available.

Indicator	Primary source(s)	Year	Indicator definitions and construction
Access to financing for farmers	Qualitative scoring by EIU analysts	Based on data availability, 2009-17	A measure of the availability of financing to farmers from the public sector. Measured on a 0-4 scale based on the depth and range of financing for farmers: 0 = Virtually no access to government or multilateral financing programmes (typically, but not necessarily, a developing economy). 1 = Limited multilateral or government financing programmes (typically, but not necessarily, a developing economy). 2 = Some multilateral or government financing (typically, but not necessarily, an emerging-market economy). 3 = Broad, but not deep, financing (typically, but not necessarily, a developed economy) OR well-developed multilateral financing programmes (typically, but not necessarily, an emerging-market economy). 4 = Access to deep financing (typically, but not necessarily, an advanced economy). Depth indicates the quantity of funds available; range covers credit and insurance.
2) Availability			
Sufficiency of supply	EIU scoring	–	A composite indicator that measures the availability of food. It comprises the following subindicators: • Average food supply in kcal/capita/day • Dependency on chronic food aid
Average food supply	FAO	2005-13	An estimate of the amount of food available for human consumption in kcal/capita/day.
Dependency on chronic food aid	OECD	2010-15	Measures whether a country is a recipient of chronic food aid. For the purpose of this index, chronic aid recipients are defined as those countries that have received non-emergency food aid over a five-year time span. Measured on a 0-2 scale: 0 = Received chronic food aid on an increasing basis over the past five years. 1 = Received chronic food aid on a decreasing basis over the past five years. 2 = Receives little or no food aid, or receives food aid only on an emergency basis.
Public expenditure on agricultural research and development (R&D)	EIU estimates based on OECD and Agricultural Science and Technology Indicators (ASTI)	Latest available year in 2002-15	A measure of government spending on agricultural R&D. Expenditure on agricultural R&D is a proxy for agricultural innovation and technology that increases market efficiency and access. Measured as a percentage of agricultural GDP and is scored on a nine-point scale: 1 = 0-0.5% 2 = 0.51-1.0% 3 = 1.01-1.5% 4 = 1.51-2.0% 5 = 2.01-2.5% 6 = 2.51-3.0% 7 = 3.01-3.5% 8 = 3.51-4.0% 9 = 4.01-4.5%

Indicator	Primary source(s)	Year	Indicator definitions and construction
Agricultural infrastructure	EIU scoring	-	A composite indicator that measures ability to store crops and transport them to market. Subindicators include: • Existence of adequate crop storage facilities • Road infrastructure • Port infrastructure
Existence of adequate crop storage facilities	Qualitative scoring by EIU analysts	Based on data availability, 2007-17	This binary indicator assesses the presence of sufficient crop storage facilities based on size of agricultural sector and population. Measured on a 0-1 scale: 0 = No 1 = Yes
Road infrastructure	EIU Risk Briefing	2017	This qualitative indicator measures the quality of road infrastructure and is measured on a 0-4 scale, where 4=best.
Port infrastructure	EIU Risk Briefing	2017	This qualitative indicator measures the quality of port infrastructure and is measured on a 0-4 scale, where 4=best.
Volatility of agricultural production	FAO	1995-2014	This indicator measures the standard deviation of the growth of agricultural production over the most recent 20-year period for which data are available.
Political stability risk	EIU Risk Briefing	2017	A measure of general political instability. Political instability has the potential to disrupt access to food, for example through transport blockages or reduced food aid commitments.
Corruption	EIU Risk Briefing	2017	This indicator measures the pervasiveness of corruption in a country by assessing the risk of corruption. Corruption can impact food availability through distortions and inefficiencies in the use of natural resources, as well as bottleneck inefficiencies in food distribution. Measured on a 0-4 scale, where 4=highest risk.
Urban absorption capacity	World Bank, World Development Indicators; EIU	2013-17	This indicator measures the capacity of a country to absorb the stresses placed on it by urban growth and still ensure food security. It does so by evaluating a country's resources (real GDP) against the stress of urbanisation (urban population growth rate). It is calculated as the average (annual) real percentage change in GDP minus the urban population growth rate.
Food loss	FAO	2013	A measure of post-harvest and pre-consumer food loss as a ratio of the domestic supply (production, net imports and stock changes) of crops, livestock and fish commodities (in tonnes).
3) Quality & Safety			
Diet diversification	FAO	2009-11	A measure of the share of non-starchy foods (all foods other than cereals, roots and tubers) in total dietary energy consumption. A larger share of non-starchy foods signifies greater diversity of food groups in the diet.
Nutritional standards	EIU scoring	–	A composite indicator that measures government commitment to increasing nutritional standards. It comprises the following binary subindicators: • National dietary guidelines • National nutrition plan or strategy • Nutrition monitoring and surveillance

Indicator	Primary source(s)	Year	Indicator definitions and construction
National dietary guidelines	Qualitative scoring by EIU analysts based on WHO, FAO and national health ministry documents	Based on data availability, 2001-17	A binary indicator that measures whether the government has published guidelines for a balanced and nutritious diet: 0 = No 1 = Yes
National nutrition plan or strategy	Qualitative scoring by EIU analysts based on WHO, FAO and national health ministry documents	Based on data availability, 1995-2017	A binary indicator that measures whether the government has a current, published national strategy to improve nutrition: 0 = No 1 = Yes *A country receives credit if the national strategy was current as of June 2017. For example, a national strategy covering 2010 20 would receive credit; a strategy covering 2011-16 would not receive credit. Credit may also be assigned if there is clear evidence that an expired strategy is currently being re implemented or updated.
Nutrition monitoring and surveillance	Qualitative scoring by EIU analysts based on WHO, FAO and national health ministry documents	Based on data availability, 2002-17	A binary indicator that measures whether the government monitors the nutritional status of the general population. Examples of monitoring and surveillance include the collection of data on undernourishment, nutrition-related deficiencies, etc. 0 = No 1 = Yes
Micronutrient availability	EIU	-	A composite indicator that measures the availability of micronutrients in the food supply. Subindicators include: • Dietary availability of vitamin A • Dietary availability of animal iron • Dietary availability of vegetal iron
Dietary availability of vitamin A	FAO	2005-07	The dietary availability of vitamin A is calculated by converting the amount of food available for human consumption (as estimated by the FAO Food Balance Sheets) into the equivalent of vitamin A. This indicator is expressed in micrograms of retinol activity equivalent (RAE)/capita/day on a 0-2 scale. 0 = less than 300 mcg RAE/capita/day; 1 = 300-600 mcg RAE/capita/day; 2 = more than 600 mcg RAE/capita/day
Dietary availability of animal iron	FAO	2005-07	The dietary availability of iron is calculated by converting the amount of food available for human consumption (as estimated by the FAO Food Balance Sheets) into the equivalent of iron. Animal iron is obtained from foods such as meat, milk, fish, animal fats and eggs. This indicator is expressed in mg/capita/day.
Dietary availability of vegetal iron	FAO	2005-07	The dietary availability of iron is calculated by converting the amount of food available for human consumption (as estimated by the FAO Food Balance Sheets) into the equivalent of iron. Vegetal iron is obtained from foods such as cereals, pulses, roots and tubers, vegetable oils, fruits and vegetables. This indicator is expressed in mg/capita/day.
Protein quality	EIU calculation based on data from FAO, WHO and US Department of Agriculture (USDA) Nutrient Database	2005-11	This indicator measures the amount of high-quality protein in the diet using the methodology of the Protein Digestibility Corrected Amino Acid Score (PDCAAS). The PDCAAS methodology assesses the presence of nine essential amino acids in the average national diet. The inputs for this calculation include: the amino acid profile, protein digestibility value and the average amount (in grams) consumed of each food item that contributes a minimum of 2% to total protein consumption.

Indicator	Primary source(s)	Year	Indicator definitions and construction
Food safety	EIU scoring	-	A composite indicator that measures the enabling environment for food safety. The subindicators are: • Agency to ensure the safety and health of food • Percentage of population with access to potable water • Presence of a formal grocery sector
Agency to ensure the safety and health of food	Qualitative scoring by EIU analysts	Based on data availability, 2009-17	Binary indicator that measures the existence of a regulatory or administrative agency to ensure the safety and health of food: 0 = No 1 = Yes
Percentage of population with access to potable water	World Bank	Latest available in 2012-15	The percentage of people using improved drinking water sources, namely household connection, public standpipe, borehole, protected dug well, protected spring, rainwater.
Presence of formal grocery sector	Qualitative scoring by EIU analysts	Based on data availability, 2010-17	Qualitative indicator measuring the prevalence of a formal grocery sector, measured on a 0-2 scale: 0 = Minimal presence 1 = Moderate presence 2 = Widespread presence
4) Natural Resources & Resilience			
Exposure	EIU scoring	-	A composite indicator that measures exposure to and management of the impacts of climate change. Subindicators include: • Temperature rise • Drought • Flooding • Storm severity (AAL) • Sea level rise • Commitment to managing exposure
Temperature rise	ND-GAIN	2015	Assessment of a country's projected temperature rise, and the potential impact on agricultural production. Measured on a linear transformation of data values (0 = least vulnerable) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Drought	WRI Aqueduct	2013	Assessment of a country's historical susceptibility to drought, and the potential impact on agricultural production. Linear transformation of data values (0-5, where 5 = most risk) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Flooding	ND-GAIN	2015	Assessment of a country's projected susceptibility to flooding, and the potential impact on agricultural production and food distribution systems. Linear transformation of data values (0 = least vulnerable) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Storm severity (AAL)	Global Assessment Report on Disaster Risk Reduction	2015	Assessment of a country's historical susceptibility to damage from storms (aside from flooding), and the potential impact on agricultural production and food distribution systems. Measured as Annual Average Loss (AAL) from earthquakes, wind, storm surge and tsunamis. Linear transformation of data values (US$m) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.

Indicator	Primary source(s)	Year	Indicator definitions and construction
Sea level rise	ND-GAIN	2015	Assessment of a country's projected sea-level rise, and the potential impact on agricultural production and food distribution systems in coastal areas. For land-locked countries, and estimate is provided based on the country's major coastal trading partners. Linear transformation of data values (0 = least vulnerable) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Commitment to managing exposure	CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)	2016	Assessment of whether countries are committed to addressing agriculture-related climate exposure and natural resource management into the Nationally Determined Contributions. NDC mitigation measures include croplands, grasslands, forest management, degraded lands, coasts and peatlands. NDC adaptation measures include water management, soil, fisheries and aquaculture, and agroforestry. The high-income countries that do not cover adaptation in their NDCs were given full credit for adaptation measures based on proxy scoring. Qualitative measurement from 0-13: 0 = No commitments 13 = Full commitment
Water	EIU scoring	-	A composite indicator that measures the health of fresh-water resources and how depletion might impact agriculture. Subindicators include: • Agricultural water risk – quantity • Agricultural water risk – quality
Agricultural water risk – quantity	WRI Aqueduct	2014	Assessment of the ratio of total annual water withdrawals to total available annual renewable supply, which may limit water available for agriculture. Data is based on the World Resource Institute's agriculture weighting scheme and is an average of baseline water stress, inter-annual variability, seasonal variability, upstream storage and groundwater stress. Linear transformation of data values (0-5, where 5 = highest risk) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value score 0.
Agricultural water risk – quality	WRI Aqueduct	2014	Assessment of the risk that water might be polluted making it unsuitable for agriculture. Data is based on the World Resource Institute's agriculture weighting scheme for return flow ration and upstream protected land. Linear transformation of data values (0-5, where 5 = highest risk) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value score 0.
Land	EIU scoring	-	A composite indicator that measures the health of land, and how land degradation might impact agriculture. Subindicators include: • Soil erosion / organic matter • Grassland • Forest change
Soil erosion / organic matter	Harmonized World Soil Database	n/a	Assessment of land degradation through soil quality constraints. Soil quality is an aggregate of nutrient availability, nutrient retention capacity, oxygen availability to roots, excess salts and toxicity. Qualitative measurement from 0-15: 0 = Low soil quality 15 = High soil quality

Indicator	Primary source(s)	Year	Indicator definitions and construction
Grassland	FAO	2014	Assessment of GHG emissions from the drainage of organic soils (eg, peatlands) under grassland. Grasslands act as carbon sinks that help to maintain organic matter in the soil. Loss of this organic matter could impact agricultural production. Linear transformation of data values (Net emissions / removals of CO2, gigagrams) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Forest change	World Bank	2000-15	Assessment of the health of forests, which help store groundwater and act as carbon sinks, preserving ecosystems. Ecosystem changes could impact agricultural productivity. Linear transformation of data values (change in forest areas as % of total land area) to a fixe range of 0-100. The country with the highest data value scores 100 and the country with the lowest data value scores 0.
Oceans	EIU scoring	-	A composite indicator that measures the health of oceans, a crucial source of protein for many populations. Subindicators include: • Eutrophication and hypoxia • Marine biodiversity • Marine protected areas
Ocean eutrophication and hypoxia	WRI	2000-10	Assessment of the health of oceans. Over-enrichment of oceans depletes oxygen, kill off aquatic life and disrupting ecosystems, which can ruin fisheries as well as agricultural production from salt-water areas. Land-locked countries receive the highest possible score. Qualitative measurement from 0-2: 0 = Salt water bodies with both eutrophication and hypoxia 1 = Salt water bodies with either eutrophication or hypoxia 2 = No salt water bodies with eutrophication or hypoxia
Marine biodiversity	Yale Environmental Performance Index	2016	Assessment of the health of marine life through the overexploitation and collapse of fishing stocks. Falling fish stocks limits access to protein for populations whose diets are fish dependent. Land-locked countries receive the highest possible scores. Linear transformation of data values (%) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Marine protected areas	World Bank	2014	Assessment of the percentage of territorial waters that are protected areas. Preservation of protected waters helps to maintain marine ecosystems, which preserves fish as a food source while also protecting against over-fishing. Land-locked countries receive the highest possible score. Linear transformation of data values (%) to a fixed range of 0-100. The country with the highest data value scores 100 and the country with the lowest data value scores 0.
Sensitivity	EIU scoring	-	A composite indicator that measures how susceptible countries are to the depletion of natural resources and agricultural productivity. Subindicators include: • Food import dependency • Dependence on natural capital • Disaster risk management
Food import deficiency	FAO	2013	Assessment of how dependent a country is on cereal imports. If climate and natural resource risks negatively impact agricultural production, countries that are dependent on imports could become more vulnerable to food shortages as major agricultural producers limit food exports to feed their own populations. Linear transformation of data values (ratio) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.

Indicator	Primary source(s)	Year	Indicator definitions and construction
Dependence on natural capital	World Bank	2015	Assessment of how dependent a country is on natural resources for economic output. In countries dependent on natural resources, natural resource shortages could impact the economy and affect incomes, making it harder to purchase food. Linear transformation of data value (sum of forest rents and mineral rents as % of GDP) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
Disaster risk management	EIU Risk Briefing; World Bank Climate Smart Agriculture Indicators	2016-17	Assessment of whether countries are coordinating their disaster risk management and their adaptation and mitigation measures, particularly in the agriculture sector. Underlying metrics include: social capital; legislation and / or policy for DRR in the agriculture sector; specific action plan or strategy for addressing DRR in agriculture, and commitment to the Hyogo Framework for DRR. For countries not covered by the World Bank's Climate Smart Agriculture Indicators, The Economist Intelligence Unit has undertaken qualitative research. Where information is not publicly available, The Economist Intelligence Unit has not given credit. Measured on a scale of 0-7: 0 = Low coordination 7 = High coordination
Adaptive capacity	EIU scoring	-	A composite indicator that measures the degree to which countries are creating systems and adopting practices to manage the risk that exposure poses to the agricultural sector. Subindicators include: • Early warning measures / climate smart ag • National agricultural risk management systems
Early warning measures / climate smart ag	CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)	2016	Assessment of commitment to developing early warning measures for the agriculture sector and investing in climate-smart agriculture practices. The high-income countries that do not cover adaptation in their NDCs were given full credit based on proxy scoring. Qualitative measurement from 0-2: 0 = No commitment 2 = High commitment
National agricultural risk management systems	World Bank Climate Smart Agriculture Indicators	2017	Assessment of a country's commitment to managing risk to the agriculture sector. Underlying metrics include grain stock management, agricultural insurance and agricultural information systems. For countries not covered by the World Bank's Climate Smart Agriculture Indicators, The Economist Intelligence Unit has undertaken qualitative research. Where information is not publicly available, The Economist Intelligence Unit has not given credit. Qualitative assessment from 0-6: 0 = No commitment 6 = High commitment
Demographic stresses	EIU scoring	-	A composite indicator that measures the degree to which demographic stresses might increase countries' sensitivity to agriculture-related climate exposure and natural resource risk. Subindicators include: • Population growth (2015-20) • Urbanisation (2015-20)
Population growth (2015-20)	UN	2017	Forecast population growth. Rapid population growth increases demand for food, straining food systems. Linear transformation of data values (population growth %, 2015-20) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.

Indicator	Primary source(s)	Year	Indicator definitions and construction
Urbanisation (2015-20)	UN	2014	Forecast urban growth. Rapid urbanisation can disrupt food systems, putting strain on production and infrastructure. Linear transformation of data values (urbanisation rate, 2015-20) to a fixed range of 0-100. The country with the lowest data value scores 100 and the country with the highest data value scores 0.
5) Output variables			
Prevalence of undernourishment	FAO	2014-16	The percentage of the population that does not receive the minimum number of required calories for an average person as defined by the FAO/WHO/UN University Expert Consultation in 2001.
Percentage of children stunted	WHO	Latest available year in 1970-2015	The percentage of children aged less than five years who have a height-for-age below -2 standard deviation from the National Centre for Health Statistics (NCHS)/WHO reference median.
Percentage of children underweight	WHO	Latest available year in 1970-2015	The percentage of children under five years who have a weight-for-age below -2 standard deviation from the NCHS/WHO reference median.
Intensity of food deprivation	FAO	2014-16	A measure of how far, on average, the population falls below the dietary energy requirement. It is measured as the difference between the minimum dietary energy intake and the average dietary energy intake of the undernourished population.
Human Development Index	UNDP	2015	A composite index that measures development by combining indicators on life expectancy, educational attainment and income.
Global Gender Gap Index	World Economic Forum	2016	The Global Gender Gap Index seeks to measure the gaps between women and men across a large set of countries and across the four key areas of health, education, economy and politics.
EIU Democracy Index	EIU	2016	The Democracy Index provides a snapshot of the state of democracy in 165 states and two territories. The index includes indicators in the following five categories: electoral process and pluralism, functioning of government, political participation, political culture, and civil liberties.
Prevalence of obesity	WHO	2014	Measures the percentage of the population over 18 years of age that is obese. Obesity is defined as having an age-standardised body mass index (BMI) greater than 30.

London
20 Cabot Square
London
E14 4QW
United Kingdom
Tel: (44.20) 7576 8000
Fax: (44.20) 7576 8476
E-mail: london@eiu.com

New York
750 Third Avenue
5th Floor
New York, NY 10017
United States
Tel: (1.212) 554 0600
Fax: (1.212) 586 0248
E-mail: newyork@eiu.com

Hong Kong
1301 Cityplaza Four
12 Taikoo Wan Road
Taikoo Shing
Hong Kong
Tel: (852) 2585 3888
Fax: (852) 2802 7638
E-mail: hongkong@eiu.com

Geneva
Boulevard des
Tranchées 16
1206 Geneva
Switzerland
Tel: (41) 22 566 2470
Fax: (41) 22 346 93 47
E-mail: geneva@eiu.com

Dubai
Office 1301a
Aurora Tower
Dubai Media City
Dubai
Tel: (971) 4 433 4202
Fax: (971) 4 438 0224
E-mail: dubai@eiu.com