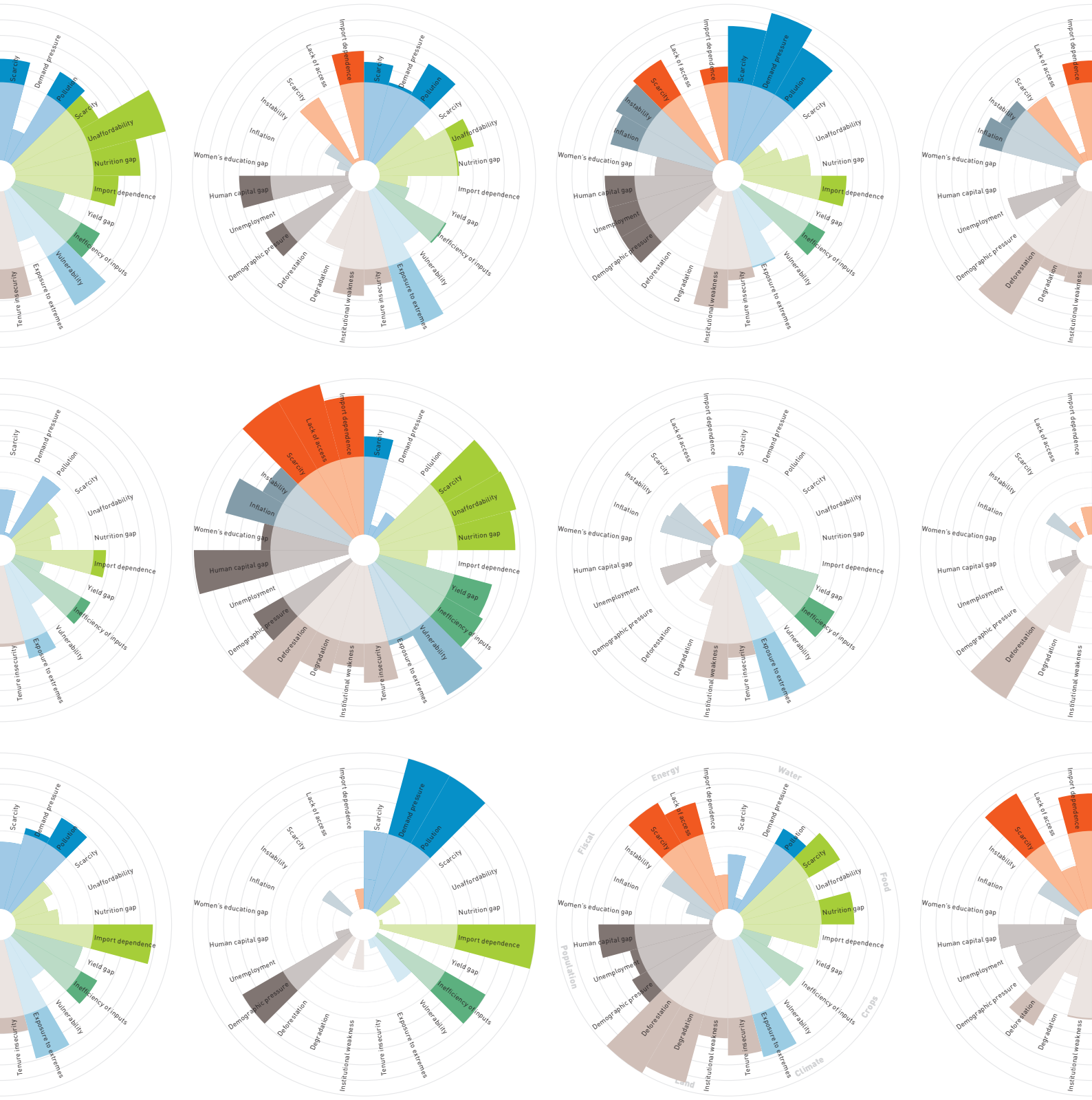
The Earth Security Index 2014

A dashboard for the transition to a resource secure future

EARTH SECURITY INITIATIVE



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The Earth Security Index
A dashboard for the transition to a resource secure future

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The Earth Security Initiative
The ESI is an innovation platform connecting creative people in industry, government, finance and civil society to respond to resource security challenges and partner to create a secure future.
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Foreword

The dramatic images from Lampedusa this fall have been a wake-up call. We have witnessed a human tragedy of major dimensions. A tragedy which must not be seen only as a compelling story of refugees trying to reach the European shores, but which necessitates an understanding of the underlying reasons for migration. There is a direct nexus between the resource scarcities experienced by local populations around the world, and the threat to regional security by large population movements impacting on adjacent regions and their societies.

Our global society is at a critical junction. Extraordinary economic progress and technological advances in some regions threaten to be upset by severe trends resulting from resource limits in other regions. These limits, which include water, food and energy security, may pose a challenge to national stability, to regional security and to economic growth. It requires urgent attention and a trans-sectoral as well as a global reassessment of our fundamental assumptions of how to respond.

Ongoing global political processes are struggling to cope with the magnitude and complexity of resource challenges. National interests and often short-term political and economic considerations are standing in the way of necessary decisive action. An almost automatic difference of views, approaches and mindsets between established powers and emerging economies seem to be blocking any breakthrough.

As we deal with pressing regional and international security challenges, we will also need to open a new space to think strategically about the future of our global society.

We need to understand that resource risks could result in even larger security threats, affecting entire regions and possible global stability. We need to start exploring solutions to meet these challenges, to find areas of convergence between our countries and societies to prevent these threats from materializing. We need to identify opportunities that could create win-win situations for all, which could drive new investments and cooperation and thus contribute to create long-term stability.

Our world is in the midst of a major geopolitical shift. New emerging powers are becoming important actors in a multi-polar international system, many of which are facing resource security dilemmas. Their ability to master domestic resource security challenges, within the realm of the global legal framework, will be a defining factor for their recognition as a responsible partner by others. Likewise, resource issues are pivotal also to the European Union's stability, with implications for energy security and immigration.
A new vision of global long-term security has to be built on the basis of trust, opportunity and open borders. Interdependency has become a driving factor, as no country or even group of countries can meet these challenges alone. Therefore any successful process to identify the right solutions must include governments, business, finance and civil society, cutting across established silos and barriers.

The Earth Security Index provides a very valuable framework for this strategic discussion. Understanding the risks, involving all sectors, considering the inter-connections and mutual interests are necessary conditions in order for leaders to identify the opportunities before them. Over the next year, the BMW Foundation and the Earth Security Initiative will use this framework and its underlying concepts of inter-dependent thinking and cross-sector convening, to bring together leaders and creative people from all these sectors to build preparedness for a rapidly changing world.

Michael Schaefer
Chairman of the BMW Foundation
Former Ambassador of Germany to China

Land

Deforestation
The loss of forest cover of a country's territory.

Degradation
A process that erodes the resilience and fertility of land, including drivers like soil erosion, salinity and deforestation.

Institutional weakness
The quality of a country's governance and institutions; their capacity to formulate and implement policies; and the respect for the rights and freedoms of citizens.

Tenure insecurity
The lack of security that a person's land rights will be recognized and protected.

Population

Women's education gap
The extent of women's access to education.

Human capital gap
Enrolment in tertiary education as a proxy for skills and human capital.

Unemployment
Overall levels of unemployment and youth unemployment.

Demographic pressure
The population growth rate and density and the availability of agricultural land per capita.

Fiscal

Instability
The sustainability of the public debt and likelihood of a sovereign debt crisis.

Inflation
The increase in consumer prices and decline in the purchasing value of money.

Energy

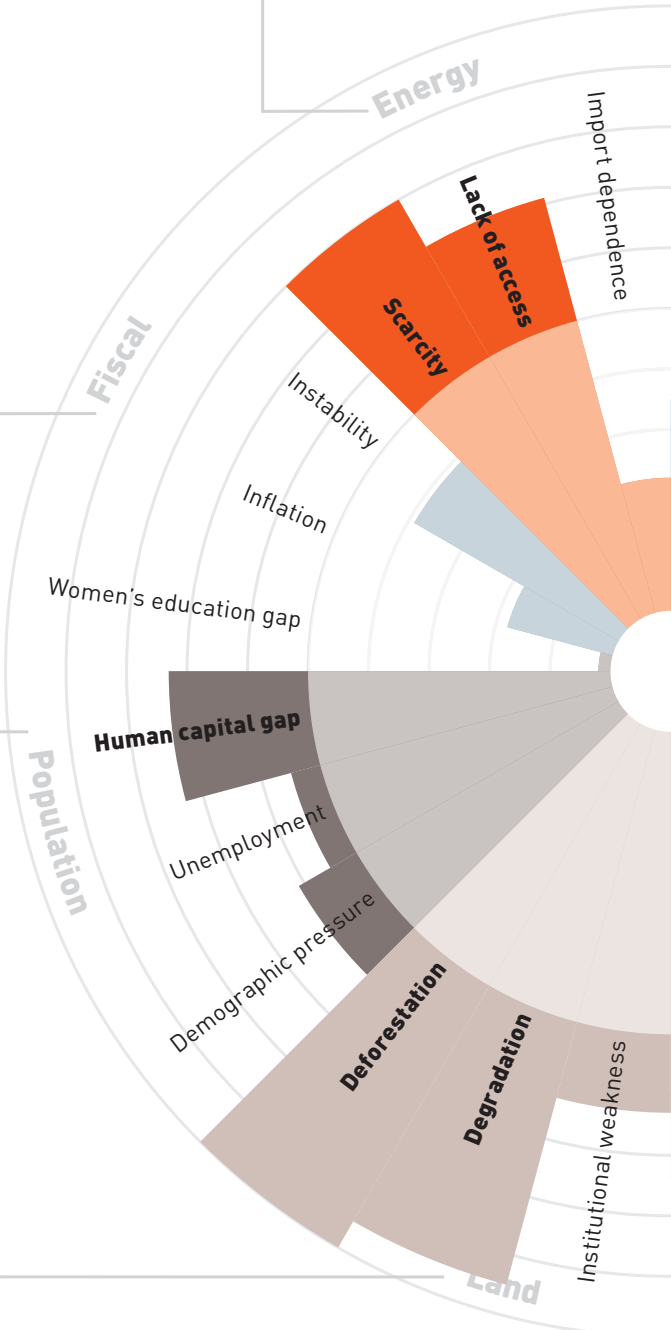
Import dependence
A country's dependence on energy imports.

Lack of access
The proportion of the population without access to electricity.

Scarcity
The country's ability to provide enough energy either through domestic production or imports.

What is the Earth Security Index?

The ESI diagram provides a dashboard that brings analytical simplicity to a complex set of resource security trends, and supports a multi-dimensional risk assessment of countries. As a risk visual, higher scores in each of the dimensions represent worse performance. A visual benchmark has been included, which draws the eye to those scores that exceed values of 50%.



Water

Scarcity
Availability of water in the country throughout the year.

Demand pressure
Water use as a share of available resources.

Pollution
The average levels of water quality and pollution in the country.

Food

Scarcity
The availability of food to meet the needs of the population, either through domestic production or imports.

Unaffordability
The ability of poor households to purchase the food they need.

Nutrition gap
The population's access to safe and nutritious food.

Import dependence
The country's reliance on food imports

Crops

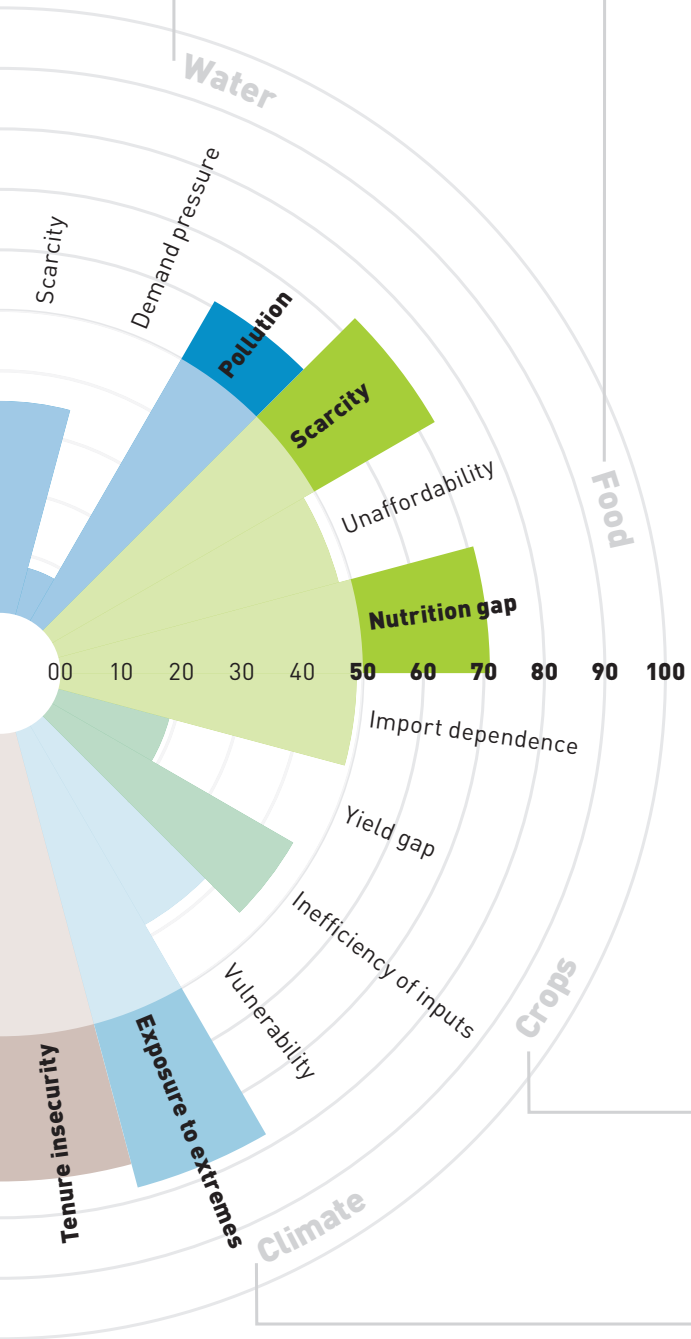
Yield gap
The difference between current crop yields and their estimated potential.

Inefficiency of inputs
The efficiency in the use of fertilizers and irrigation.

Climate

Vulnerability
The vulnerability of a country's infrastructure, human habitat, food, water, health and ecosystems to adverse climate impacts.

Exposure to extremes
The level of exposure of a country to extreme weather events, measured in human and economic losses.



The Earth Security Index

From the sidelines of the geopolitical agenda, issues like water scarcity, tropical deforestation, soil degradation and climate change are creeping up to impact the capacity of countries to generate electricity, grow sufficient food, protect their infrastructure, and rely on one another's supplies across open borders.

In the absence of trust, and a clear focus on the risks and opportunities to build resilience, the competition for scarcer resources will push governments, businesses and investors further into a scramble to gain access. This will continue to undermine the vision of multilateralism, cooperation and sustainability that is needed to deal with planetary limits.

Born out of resource crises, however, is the hope that stronger and bolder political and economic commitments to sustainability will help drive the decisions that today seem utopian.

The security implications of limited resources will capture the attention of people in positions of power. Their response will require more openness to support new investment and policy ideas that will create a more resilient, sustainable and secure trajectory for economic growth and industrialization.

The Earth Security Index 2014 provides a framework to support this transition. Through integrated information, an objective analysis of inter-connected risks, and forward-looking operational proposals, ESI involves all stakeholders to consider the risks, the new opportunities and the responsibilities that will create a secure future.

Alejandro Litovsky
Founder & CEO,
Earth Security Initiative

What is the Earth Security Index?

The ESI is a strategic data framework that captures the magnitude and scope of a series of resource pressures, looking at the inter-dependence across resource 'silos', and providing companies, investors, governments and civil society at large with a tool for a strategic discussion of country risks and opportunities.

The clear understanding of these actors of the risks that resource limits can create on national security and stability, as well as economic competitiveness, is a necessary condition for shifting support for new investment strategies, economic policies and ideas that will revitalize natural systems and human security in an era of increased pressures.

Structure
8 themes that are deemed critical for a country's long-term stability: land governance, water security, climate security, crop performance, population growth, food security, fiscal stability and energy security. These themes are divided into a total of 24 dimensions.

Data
The 24 dimensions measured by the ESI are created using a total of 49 data points. The normalization and transformation processes of the data allows for the magnitude of those dimensions to be comparable across countries. This report presents the framework applied to 17 countries, selected on the basis of their diversity and significance to the global resource security agenda, out of the 200 countries in the ESI database.

Visual
The ESI visual provides a holistic risk dashboard to bring simplicity to a complex set of inter-dependencies, and support the multidimensional risk assessment of countries. Higher scores represent worse performance. A visual benchmark has been included, which draws the eye to those wedges that exceed values of 50%.

Partners and network
The index has been created in consultation with country experts (see acknowledgements) and with the active participation of two project partners: the International Food Policy Research Institute (IFPRI) and the Institute on the Environment at the University of Minnesota.

Sources
The index draws on publicly available global datasets produced either by peer-reviewed research or by international institutions.

Open data agenda
ESI draws on the best available global datasets for each dimension, highlighting gaps in the existing global data architecture (as in the case of 'land tenure insecurity' and 'land degradation').

Please see page 27 for details on the methodology used for the ESI 2014 as well as the specific definition of themes, dimensions and data points.

1.0 Preparing for a world of scarcer resources

1.1 Business as a 'partner of choice'

Investments in infrastructure, extractives and agriculture are being made on the basis of 20, 30 and even 40-year time horizons. Investors are now more aware that these assets will be exposed to the resource security crises that are building up in many host countries. In the face of limited resources, companies will have to demonstrate why they are the 'partners of choice' of host governments and local people.

Mainstream financial markets are only beginning to discuss the signals, but the direction of this debate is now clear. A 2013 report by Moody's, the financial rating agency, foresees an increase in political risk for mining companies as competition for local water resources intensifies.

"Water scarcity is already changing the mining landscape as environmental legislation becomes more stringent — and operating in some countries increases political risk as mining companies' water supplies can be restricted if the needs of communities increase," says Andrew Metcalf, an analyst in Moody's Corporate Finance Group. "If, as a result, projects take longer to complete, and become costlier and riskier to execute, we would expect these factors to exert downward pressure on the ratings of the mining companies." [1]

Other resource-intensive sectors, like energy, agriculture and infrastructure, are beginning to hit similar barriers, as scarce resources become more contested locally. Local disruptions can have disproportionate global effects, driven by global media and inter-connected global supply chains.

Resource pressures are complex, highly political and beyond the control of individual companies. They are driven by weak governance factors and demographic pressures, as well as unpredictable weather extremes.

Corporate leaders need to rethink what it will mean to be a resource-intensive company in a resource-constrained world. Greater competition for scarcer resources will require them to demonstrate that they are the 'partners of choice' of host governments and local people in order to gain or retain their access. Being a partner of choice will mean that companies not only focus on the sustainability of their operations, but also on helping countries to deal with their resource governance priorities.

"Corporate leaders need to rethink what it will mean to be a resource-intensive company in a resource-constrained world."

1.2

Responding to interconnected risks

The ESI 2014 is designed to support strategic investments and responses to resource bottlenecks and vulnerabilities. The analysis concludes that four types of interconnected risks will be central to the strategic response of companies, investors, governments and civil society:

'Choke points'
Improving integrated thinking

Limited resources create situations where a country's growing demand for more energy, more water, more food, and more land cannot be all satisfied without incurring in trade-offs between them. 'Choke points' are reached when the available resources are insufficient to satisfy all demands and sectors of industry and the population. The choke points for China and India, for example, realistically mean that in the short-term future there will not be enough water to run coal-fired thermal power stations 'and' irrigate large fields to grow crops.[2] In China, for example, 60% of planned coal-fired power plants will be built in water-stressed regions of the country, which hold just 5% of the country's water resources and where competition from agriculture is already a contentious issue.[3]

Response
Immediate action is needed from investors to improve their due-diligence approaches to these investments. The risk signals in financial markets must adjust accordingly, which means that credit rating agencies, and insurance and re-insurance companies need to consider this inter-dependence agenda in their assumptions. It also requires that planning commissions in government improve their understanding of the conditions under which planning and investment permissions will be granted.

'Tele-connections'
Anticipating systemic risks

Rainforests play the crucial function of maintaining weather and rainfall stability. This is well known to science, but not properly discussed by the industries, financial investors and governments whose security depends on that stability. The evaporation of water created by rainforests act as a 'pump' that helps moisture travel between different regions — or what meteorologists call the 'tele-connection' of weather systems across large geographic distances.[4] The Earth's weather systems work in complex and interdependent ways, and rely on the regulatory functions of tropical rainforests. Deforestation can have a destabilizing effect on weather patterns, and amplify the frequency and severity of extreme events such as floods and droughts. The resulting liabilities to key industries and the financial sector are clear. In Brazil, for example, deforestation in Amazonia has significantly slowed down over the last five years, but Brazil has already lost over 11 million hectares of rainforest; its exposure to extreme weather has also steadily risen. Extreme floods were responsible for US$ 4.7 billion in losses in 2011 alone.[5]

Response
Affected sectors like insurance and re-insurance must work alongside scientists, civil society experts and asset owners to improve the understanding of these interactions and consider new approaches to address and seek to further minimize the growing liabilities from extreme weather losses through innovative approaches.

'Import-dependence'
Increasing cooperation for open borders

Trading across open borders is vital to the security of most countries around the world, but will be even more important for a growing number of countries as they seek to secure their supplies of food, water and energy. Open borders are a necessary condition for global supply chains to function. Therefore the trade agenda is also vital to the strategic risks faced by any global companies operating across borders. The growing dependence of many countries on food and energy imports creates new opportunities for trade and investment, but also creates critical vulnerabilities to external markets. Australia, for example, is a large exporter of coal but imports most of its refined fuels and holds just three days of fuel stockpiles.[6]

Examples of countries reviewed in the ESI 2014 that are heavily dependent on cereal imports from a small number of suppliers are Egypt, Peru, and the UAE. A growing exposure of the world's grain suppliers to extreme weather may compromise their ability to sustain their supplies. In 2010, for example, Russia raised an export ban on wheat as a result of a severe drought. Russia is one of Egypt's main suppliers of wheat and the resulting food price increases are believed to have played a role in Egypt's revolution.[7] Resource stresses will affect the exporting ability of certain countries, with knock-on effects to import-dependent countries.

Response
Deepening cooperative trade policies among trading governments is vital. This should involve the companies whose main business is to connect demand and supply in order to fully understand the scope of risks and opportunities in the global trade system. Global trade rules will also have to be adapted to enable the World Trade Organization to develop the capacity to address the security dilemmas that are being created by weather-induced food export restrictions.[8]

'Food productivity bottlenecks'
Investing in sustainable land

Agriculture systems are hitting resource limits and persistent governance gaps compromise their ability to ensure food security, dignified livelihoods and ecological stewardship. Companies, investors, governments and communities confront a series of critical barriers: Insecure land ownership of local populations; receding water tables due to unsustainable water extraction rates; the inefficient use of inputs like fertilizers and pesticides that creates pollution; the loss of vital ecosystems affecting resilience of food production; and the ability of certain areas to cope with extreme weather. In some regions of India, for example, these issues are playing out like a perfect storm. Insecure land tenure acts as a disincentive for smallholder farmers to invest in the productivity of their land, water extraction rates are depleting underground water as a result of permissive policies, and food security remains out of reach for millions of people despite rapid economic growth in urban areas.

Response
Anticipating the bottlenecks on agriculture will require that global companies demonstrate that their sourcing of global commodities is driving more integrated approaches to sustainable land. This implies that local communities enjoy secure land rights and benefit from high levels of agricultural productivity, while soils, water and biodiversity are stewarded. This will be hard to achieve without the weighing in of government policies, pre-commercial investments, extension services to smallholder farmers and legal frameworks that turn voluntary sustainability criteria into widespread operating norms. Business leaders should articulate more clearly the kind of support that the private sectors needs from governments in order to streamline sustainable models, and pursue this agenda in cooperation with civil society initiatives and policy-makers.[9]

1.3

New visions of opportunity

Countries on the brink of resource crises are becoming more open to support new business and investment ideas through decisions that will help create longer-term resilience.

The Japanese government has put forward a bold new vision to pursue its energy security through wind power investments in its vast offshore continental shelf. This would have been deemed utopian before the Fukushima nuclear security disaster, and the provisional shut down of its 50 nuclear power stations.

The initial investment of US$ 226 million made by the Japanese government is intended as a first step to attract private investors. But this has already invigorated the Japanese industrial system to design and manufacture the turbines. This future-oriented vision will create jobs and revitalize the Japanese economy.[10]

The Earth Security Index 2014 signals worrying trends for many countries, but also anticipates the compelling mutual interests that could bring governments, companies, investors and civil society together to support bolder visions of sustainable prosperity.

— In Egypt, this may include investments that will make the sustainable reclaiming of the desert possible; or a pan-Arab cooperation of industry, governments and finance to spark an Arab 'solar' revolution. The latter could help turn a predominant narrative of social instability into one of investments in renewable energy that create thousands of youth jobs and a vibrant business environment, while improving the resilience of weak energy systems.

— In Brazil, rainforests are helping to stabilize the weather and provide resilience against weather extremes. Deforestation and the loss of this resilience is amplifying the losses that insurance and reinsurance companies are confronting due to extreme weather. The connection has not yet been properly made that will allow this sector to help improve the protection of rainforests as an insurance policy.

— In much of sub-Saharan Africa and South Asia, land tenure insecurity and vulnerabilities are converging with insufficient access to water, energy, food security, soil degradation, and biodiversity loss. Many sustainable agriculture initiatives have sprung from civil society and business to address these various issues. More integration is needed across these themes, as well as greater involvement of governments to create the enabling environment for larger-scale transitions towards sustainable land use. Global agricultural companies must work more closely with governments in new commercial relationships that improve the conditions of local people, of food production and the environment. Governments must help translate the voluntary criteria for sustainable commodities into country legal frameworks, to help shift global commodities sourcing to sustainable land.

The strategic country analyses of the ESI 2014 framework will help companies, investors, governments, and civil society to focus their responses to resource risks by supporting new visions of prosperity and market opportunity.

"Countries on the brink of resource crises are more open to support new investment and policy ideas that will help create longer-term resilience."

A Countries with high levels of food insecurity and low crop yields will need agricultural input companies to help small-scale subsistence farmers to improve their productivity and output, while using inputs efficiently to avoid environmental pollution.

B Countries with high levels of youth unemployment, energy and water scarcity will be prime markets for solar power investments that harness the energy of the sun to produce electricity, power irrigation systems and desalinate water, while creating jobs.

C Countries with high levels of water stress and soil erosion will require investments and better markets for efficient irrigation technologies, as well as enterprises that deploy the type of farming practices that help re-build a region's ecological resilience.

D Countries with high levels of exposure to extreme weather and agricultural vulnerabilities will require better insurance products and preparedness to help communities, companies and governments deal with extremes.

Moving beyond inertia

This transition is not happening at the speed that is required. On the contrary, the pace of resource demands is accelerating. The pressure on rainforests, aquifers, and other vital Earth support systems is reaching critical thresholds. Governments face other short-term pressures, like fiscal stress or unemployment, leaving some to consider environmental issues as a luxury that cannot be afforded. The dangers of this kind of thinking are increasingly evident.

In this leadership and solution vacuum, business leaders have been asked to step in to fill the gap and become champions of sustainability. Leading global companies that have taken a stance on sustainability are mainstreaming higher standards across borders. However, on balance, their voluntary commitments, standards and best practices will continue to have a limited systemic impact without changes to the legal system by host countries, international arbitration courts, international agreements and the law of the countries where the companies are headquartered.

This transition will not be possible through business leadership alone. All of these practices and technologies already exist. They are being deployed usually on a small scale. To be economically viable, they will require subsidy reforms and new trade policies. This is why a far more strategic dialogue between businesses, governments, investors and civil society is urgently needed.

1.5

Target audience: how to use the ESI 2014

The ESI's data framework and the innovation propositions being put forward should be used by all sectors confronting resource security challenges. They have a role to play in turning the risks they face into opportunities for sustainability and resilience:

Business

Global companies operating across borders in many countries need to anticipate different configurations of risk, which are inherent to specific political conditions. Responding to these risks with foresight will require sustainable business models, new R&D priorities, corrective measures to existing investments, and government relations to help address these pressures.

Being a partner of choice for host countries will require that companies demonstrate not only how they manage the sustainability of their own operations but also that they are aware of, and bring practical value to, how countries and their populations deal with their own resource governance priorities.

Immediate management opportunities include reviewing corporate sustainability strategies to include targets that go beyond resource efficiency measures, and measure a company's engagement in improving the quality of resource governance where it operates. It also requires a review of global operational protocols to ensure that country-based operations are identifying and responding to the right combination of priorities.

Investors

Private and public investors, asset owners, development finance institutions and insurance companies must urgently consider the liabilities growing in their portfolios and how to shift their capital to sustainable opportunities.

Investee companies that are not aligning their strategies with resource stress conditions in the countries where they operate (food security, land security, water security, energy security and climate extremes) are likely to face the resulting risks, whether these are financial, operational or reputational.

Private equity investors will improve the due diligence questions they ask of companies to understand the resource stability of their operating context and some of the inter-connected risk propositions presented in this report.

On the opportunity side, new sustainable investments should be considered and pursued in resource-efficient companies and technologies, which target markets that are facing resource stresses with new sustainability propositions. These will open new opportunities to shift capital towards longer-term resilience and profitability.

Governments

Government decision-makers are at the center of the resource governance agenda. This applies to countries where resource scarcity and vulnerabilities are building momentum, but it also applies to those governments with trade interests who can provide strategic resources for this transition. It also applies to governments that are hosting the headquarters of resource-intensive companies and may face diplomatic backlashes associated with resource conflicts in third countries.

New investments and infrastructures are needed to confront resource limits. Drawing on the ESI 2014 analysis, governments need to consider the market incentives and investment promotion programs that will attract the right kind of private sector partners to the country. Policy-makers will consider how the risks and opportunities will be addressed by combining foreign policy, investment policy, trade agreements, and resource governance.

Cutting across the silos of government that prevent holistic responses to the inter-dependences discussed here is critical. Selecting or creating government agencies that will act like 'hubs' and report directly to the head of government, such as a planning commissions or cabinet-level working groups, may offer immediate opportunities to pursue this agenda.

Civil society

Advocacy groups and citizen movements self-organizing through social media have a critical role to play in creating the conditions for change. Reforming subsidies or trade policies don't make for appealing public rallying topics, and the challenge of civil society will be to combine its mobilizing power with a focus on overcoming the systemic barriers to change.

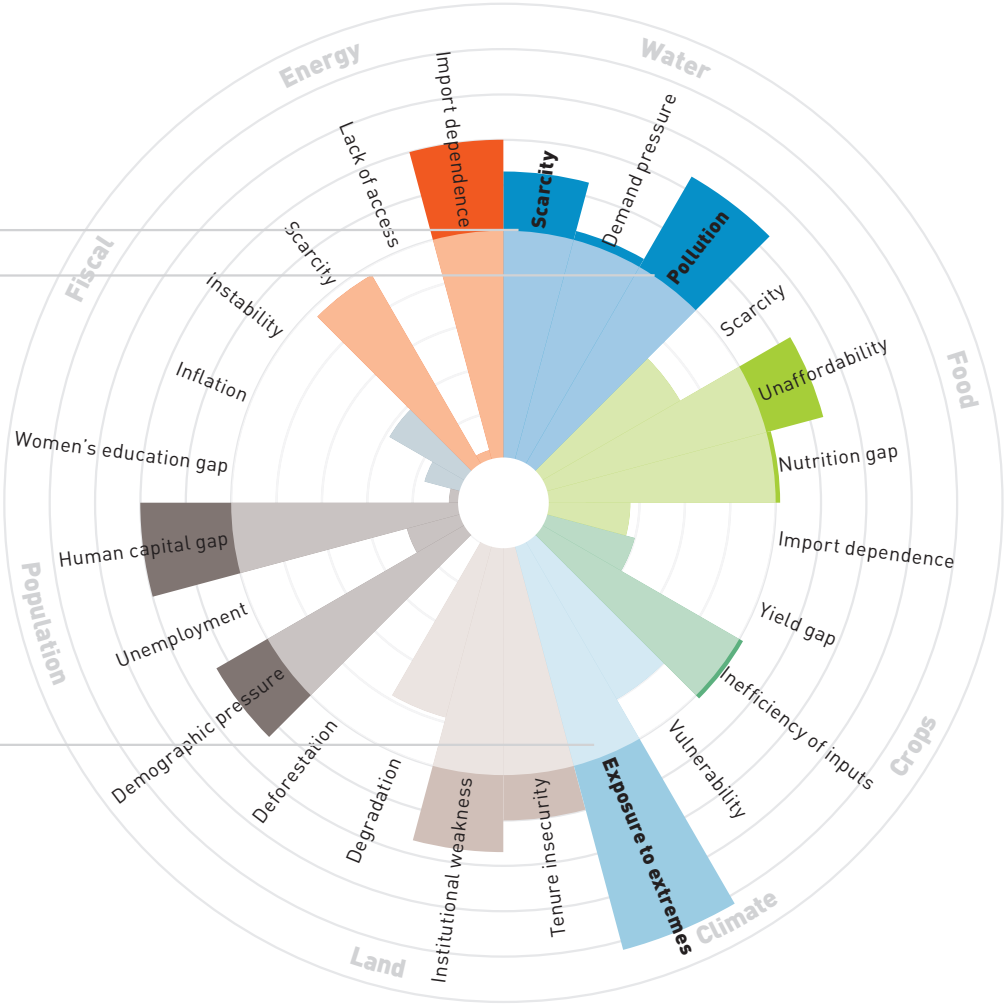
Civil society initiatives are addressing many of these individual resource topics discussed here and have an important role to play in collaborating with one another across silos (for example, topics such as agriculture, land tenure, water security, food security, fiscal reform, renewable energy, democratic transitions, citizen participation, etc.) Overcoming these silos in new ways will be needed.

Targeting the systemic barriers that prevent better resource governance is a critical task ahead. For example, global campaigns on land tenure insecurity (or 'land grabs') that have targeted individual investor or corporate deals have had a positive impact on reverting situations of injustice, and sent signals to decision-makers. Equally important will be for civil society campaigns to address the more complex institutional and legal weaknesses that create land tenure insecurity in the first place, and are endemic to certain developing countries' governance systems.

In other cases, addressing land tenure insecurity alongside food insecurity, deforestation and weak agricultural productivity may offer opportunities to create market and investment proposals that will help move these agendas from ones of fear and risk management to ones of inclusive economic prosperity.

"New investments and infrastructures are needed to confront resource limits. Governments need to consider the market incentives that will attract the right kind of private sector partners to the country."

2.0 Country profiles



China

The gigantic scale of China's economic growth is evident in everything from the size of its cities and infrastructure, to manufacturing, agriculture, energy production and demographics. The predominant view of China as the rising contender of global power is, however, at odds with the diminishing availability of safe freshwater and its increasing exposure to extreme weather. The 'China way' of responding to these threats with large-scale shifts toward sustainability can inspire the world. In the immediate future, however, China's bold vision faces a series of challenges.

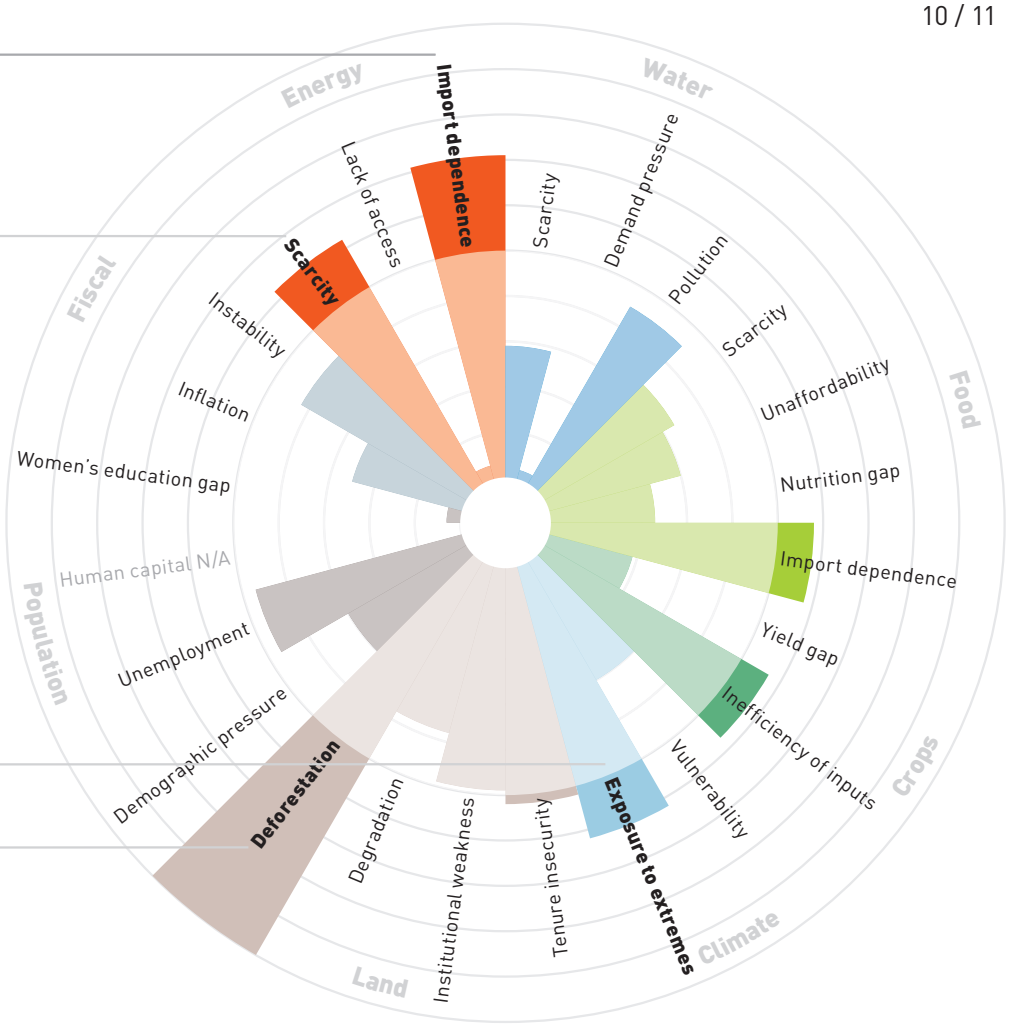
Managing the energy-water nexus
Coal is the centrepiece of China's energy matrix, providing over seventy percent of the country's power. Mining, processing and generating power out of coal requires large amounts of water.[11] China is planning a seventy-five percent increase in its coal-fired power capacity. According to the World Resources Institute, the majority of the proposed new plants will be built in areas that suffer from high water stress, where competition for water with other industries, farms and communities is already present.[12] China's transition toward renewable energy should be therefore seen as a strategy to improve its long-term water security.

A sustainable irrigation revolution
Half of China's arable land is being irrigated with 40,000 irrigation networks. Most of these were built over half a century ago; less than forty percent are in good conditions.[13] Chinese scientists have recently developed a new irrigation technology that consumes half the water of advanced drip irrigation techniques. Its 'trace quantity irrigation' is based on the principle of capillary force, where roots pull the amount of the water they need as opposed to being watered with it. If used at scale, this could protect and expand China's cultivated land area and improve the conditions of its arid regions, according to official sources.[14] The innovation drive for 'invented in China' technologies can position the country as a global market leader to deal with resource security.

Water pollution is another Achilles heel of China's resource security. More than half of the groundwater nationwide is categorized as polluted. This results from a combination of untreated industrial wastewater the organic pollutants of livestock, and the overuse of agricultural inputs. China's Ministry of Land and Resources estimates that pollution from heavy metals destroys 10 million metric tons of grain and contaminates another 12 million metric tons annually.[15]

China's self-sufficiency in the production of grains (only 2.2% of the cereal supply is imported) is an important part of its food security strategy. China's large imports of soybeans to feed its livestock, on the other hand, are likely to continue to grow as soybean was taken off the country's strategic commodity list.

Chinese officials recognize that water scarcity and pollution, a rapidly transforming diets, and the migration of farmers to cities, may combine to jeopardize China's grain self-sufficiency goals. in response, Chinese agricultural investments abroad and trade partnerships are expected to grow. China's understanding that ecological stability is pivotal to its long-term security may have to figure more centrally in its investment and trading agreements with other countries.



Brazil

Brazil is a tropical, emerging global power. Thirty years ago Brazil was a net food importer. Today it has become a major food export player. Its abundant water resources, however, are unevenly distributed: Amazonia has a water surplus, the northeast is acutely water-stressed, and the south, which is home to Brazil's mega-cities and agricultural activities, is vulnerable to extreme weather events. Brazil generates eighty percent of its electricity through hydropower dams. A growing variability in rainfall may affects it power-generation capacity. So far, the main share of Brazil's large energy imports of crude oil, coal and peat are used by industry,[16] but this could change if in the future its domestic power generation is affected by extreme weather.

Amazonia as an insurance policy

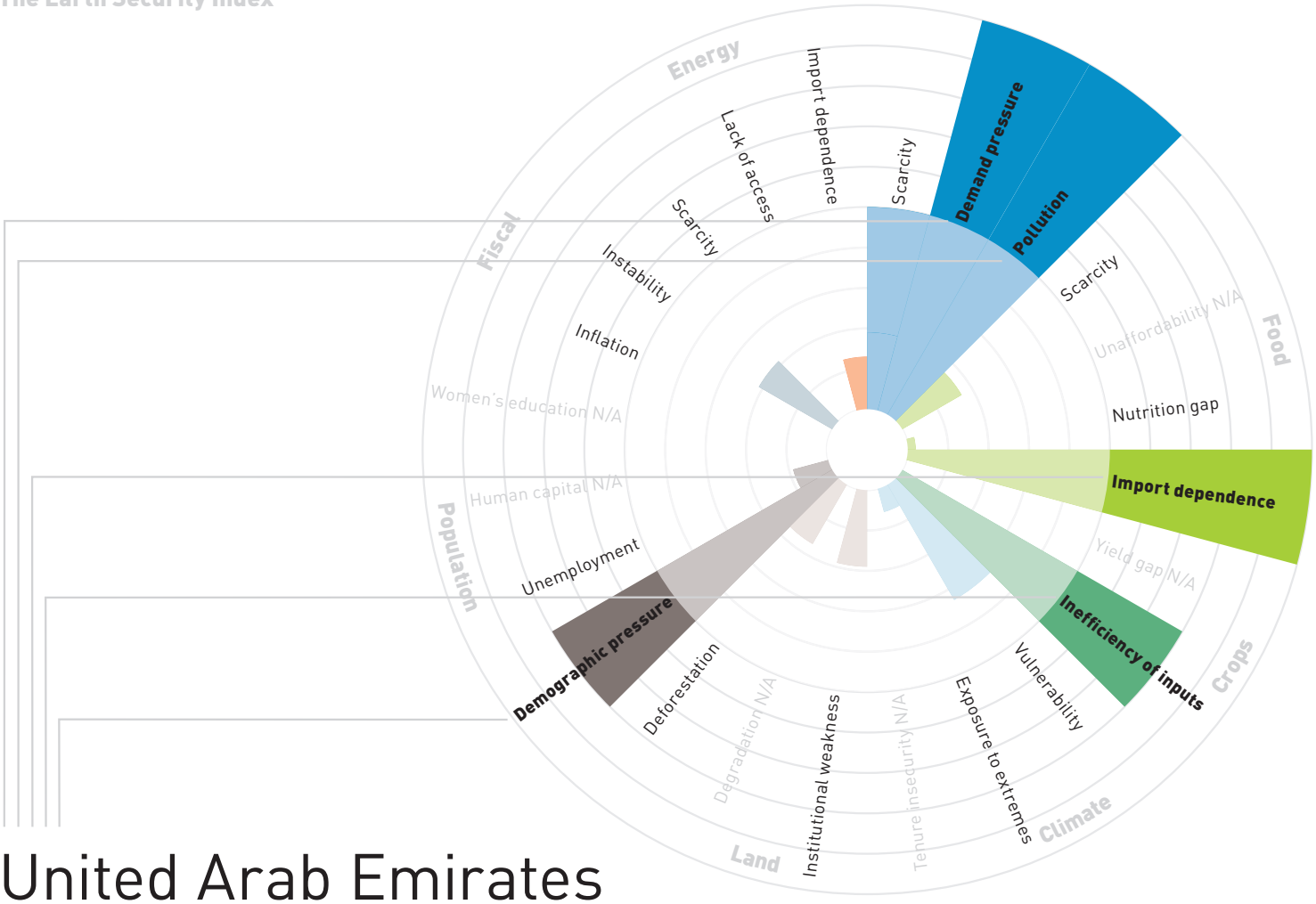
In 2011, the economic losses from extreme floods were estimated at US$ 4.7 billion, and an average annual loss of US$ 979 million over the last two decades.[17] Tropical rainforests play a crucial role in regulating the stability of climate conditions. Brazil lost close to 11 million hectares in Amazonia between 2005 and 2010.[18] The rate of deforestation between 2004 and 2012 slowed down by almost eighty percent, thanks to a combination of efforts that included screening of public financing to industry, real-time satellite monitoring by government and a NGOs like IMAZON, and law enforcement.[19] However, 2013 figures again show a 28% increase in deforestation with regards to 2012.[20]

The impact that the absolute loss of forest has over the stability of Brazil's water cycles is not yet fully understood. Changing rainfall patterns are likely to affect Brazil's security in the next decade. Despite the uncertainties that remain between the interaction of rainforests and weather stability, the Brazilian scientific community is able to predict that weather extremes will grow towards 2020 — with agriculture, hydropower and insurance being identified as the most vulnerable sectors.[21]

The insurance sector faces unprecedented costs and liabilities from extreme weather, but also new markets for insurance solutions to improve preparedness. The role that tropical rainforests play in maintaining weather stability should be considered as the insurance sector anticipates greater liabilities.[22] Recalibrating insurance premiums and developing new market strategies will also improve the signals that insurance rates send to the rest of the financial sector.

Investing in resource efficiency

Intensifying agriculture sustainably (i.e. producing more in less space) is vital to sustain economic activity without eating further into Amazonia—and it makes for an attractive business case. The average productivity of cattle ranching in the Amazon is almost 4 times lower than its potential.[23] Linking land efficiency improvements to, for example, investments in the preserved forest carbon is a growing area of interest for commodity companies, financial investors and NGOs.[24]



United Arab Emirates

Between 2002 and 2012, the UAE's population grew by 186%. Immigration has been pivotal to the UAE's phenomenal growth in everything from financial services to infrastructure and the construction industry. The UAE's ambition to become a global hub of renewable energy and sustainability innovation is at a critical junction: It will be either thwarted by the instability of the UAE's dwindling water reserves and food vulnerabilities, or these will act as a driver of bolder policy and market innovations, and catapult the UAE onto to the world stage as a pioneer investor of new sustainable resource technologies.

The threats of water scarcity and food security are already helping the government become more aware of the need to manage the limits of scarce resources more effectively, for example, by shifting water subsidies towards more sustainable policies.[25] Addressing these pressures with sustainable investments is critical, not just to the UAE's local resource security, but also to define its international positioning abroad. Two areas for the pragmatic pursuit of opportunity are:

Solar-powered water desalination

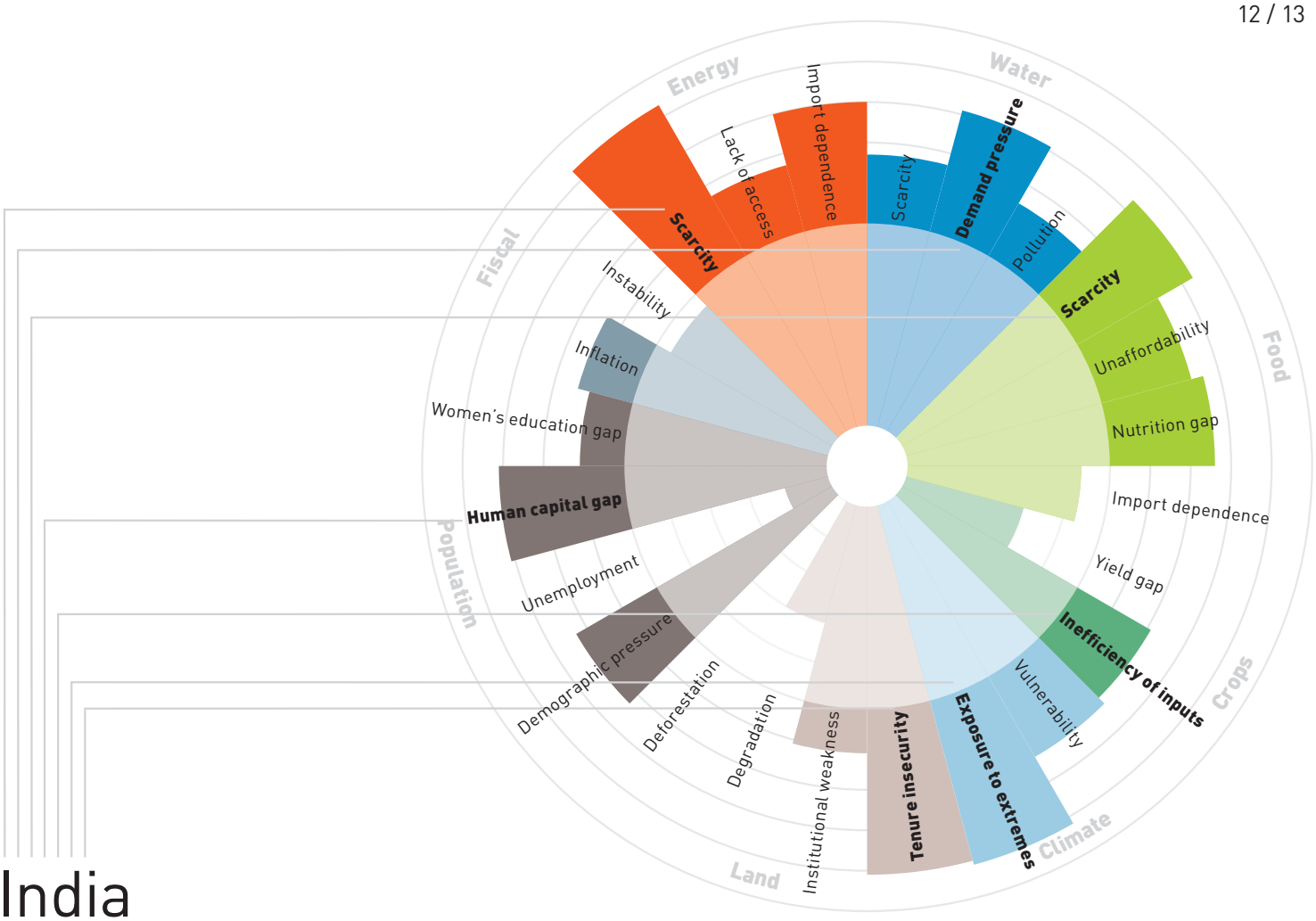
Water security is one of UAE's fundamental challenges. Dubai's water consumption is 24 times higher than the recharge rate of its underground water reserves. Water supplies are dependent on these reserves. Seventy-one percent of UAE's water is sourced from underground reserves, twenty-four percent by desalinated water and five percent through treated wastewater.[26] Groundwater reserves are exposed to evaporation, salinization and seawater intrusion.[27] A growing reliance on desalinization plants has dominated short-term responses; they are expensive and energy-intensive to run. But water stress is proving to be a powerful driver of innovation. UAE's Masdar innovation facility is expected to launch the first renewable energy-based water desalination plant at a full commercial scale by 2020.[28]

UAE's vision of sustainable food

The UAE is acutely dependent on food imports (over ninety percent of the food consumed in the UAE is imported — main suppliers are India, Germany, Canada, Brazil and Argentina). Supporting its domestic food production sector is seen as a cornerstone of its food security strategy.[29]

However, local agriculture is taking up most of the UAE's precious water, using almost seventy percent of its resources. Improving the efficiency and intensification of agricultural inputs is a priority.

Food prices in the UAE are sensitive to the stability of supplies of its trading partner countries. The exposure to climate change of food producing countries has affected global food prices and food availability in recent years.[30] As a response, private and public investors in the Middle East have invested in farmland abroad and are entering into long-term sourcing contracts with producers in other countries. Given its dependence on other countries, ensuring that UAE is seen as a partner of choice in agricultural investments will require responding to the priorities of host countries. By focusing on sustainable agriculture and taking a responsible approach to these investments, UAE investors could help create the type of win-win relationships on which to base its long-term food and water supplies across open borders.



India

India's economy is growing and is attracting investments in booming technology and service industries, but also growing is extreme water scarcity and the potential destabilizing effects on energy and food security. India is expected to cross the threshold of severe water stress before 2025.[31] Some of its large cities are already relying on water being transported in by tankers from nearby villages. In cities like Chennai, a base for automakers and IT firms providing services to the biggest American and European corporations, severe water shortages have recently pushed companies to the brink of shutdown. The regulatory gaps that have given way to a free-for-all underground water extraction must be confronted. According to a survey by the Indian Chambers of Commerce and Industry in 2011, eighty-seven percent of respondents said water constraints are going to impact their business in the next ten years.[32]

India's water choke point

India's reliance on groundwater extraction is, on average, thirty-seven percent higher than its natural recharge rate. Water scarcity creates complex trade-offs between energy and food production. According to the Energy and Resources Institute (TERI) in India, projected coal-fired power stations will be built in areas that already are water-stressed, while water shortages have already forced power plants to shut down their operations.[33] Subsidies for India's farmers have led to the proliferation of millions of electric water pumps that deplete groundwater supplies in the fertile northern grain-growing region. The due diligence of investors financing existing, as well as the proposed coal-fired power plants, argues TERI, should consider issues beyond the power sector. They should be asking, for example, how many other activities surrounding the power plants, such as agriculture, will also require and compete for water in the future.[34]

Integrated land productivity

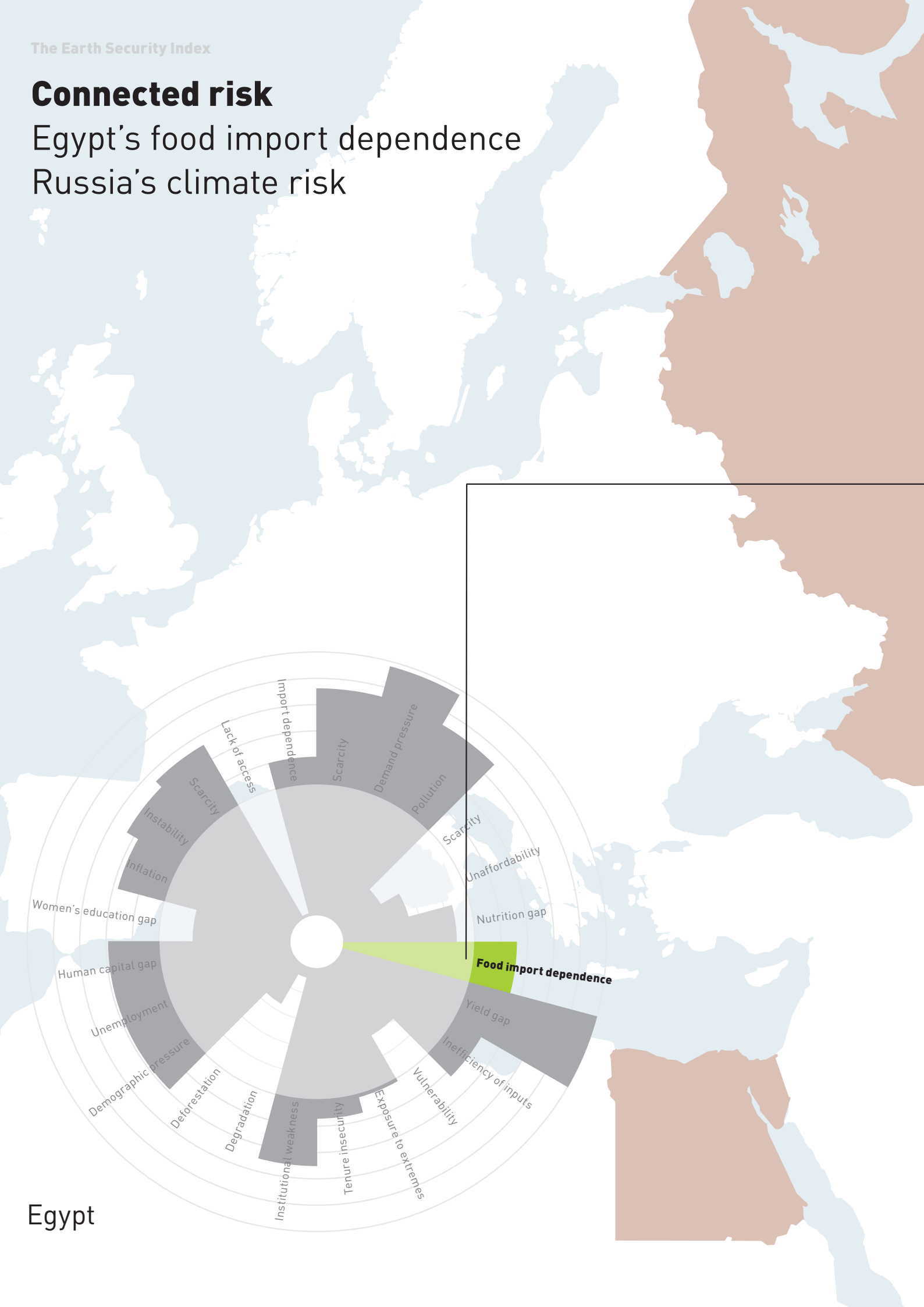
India has one of the highest population densities in the world. Food security is a growing concern. Weak land tenure is a problem as land is increasingly contested by urbanization and industrialization.

Not having a secure land title creates uncertainty for farmers, who hesitate to invest in improving the productivity of their land. A new Land Acquisition Act in 2013 will make it more difficult for agricultural land to move away from agriculture, requiring the consent of eighty percent of the people affected by projects. The law protects farmers from losing their sole asset and will strengthen market conditions for sustainable agricultural investments.[35]

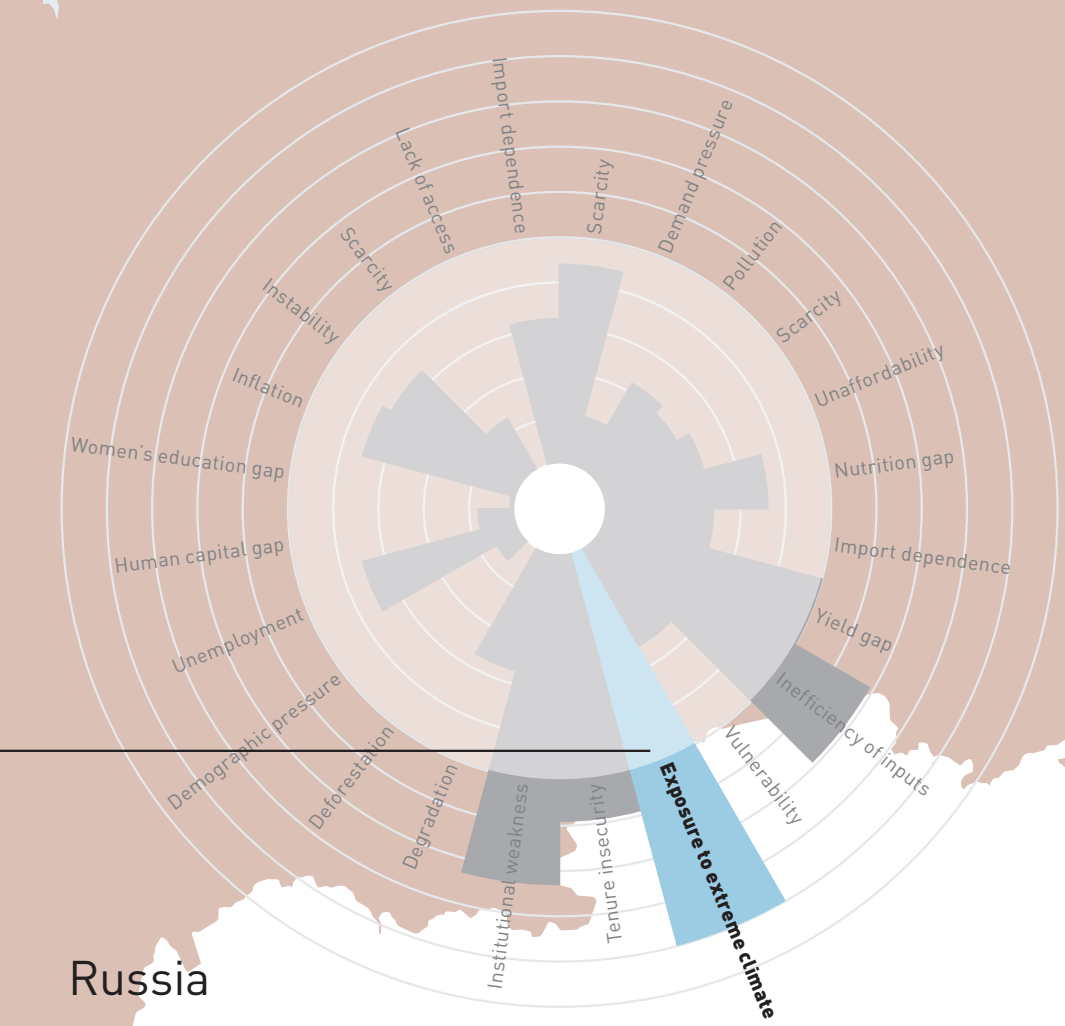
The endemic use of excessive irrigation and overuse of fertilizers has resulted in an estimated one-third of all irrigated land to become degraded through waterlogging, salinization and pollution. Seven million hectares have been reportedly abandoned.[36] A range of companies that are playing into these crises with solutions that give farmers the access to better skills, financing and technologies are creating more virtuous markets. One example is ITC's weather insurance products for farmers, which help them to cope with India's growing exposure to extreme weather events.[37]

Connected risk

Egypt's food import dependence
Russia's climate risk



Egypt



Russia

Egypt is acutely dependent on wheat imports, being the world's largest wheat importer. More than a third of Egypt's wheat imports come from Russia. In 2010, Russia was hit by a drought; the highest summer temperatures recorded in 130 years. The summer harvest was decimated, affecting 17% of Russia's total crop area — or some 25,000 farms.

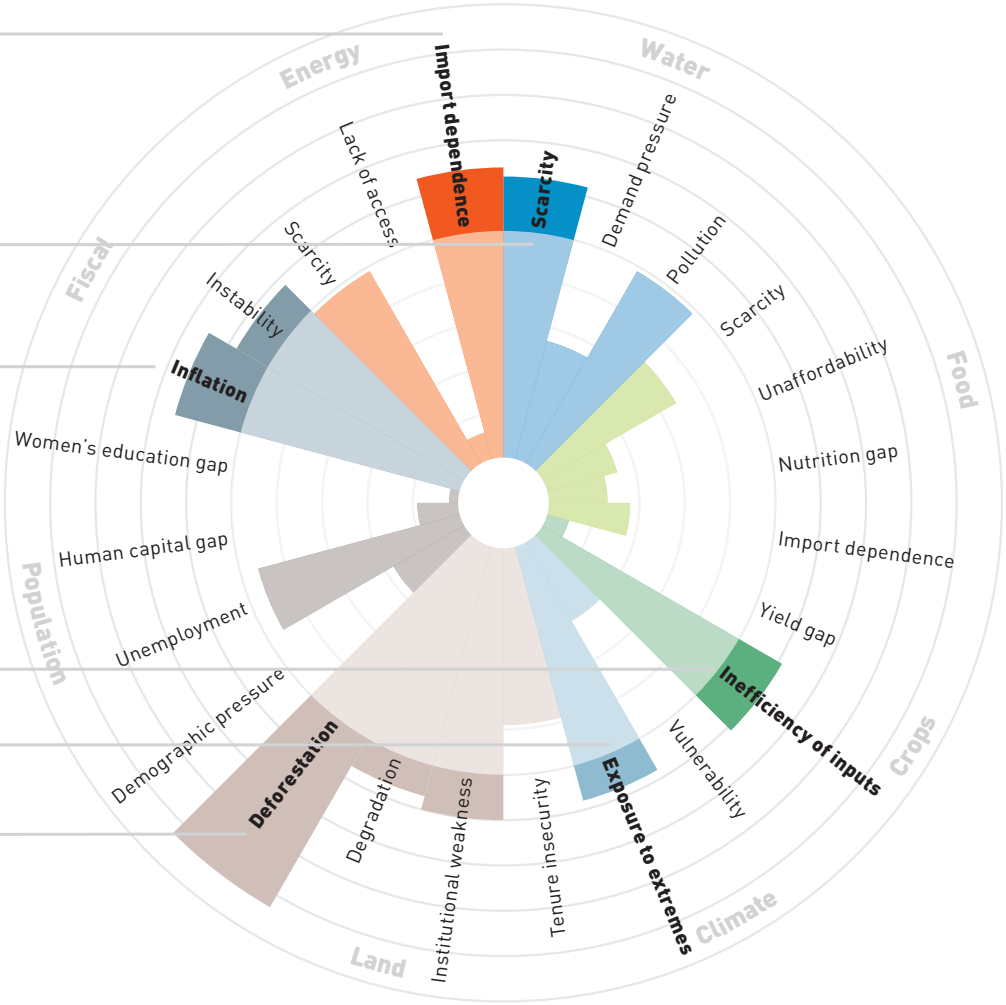
The export ban

Once it became clear in global markets that the Russian harvest would be severely affected, this being one of the world's major exporters, global grain prices rose sharply. The price of a ton of wheat rose from US$157 in June 2010 to US$246 in August, and would reach US$350 in February (an increase of 80% in one year).[A] The increase was amplified, it was reported, by grain speculators in Russia withholding their grains in anticipation of future price increases and the possibility that Russia might impose an export ban.[B] This effectively happened. In order to maintain the stability of its internal prices and supply, Russian authorities imposed a grain export ban in mid-August. The ban was to override existing contracts that exporters had with clients abroad and, this being a case of force majeure, exempted them from liabilities.[C]

Egypt's revolution

When its contracts were cancelled, Egypt was forced to find 600,000 additional tons of wheat from other international suppliers at a higher price.[D] Egyptian authorities reacted quickly, and at enormous government expense, to minimize the short-term impact on the poorest households and sustain bread subsidies. In comparison, Pakistan (which is Russia's fourth largest customer) saw a 16% increase in the price of wheat, just as the government was reducing food price subsidies. As a result, Pakistan experienced a poverty increase of 1.9 percentage points in only six months.[E] Most middle-class Egyptians buying bread beyond the subsidies were exposed to the price inflation.[F] By the end of 2011, the price of food had increased more than 70% compared with 2008, when skyrocketing prices sparked food riots. This hit Egyptians hard. Egyptians spend up to 40% of their monthly income on food (compared to 17% for Brazilians and 20% for Chinese).[G] Rising food prices, high levels of youth unemployment and a crisis of political legitimacy all combined to create popular unrest in January 2011, which escalated and led to the toppling of the president, Hosni Mubarak, 18 days later.[H]

A Wheat price, Index Mundi. www.indexmundi.com
B Grain speculation as prices rise prompts intervention comment, Russia Today, August 2010.
C The impact of Russia's 2010 grain export ban, Oxfam, June 2011.
D Russia Grain-Export Ban to Affect Some Egypt Imports, Bloomberg, August 2010.
E Food Price Watch, The World Bank, February 2011.
F Protesting on an empty stomach, Annie Lowrey, Slate, 31 January 2011.
G Emerging Consumer Survey 2011, Credit Suisse Research Institute, January 2011.
H Egypt uprising: timeline, The Telegraph, November 2011.



Argentina

Argentina is the world's third largest producer of soybeans, and a key supplier of grains to various countries. Investors, companies and governments doing business with Argentina have looked on with unease as the main oil & gas company was re-nationalised last year; as additional tax retentions were imposed on the main agricultural exports (up to thirty-five percent additional taxes for soybeans) affecting in some cases the economic viability of grain producers; and as official inflation figures were tampered with. The combined pressures of fiscal stress, a growing dependence on energy imports, and the weakening of its natural capital are likely to shape Argentina's resource security agenda.

Sustaining food exports

Over the last twenty years, land degradation has been largely curbed due to the mass introduction of no-tillage technologies (this is not picked up by global data-sets on land degradation). Agricultural productivity and output has been boosted through the increasing application of external inputs and modern technology. In some regions the high overuse of agricultural inputs may threaten the productivity of the soil, one of Argentina's most valuable natural assets.

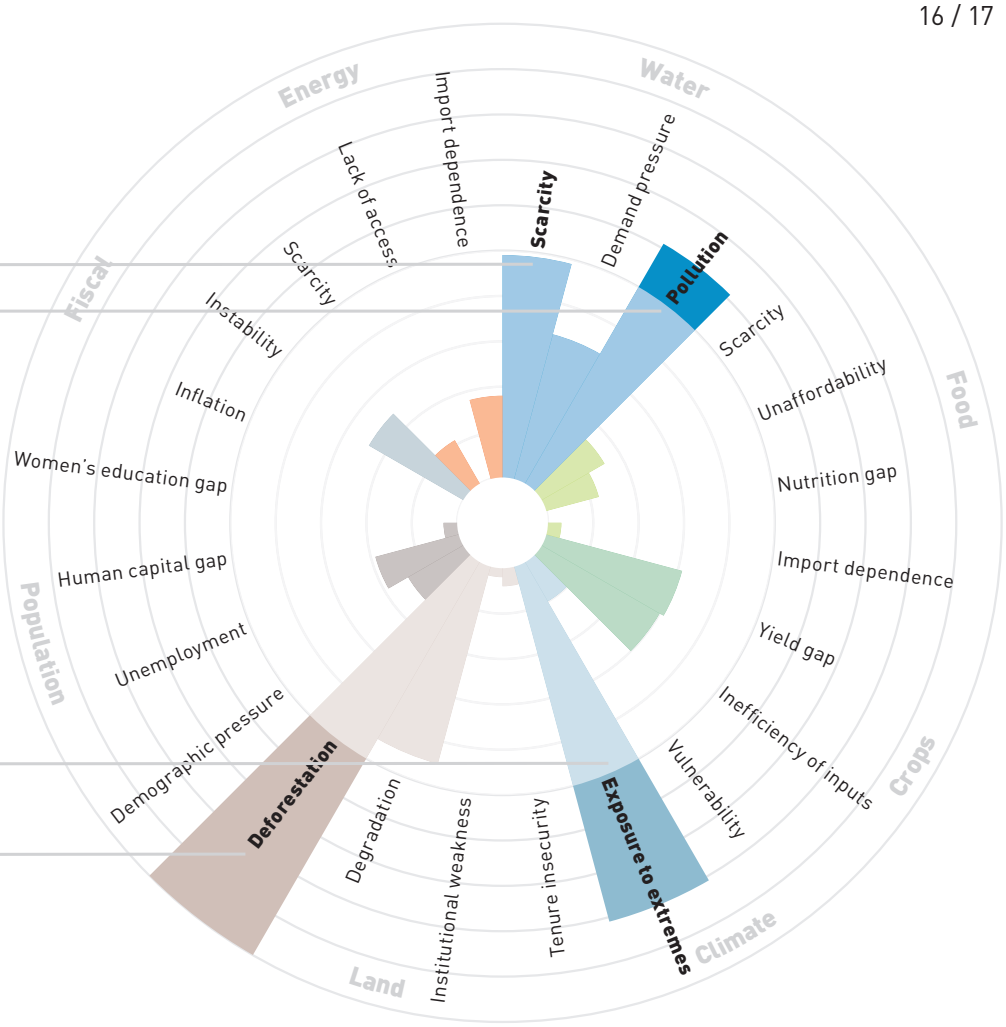
Argentina's agricultural frontier is expanding to the north, driven by the global demand for soybeans and other commodities. This is bringing investment to neglected rural areas, raising agricultural productivity and creating rural employment. But in areas where land tenure rights are not clear, this expansion has escalated social tensions and reinforced inequality while driving deforestation.[38] Improved national forest protection laws have had a positive impact, but deforestation in the new agriculture frontiers in northern regions like Chaco has in fact accelerated, with the rate of deforestation increasing three-fold between 1997 and 2007.[39] The loss of forest cover can have an amplifying effect on weather extremes, which will affect agricultural output. As this report goes to print, the region of Chaco is in a state of emergency due to extreme droughts — requesting emergency financing from the central government and thus affecting the country's fiscal agenda.

Energy import dependence and fiscal stability

A growing dependence on gas imports is one of the country's top short-term priorities as natural gas accounts for sixty percent of energy demand and is vital to transport, industry and households.

Argentina's spending on importing gas has grown six-fold between 2007 and 2011.[40] Production is falling and investment in exploration has dwindled. The external energy deficit is in the billions of US dollars — and has been a prime political driver for the government decision to nationalize its main oil company, Repsol-YPF.[41] Argentina has one of the world's largest reserves of shale gas, which is geologically more difficult to extract and expensive to produce. The likely ecological costs to the Patagonia region remain largely uncalculated by policy-makers and should be explicitly considered.

Investing in Argentina's renewable energy capabilities should be at the center of the energy deficit agenda, but will require forward-looking infrastructure investments. Putting Argentina onto an investment path that prioritizes a decentralized, renewable energy future must first capture the imagination of policy-makers, investors and companies, with a narrative that plays into the country's growing energy import dependence and vulnerability.



Australia

Australia is a prominent global energy producer, exporting most of its annual production of metallurgical coal (97%), oil (85%), thermal coal (71%) and gas (50%).[42] Australia's geographic proximity to Asia interests investors and policy-makers, and this will help expand the country's export-oriented investment opportunities.[43] Domestic resource pressures, however, are likely to undermine those investments and should be considered on an equal footing.

Water scarcity in vital parts of the country and a growing exposure to climate change may combine to challenge Australian's sense of security and prosperity. An investment boom will be needed in the infrastructures that will secure Australia's water and energy supply, while shifting its agriculture to regenerate the country's ecological resilience. Investing the benefits from today's 'resource booms' into these opportunities should be deemed a highly strategic direction.

Despite this resource wealth, Australia is critically dependent on importing refined fuels, holding just three days worth of fuel stockpiles.[44] The potential for supply interruptions pose a significant economic security risk. Australia's dwindling water reserves and its increasing dependence on energy-intensive water desalination technology may combine to create complex security dilemmas with wider ranging implications.

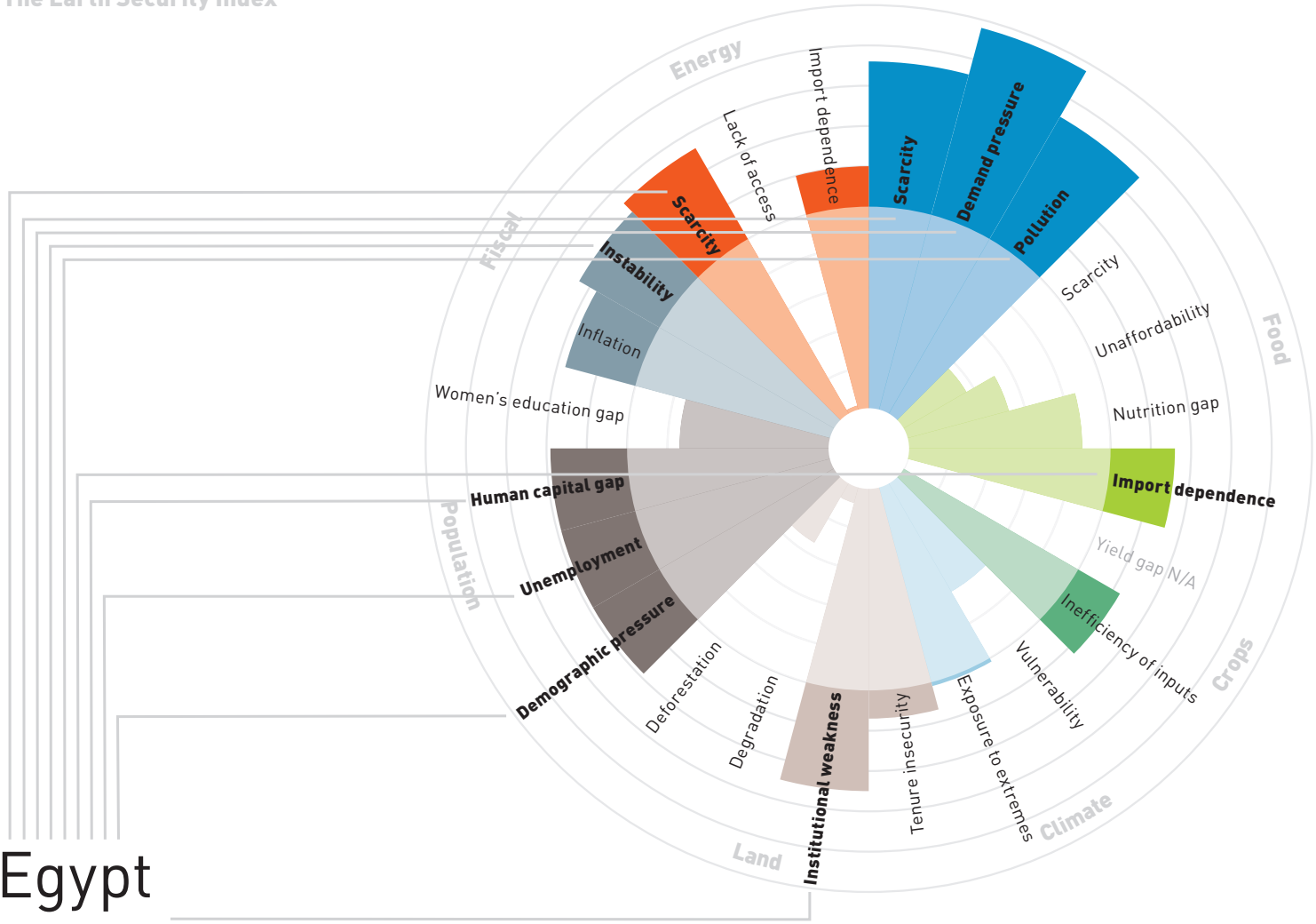
Investing in sustainable water security

Australia's water resources are very unevenly distributed in the country, with the most densely populated cities and agriculture facilities concentrated in the water-scarce south. Australia's exposure to weather extremes (extreme droughts and extreme floods), provides an uncertain operating space for resource-intensive industries. In 2010, for example, severe floods in Queensland led to a shut down of operations of ninety percent of its coalmines.[45] Australia's reliance on its groundwater reserves has almost doubled in the last two decades, with the trend expected to grow.[46] Investments in water desalination plants are also growing. Opportunities to redouble capital investments and R&D towards renewable energy desalination technology should be encouraged.

The costs of desalination, however, may be too expensive for farmers, whose security presses on fiscal contributions to deliver water or drought relief funds. In the future, water scarcity will either push domestic food prices upwards or oblige farmers to go out of business, increasing Australia's import dependence on grains.[47]

Investing in infrastructures for resilient agriculture

The quality of water supplies has also suffered. Historical deforestation has increased the salinity levels of the soil (Australia has lost more than 4.6 million hectares of forest between 2005 and 2010). Soil acidity is a serious issue for Australia's agriculture, and was estimated to cost almost A$1 billion in lost production in 2000 alone.[48] Given Australia's proximity to Asia, new global investments are expected to flow to develop Australia's agriculture in its northern regions, and provide capital investments for infrastructure (ports, irrigation, roads, etc.) Sustaining Australia's ecological conditions, forests, soil, and groundwater reserves, by drawing on practices of agro-forestry and ecological restoration, should be a security priority for investors, companies and planners.



Egypt

Most of Egypt's population of 80 million is packed into the Nile Delta, comprising roughly five percent of Egypt's landmass. Arable land is being lost to urbanization and desertification. Egypt was a self-sufficient food producer in the 1960s and since then has become dependent on cereal imports. Up to seventy-five percent of its wheat is imported — mostly from Russia and the United States. Key producing areas within both these countries have experienced significant droughts in recent years, which have helped push food prices in Egypt above the critical thresholds of probability of social unrest.[49] Addressing these risks requires shifting the predominant narrative of food insecurity and political instability to a proactive vision of sustainability opportunities.

An Arab Solar Revolution

Diesel fuel in Egypt is, ironically, referred to as 'solar'. And its supplies are running out. Fuel subsidies are unsustainable for a cash-strapped, fiscal-stressed government. This raises fears that fuel bottlenecks will lead to food shortages and further increase political instability.[50] Electricity is needed to pump water and irrigation systems. Agriculture is Egypt's largest employer of young people — the potential domino effect of fuel shortages on water, energy, food and jobs must be contemplated.[51] Policy-makers, business and civil society must work together to replace energy policies that rely on diesel subsidies with ones that favour renewable solar-power investments and job creation. Solar technology remains expensive and uncompetitive because it is not favored by market policies. The Egyptian National Competitiveness Council (ENCC) sees the potential of this revolution, but investments will flow only if the right policies are in place.[52]

Egypt has been mentioned as one possible next destination for the Desertec Industrial Initiative (Dii), which is underway in Morocco with a €400 billion solar infrastructure project.[53] Egyptian policy-makers should go out of their way to attract initiatives like these. But investments will struggle in today's uncompetitive market that is distorted by fuel subsidies[54] and will require policy-makers to join in the discussions of Egypt's long-term security and prosperity.

Sustainably reclaiming the desert

Ninety percent of Egypt's agriculture sector is made up of small-scale farmers who rely on wasteful water techniques such as flood irrigation, losing as much as 3 billion cubic meters of water per year.[55] Activating private sector investments and attracting foreign capital towards efficient irrigation is critical. In the meantime, the government has turned towards reclaiming land from the desert as a way of managing the pressures on land, water and food and to employ people. In the last decade, according to government officials, Egypt has reclaimed 400,000 hectares of desert, with another million hectares to be added by 2017.[56] Sustainability is a big challenge in desert reclamation strategies, but is also be an opportunity to choose to support sustainable investments, prototypes and create pockets of innovation where investors, companies, government agencies and civil society can collaborate in new ways.

Bolivia

Bolivia holds the world's largest deposits of lithium, the mineral needed to produce the batteries for electronic devices and electric cars. The launch of the country's first pilot processing plant earlier this year is set against speculation over its ability to retain more value of its natural resources within the country's borders.[57] The shadow of expropriations in extractive sectors is a source of concern for international companies eyeing Bolivia's lithium deposits. Bolivia's investment climate for extractive industries will continue to depend on resource pressures that are shaping social cohesion and stability.

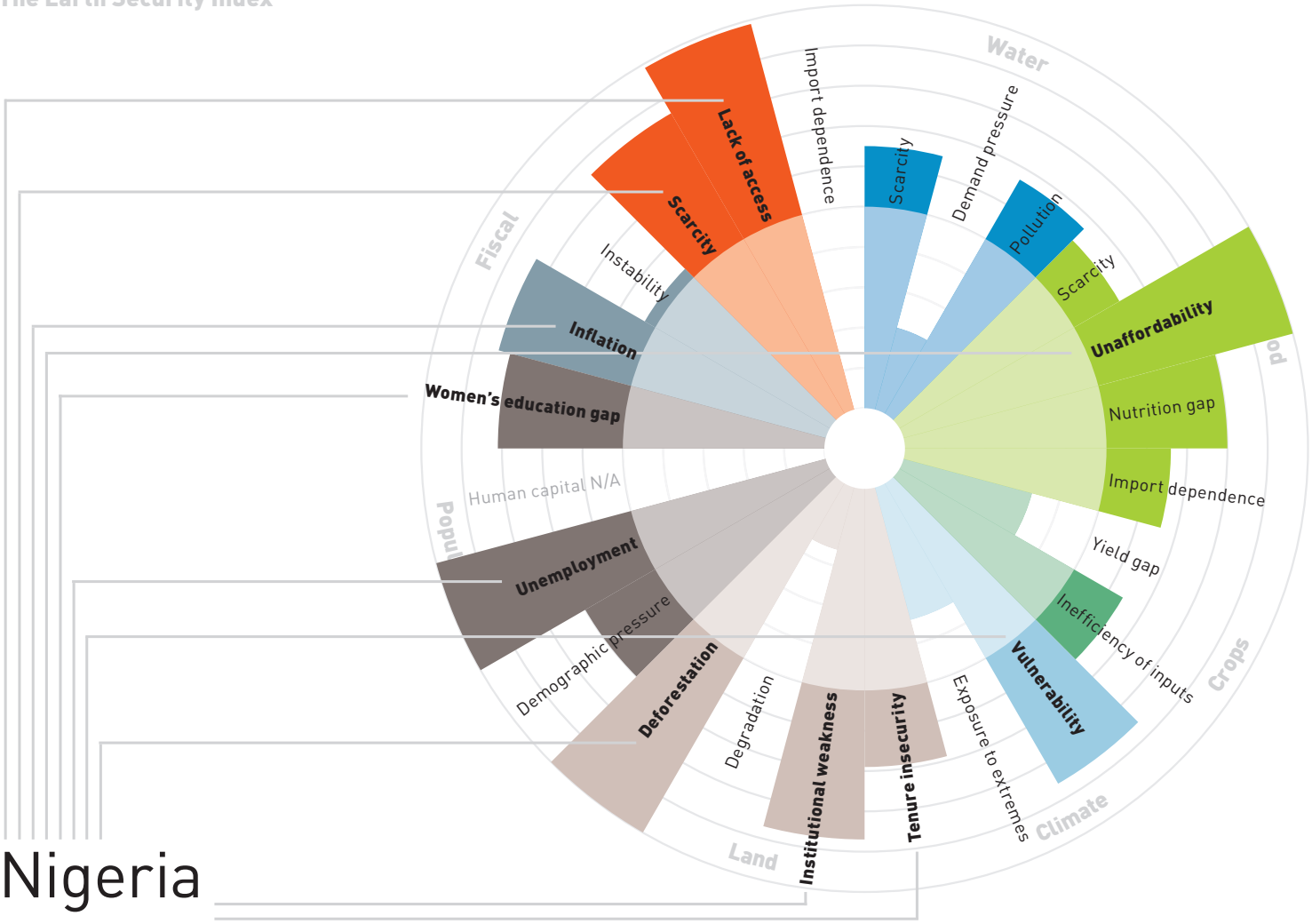
Food security
Despite its anti-capitalist rhetoric, Bolivia has jumped on the bandwagon of South America's export-led agricultural commodities model. Foreign land investments are pouring in, especially from Brazil.[58] But social divisions are deepening.

The Eastern region of landowners is increasingly integrated into global markets while the Western (Andean) region is based on a traditional, family-run smallholder model. Articulating these two different speeds and politics is a major challenge for the national government. The poor are spending over 60% of their income on food. Bolivia's import dependence on cereals makes it extremely vulnerable to global food price shocks.

Deforestation
Deforestation is accelerating, and can affect Bolivia's exposure to climate change, further reinforcing food insecurity. Bolivia has lost 1.5 million hectares of tropical forests in the last decade, mostly due to the pressure of an expanding agricultural frontier.[59] Bolivia's high exposure to extreme weather events (floods, mudslides and droughts) combines with seventy percent of households in food-insecure municipalities having a low capacity to respond to disasters. Deforestation and climate risks are likely to grow in importance as the public understands the inter-linkages of this agenda.[60]

Land security
This has improved for indigenous communities, but this has not fully translated to smallholder producers, which make up a large proportion of the country's population. The unequal distribution of land and capital, and a concentration of large underutilized properties have created a regional polarization of wealth and productivity.

An estimated thirty percent of Bolivia's farmers are landless and either lease land or work as agricultural labourers.[61] Sixty percent of cultivable land is located in the Easter region and is held by a few thousand large landowners. The Western Andean region has five to ten percent of the agricultural land, which is held by hundreds of thousands of smallholders.[62] Addressing the security of land titling while helping farmers increase their productivity may be strategic to long-term social stability.



Nigeria

Earlier this year, Nigeria was ranked by KPMG as one of the world's leading investment destinations.[63] Africa's most populous country vibrates with the possibilities of a mass consumer market. Its resource security challenges and priorities, however, tend to be disregarded by conventional investment analysts and bear all the ingredients that concoct social unrest. This should encourage investors, companies and governments to consider hedging the risks by investing in sectors that will contribute to the country's longer-term resilience.

Up to seventy percent of Nigeria's population of 168 million live below the poverty line. This social deprivation contrasts powerfully with the US$60 billion a year that the Nigerian government earns in oil revenues, amid concerns of endemic corruption and mismanagement.[64] Religious and ethnic divisions run deep and tend to erupt violently. Boko Haram, Nigeria's Islamist insurgent group is active in the Muslim north while in the Christian south, the Movement for the Emancipation of the Niger Delta (MEND) is a broad coalition of armed groups that have waged an insurgency war for years at the heart of Nigeria's oil production region.[65]

The islands of modernization being created in the capital, Abuja, create resentment in the urban poor who continue to swell in numbers.[66] Urban mobilization is the critical trigger of instability, as seen recently elsewhere in North Africa.

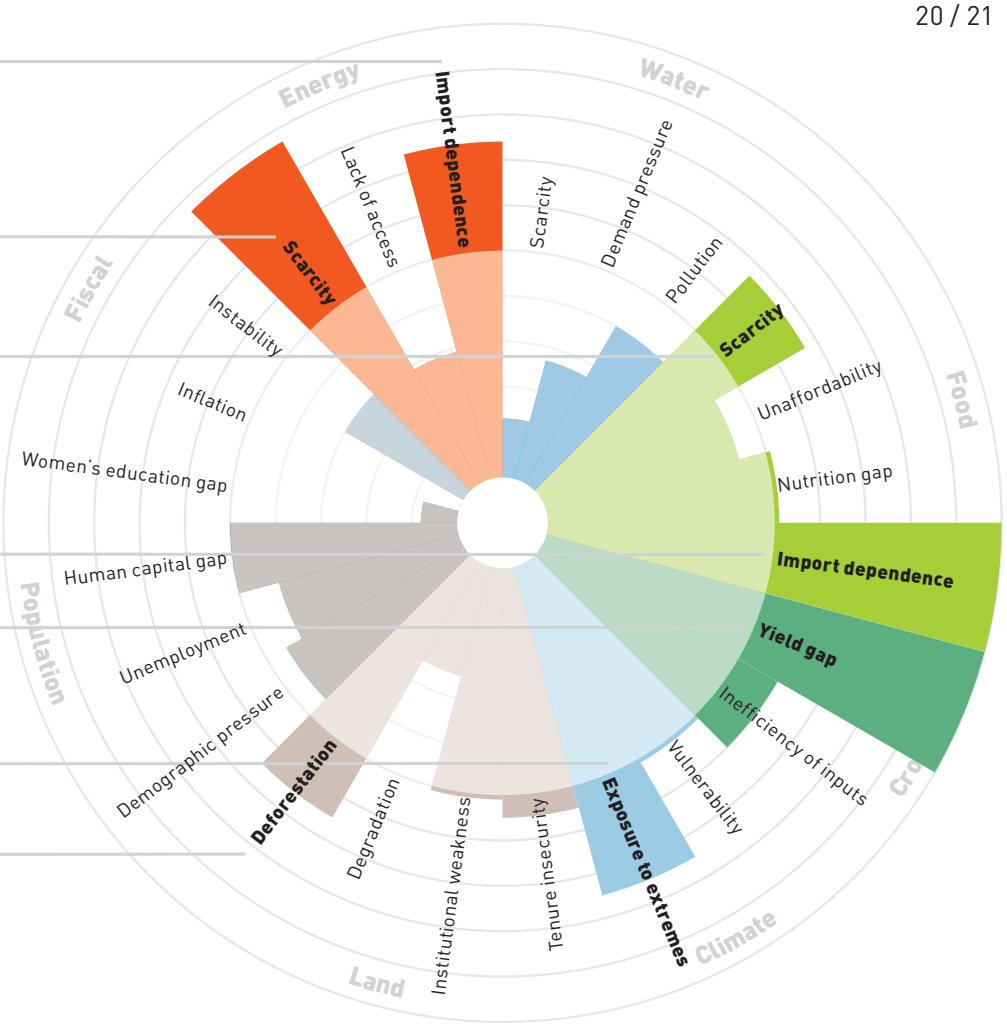
A renewable energy future

Thousands of protesters took to the streets in Nigeria in 2012 to demonstrate against the removal of a fuel subsidy, which was costing the government US$8 billion a year. Its removal doubled petrol prices and transport fares. It illustrated how difficult it will be for Nigeria to juggle resource stability and accessibility with fiscal, demographic and political factors.[67]

A reallocation of public funds will be needed to shift the subsidy-dependent energy markets towards self-reliant, decentralized renewable energy enterprises, which can create employment in the process. Fighting corruption in oil revenues is a critical priority to allow the government to use the millions of dollars that are being lost through mismanagement to reinvest in helping create future industries. Companies, entrepreneurs and investors will jump on the opportunities to shift Nigeria's pathway towards long-term sustainable enterprises when the vision aligns with incentives and opportunities.

Food security & resilience

Given the broader societal pressures, Nigeria's food security is an important issue. The growth in imports of food crops such as rice raises questions about the ability of the country to achieve its self-sufficiency goals.[68] Land tenure protection is weak. A 1978 Land Use Act sought to replace the customary rights system but has reportedly made land less accessible to most people, and its allocation more discretionary.[69] Eighty percent of the population still depends on wood charcoal for cooking. These trends tend to reinforce each other to give Nigeria one of the world's highest rates of deforestation (2 million hectares of forest were lost between 2005 and 2010).[70] Building greater resilience of the population to access food, energy and land is key to Nigeria's future. Nigeria's National Planning Commission has outlined a vision for 2020 where a 'modern technologically enabled agricultural sector that fully exploits the vast agricultural resources of the country, ensures national food security and contributes to foreign exchange earnings.'[71] The provision of agricultural inputs, smart irrigation systems and access to markets will continue to grow as market opportunities, but this productivity mind-set must go hand in hand with an improvement of the security of local people's rights to their land.



Peru

Peru is one of the world's largest suppliers of minerals and metals; and the global mining sector is key to Peru's export revenues. Peru's resource pressures are individually worthy of attention: its exposure to extreme weather events, its dependency on imported grain supplies, and the low performance of crop yields in its agricultural system. Taken together, however, these trends could redefine Peru's national security agenda, as well as the social operating environment for the mining sector.

Peru's arable land is limited to just three percent of the country, which is located in the northern and southern coastal areas of Peru. Peru's rapid urbanization is happening along the coast and therefore decreasing the availability of arable land. Food production is not enough to meet the country's growing demands. Peru imports nearly half of the cereals consumed domestically. This dependence does not pose a direct risk, as long as there is sufficient income, and a steady supply from trading partners.

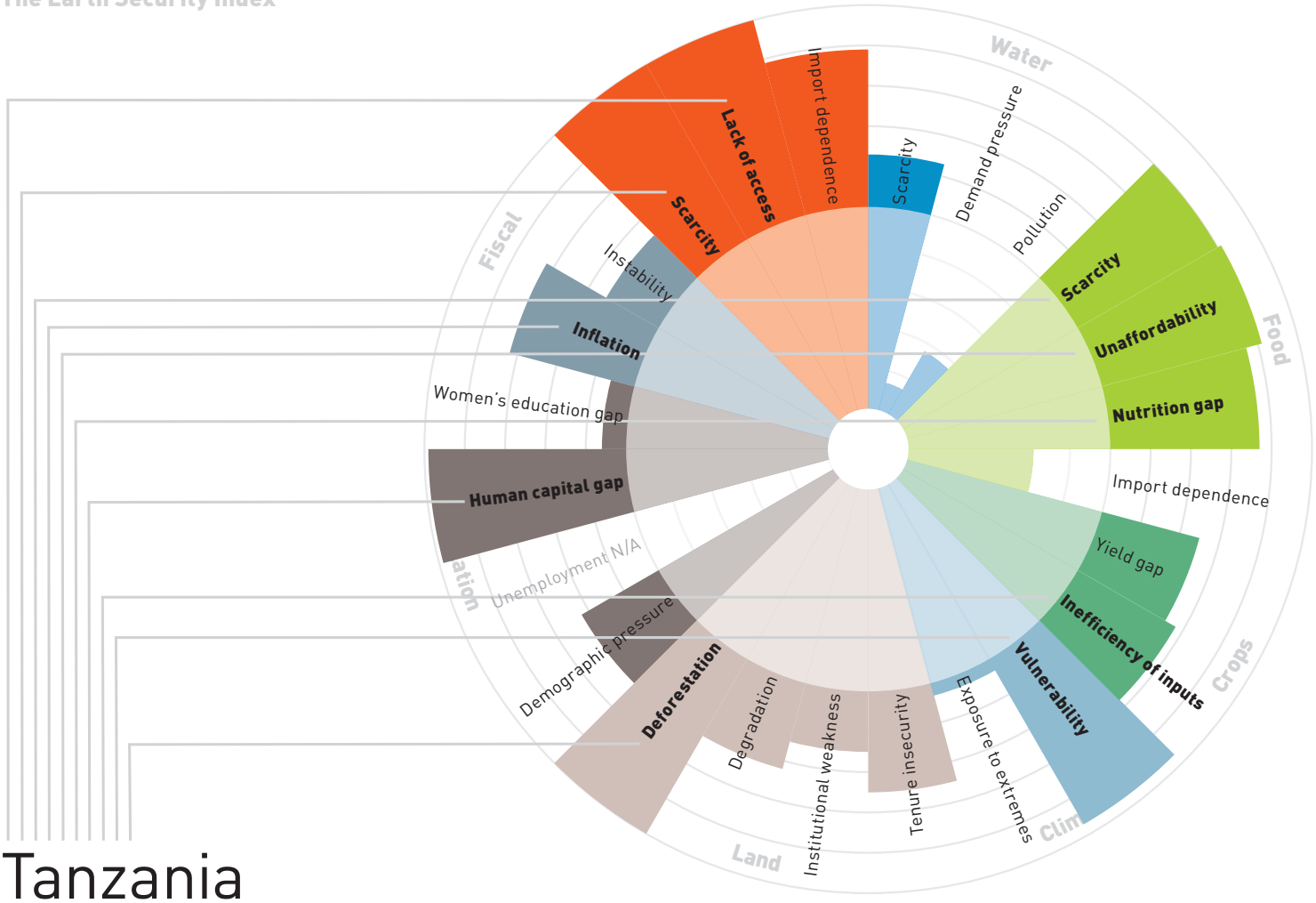
Maize is bought regionally from Argentina, Brazil and Paraguay, while wheat is sourced from the United States, Canada, Argentina and Russia. Many of these countries show a growing exposure to climate change, which in some cases has affected the stability of their grain exports.[72]

Extreme weather insurance

The Peruvian Amazon contains 98% of the country's water supplies. Deforestation, resulting from agriculture, extractive and infrastructure pressures, is accelerating. Peru lost 750,000 hectares of forest between 2005 and 2010. The impact of this loss on Peru's resilience to climate risks is not fully understood, but should be further investigated. The vulnerability of Peru's agriculture to climate change is an increasing area of attention by the government.[73] The insurance sector has a stake in this agenda. Peruvian insurance companies are already leading the way in the development of weather insurance products for agriculture. An insurance product for catastrophic climate risks in agriculture in Peru, for example, has recently paid out US$ 13 million to 145,000 smallholder farmers over the last three years.[74]

A resilience agenda for extractive industries

Mining remains the big driver of Peru's economic growth, representing sixty percent of Peru's export revenues.[75] The social and environmental consequences of mining projects, however, have increased conflicts with communities, with 149 disputes involving extractive industries in 2012 alone.[76] Local governments have had a limited capacity to manage the windfall revenues and translate them effectively into public spending, water treatment plants to avoid water pollution, and other investments.[77] The effects of mining operations on water quality and pollution could have amplifying effects on Peru's food security vulnerabilities and its exposure to extreme weather. Considering some of Peru's converging resource pressures; the role that rainforests play in providing resilience against extreme weather; and helping local communities address agriculture needs, are likely to continue to grow in importance on the agenda of global mining companies that are interested in tapping into Peru's mineral wealth.



Tanzania

Tanzania has discovered large reserves of natural gas offshore that will make the region the world's third-largest exporter of natural gas, strategically located to export to Asia.[78] This is attracting major global investment interests. A new gas pipeline in Tanzania is funded by a US$1.2 billion Chinese loan that will enable Tanzania to export gas to its neighbours. Domestically, however, Tanzania's rapid population growth is running ahead of the population's education. People will struggle to tap into Tanzania's modernization opportunities. Most of Tanzania's population has no access to modern energy, only 14% have electricity at home.

Inclusive land productivity

Poverty and food insecurity are high on the agenda. Tanzania's small-scale subsistence farmers use over eighty percent of Tanzania's arable land and the security of their land tenure is predominantly weak. The lack of access to skills, markets, and agricultural inputs means that crop yield gaps are likely to remain low, and farmers are likely to remain poor.[79]

Some companies in Tanzania as driving best practices, working with smallholder farmers as part of broader commercial supply chains; providing better inputs and skills, which help farmers improve their yields. One example that has gained government support is the Southern Agricultural Growth Corridor of Tanzania (SAGCOT).[80] A vision of inclusive productivity is needed that considers land, water, food, and energy securities in a more integrated way.

Rainforests vital to stablity

Tanzania's agriculture is predominantly reliant on rain and, consequently, food insecurity levels have fluctuated over the years in response to good and bad rainfall seasons. Tanzania's forests are important to this weather regulation but are being lost at an alarming speed. Millions of people in Tanzania rely on wood-charcoal for cooking, which is produced by burning forests to produce wood coal. Tanzania's forests are likely to remain the main source of cooking energy for unforeseeable future and very likely to affect rainfall patterns and food security.[81] Support for companies and technologies that commercialize cooking fuel made of organic waste may have the biggest short-term potential and provide new business growth opportunities, including youth jobs.[82]

But bigger visions may be possible too. In Burkina Faso and Niger, for example, the reintroduction of traditional agroforestry practices and land tenure policies have transformed large swathes of the region's arid landscape into productive agricultural land and recovered the water cycle with an estimated impact on the food security of 2.5 million people.[83] The links between energy, deforestation, rainfall and food, may require creative approaches to developing new markets.

These priorities will need to figure more prominently in the conditions placed on the 16 international energy companies that Tanzania has so far licensed to search for oil and gas.[84] They may also help create a debate about the best use of sovereign wealth funds and other ways of capturing resource wealth for investing in Tanzania's future resilience.

3.0 Next steps

Resource limits and the restricted access to water, food and land are already creating difficult dilemmas for many governments and populations; as well as for the companies and investors operating in those markets.

Every country faces a unique combination of resource pressures and vulnerabilities. Managing the resulting risks, and overcoming the barriers that are holding back the significant investment opportunities for resilience, will require collaboration.

ESI provides an independent analysis of the priorities using transparent data; an objective consideration of the forward-looking investment and policy proposals to improve resilience, and opens a strategic space for different sectors to consider their responses. In 2014 the ESI will develop this agenda through:

Earth Security Index 2015

The scope and methodology of the framework will be further developed in cooperation with partners. The ESI 2015 will cover a larger group of countries out of our database of 200 countries, through an online platform.

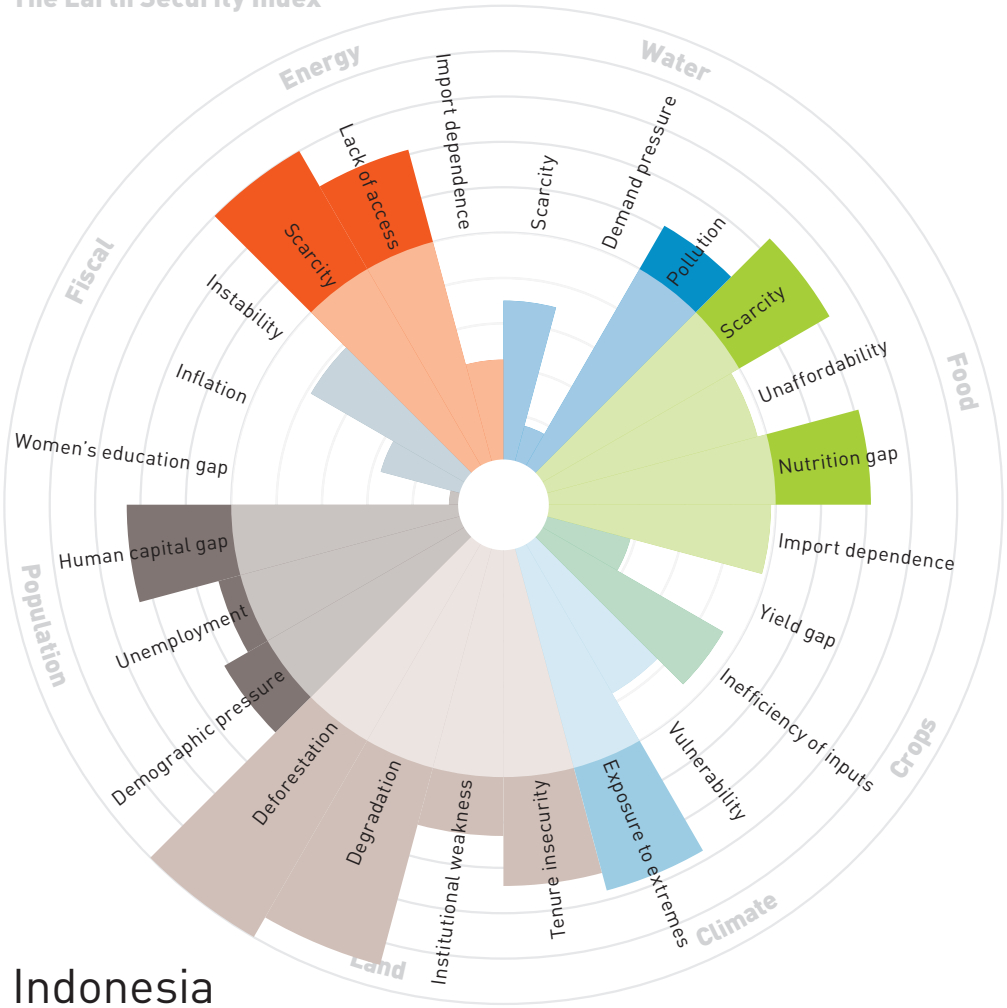
For more information please visit:
www.earthsecurity.org

Strategic responses to build resilience

Drawing on strategic focus provided by the framework, the ESI is bringing together creative people from business, government, finance and civil society to collaborate on innovative responses to global challenges as well as country priorities:

— **Global responses**
ESI is creating a process of global networking across sectors, through strategic global meetings that alternate between special places in nature and high-level venues. It is working with strategic partners to define core areas of opportunity to create global resilience responses to the risks identified.

— **Country responses**
In priority countries for the resource security agenda, ESI is working with partners through country projects. These bridge traditional sectors and areas of expertise in order to assess inter-dependent risks; consider opportunities for investment and competitiveness; and pursue innovative responses to resource limits.



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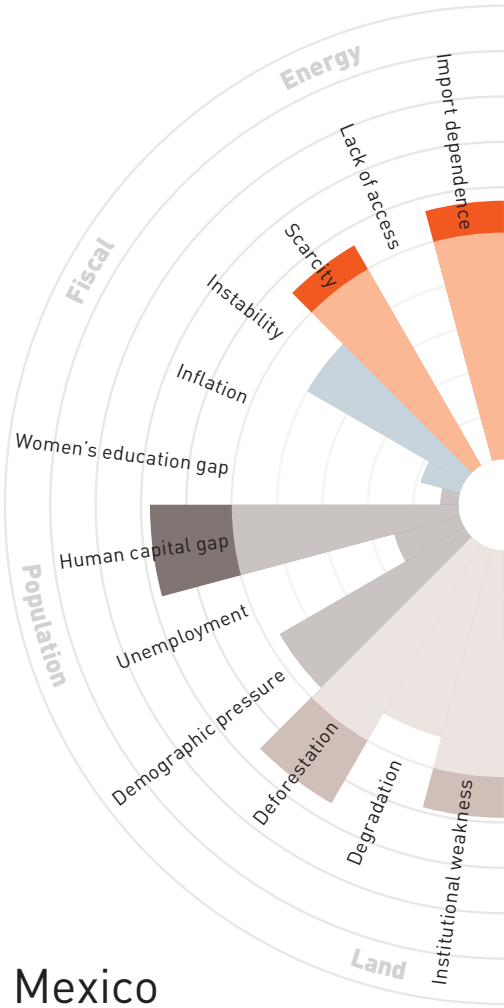

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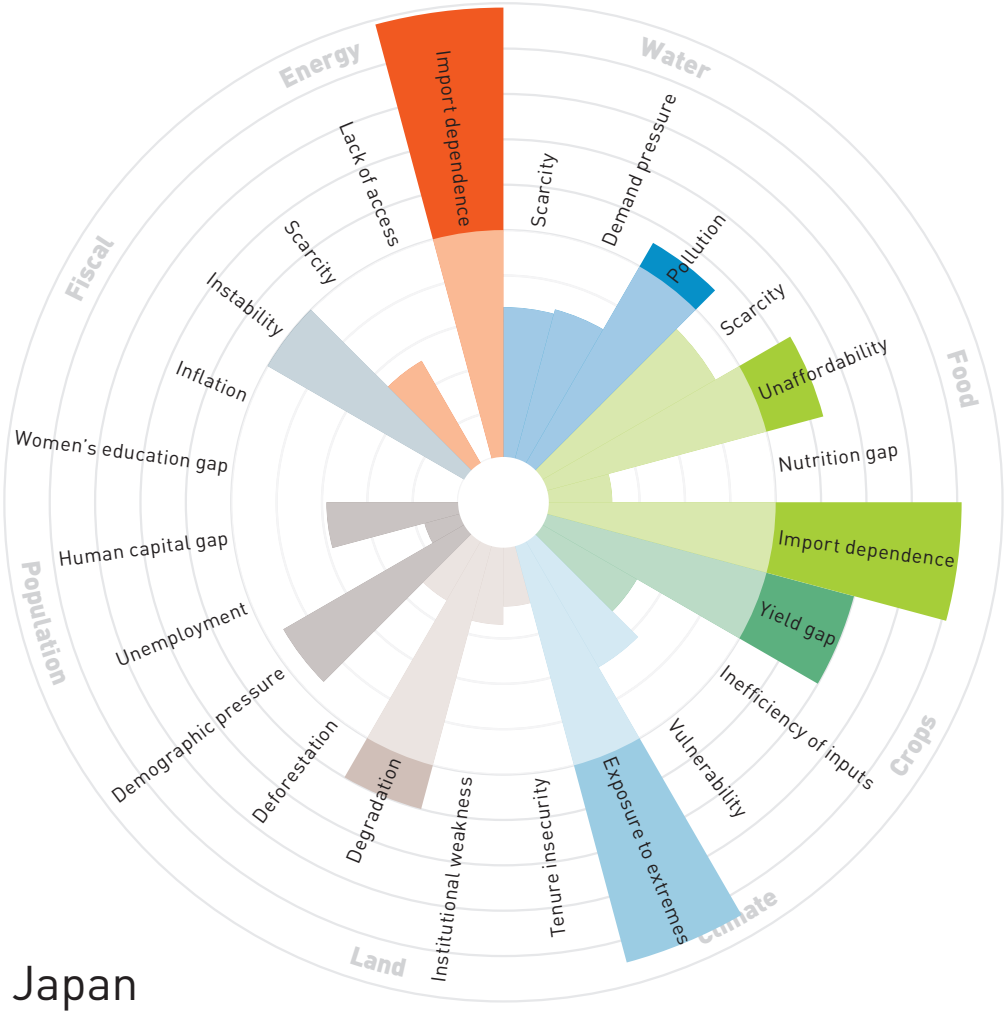
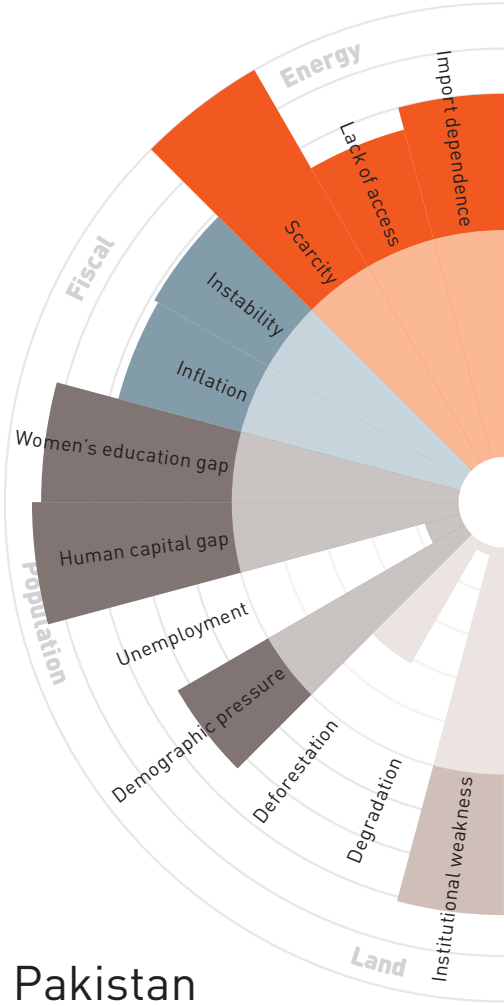
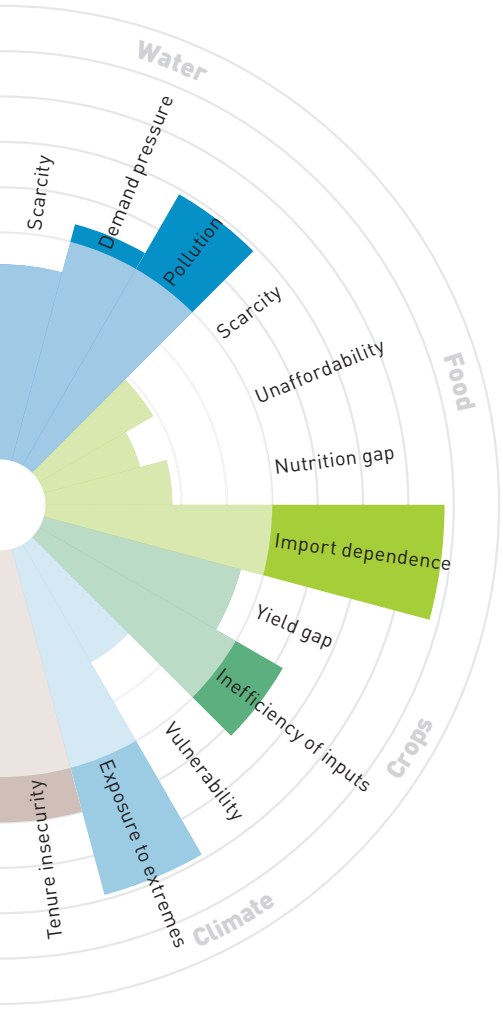
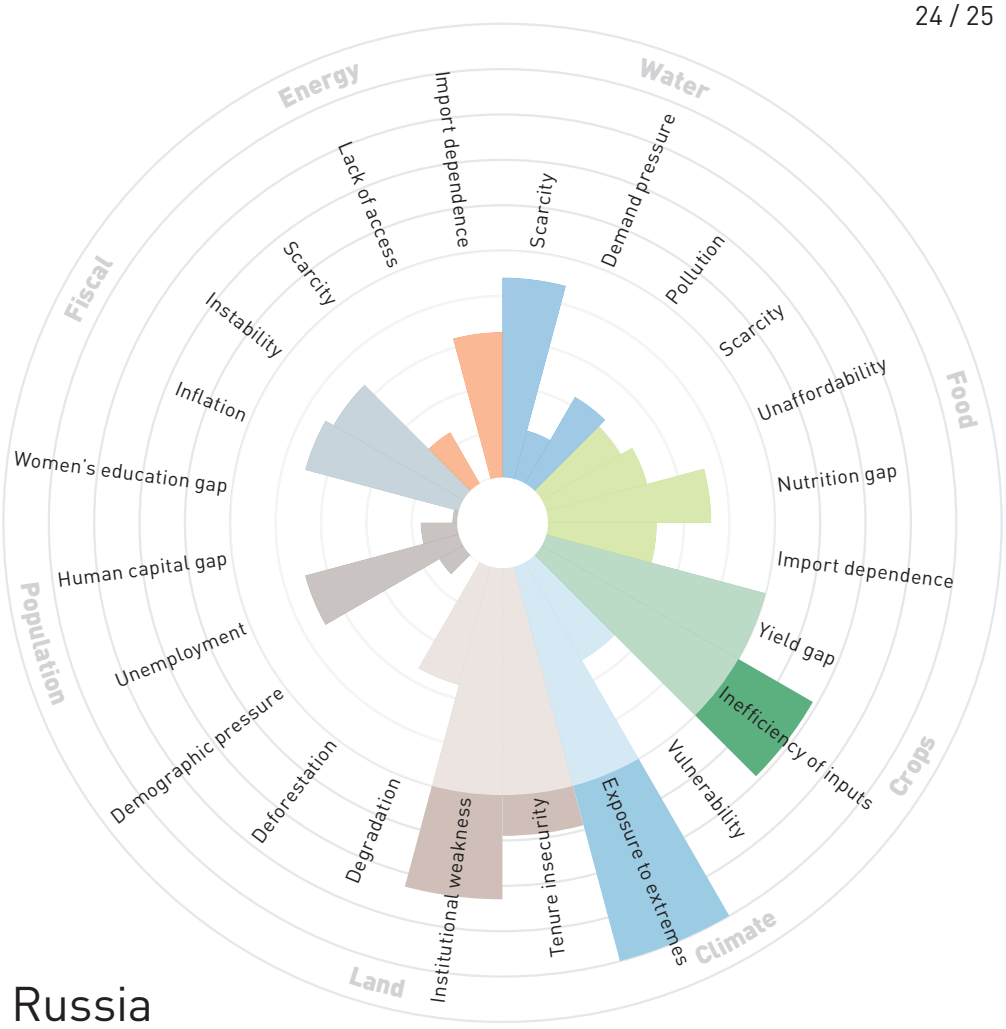


Japan

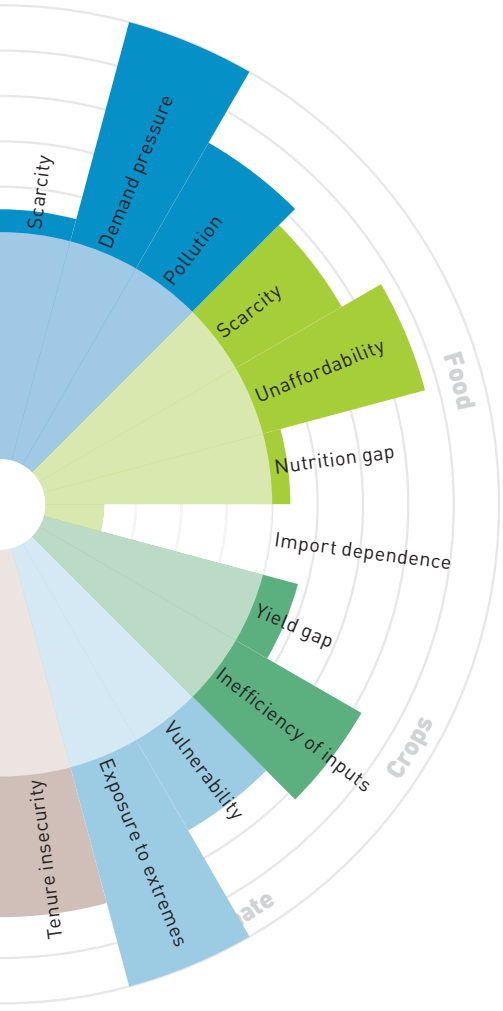


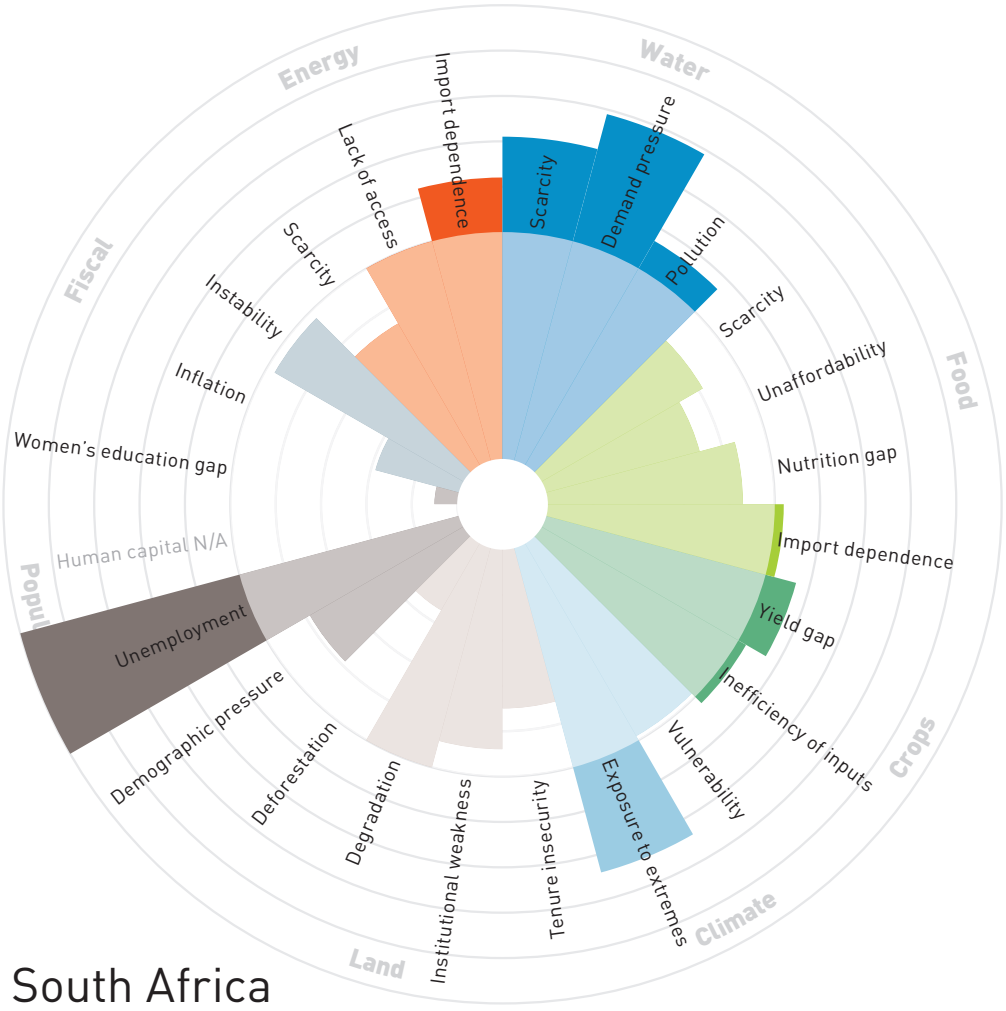
Pakistan





Russia





South Africa

4.0 Acknowledgments

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Mexico
Adrian Fernandez, ClimateWorks Foundation.
Nigeria Dapo Oyewole, Nigerian National Planning Commission; Robert Hale, DFID Nigeria; Mark Essex, Facility for Oil Sector Transparency and Reform in Nigeria.
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5.0 Methodology

The Earth Security Index 2014 (ESI 2014), developed by the Earth Security Initiative, is a country framework that captures the magnitude and scope of a series of resource pressures. The resulting visuals provide a risk dashboard, where higher scores represent worse performance. In this report, the index is applied to 17 countries from the ESI database of 200 countries. In 2015, the methodology and indicators will be further improved and new datasets will be incorporated.

The ESI 2014 assesses and visualises eight resource-related themes that are deemed critical for a country's long-term stability: land governance, water security, climate security, crop performance, population growth, food security, fiscal stability and energy security. The resulting risk visual allows for a multidimensional risk assessment of countries.

The eight themes are divided into a total of 24 dimensions. These dimensions, which are mapped on the visual, are built using a total of 49 data points. Please see Table 1 (pages 28–33) for more information on the structure and sources of the index, and a detailed definition of the themes, dimensions and data points.

The index has been created in consultation with country experts (see acknowledgements) and with the active participation of two project partners: the International Food Policy Research Institute (IFPRI) and the Institute on the Environment at the University of Minnesota. The ESI framework and its visualization can support the discussion of interdependencies between multiple dimensions. The normalization of the data allows for the magnitude of those dimensions to be comparable across countries.

The index is designed to create greater awareness among a global audience in business, finance, and governments, of the interdependences of resource pressures that are likely to affect the social and political stability and economic development of countries. The index provides risk profiles that aim to influence decision-making in industry, government, finance, military, science and civil society regarding the steps that will be taken to create investment and economic environments more conducive to the resilience of countries.

5.1 The data

The selection and processing of data for the ESI 2014 has followed five criteria:

Coverage
Data that allows for the assessment of country-level trends drawn from global datasets that allow for a comparison between countries.

Relevance
Data that is relevant to assess resource-related risks in an unambiguous way.

Accessibility
Data that is freely available, either through peer-reviewed scientific data or data compiled by international organisations.

Quality
Data whose quality is monitored and that represent the best measure of the issue currently available globally.

Recency
The most up-to-date datasets available for all data points.

Table 1
List of sources and years for all data points

Theme	Dimension	Data point / year	Data source
Water This theme measures a country's water stress. This occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.) [A] NB: For the dimensions in the water theme, the datasets use aggregate scores at a country level, acknowledging that situations of water stress and scarcity occurs largely at a local and regional levels.	**Scarcity** Availability of water in the country throughout the year.	**Renewable water resources** Total renewable water resources per capita (m^3/inhabitant/year). 2008–2012	AQUASTAT database, Food and Agriculture Organization's information System on Water and Agriculture.
		Drought incidence and severity Country area affected by severe drought in the last 3 years (%). 2010–2012	Global Drought Monitor, Department of Space and Climate Physics, University College London (UCL).
	Demand pressures Water use as a share of available resources.	**Pressure on water resources** Total water withdrawal as percentage of total renewable water resources (%). 2008–2012	AQUASTAT database, Food and Agriculture Organization's information System on Water and Agriculture.
		Water stress Country area under severe water stress (%). 2000	WaterGap 2.1, Center for Environmental Systems Research, University of Kassel.
		Reliance on non-renewable groundwater resources Groundwater abstraction beyond natural recharge rates (%). 2000	'Nonsustainable groundwater sustaining irrigation: A global assessment', Yoshihide Wada et al., Water Resources Research, Vol 48, January 2012.
	Pollution The average levels of water quality and pollution in the country.	**Water quality** Overall water quality based on nutrient levels (dissolved oxygen, total nitrogen) and total phosphorus and water chemistry (pH and conductivity). 2008	'Water Quality: Development of an index to assess country performance', Genevieve M. Carr and Carrie J. Rickwood, United Nations Environment Programme, Global Environment Monitoring System/ Water Programme, January 2008.
		Nutrient overload Total excess nutrients of crop area (kg/hectare). 2012	Agricultural land productivity database, Institute on the Environment, University of Minnesota.
		Grey water footprint Total grey water footprint per volume of total renewable water resources (hectare/m^3). 1996–2005	National Water Footprints, WaterStat database, Water Footprint Network; AQUASTAT database, FAO's information System on Water and Agriculture.
Food This theme measures food security, defined as food availability, access, utilization and stability, resulting in a situation where all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs for an active and healthy life.[B]	**Scarcity** The availability of food to meet the needs of the population, either through domestic production or imports.	**Domestic food availability** 3-year average food supply (kcal /capita/day) 2007–2009	Food supply, FAOSTAT database, Food and Agriculture Organization of the United Nations.
		Domestic protein availability 3-year average protein supply (g/capita/day). 2007–2009	Food Security Indicators, The State of Food Security in the World 2012, Food and Agriculture Organization of the United Nations.

[A] European Environment Agency www.eea.europa.eu/themes/water/wise-help-centre/glossary-definitions/water-stress

The theme also includes a country's dependence on cereal imports as a measure to evaluate the trade-offs in the choices of agricultural commodities that are grown on its available land.

Unaffordability The ability of poor households to purchase the food they need.	**Food price level** Domestic food price level index. 2012	Food Security Indicators, The State of Food Security in the World 2012, Food and Agriculture Organization of the United Nations.
	Food expenditure of the poor Share of food expenditure of the poor (%). 2000–2010	Food Security Indicators, The State of Food Security in the World 2012, Food and Agriculture Organization of the United Nations.
	Population living in poverty Population with less than $1.25 per day (PPP). 2007–2011	Poverty and Inequality database, World Databank, The World Bank.
Nutrition gap The population's access to safe and nutritious food.	**Access to sanitation** People with no/bad access to improved sanitation facilities (%). 2010	Food Security Indicators, The State of Food Security in the World 2012, Food and Agriculture Organization of the United Nations.
	Diet diversification Non-starchy foods in total dietary energy consumption (%). 2005–2007	Global Food Security Index, The Economist Intelligence Unit.
Import dependence The country's reliance on food imports.	**Cereal reserves** Cereal closing stocks (kg/capita). 2010–2013	Statistics, Agricultural Market Information System.
	Cereal import dependence 3-year average cereal import dependence ratio (%). 2007–2009	Food Security Indicators, The State of Food Security in the World 2012, Food and Agriculture Organization of the United Nations.

[B] 'The Food Security System, A New Conceptual Framework', Olivier Ecker and Clemens Breisinger, IFPRI Discussion Paper, March 2012. www.ifpri.org/sites/default/files/publications/ifpridp01166.pdf

Crops

This theme measures the efficacy and efficiency in the production of the 16 most important global crops in terms of total calorie contribution: Wheat, Maize, Rice, Barley, Rye, Millet, Sorghum, Soybean, Sunflower, Potato, Cassava, Sugarcane, Sugar beet, Oil palm, Rapeseed, and Groundnut. It draws on data compiled by the Institute on the Environment at the University of Minnesota, which in 2008 developed spatial datasets that combined sub-national agricultural census data with newly created satellite-derived cropland maps. The result has been global high-resolution maps of production, area, and yield that help to explain agricultural risks globally across multiple scales and crops. The efficacy and efficiency of crop production is linked to the land, water and food pressure dimensions.[C]

Yield gap The difference between current crop yields and their estimated potential	**Crop yield gap** The difference between the current yield and the estimated yield in a particular 10km x 10km agricultural area (%). 2012	Agricultural land productivity database, Institute on the Environment, University of Minnesota.
Inefficiency of inputs The efficiency in the use of fertilizers and irrigation.[D]	**Irrigation efficiency** Blue water use efficiency (kcal/mm^3/year). 2012	Agricultural land productivity database, Institute on the Environment, University of Minnesota.
	Fertilizer use inefficiency Total excess nutrient per unit of nutrient applied (kg).[E] 2012	Agricultural land productivity database, Institute on the Environment, University of Minnesota.

[C] 'Farming the Planet. Part 2: The Geographic Distribution of Crop Areas and Yields in the Year 2000', Monfreda, C., Ramankutty, N. and Foley, J. A. (2008), Global Biogeochemical Cycles, 22(GB1022).

[D] The ESI 2014 is not currently measuring pesticide use and will seek to incorporate this data in its future publications.

[E] 'Closing yield gaps through nutrient and water management.' Mueller, N., Gerber, J. S., Johnston, M., Ray, D. K., Ramankutty, N. and Foley, J. A. (2012), Nature, 490(7419).

Climate

Climate change is increasing the variability of weather extremes and is likely to act as a 'threat multiplier' on existing resource pressures and affect the availability of water, food and other raw materials as well as impact their trade.[F] This theme measures the vulnerability of a country's population and infrastructure to climate change, as well as the level of exposure to extreme weather events such as floods or storms.

[F] 'Resources Futures', Bernice Lee et al., A Chatham House Report, December 2012.

Vulnerability The vulnerability of a country's infrastructure, human habitat, food, water, health and ecosystems to adverse climate impacts.	**Vulnerability to climate change** Exposure to climate-related hazards, sensitivity to their impact and capacity to cope with them in terms of water, food, health, ecosystem, human habitat and infrastructure. 2012	GAIN Index, The Global Adaptation Institute (GAIN).
Exposure to extremes The level of exposure of a country to extreme weather events, measured in human and economic losses.	**Exposure to extreme weather events** The adverse impact both in terms of human and economic losses of extreme weather related events, as well as temperature extremes and mass movements. 1992–2011	Global Climate Risk Index 2013, Germanwatch.

Land

Arable land is a fundamental asset needed to produce food and other commodities; build infrastructure and organize human settlements, from rural to urban settings. Land can be fertile when the soil is rich, and hold important ecosystems. Within a given physical space, these goals (human settlements, food production and ecosystems) are increasingly presenting difficult trade-offs. Increasing commercial pressures on rural and urban land, land tenure security is increasingly a major governance issue.[G] This theme measures the ability of countries to manage their land effectively and sustainably, ranging from the protection of land tenure rights, to the broader qualities of institutions and governance; its degradation and deforestation.

Tenure insecurity The lack of security that a person's land rights will be recognized and protected.[H]	**Security of land tenure rights** Share of people with no recognized, formalised or registered land rights or land disputes or vulnerable groups at risk of expropriation or eviction without compensation (%). 2006–2009	Institutional Profiles Database 2009, French Ministry for the Economy, Industry and Employment (MINEIE).
	Bribe to land services Share of people that have paid a bribe to land services in the country (%). 2012–2013	Global Corruption Barometer 2013, Transparency International.
	Corruption in land matters Share of people that think political/grand corruption in land matters is a serious and very serious problem in the country (%). 2008–2009	Global Corruption Barometer 2009, Transparency International.
Institutional weakness The quality of a country's governance and institutions; their capacity to formulate and implement policies; and the respect for the rights and freedoms of citizens.[I]	**Days to register property** The time necessary to register a property (days). 2012	Registering property, Doing Business, The World Bank & International Finance Corporation.
	Government effectiveness Perception of the credibility, quality and independence of public services, civil service as well as policy formulation and implementation. 2011	Worldwide Governance Indicators, The World Bank.
	Regulatory quality Perception of the ability of the government to formulate and implement sound policies and regulations, which permit and promote private sector development. 2011	Worldwide Governance Indicators, The World Bank.

	Rule of law Perception of citizens confiding and abiding by the rules of society, including contract enforcement, property rights, police, courts, and the risk of crime and violence. 2011	Worldwide Governance Indicators, The World Bank.
	Voice and accountability Perception of the extent to which a country's citizens are able to participate in elections, as well as freedom of expression, freedom of association, and a free media. 2011	Worldwide Governance Indicators, The World Bank.
	Political stability and absence of violence Perception of the likelihood that the government will be destabilized by unconstitutional or violent means, including politically motivated violence and terrorism. 2011	Worldwide Governance Indicators, The World Bank.
	Control of corruption Perception of the extent to which public power is exercised for private gain, including corruption, as well as 'capture' of the state by elites and private interests. 2011	Worldwide Governance Indicators, The World Bank.
Degradation A process that erodes the resilience and fertility of land, including drivers like soil erosion, salinity and deforestation.[J]	**Degraded area** Share of the country's territory that has been degraded (%). 1981–2003 [K]	'Global Assessment of Land Degradation and Improvement 1. Identification by remote sensing', Z G Bai et al., Land Degradation Assessment, World Soil Information & Food and Agriculture Organization of the United Nations.
Deforestation The loss of forest cover of a country's territory.	**Change in forest cover** Change in forest cover (hectares). 2005–2010	Global Forest Resources Assessment 2010, Food and Agriculture Organization of the United Nations

[G] 'Land tenure security and poverty reduction', International Fund for Agricultural Development, May 2012. www.ifad.org/pub/factsheet/land/e.pdf

[H] 'What is land tenure', FAO. www.fao.org/docrep/005/y4307e/y4307e05.htm

[I] 'What is governance?' Worldwide Governance Indicators. http://info.worldbank.org/governance/wgi/indexaspx#home

[J] 'Global Assessment of Land Degradation and Improvement 1. Identification by remote sensing', Z G Bai et al, LADA, ISRIC World Soil Information, FAO, November 2008.

[K] Some of the data is only collected in irregular time intervals. This is the case for both the groundwater extraction and the land degradation metric: estimates of groundwater extraction beyond natural rates use data that is more than 10 years old. The proportion of the national territory that has been degraded is based on a study conducted over the period 1981–2003. The data and metrics included in the ESI 2014 represent the best available data at this time.

Population

This theme measures demographic growth and the pressure of this growth over the available fertile land per person. It also assesses the performance of countries in two social progress dimensions: education and unemployment, which may define the trajectory of innovation opportunities and political risks respectively for this agenda. Other measures of human health and development have been omitted in this version of the index, but will be re-assessed in subsequent versions.

Demographic pressure The population growth rate and density and the availability of agricultural land per capita.	**Population growth** Population rate of growth between 2002 and 2012 (%). 2002–2012	World Population Prospects: The 2012 Revision, Population Estimates and Projections, Population Division, Department of Economic and Social Affairs, United Nations.
	Population density Average number of inhabitants in the country (persons/km^2). 2011	World Population Prospects: The 2012 Revision, Population Estimates and Projections, Population Division, Department of Economic and Social Affairs, United Nations.
	Agricultural land availability The ratio of arable land and permanent crops area to the number of people dependent on agriculture for their livelihood. (hectares/person). 2011	Resources, FAOSTAT database, Food and Agriculture Organization of the United Nations.
Unemployment Overall levels of unemployment and youth unemployment.	**Total unemployment** Share of the total labour force that is unemployed (%). 2007–2011	Labour market database, International Labour Organization.
	Youth unemployment Share of the total labour force ages 15–24 that is unemployed (%). 2007–2011	Labour market database, International Labour Organization.
Women's education gap The extent of women's access to education.	**Women's literacy rate** Proportion of female aged 15–24 that can read and write (%). 2006–2010	Institute for Statistics, UNESCO.
Human capital gap Enrolment in tertiary education as a proxy for skills and human capital.	**Enrolment in tertiary education** Total enrolment in tertiary education regardless of age, expressed as share of the population of the five-year age group following on from secondary school leaving (%). 2007–2011	Institute for Statistics, UNESCO.

Fiscal

This theme measures the ability of a government to manage the public finances in a sustainable way and to maintain the stability of prices. Fiscal sustainability encompasses government solvency, which represents its ability to pay financial obligations, and continued stable economic growth.[L]

Inflation The increase in consumer prices and decline in the purchasing value of money.	**Inflation rate** Annual growth rate of average consumer price. NB: Experts consider inflation between 0% and 3% as conducive to price stability.[M] 2010–2012	World Economic Outlook Database 2013, International Monetary Fund
Instability The sustainability of the public debt and likelihood of a sovereign debt crisis.	**GDP growth** Annual growth rate of the Gross Domestic Product. (3-year average %) 2010–2012	World Economic Outlook Database 2013, International Monetary Fund
	Government budget balance The difference between public revenues and expenditures, expressed as percentage of the Gross Domestic Product. (3-year average % of GDP) 2010–2012	World Economic Outlook Database 2013, International Monetary Fund
	Government debt General government gross debt expressed as percentage of Gross Domestic Product. (% of GDP) 2012	World Economic Outlook Database 2013, International Monetary Fund
	Probability of sovereign debt default The probability of sovereign debt default based on country expert assessments. 2012	Global Competitiveness report 2012–2013, The World Economic Forum

[L] Government at a glance 2009, Fiscal sustainability, OECD .

[M] 'An operational definition of price stability', Tito Nicias Teixeira da Silva Filho, Banco Central do Brazil, Working Paper Series, 2002. www.bcb.gov.br/pec/wps/ingl/wps35.pdf

Energy

This theme measures the stable availability and accessibility of energy sources at an affordable price, while taking into account geopolitical, economic, infrastructural and environmental concerns.[N]

Scarcity The country's ability to provide enough energy either through domestic production or imports.	**Domestic energy supply** Total primary energy supply per capita (tonne of oil equivalent / capita). 2011	Indicators for 2011, Statistics, International Energy Agency
Lack of access The proportion of the population without access to electricity.	**Lack of access to electricity** Proportion of the population without access to electricity. (%) 2010	World Energy Outlook 2011, International Energy Agency
Import dependence A country's dependence on energy imports.	**Energy import dependence** The ratio of total primary energy production over total primary energy consumption. 2012	Energy Sustainability Index 2013, World Energy Council

[N] The IEA Model of Short-term Energy Security (MOSES)', Jessica Jewell, International Energy Agency, 2011. www.iea.org/publications/freepublications/publication/moses_paper.pdf

5.2
Index construction

The transformation of raw data into the index scores involves several steps. The following section discusses how the data was transformed and normalised and how missing values were dealt with.

5.2.1
Missing values

The datasets containing all the raw data were integrated into a single database. Depending on the nature of the missing values, for example, when the country was not included in the source dataset or the country was included but the values were missing, either their omission or their imputation were considered as options. As most of the time there were no obvious criteria for imputation, the data were omitted and the choice noted in the database.

Example Where imputation was possible, missing values were replaced with imputed ones, for example for data points like women's literacy rate and access to electricity. For these metrics, the missing data for OECD countries were replaced by the value 100%.

5.2.2
Transformation

After missing values were dealt with, the raw data values were averaged over years or transformed and weighted either by population, GDP, surface or other denominators in order to make data points comparable across countries.

Given the vast differences between countries, some of the resulting data were highly skewed, meaning that some values were highly different from others. To make these values comparable, these data points were transformed using the natural logarithm. The natural logarithm is a commonly used statistical tool that presents differences between values in a way that highly different data can be compared on a common scale.

The data point population density (in the dimension demographic pressure) takes into account both the total population and the surface of a country. The raw data shows a great range of values between some countries, while most countries have fairly similar scores.

Example India's population density (417.56 per square kilometre) is much higher than the population density of Australia (2.90 per square kilometre). Using these highly different values would lead to a scale where smaller yet meaningful differences between countries are ignored.

Example Using the raw data, the difference between Russia (8.73 per square kilometre) and Argentina (14.89 per square kilometre) would seem negligible as compared to the difference with Japan (350.66 per square kilometre), although the difference is meaningful. Using the untransformed scores would thus result in risk scores that are only informative about the difference between lowly and highly risky countries. Hence, the data were transformed using the natural logarithm, leading to a transformed score of 1.06 for Australia, 2.17 for Russia, 2.70 for Argentina, 5.86 for Japan and 6.03 for India. While these transformed scores still show a meaningful difference in risk between highly different countries, they also express a meaningful difference between countries that show smaller differences in raw scores.

5.2.3
Normalisation

Finally, to allow for aggregating and comparing different data on a common scale, the data points were normalized on a 0–100 scale (100 meaning the riskiest). This scale was developed taking into account the lowest and highest values of all countries for a data point, allowing for a comparison not only between the countries profiled in the 2014 report, but of all 200 countries in the database, thereby reflecting the global relative risk that countries are facing.

For some data points, extremely high or low values distorted the scale, making it impossible to compare the values in a meaningful way. Thus, using a common statistical procedure, new minima and maxima were created that excluded these extreme values. In most cases, values lower than 5% and higher than 95% of all countries were not taken into account for the calculation process. For data points with more extreme values different thresholds were used. For example, the 10th and 90th percentiles of all countries were used as minima and maxima, excluding the lowest and highest 10% of the range of values.

Example
Pakistan's value for the data point's exposure to extreme weather events is higher than the 95% of all other countries. Since taking this value would distort the scale, the highest value of 95% of all countries is used as the top threshold, resulting in a maximum risk score of 100 for Pakistan on the 0–100 point scale.

The data points can have two different directions; in some cases a higher value means a riskier situation, while for other data points a higher value means a more desirable situation. The formula has been therefore applied in two different ways in order to provide for a common scale, where 0 is the least and 100 the most risky.

Example For Enrolment in tertiary education, greater values mean more positive outcomes. Thus, the following formula was used:

Normalised score
= (data – maximum)
÷ (minimum – maximum)
× 100

For bribes to land services (proportion of the population that have paid a bribe to land services), a greater value means a more negative outcome. Thus, the following formula was used:

Normalised score
= (data – minimum)
÷ (maximum – minimum)
× 100

5.2.4
Calculation of a score for the metric crop yield gaps

The score for the data point crop yield gap (expressed in %) is calculated as follows:

1 The direction of the metric is negative, i.e. higher scores are riskier, since a larger crop yield gap means that crops are performing below their potential.

2 Taking the full range of available values of all countries would mean calculating the normalised scores based on extreme values that are not representative of the overall distribution of values. Hence, country raw data values that are below 5% or above 95% of the range of values of all countries in the database are not taken into account for the calculation of the normalised score. This means that for the above normalisation formula, not the lowest of all country values is taken as the minimum, but the value that is 5% above the lowest value of all countries. Respectively, not the highest of all country values is taken as the maximum, but the value that is 5% below the highest value (equal to 95% above the lowest value) of all countries. For the crop yield gap data point the minimum used is thus the value 20, and the maximum the value 87.

3 For example, Nigeria's raw data score for the crop yield gap data point is 45, which means that the crop yield gap, i.e. the difference between the current yield in a particular 10km x 10km agricultural area and the estimated potential yield for 16 main crops is 45% in Nigeria.

4 Since the higher the raw data value, the higher the risk, the first formula of the above example is used:

Normalised score
= (data – minimum)
÷ (maximum – minimum)
× 100

5 Using the values for this formula results in the following equation:

Normalised score
= (45 – 20)
÷ (87 – 20)
× 100

6 So for Nigeria with a crop yield gap of 45:

Normalised score
= (25)
÷ (67)
× 100
= 37.3

5.3
Weighting and aggregation

After transforming the data and normalising the data points into a common scale, data points were aggregated and weighted into dimensions. The following section describes this aggregation and weighting process.

As aggregating scores on the level of ultimate themes requires making too many assumptions, the aggregation of data points was done on the level of dimensions. The dimension score is calculated from the weighted average of all its underlying data points. This is the case for all dimensions, except for the fiscal instability dimension. Here, to reflect the importance of the risk of sovereign debt default, the probability of sovereign debt default has been given a greater weight than the other data points.

Example The dimension tenure insecurity is composed of three data points (bribes to land services, corruption in land matters, and security of land tenure rights). As equal weightings are assigned to the three data points of the dimension, each one of the data points gets an equal weight of 33.33 of the total score of the tenure insecurity dimension (100 ÷ 3 = 33.33).

Finally, in case of missing values for underlying data points, the following rule is applied: weightings of missing scores are redistributed equally across other data points, so that the overall weighting within the dimension does not change.

Example For the theme of food, the dimension unaffordability is calculated as the average of the data points food price level, food expenditure of the poor, and population living in poverty. For Australia, raw data is only available for the data point food price level. Thus, the weights of the two other data points are distributed to the data point for which data is available, resulting in a weighting of 100% of the data point food price level for the dimension unaffordability for Australia.

If no data is available for a dimension, no score is calculated.

Example For Tanzania, there is no raw data available on the data points: total unemployment and youth unemployment. As a result, no score is calculated for the dimension unemployment.

5.4
The visual

Finally, using the values from the weighting and aggregation processes, the country risk visuals were created. The following section describes the methodology behind the country risk visuals.

5.4.1
Scale

The visuals provide a risk profile that aims to highlight the most critical resource pressures for each of the countries covered by the index. In each case, the visual represents dimension scores on a 0–100 scale, following the methodology described above.

5.4.2
Visualisation

The wedges should be read in the same way as the scores: the bigger a wedge is, the riskier is the performance of that dimension. To aid the use of the visuals, a visual benchmark has been added that highlights those wedges that have a higher score than 50. This is a purely visual aid and does not imply a value judgement that means that dimensions scoring 50 or less are not relevant to the risk profile of the country, but allows the reader to focus on the smaller number of dimensions that surpass the 50 mark.

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