

Earth Security Index 2016

Business Diplomacy for Sustainable Development



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**Swiss Agency for Development
and Cooperation SDC**

The Earth Security Group

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Note

All currency \$ refers to US dollars unless otherwise stated.

How to use this report

Audiences

Multinational Companies with a large footprint in developing countries in infrastructure (engineering and construction, power generation, water and transport); extractives (mining and oil & gas), food & agriculture (beverages & tobacco, paper & timber, and agrichemicals).¹ The report provides companies an eye-opening approach to sustainable growth in the countries where they operate.

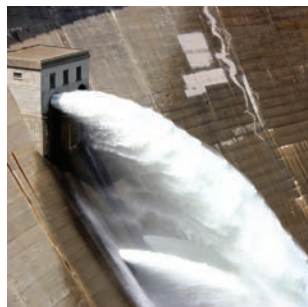
Governments seeking to collaborate with the private sector to address development challenges in the context of the global goals for sustainable development. The report provides policy-makers with a framework to guide their engagement of companies and the opportunities for strategic partnerships around key issues.

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Industry



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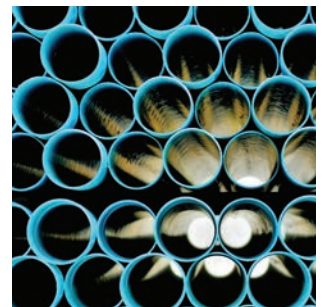


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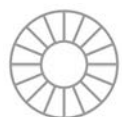
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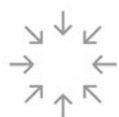
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Structure of industry chapters



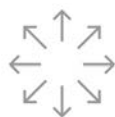
1
Industry sector context

A snapshot for CEOs of the main pressures affecting the company's operating environment in its most important developing countries



2
Exposure to development pressures

A clear explanation of the business risks that result from converging development pressures in key markets for companies.



3
Recommendations for business leadership

Recommendations to be integrated into corporate strategy that show routes for collaboration with governments and other stakeholders.



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Examples from leading companies in the sector that are transforming risks into opportunities, building resilience in their operating context.



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The trends that will shape a company's operating context in key regions with recommendations for regional executives.

Forewords



Alejandro Litovsky
Founder & CEO
Earth Security Group

The societal context for companies operating on a global scale is changing and requires a new kind of business leadership. Companies must look for new ways of partnering with governments and stakeholders to improve the social and ecological stability of the environment around them. At the Earth Security Group, we call this 'business diplomacy for sustainable development.'

Over the next 5 to 10 years, the developing countries that host large capital investments of global companies in infrastructure, extractives and agriculture, will experience greater social and environmental stress. Large dams, mines, factories and farms are becoming more exposed to water scarcity, land conflicts, power outages and more extreme weather. Companies must build trust in their capacity to steward resources in order to retain the legitimacy to operate and grow.

We have developed the 2016 Earth Security Index as a strategic tool for corporate boards to identify the opportunities to adopt a resource leadership position. The recommendations focus on three global industries. They are based on our outlook of their operating environment in the developing countries that are most important to their investments.

The report should be used as a practical guide to shape corporate strategies, to communicate a company's alignment with country priorities, and to inform their dialogue with governments. These are three necessary conditions to unlock the next phase of cross-sector cooperation for sustainable development.



Pio Wennubst
Ambassador, Assistant
Director General, Swiss
Agency for Development
and Cooperation, SDC

SDC is supporting the Earth Security Index Report as a modern, fresh and useful tool to engage the private sector on global development challenges.

I personally value this report because it helps me to spread the key message that is embedded in all my activities in development diplomacy: That a strategic dialogue based on facts can help to bridge the different perceptions, interests and personal experiences surrounding development challenges. This is vital for an agency pursuing positive systemic changes.

Societal evolution has shown us that systems often don't change without a crisis. However, in a crisis, decisions made are often based on fear, undermining trust and cooperation and limiting the potential energy for change. The challenge is to move from a personal to a collective mood for change. I consider the Earth Security Index 2016 as the best of the series so far. This is because it helps to activate the corporate sector towards a fact-based dialogue on development priorities. It proposes to embed new collaborations in a much needed process of business diplomacy that goes beyond corporate philanthropy and corporate social responsibility.

We are at a point where the private sector now needs to move to integrate all the three dimensions of sustainability — economic, social and environmental — into their main business plans. And we, in the public sector, must help to develop incentives to move in this direction. Congratulations for this excellent piece of work.



Lise Kingo

Executive Director,
United Nations Global
Compact

Our world is facing enormous challenges that affect businesses and societies alike: poverty, a declining environment, a lack of skilled labour and social instability. Companies are becoming more aware of how development challenges are reshaping their markets. The new Sustainable Development Goals, agreed upon by all UN Member States, came into force in January 2016. At the UN Global Compact, we are seeing business leaders tune into this agenda as the next frontier for good practices, new markets and innovation.

Last year, our UN Global Compact Annual Implementation Survey found that 68% of businesses are aware of the SDGs. Our priority is to make that number even higher, and to encourage a move from awareness to bold action, quickly. This must be done by conducting business responsibly in line with universal principles and finding opportunities to provide solutions to our world's problems.

The Earth Security Index 2016 underscores that in order to embrace the opportunities of the new era, companies will need to understand the development pressures of the new markets they are entering, and the stakeholders they will need to work with. Over more than 15 years of engaging business, we at the UN Global Compact have found that collaboration among the private sector, governments, civil society and the UN is critical to addressing systemic issues.

The Earth Security Group's report offers a new type of intelligence and recommendations, which will support companies as they embark on the journey to align their business with the sustainable development agenda.



Philippe Joubert

Chair, Prince of Wales's
Corporate Leaders Group;
former President of Alstom
Power & Deputy CEO of
Alstom Group

Water shortages have been seen for years as a key systemic challenge for business, leading to the analysis of impacts and necessary mitigation measures. However, water, because of its societal and emotional content, must be looked at in a different way from other resources.

Business must understand this, as they will never be considered as a priority user of water against other stakeholders when we will go from sharing resources, to sharing scarcity, to dealing with nonexistence. Business will be pushed towards zero use of water. New technologies enabling zero impact operations as well as perhaps, one day, low impact or no impact products will have to be developed. Some businesses have already understood this and are changing their processes and products to adopt this new behaviour.

On a systemic level, the highest priority to deal with this challenge will be to put a governance model in place to preserve precious aquifers, and sensibly administer water use going forward. This is no easy task, especially for groundwater where multi-country governance will be needed. Additionally, infrastructure investment that recognise the services rendered by nature should be accelerated. A true price of water will be necessary to justify these investments and secure a long-term future.

The 2016 Earth Security Report once again provides business leaders with critical thinking and intelligence on key risks and opportunities and with a view to induce changes to ensure a truly sustainable business model and economy.



Dr. Frannie A. Léautier

Senior Vice President,
African Development Bank

We are faced with an increasing complexity in development. In many regions, but particularly in the African continent, this complexity emanates from demographic pressures, such as migration and urbanization, and youth unemployment, being further compounded by resource constraints on water, energy and food. This is increasing the scrutiny on the private and public sectors to develop more integrated investment strategies.

For example, creating jobs in the region will need to consider issues such as sustainable urban development, promote the right kind of industrialization, and encourage an energy mix that meets both development and sustainability objectives. We are forced to think beyond silos and to consider investments that integrate social, environmental, economic and energy goals. It is clear that in order to seize the opportunities for transformation, industry agendas will need to be aligned with the development priorities of host countries.

The 2016 Earth Security Index is making a fundamental contribution to bridge the agendas of industries and governments to reach common development goals. The strategic thinking and the recommendations in the report show how investments can consider and anticipate the societal demands for sustainability and social inclusion that will prevail in different regions. I have followed the work of the Earth Security Group over the last years, and I commend the 2016 Earth Security Index very highly. The specificity and clarity it brings regarding key industries and geographical regions makes it a great companion to decision-makers seeking to develop a sustainable and future-oriented portfolio of investments.

The Earth Security Index 2016

The Earth Security Index is a visual data framework, mapping converging pressures along social, environmental, governance and energy dimensions for countries. It provides leaders in business, government and society with a way to assess a complex set of forces and scenarios that are shaping a country's development challenges.

The 2016 version of the diagram visualises the performance of countries across the 24 issues listed below. Higher scores represent higher levels of pressure. A visual benchmark highlights those dimensions whose scores exceed values of 50%.

Environmental

Climate Infrastructure Risk

The vulnerability of infrastructure to adverse climate impacts.

Land Deforestation

The loss of forest cover.

Land Degradation

The costs of a reduction or loss of land ecosystem services.

Water Insecurity

The availability of water throughout the year and the relative performance of water provision.

Water Pollution

The degree of water pollution from households, industry and agriculture.

Water Virtual Imports

The amount of water that is imported by being embedded in commodities and products.

Weather Extremes

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

Social

Food Import Dependence

The dependence on food imports.

Food Insecurity

The level of food insecurity, reflecting continuing or structural poverty and low income.

Gender Inequality

Gaps in reproductive health, empowerment and labour market participation due to gender inequality.

Land Tenure Insecurity

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

Poverty

The country's proportion of the population living in poverty.

Skills Gap

The country's level of knowledge-based skills and talent competitiveness.

Unemployment

The country's levels of total unemployment and youth unemployment.

Urban Population Pressure

The country's urban population growth rate.

Governance

Fiscal Sustainability

The sustainability of the public sector, including economic growth, government debt, and the probability of sovereign debt default.

Government Effectiveness

The quality and independence of the public service and the effectiveness of policy implementation.

Inflation

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

Political Accountability

The level of transparency, accountability of and participation in government decisions, including the degree of press freedom.

Rule of Law

The quality of contract enforcement, property rights, the police, the courts, and the likelihood of crime and violence.

Energy

Carbon Intensity

Carbon emissions from electricity generation and industry.

Electricity Access

The proportion of the population without access to electricity.

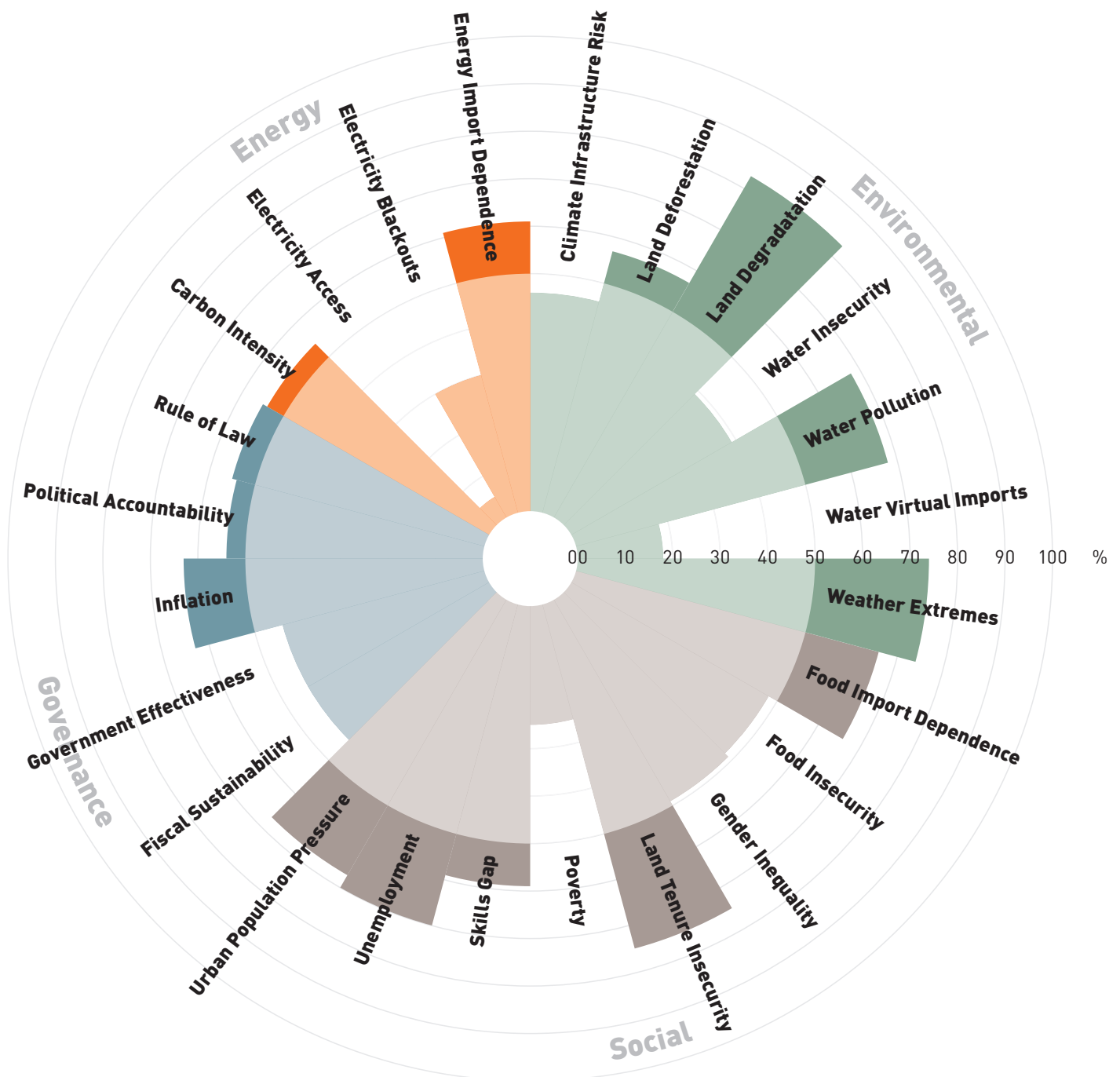
Electricity Blackouts

The number of power outages.

Energy Import Dependence

The country's external dependence for primary energy.

Figure 1
The 2016 Earth Security Index Diagram



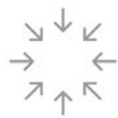
Executive Summary

The operating context for resource-intensive industries is becoming more complex. Development pressures are undermining the business environment. Business leaders must align their companies to the societal priorities of the countries in which they operate. We call this ‘business diplomacy for sustainable development’. Key messages:



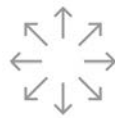
1
The business context is changing rapidly

Development pressures are converging along social, environmental, governance and energy issues. This is creating a more complex environment in countries that are vital to the profitability of global companies.



2
Societal challenges undermine investment

Companies are acutely challenged by societal issues, which can hamper their legitimacy to operate and their growth. Business leaders need to manage the risks by improving the social and ecological stability on which their investments depend.



3
Business diplomacy is a driver of change

Beyond their existing efforts to improve resource efficiency and corporate responsibility, companies should prioritise investments and relationships that build trust with their stakeholders in their capacity to be stewards of limited resources.



4
Regional approaches are needed

Each of the world's regions face a distinctive set of development pressures that affect the business environment. Companies have to understand these differences and develop clear regional priorities to navigate a mosaic of global realities.

Global context for resource-intensive industries



Figure 2
The diagram shows the converging pressures that will affect resource-intensive companies. It aggregates the scores for the top developing countries that host most of the investments of global companies in infrastructure, extractives and agriculture sectors (Brazil, Chile, China, Colombia, Peru, Indonesia, Russia and South Africa).

Business risks	1 Land conflicts	2 Social opposition to projects	3 Water scarcity	4 Local employment pressures	5 Electricity instability
Converging pressures	Deforestation, weak rule of law and food insecurity amplify the weak protection of land rights for local people adding momentum to land conflicts.	Water scarcity, coupled with climate change, undermines farming and food insecurity, adding to communities' perception of threat by industry projects.	Rapid land degradation, coupled with climate change and unsustainable farming, are increasing pollution and reducing the availability of water for projects.	Urban demographic pressure and unemployment of a growing youth jobless population, pressure politicians to demand more of companies.	Climate change-driven drought and water pollution amplified by land degradation, reduce water available for power generation.
Business diplomacy in action	Help formalise the land titles of local communities around projects, which do not have the recognition to their land tenure, by partnering with governments and civil society organisations with the legal track-record.	Co-invest in water infrastructure to increase the security of water supplies for family farming. Develop basin-wide partnerships that improve the collaboration capacity of water utilities, industry and governments.	Go beyond water efficiency targets towards the stewardship of the watersheds and aquifers on which companies depend. Develop external targets that help advance water management at a catchment level.	Scale-up the support for small and medium enterprises in a company's value chain, setting procurement targets. Develop partnerships to provide training, access to finance, technology and markets.	Commit companies to generate or purchase renewable energy, and build partnerships with governments, independent power producers and power utilities to facilitate the building of new transmission infrastructure.



01 Extractives

Building trust in the role of extractive companies in sustainable development requires building skills that foster employment, and strengthening communities to increase their land, water and food security.



Introduction

More of the world's mineral and metal deposits are now found in countries facing big development challenges, such as unemployment.² An extractive company may be a significant driver of export revenues for a government, but might only contribute 1–2% of total employment for the country. Over 100 government laws have been passed since 2008 that mandate foreign companies to employ locals. With a shortage of highly-skilled labour for technical roles, projects have faced substantial costs due to delays and accidents. A resource leadership position on these issues will be critical to a company's social license to operate in the years to come.

Social conflicts in the mining sector increased 8-fold from 2002 to 2013.³ Communities' access to water, and concerns over land and food security, are critical drivers of mistrust and threat perception.⁴ In 2015, the CEO of Anglo American estimated that USD 25 billion worth of projects had been stalled or halted due to community opposition.⁵ Major mining projects can expect to pay up to USD 20 million per week due to such disruptions.⁶

Summary



1.1 Industry sector context

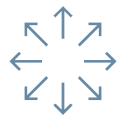
A snapshot of the development pressures in key countries that are shaping the operating context for extractive companies
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1.2 Exposure to development pressures

Social conflicts intensify due to the nexus between water scarcity, land and food security.
[Page 12](#)

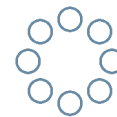
Local content policies to increase due to poverty, unemployment and urban demographic pressure.
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1.3 Recommendations for business leadership

Co-invest in shared water infrastructure and improve the livelihoods of communities with an interconnected approach to land, water and food.
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Scale-up the support for small enterprises across a company's value chains and work with governments to improve skills development.
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1.4 Company case studies

Freeport McMoRan, Peru
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Newmont Mining Ghana
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1.5 Future regional challenges and opportunities

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Industry sector context

A snapshot of the development pressures that are shaping the operating context for extractive companies in key countries



We have identified a group of developing countries that are strategically important to the profitability of the 25 largest publicly-listed corporations in the mining and oil and gas sectors, given their allocation of global investments.⁷ The companies reviewed, given their presence in developing countries, are listed below.

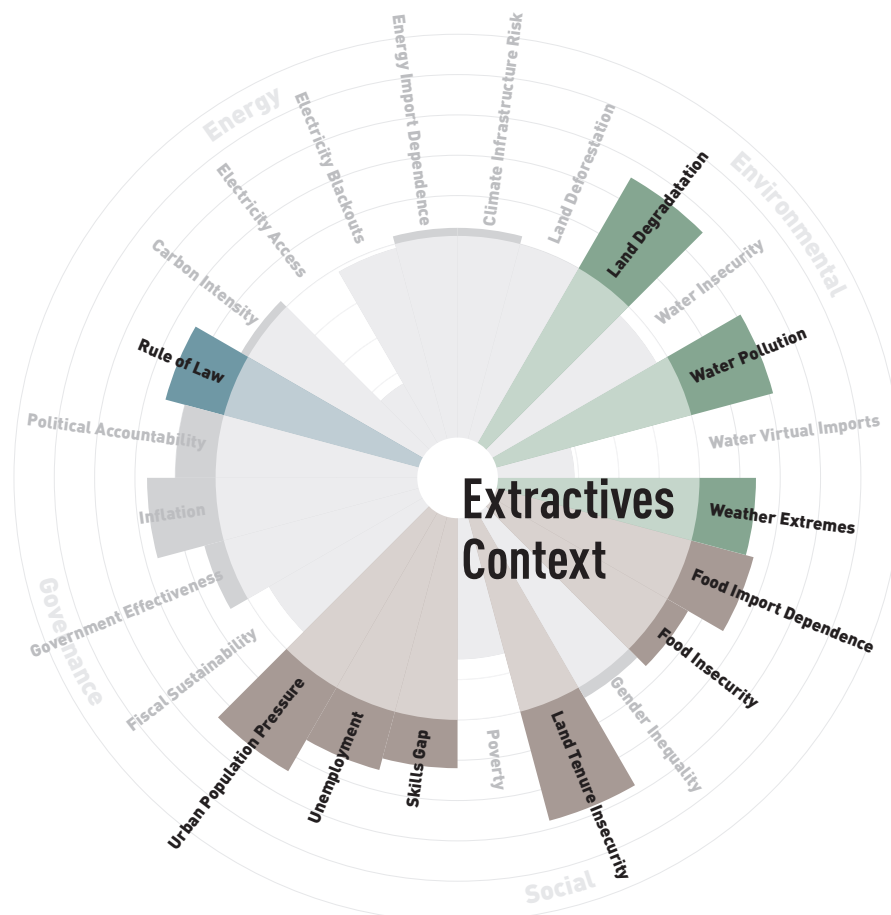
The group of countries include major net exporters of crude oil and OPEC members (e.g. Nigeria, Angola, Iraq) as well as countries with large growth potential, such as Kazakhstan.⁸ Kazakhstan is expected to join the top 10 oil and gas exporters by 2020.^{9/10} The group of countries also includes major producers of metals and minerals, including Chile, which alone accounted for 31% of global copper production in 2014 and for 6% of global expenditures in non-ferrous¹¹ exploration in 2013.^{12/13}

South Africa remains the leading African destination for merger and acquisition deals in the extractives sector across key global resources like uranium, copper, lead and zinc.¹⁴

Figure 3
Development pressures shaping the operating environment for extractive companies across top developing countries

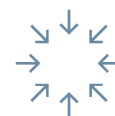
The visual represents the aggregate resource pressures in the developing countries that are key to the investments of the largest extractive companies. These are listed below.

Countries	Companies
Algeria	Alcoa (US)
Angola	Anglo American (US)
Argentina	BHP Billiton (Australia)
Bolivia	BP (UK)
Brazil	Chevron (US)
Chile	China PTL (China)
China	CNOOC (China)
Colombia	ConocoPhillips (US)
Indonesia	Eni (Italy)
Iraq	Exxon Mobil (US)
Kazakhstan	Freeport-McMoRan (US)
Libya	Gazprom (Russia)
Myanmar	Glencore (Switzerland)
Nigeria	Goldcorp (Canada)
Papua New Guinea	MMC Norilsk Nickel (Norway)
Peru	Occidental Ptl (US)
Qatar	Petrochina (China)
Russia	Reliance (India)
South Africa	Rio Tinto (UK)
Venezuela	Royal Dutch Shell (Netherlands)
	Schlumberger (US)
	Southern Copper (US)
	Statoil (Norway)
	Total (France)
	Zijin Mining Group (China)



Exposure to development pressures

Two societal challenges where companies should develop a resource leadership position to create long-term conditions for their operations



1 Social conflicts intensify due to the nexus of water scarcity, land and food security

The six largest mining companies have 70% of their combined operations in countries that already face the risk of water scarcity.¹⁵ The companies' expenditures on water infrastructure more than tripled from 2009 to 2013, to USD 11.9 billion.¹⁶ Moody's, the rating agency, warns that water-related risks are likely to affect the credit ratings of extractive companies.¹⁷ In the gold sector alone, water stress could render USD 152 billion of deposits inaccessible.¹⁸

Social opposition to mining activities in water insecure areas has grown exponentially in recent years and the growing nexus of water, land and food security will accelerate those conflicts.¹⁹ Community opposition to Southern Copper's USD 1.4 billion Tia Maria project, located in one of Peru's most fertile regions, has led to violent protests from local farming communities. These are concerned that the open pit mine will pollute and exhaust water from the river Tambo, affecting their crops. Despite proposing a USD 95 million desalination plant to provide water to the mine, and a USD 3.2 million fund to compensate farmers, the project had to be suspended in March 2015.^{20/21}

In Chile, 16 mining-related desalination projects worth USD 10 billion are being planned or under construction to secure water needed to run mines.²² While they address the primary water needs of a project, they may not adequately address social opposition, or inflame local resentment if communities see their access to water restricted.²³

The main developing countries for extractive investments show on average converging pressures of land tenure security, food insecurity, dependence on food imports, and more extreme weather – all factors necessary for food production. While the demand for metals is set to grow 250% by 2030, global food production must also grow by at least 60% to meet demand.^{24/25} These converging pressures will increase the scrutiny on companies to ensure sustainable water resources in the areas where they operate.

2 Local content policies to increase due to poverty, unemployment and urban demographic pressure

Since 2008, over 100 policies have been passed by governments around the world requiring foreign companies to hire local people.²⁶ The extractive sector is a core target given its high revenue generation, but potentially low effect on local jobs.²⁷ For example, Angola's oil sector accounts for 46% of GDP, and 95% of Angola's exports, but employs just 1% of Angolan workers.²⁸ For companies, the local shortage of qualified people challenges their ability to meet local content expectations and regulations, and has become a key factor in the overrun of project costs.^{29/30} For example, Chevron's USD 10 billion investment in Angola LNG was delayed by 18 months due to fires, accidents, and labour gaps, which are attributed to the shortage of qualified people, costing the company up to USD 4 billion.^{31/32}

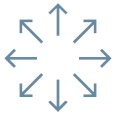
A survey of oil and gas executives identified local content as one of the top drivers of business instability for future operations in Africa. Of 53 companies surveyed in 2015, only half were fully compliant with local content laws in Africa; a drop from 60% in 2014. This is expected to be a top issue for companies, second only to efficiency improvements.³³

Companies will be constrained by a global shortage of experienced oil industry professionals, which is expected to reach 20% by 2016.³⁴ At the same time, in host countries, the expectation that companies create jobs and develop local enterprise, rather than rely on workers from overseas, will continue to grow.³⁵ Furthermore, mandatory investments in 'local content' funds that run by governments can expose companies to corruption risks.³⁶

The top developing countries for the extractive sector display converging pressures of unemployment and youth unemployment, skills gap, urban demographic pressure and rule of law. Many of the top developing countries for the sector have taken a proactive legislative stance on local content, including South Africa, Nigeria, Angola, Indonesia, Brazil and Kazakhstan.^{37/38}

Recommendations for business leadership

Strategic responses to resource pressures that build trust with stakeholders and align a company strategy with sustainable growth



1 Co-investments in shared water infrastructure

In the absence of strong government oversight, extractive companies will need to ensure that the quality and availability of freshwater around a mine can support communities and farming.³⁹ While mining companies in drought prone regions are investing heavily in desalination plants to ensure their operations, acting beyond the company fence on water security will be critical. Mining companies need to be proactive in defining not just their own water use, but also how water resources will be managed more broadly, and invest in water infrastructure that provides shared benefits with the mine's neighbours.

The International Council on Mining & Metals (ICMM) has developed a 'water stewardship framework'.⁴⁰ This outlines a common industry approach for a highly complex and localised issue. According to ICMM, a key feature of this framework is the need for companies to adopt a 'catchment area approach'.⁴¹

This must ensure that companies are finding solutions that work for the business as well as for other water users within the catchment area. Additionally, extractive companies should consider becoming signatories of the CEO Water Mandate, which emphasises the role of companies in watershed management and provides a framework for a company to disclose and communicate information.⁴² With these frameworks in place, companies should engage with governments, water utilities and communities to take a proactive role, through their capital investments, the talent of their engineers and other corporate assets, to collaborate to improve water management in the areas where they operate.

2 Scale-up the support for small enterprises across a company's value chains

Governments face a political dilemma: On one hand, the programmes needed to create a highly skilled population require a sustained, inter-generational investment that is unlikely to yield short-term results. On the other hand, they are subject to short-term pressures to deliver more jobs within their electoral period. The greater convergence of social pressures can lead governments to adopt intransigent positions or unrealistic goals, which in turn hinder investment in the country. Companies must anticipate this and engage with governments with a proactive plan, a vision and new ideas.

These should balance investments in short-term objectives that will show results, such as creating and/or strengthening small and medium-sized enterprises within a company's multiple value chains and training employees; with longer-term investments to develop a country's skill base in fields like engineering and science for the future, including schemes to attract diaspora to the country.

Local chambers of commerce have a key convening role to play to develop proposals that mediate between the interests of companies and those of governments. For example, In Ghana, the Sekondi Takoradi Chamber of Commerce and Industry, in the resource-rich western region of Ghana, is a case in point. The Chamber is developing the idea of a 'Local Content Prize' for extractive companies with which to foster innovation in the region. These efforts should be supported by companies and international agencies, in order to raise the profile of initiatives and inform the most productive way in which governments can approach the issue.⁴³

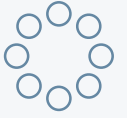


Guidance on the Global Goals for Sustainable Development

As companies take a proactive approach to managing this issue, they are advancing the Global Goals for Sustainable Development in the countries where they operate.

Case Study Freeport McMoRan, Peru

Building water infrastructure and improving government capacity



Country context

Peru is one of the region's leading producers of metals and minerals.⁴⁴ Some regions of the country face the prospects of acute water stress. Since 2010, water-related conflicts with local communities in Peru have halted three mining projects worth USD 7 billion.^{45/46} Food insecurity remains high despite progress fighting poverty. In rural areas, one out of three children is undernourished. Mining operations are often clustered in key agricultural regions of the country, where over 70% of the population may rely on agriculture for their livelihoods.⁴⁷ 66% of agriculture is directly rain-fed, exposing the sector to more extreme weather.⁴⁸ Climate change in Peru is set to threaten the food security of five million people and increase Peru's dependence on food imports.⁴⁹

A resource leadership position

Freeport McMoRan operates Cerro Verde, an open pit copper and molybdenum mining complex 20 miles of the city of Arequipa in Peru. In 2010, Cerro Verde produced 49% of the company's South American copper and 10% of all its molybdenum. The operation relies on water supplied by the Chili river, which also supplies the drinking water needs of Arequipa, as well as the needs of local agriculture and other industries. However, water scarcity in Arequipa is high and the Chili river is contaminated from mining, agricultural and municipal pollution. Water shortages have affected 30% of agricultural cultivation area in the region,⁵⁰ and is expected to grow as a driver of conflict.⁵¹

Freeport McMoRan co-invested USD 120 million along with government agencies to install a potable water treatment system that would supply clean water to the Cerro Verde mining complex and the neighbouring 700,000 habitants of Arequipa.⁵² A stakeholder consultation at the outset of the mine project was instrumental in designing a public-private partnership between Cerro Verde, civil society representatives, the local water utility company, local authorities and the central government. Key players would co-invest in the plant in order to address the water supply deficit to both the mine and local population.⁵³ Cerro Verde is investing a further USD 400 million in the construction, operation and maintenance of a wastewater treatment plant for Arequipa.⁵⁴

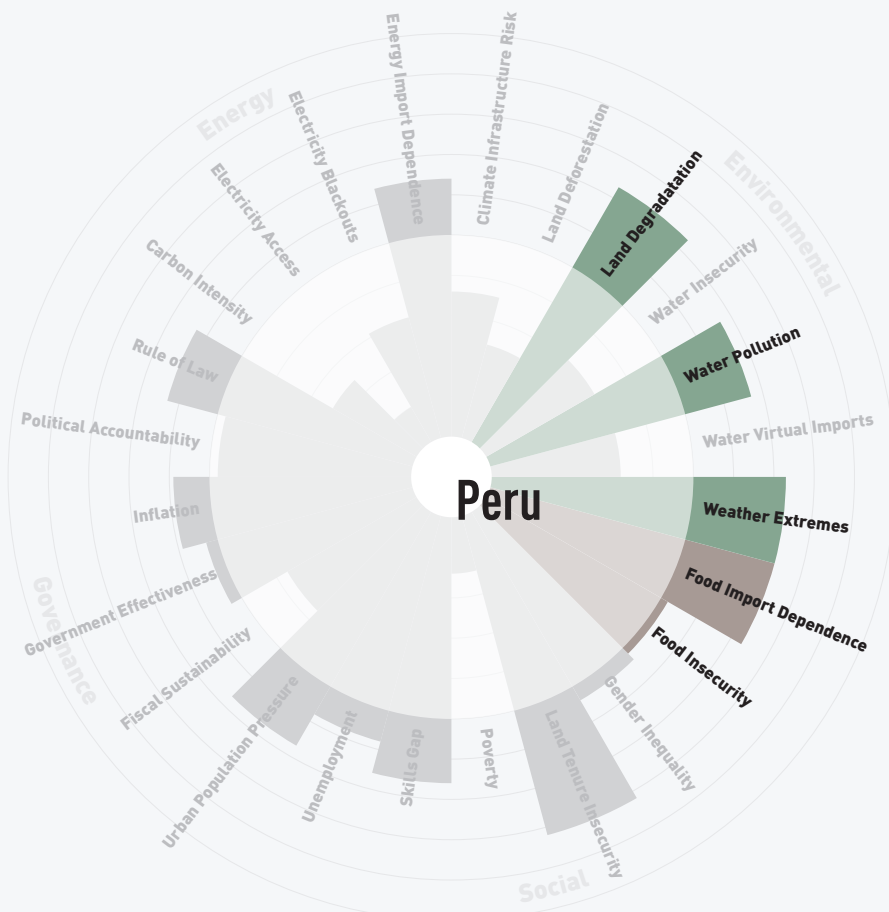


Figure 4
The combined pressures of climate change, land degradation and water pollution in Peru will worsen the country's water security in the future.

Case Study Newmont Mining, Ghana

A public-private partnership for enterprise development



Country context

Despite Ghana's long standing technical colleges, the country has a shortfall of training opportunities to match the needs of the rapidly growing young population. Only 1% of the education budget is allocated to technical and vocational training.⁵⁵ Almost 50% of Ghanaians live in, or on the verge of, poverty.⁵⁶ Urban migration and demographic pressure in cities is expected to grow dramatically, and with it the indices of urban poverty.⁵⁷ Unemployment is likely to become more urgent than it is today. Ghana's fiscal deficit grew to 10.4% of GDP in 2014, due to the fall in gold and oil prices on which Ghana's budget depends. In response, the government has continued to remove subsidies from fuel and electricity tariffs. Cuts to public spending are likely to increase the pressure on the government to enforce local content requirements and improve the equitability of development.⁵⁸

A resource leadership position

The Ahafo Mine in Ghana holds nearly 20% of the Newmont Mining's global gold reserves. Approximately 20% of the mine's costs (USD 588 million) were financed by a 12-year loan of the International Finance Corporation (IFC). The mine is located in tropical mid-western Ghana, a region that supplies 30% of Ghana's food and where poverty is higher than the country's average.⁵⁹ The high poverty levels combined with a significant resettlement process created large expectations on the mine to generate local jobs and opportunities for local suppliers.⁶⁰ However, with low skills and enterprising levels in the region, the company was challenged to draw on the local workforce and supplier base.⁶¹ Newmont's local subsidiary, Newmont Ghana Gold Limited partnered with the IFC and Ghanaian Chamber of Mines to develop the 'Ahafo Linkages Programme'.

It worked with small and medium enterprises (SMEs) and regional business associations to support skills development in employees and members through training programmes.⁶² The project invested in improving mobile phone coverage, roads and transport, and access to electricity – all infrastructures needed to support enterprises.⁶³

Over three years, local procurement grew from USD 1.7 million from 25 suppliers to USD 9 million from 143 suppliers.⁶⁴ Based on the success of the project, the Ghana Chamber of Mines sought other mining companies to support the programme.⁶⁵ In 2013 Ghana passed a Local Content Regulation for the oil industry. This aims to achieve 90% local participation in the country's oil industry by 2020, with 60% of the local employment achieved by 2017.⁶⁶ In learning from Newmont's experience, the government set up a public-private 'Enterprise Development Centre' to develop technical skills in the oil and gas sector. It is capitalising a USD 17 million 'Local Content Fund' to improve access to finance that local SMEs need to supply international oil and gas projects.^{67/68}

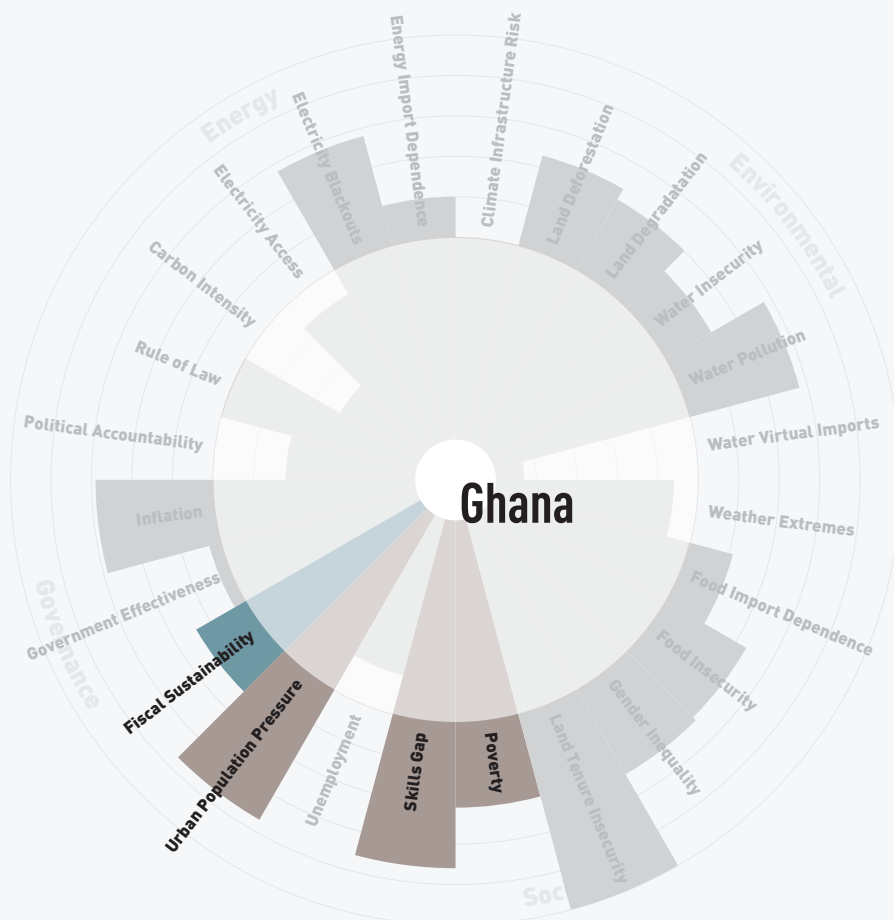


Figure 5
The combined pressures urban migration, skills gap, poverty and fiscal sustainability are likely to jeopardise Ghana's gains on employment.

Future regional challenges and opportunities

Our regional forecast is based on an average of the developing countries that are most important to the sector's investment outlook. The forecasts are intended to be used by global companies to ensure that their regional strategies, implemented by regional executives and country subsidiaries, are anticipating the region-wide trends and adopting a resource leadership position.

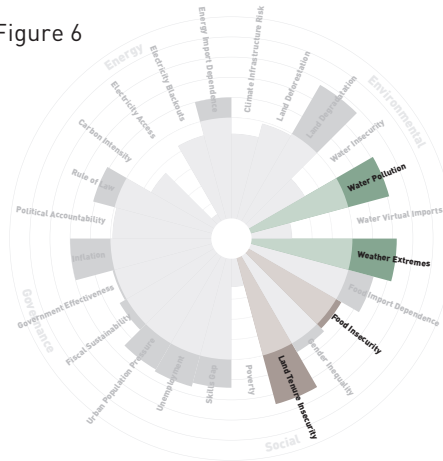
Region

Latin America Argentina, Bolivia, Brazil, Chile, Colombia, Peru, Venezuela

What to expect

Food security to drive social conflicts for mining companies.

Figure 6

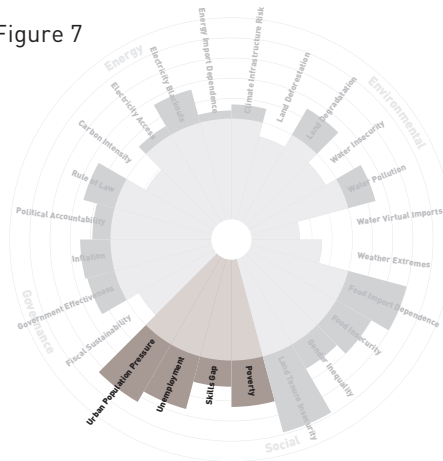


Social conflict is the most prominent threat to the industry in Latin America. In 2014, the Observatory of Mining Conflicts in Latin America identified 215 social conflicts between industry and communities in 19 countries; with Peru, Mexico and Chile top of the list.⁶⁹ Weak land tenure rights and water pollution are two leading conflict drivers across the region⁷⁰ where 70% of water in municipal and industrial use is returned to rivers untreated.

Sub-Saharan Africa Angola, Botswana, DR Congo, Gabon, Liberia, Libya, Namibia, Nigeria, Republic of Congo, South Africa

Skills gap and poverty to intensify local content pressures on extractives.

Figure 7

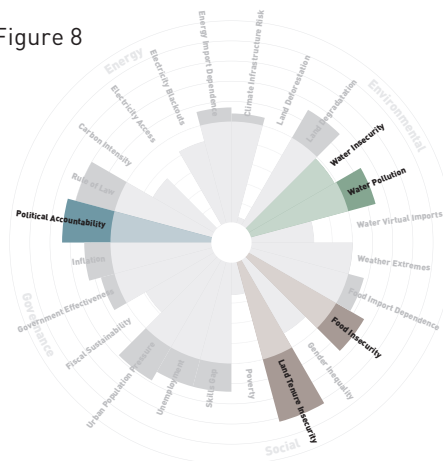


High levels of unemployment and poor working conditions are a main driver of protests against extractive companies in Sub-Saharan Africa.⁷² These can easily spiral into violent conflict, as in the case of the Marikana mine owned by Lonmin in South Africa.⁷³ The situation is fuelled by the pressure on politicians to respond to unemployment, and a popular sense that more of the wealth and jobs created by international extractive companies should remain in the country.^{74 / 75}

Central Asia Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan

Political risk to be amplified by water scarcity.

Figure 8



Central Asia is a key frontier region for the extractive sector. Here the erosion of environmental conditions is taking place alongside low levels of political accountability. Central Asia's intensifying relations with China to accelerate large infrastructure investments in the sector could confront new land conflicts given the region's land tenure insecurity. Kazakhstan and Kyrgyzstan have sought to improve transparency in the sector as part of the Extractive Industries Transparency Initiative (EITI),⁷⁸

Future regional challenges and opportunities



Recommendations

Latin America

Support local sustainable agriculture for an integrated approach to land, water and food security.

Farming in Latin America is expected to suffer the impacts of climate change; changes in rainfall and soil conditions. Communities surrounding mines are generally dependent on family agriculture. The prospects of food insecurity as the result of negative impacts on land and water, will be an increasing driving factor of social conflict for companies, fuelling the mistrust and perception of threat that communities associate with large extractive projects.⁷¹

Companies must see a more interconnected picture between access to clean water, land security, food security and livelihoods. Taking a proactive stance on sustainable and inclusive agriculture – with models that build greater security for communities across all these issues – is necessary.

Putting in place water infrastructure that can support this is vital. Companies should build partnerships with governments, water utilities, and civil society to improve overall water access and water quality. The focus should be on co-benefits among stakeholders, and supporting government capacities to improve water management, in order to build trust in the role of companies in a country's development.

Sub-Saharan Africa

Partner with governments to scale support for small and medium enterprises in value chains.

'Local content' laws have been on the rise across the region, driving uncertainty about project plans as well as creating delays and rising costs.⁷⁶ Skills shortages are seen by businesses as a major obstacle to Africa's growth.⁷⁷ Growing urban demographic pressure, as more people move from rural areas to crowded cities, is likely to contribute to urban poverty, drive up unemployment, and put pressure on governments to adopt a more rigid position towards industry.

Companies need to be proactive about their impact on local jobs and livelihoods. Where technical talent is needed, they should invest with a long-term, inter-generational approach to skills building. In the short-term, they must demonstrate vision and ambition in creating dignified livelihoods for the population.

They must open new avenues of dialogue and collaboration with governments that meet both between short-term goals to support enterprises and skills, such as local procurement policies and SME support and access to finance, to those actions that will have longer-term impact, such as building a highly-skilled workforce in the country through a better education infrastructure.

Central Asia

Support initiatives that create jobs in ecological regeneration and food security.

while others like Azerbaijan have been downgraded due to the obstacles to civil society participation in the process.⁷⁹ Social conflicts over working conditions have been prominent throughout the region. Land tenure insecurity poses a challenge to new projects. Water pollution and land degradation, due to industrial discharge will impact water availability and local agriculture – further amplifying food insecurity and the underlying conditions for social conflict.⁸⁰

Companies must identify the critical risks that are likely to result in their operating context when weak political accountability combine with resource bottlenecks such as water, land and food security. Focusing on sustainable agriculture is a way for extractive companies to take a holistic approach to the bottleneck of context challenges.

Supporting the regeneration of depleted and polluted ecosystems with an emphasis on food security and job creation, can be a vital precondition to build trust from local stakeholders. Ensuring that expansion projects take into account pre-existing informal land rights must be part of this holistic approach.



02 Infrastructure

Building trust in the role of infrastructure companies in sustainable development requires investments in ecological resilience to secure water supplies, and in renewable energy to ensure that energy security is compatible with the low-carbon transition.

Introduction

Governments in developing countries are competing for private capital participation in large engineering and construction projects in power generation, water and transport.^{81/82} This is also forging new global alliances driven by public-private participation. In 2015, under the auspices of China's 'One Belt, One Road' initiative, Chinese companies signed infrastructure deals worth more than USD 1.7 billion in Tanzania and plan to invest USD 46 billion in infrastructure in Pakistan — along vast land and maritime corridors.^{83/84} These type of large infrastructure investments will shape the barriers and opportunities for the global sustainable development agenda and must focus on sustainable growth.

Climate change, water stress and land degradation are posing significant threats to infrastructure. India and Brazil are living examples of the crippling impact of more intense droughts on electricity generation.^{85/86} But electricity demand in developing countries is set to grow significantly in the next decades alongside urban demographic pressures. The additional costs of adapting to climate change impacts for infrastructure assets are estimated to range from 5% to 20% of the initial investment cost.⁸⁷ This is prompting large infrastructure companies to rethink how to adapt to climate change.^{88/89}

Companies are beginning to view investments into decentralised renewable energy infrastructure, and reinforcing 'green infrastructure' that maintains the hydrological functions of ecosystems, as pragmatic strategies to face the more volatile conditions that will clearly undermine infrastructure assets in the years to come.⁹⁰

Summary



2.1 Industry sector context

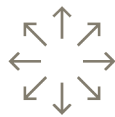
A snapshot of the development pressures in key countries that are shaping the operating context for infrastructure companies.
Page 21



2.2 Exposure to development pressures

Electricity shortages due to climate change, water stress and demographic pressure.
Page 22

Water pollution and scarcity to worsen due to conversion of land ecosystems.
Page 22



2.3 Recommendations for business leadership

Corporate commitments to 100% renewable energy and energy infrastructure.
Page 23

Investing in green infrastructure to maintain ecosystem services.
Page 23



2.4 Company case studies

Elion Resources Group, China
Page 24

Energia del Pacifico, Colombia
Page 25



2.5 Future regional challenges and opportunities

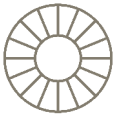
Asia
Page 26

Latin America
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Middle East
Page 26

Industry sector context

A snapshot of the development pressures that are shaping the operating context for infrastructure companies in key countries



We have identified a group of developing countries that are strategically important to the profitability of the 25 largest publicly-listed corporations in the infrastructure sector in engineering and construction projects in power generation, water and transport.⁹¹ The companies reviewed, given their presence in developing countries, are listed below.

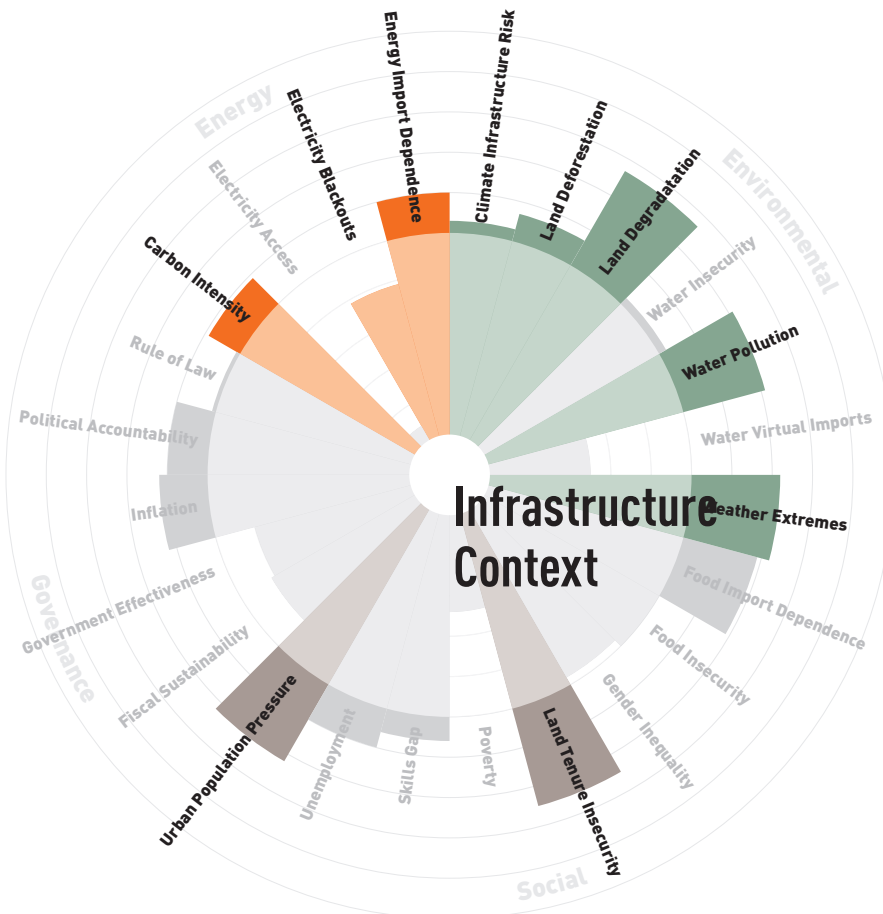
The group of countries includes major markets for infrastructure such as Brazil, China and India. Brazil is facing a profound political crisis that has affected the country's largest infrastructure companies on corruption charges and is likely in the short term to define the operating context for infrastructure companies. China's infrastructure spending is expected to grow by 10% per year to just under USD 3.5 trillion by 2025.⁹²

In India, where 70-80% of the built infrastructure needed by 2050 has yet to be developed,⁹³ it is estimated that USD 724 billion will be needed by 2030 to invest in urban infrastructure.⁹⁴

Figure 9
Development pressures shaping the operating environment for infrastructure companies across top developing countries

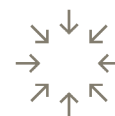
The visual represents the aggregate resource pressures in the developing countries that are key to the investments of the largest infrastructure companies. These are listed below.

Countries	Companies
Brazil	ABB (Switzerland)
Chile	Atlas Copco (Sweden)
China	Caterpillar (US)
Colombia	China Railway Group (China)
India	China Railway Corporation (China)
Indonesia	China Yangtze Power (China)
Malaysia	Corning (US)
Mexico	Danaher (US)
Peru	Duke Energy (US)
Qatar	Eaton (US)
Russia	EDF (France)
Saudi Arabia	Enel (Italy)
South Africa	Emerson Electric (US)
Thailand	Engie (France)
Turkey	E.ON (Germany)
United Arab Emirates	General Electric (US)
Vietnam	3M (US)
	Hitachi (Japan)
	Hon Hai Precision Industry (Taiwan)
	Hutchison Whampoa (China)
	Iberdrola (Spain)
	Schneider Electric SE (France)
	Siemens (Germany)
	TE Connectivity (US)
	Vinci (France)



Exposure to development pressures

Two societal challenges where companies should develop a resource leadership position to create long-term conditions for their operations.



1 Electricity shortages due to climate change, water stress and demographic pressure

The growing demand for electricity in developing countries is straining energy infrastructure.⁹⁵ Power blackouts, and the more common 'brownouts' (dips in voltage), have serious consequences for a country's industry and population at large. At least USD 48 to 53 trillion in cumulative global investments are needed in energy infrastructure by 2035 to meet increasing energy demands. 50% of this needs to be directed to electricity transmission and distribution.⁹⁶ Failure to do so could leave electricity supplies of developing countries critically exposed.

In the last few years, extreme drought and floods have been increasingly responsible for country-wide power outages and load-shedding across Asia, Africa and Latin America. The Global Electricity Initiative found that over 70% of power utilities surveyed around the world have been severely affected by extreme weather events.⁹⁷ In 2012, for example, following a higher-than-average drought that crippled hydropower generation capacity by 19%, blackouts across 20 states in India affected over 670 million people.⁹⁸

Today, India already faces a peak energy deficit of almost 7% of its total electricity demand.⁹⁹ The trend is expected to continue as multiple forces, including extreme weather that increased more than 4 times between 1980 and 2014, act to create a supply bottleneck.¹⁰⁰

The average pressures on the most important developing countries for the global infrastructure sector show a convergence of carbon intensity, electricity blackouts and a general reliance on energy imports.¹⁰¹ High exposure to extreme weather and the risk to infrastructure, coupled with urban demographic pressure, will increase the scrutiny from consumers and regulators on the quality of energy supplies. The pressure on companies in the infrastructure sector to deliver 'both' on goals of climate change and energy security will increase.

2 Water pollution and scarcity to worsen due to the conversion of land ecosystems

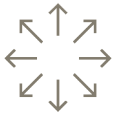
Energy and electricity production account for 15% of global water use. Water withdrawals for energy production are expected to increase by 20% by 2035. Hydropower facilities with large reservoirs can have some of the highest water consumption levels per unit of electricity generated.¹⁰² The Global Electricity Initiative sees water security as one of the top challenges for the sector.¹⁰³ For example, in September 2015, the state of Maharashtra in India was considering a complete halt to hydropower generation at three Tata Power stations due to drought.¹⁰⁴ The challenge will only be aggravated by climate change. In Africa, failure to consider climate change in the planning stages of hydropower plants could lead to revenue losses of up to 60%, according to the World Bank.¹⁰⁵ Global investments in the construction of dams are expected to grow steadily by 3% to 4% annually.¹⁰⁶ However, many hydropower companies are already having to deal with more volatile water availability by cutting production.

This has exacerbated the intermittency of power supply and increased electricity tariffs leading to disputes with regulators.¹⁰⁷ Droughts have forced utilities in Brazil, Zimbabwe and Tanzania to revert to more carbon intensive power sources, affecting their overall carbon intensity and corporate footprint.^{108/109} The awareness of these risks is creating more receptivity to climate change among corporate audiences.¹¹⁰

However, companies will be more vulnerable in regions where land is being degraded fastest. Unsustainable farming methods upstream can have a major impact on dams downstream,¹¹¹ such as less water flowing into a reservoir and more sedimentation damaging equipment.¹¹² Land degradation is particularly acute in the areas of highest projected growth for hydropower investments. Deforestation in the Amazon Basin, for example, has been directly linked to drought conditions that crippled Brazil's hydropower infrastructure from 2013 to 2015.¹¹³ These pressures are converging in key countries for global infrastructure, with land tenure insecurity creating an additional barrier to the effective management of land.

Recommendations for business leadership

Strategic responses to resource pressures that build trust with stakeholders and align a company strategy with sustainable growth



1 Corporate commitments to 100% renewable energy, while partnering on energy infrastructure

Many large infrastructure companies, such as Siemens are committing to source 100% of their electricity from renewable sources. The average target date for these commitments is 2025–2030. This means that companies will not only need to commit their purchasing decisions but also play a proactive role in supporting the renewable energy infrastructure, such as transmission and distribution systems, to accomplish their target. Companies should sign up to global corporate networks, like The Climate Group’s RE100, which are helping companies to plan such commitments.¹¹⁴

Partnerships that build a transmission infrastructure are key to scale up the supply of renewables.¹¹⁵ For example, South Africa’s state-owned utility, Eskom, partnered with independent power producers to overcome power shortages through the integration of renewable energy into the central grid.^{116 / 117}

In 2015, Google announced an investment into Africa’s largest wind farm — the Lake Turkana Project in Kenya. An attractive part of the investment project is a 266-mile transmission line that will be built as a backbone for the Kenyan grid and enable development of further renewable capacity.¹¹⁸ Therefore, companies committing to source and generate 100% renewable energy will have to enter into such partnerships to help build the infrastructure needed to realise their goal.¹¹⁹

2 Investing in green infrastructure to maintain ecosystem services

The business case is clear: ecological restoration can lead to a 6% increase in water inflows to a dam’s reservoir and a 5% rise in revenues from increased electricity generation.¹²⁰ Maintaining the ecological integrity of watersheds is vital to the future of hydroelectric investments.¹²¹

While water utilities have been pioneering such programmes for years, support for ‘green infrastructure’ by hydropower projects must become a part of the project finance considerations, especially by development investors. The acknowledgement of green infrastructure is starting to appear in ‘voluntary’ industry standards such as the Climate Bonds Standard for Water Infrastructure and the Standard for Sustainable and Resilient Infrastructure.^{122 / 123}

Infrastructure companies must create programmes to pioneer ‘green infrastructures’ through ecological restoration. One example are Payments for Watershed Services (PWS), funds designed in collaboration with expert organisations such as Forest Trends,¹²⁴ which direct corporate funds to pay for watershed services, while resolving challenges like land tenure rights.¹²⁵ Dam operators must incorporate the practice of routinely evaluating the status of watersheds within their basins. They can collaborate with initiatives such as The Natural Capital Project, which has developed a system to measure the investment benefits of ecosystem protection that are a useful tool for companies to build an internal business case for action.¹²⁶ Global industry bodies, such as the International Hydropower Association (IHA) have a role to play in this agenda by incorporating more explicit guidance on the subject on an industry-wide scale.¹²⁷



Guidance on the Global Goals for Sustainable Development

As companies take a proactive approach to managing this issue, they are advancing the Global Goals for Sustainable Development in the countries where they operate.

Case Study Elion Resources Group, China

Corporate commitment to 100% renewable energy



Country context

China is one of the world's most vulnerable countries to climate change – in particular droughts and floods.¹²⁸ Major flooding in 2011 led to the failure of 8,500 electricity lines.¹²⁹ Up to USD 11 billion annually are needed to upgrade infrastructure to deal with flood risks.¹³⁰ By 2024, up to two-thirds of the Chinese population will be living in cities — the fastest rate of urbanisation globally. Electricity consumption in China is forecast to grow 250% from 2010 to 2030.¹³¹ This will put more pressure on electricity grids, as well as continue to raise the political pressure on air pollution — the latter already being a factor that supports decisions towards renewables in China.¹³² Renewable off-grid and micro-grid technologies are seen as vectors of market growth, playing a larger role in energy provision than diesel engines and other polluting technologies that aggravate China's air pollution in growing cities.¹³³

A resource leadership position

Elion Resources Group, one of China's top 100 private companies, with total assets of RMB100 billion (over USD 16 billion) is a leading desert and urban environmental restoration business. The company has committed to 100% renewable energy by no later than 2030. It did this by becoming the first Chinese company to join the RE100 global business initiative.¹³⁴

Elion has been involved in eco-restoration for almost three decades, transforming decertified areas into green spaces through afforestation and projects that prevent erosion. The company is particularly focused on the Kubuqi Desert in Inner Mongolia and other ecologically fragile regions in line with China's 'One Belt One Road' (OBOR) initiative. China's OBOR strategy is critically relevant to business opportunities infrastructure sector.

It is underpinned by lending from the Asian Infrastructure Investment Bank (AIIB), and will direct investment in infrastructure along various regional corridors. The commitment to 100% renewable energy comes at a time when OBOR and AIIB, two key drivers of energy infrastructure investment in China, are in the process of considering their approach to sustainable development. Companies committing to 100% renewable energy must form partnerships with governments, development banks and investors to put in place the infrastructure needed to support their commitments. Elion has already invested USD 0.15 billion in a 110 megawatt (MW) solar PV power station in the Kubuqi desert, and plans to invest USD 6.4 billion in a large-scale, five gigawatt (GW) solar PV project.¹³⁵

The company's chairman, Wang Wenbiao, has stated that 'The Elion Group is focusing on green energy in our corporate strategy to adapt to a new era where natural resources and environment have become a major constraining factor of human development.' China's Renewable Energy Industries Association (CREIA) further anticipates that besides large-scale projects, decentralised solar PV will grow faster as one of the most popular forms of energy in China, since rooftop solar projects currently offer industrial and commercial sectors a payback period of 7-9 years and an 8% rate of return.¹³⁶



Figure 10
The combined forces of climate change and weather risks on infrastructure, urban demographic pressure and carbon intensity of electricity coupled with energy import dependence create a bottleneck on the growth of China's electricity supplies.

Case Study Energía del Pacífico, Colombia

Investing in green infrastructure and land restoration



Country context

Colombia is highly dependent on dams. 71% of its electricity is supplied by hydropower plants.¹³⁷ Since 2015, Colombia has experienced one of the worst droughts on record, leaving dam reservoirs at 65% of average levels, causing a 10-fold increase in electricity prices.¹³⁸ In December 2015, a court ordered the temporary closing of operations at El Quimbo dam, the largest hydropower plant in the country, in order to ration water, but reversed its decision to avoid electricity blackouts.¹³⁹ Fitch Ratings alerted that Colombian power utilities are exposed to volatile prices due to drought conditions.¹⁴⁰ Colombia's cloud forests (high-moisture rainforests) cover a third of the watersheds supporting the country's dams. Deforestation has affected the ecological services that support their water provision.¹⁴¹

Forests help to extend the life of dams by generating moisture and rain, filtering water, regulating flows to rivers and – above all – reducing sedimentation that flows into the dam.¹⁴² Weak land tenure security for local communities, which inhabit 50% of Colombia's forests, limit their ability to manage an invest in land conservation.^{143 / 144 / 145}

A resource leadership position

Since 1999, the Colombian government's 'Plan Verde' has channelled funds from watershed users, such as agriculture, water utilities and hydropower operators, into forest recovery for the restoration of eco-hydrological services. This includes the restoration of cloud forest cover to regulate water flows and reduce sedimentation impacts in water supply reservoirs and hydropower dams.

The scheme has required hydropower companies with an installed capacity of more than 10,000 kilowatts to transfer 3% of annual electricity sales to regional management corporations (decentralised bodies of the Colombian Ministry of Environment) who are in charge of projects.¹⁴⁶ Half of the amount received (USD 135 million from 1994–2000) must be channelled to the protection of watersheds where energy is generated. Energía del Pacífico, the power utility that operates the Calima dam in Colombia, has demonstrated that restoring cloud forest in 18% of its watershed could lead to a 5% increase in electricity output.¹⁴⁷ However, the programme's high administrative costs have been reported to be a bottleneck to the funding's impact. A more direct way of investing in the integrity of watersheds will be needed, such as corporate involvement with Payment of Watershed Services (PWS) funds through partnerships between industry, civil society and other stakeholders.¹⁴⁸



Figure 11
The combined pressures of land degradation, land tenure insecurity, water pollution and exposure to extreme events, is likely to aggravate Colombia's water security, straining the conditions for its reliance on hydroelectric power.

Future regional challenges and opportunities

Our regional forecast is based on an average of the developing countries that are most important to the sector's investment outlook. The forecasts are intended to be used by global companies to ensure that their regional strategies, implemented by regional executives and country subsidiaries, are anticipating the region-wide trends and adopting a resource leadership position.

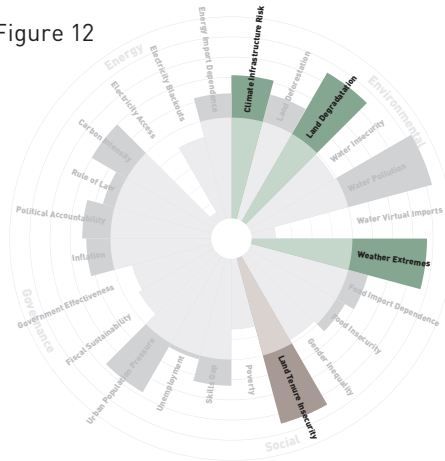
Region

Asia Indonesia, Malaysia, Thailand, China, India, Vietnam

What to expect

Extreme weather risks to grow for projects.

Figure 12

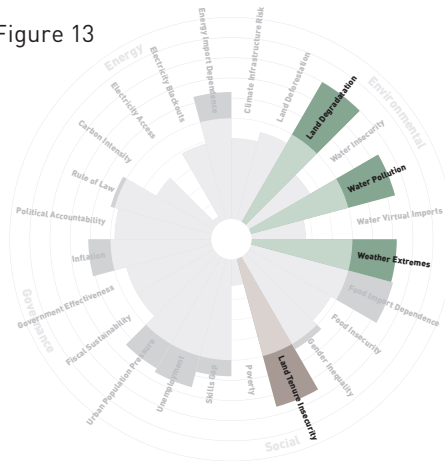


Asia's infrastructure is highly vulnerable to extreme weather events such as typhoons and floods.¹⁴⁹ Lloyd's estimates USD 22.5 billion of GDP at risk from flooding in South East Asian cities alone.¹⁵⁰ Much of Asia-Pacific's power infrastructure is located in low-lying, flood-prone areas where extreme weather events are expected to grow.¹⁵¹ Land degradation is a risk amplifier, as the resilience of landscapes to absorb shocks is diminished.

Latin America Brazil, Mexico, Chile, Colombia, Peru

Water security fuels social opposition to projects.

Figure 13

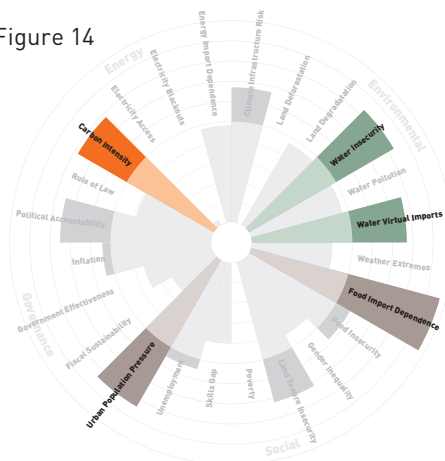


Latin American countries are seeking to increase the private sector's participation in infrastructure in order to meet their development needs. The region is also strategic for global agribusiness. Large scale agriculture has been a primary driver of land use change. The conversion of land ecosystems erodes ecological services that help buffer against extreme weather changes. The acute challenges facing hydropower projects in Brazil and Colombia are cases in point.

Middle East United Arab Emirates, Qatar, Saudi Arabia, Bahrain, Kuwait, Oman

Competition for water in cities to block projects.

Figure 14



Rapid urbanization in the Middle East is a major driver for infrastructure investments in transport, energy, housing and communications.¹⁵⁷ However, it is also accelerating pressure on water and competition with other sectors – namely energy and agriculture.¹⁵⁸ Energy demand for water will grow substantially in the next decade.¹⁵⁹ 9% of Saudi Arabia's total annual electricity consumption is attributed to ground-water pumping and desalination.¹⁶⁰

Future regional challenges and opportunities



What to expect

Recommendations

Asia

Mitigating climate risk through insurance partnerships.

Weak land tenure rights are a barrier to the effective land management as well as land acquisition.^{152/ 153} In Indonesia (which has high levels of tenure insecurity), a consortium bidding to build a new power plant in Central Java, which would provide electricity to 8 million people, stalled when landowners refused to sell their land, which accounted for 20% of the planned construction site. The dispute risks the consortium losing its concession.¹⁵⁴

Companies have to anticipate the climate change risks they face, and form partnerships with insurance companies that are growing extreme weather products in the region (see Earth Security Group's projects in India and Indonesia advancing such partnerships). Companies should develop new strategies that help regenerate ecosystems, such as coastal mangroves and forests.

New business models need to be inclusive, supporting locals to resolve land tenure disputes in the process.

Latin America

Invest in 'green infrastructure' with a social component.

Large infrastructure projects in the region are also affected by social opposition, which originates in weak land tenure rights.¹⁵⁵ Latin America, which has the greatest biological diversity on earth, registers infrastructure projects as a key driver of deforestation.¹⁵⁶

Companies investing in infrastructure in Latin America must consider innovative business models, which can deliver greater ecosystem benefits with social inclusion. To anticipate the risks of more intense droughts, companies must develop a more holistic approach to the 'land nexus' by investing in ecosystem regeneration – e.g. getting involved in models for payment for ecosystem services.

This will help to avoid land degradation and loss of ecosystem services amplifying water insecurity for their projects, and strengthening land tenure rights where these increase a project's political risks.

Middle East

Innovative joint ventures address the water-energy nexus

Other countries in the Gulf may be consuming 12% or more of total electricity consumption for desalination. With population set to double in the region over the next 40 years, per capita water availability is projected to fall by more than 50%.¹⁶¹ The intensifying competition for water between different demands, like irrigation and energy production, will increase water insecurity and regulatory challenges for infrastructure companies.

New technology investments, business models and public-private partnerships that bring a holistic approach to water management will be favoured by governments, regulators and investors. These may include waste water plants that are energy self-sufficient; or desalination technology that runs on solar power. Cross-industry innovation strategies will be needed to turn systemic risks into opportunities.

Companies will need to develop a collaborative stakeholder approach in the region. Working towards a common goal of water security with regulators and the agriculture industry will be vital.



03 Food & Agriculture

Building trust in the role of global food & agriculture companies in sustainable development requires support to communities to formalise land tenure rights and taking a wider approach to water security based on a geographic catchment area where companies operate.

Introduction

Water scarcity alone is estimated to put as much as USD 11.2 trillion of value at risk for agriculture assets, including processing plants, transportation and distribution networks.^{162/163} The demand for crops is estimated to grow 60% by 2050, requiring an extra 61 million hectares of land to be made available for agriculture.^{164/165}

Making more land available will be a challenge. With millions of family farmers in Latin America, Asia and Africa not having the formal recognition of their land ownership, the prospect for greater land conflicts driven by industrialisation pressures is clear.

Commercial farming accounted for at least 50% of global deforestation in the past decade.¹⁶⁶ Bold global corporate commitments are being made: to zero deforestation, to making more food available, to strengthening the resilience of farming communities, and to reducing greenhouse gas emissions.^{167/168}

Companies will struggle to deliver on these multiple fronts on their own. The only way to achieve a more sustainable agriculture will be to build the capacity of family farmers and governments to create virtuous systems. These will focus on improving the incomes of local people, expanding their rights, and protecting the natural capital on which food systems ultimately depend.

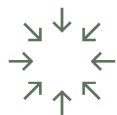
Companies may find these production models more time-consuming to develop, with an initial steep learning curve that will require new thinking from business executives.¹⁶⁹

Summary



3.1 Industry sector context

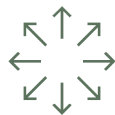
A snapshot of the development pressures in key countries that are shaping the operating context for agriculture companies.
Page 31



3.2 Exposure to development pressures

Competition over water to intensify due to pollution, land degradation and climate change.
Page 32

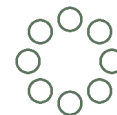
Land tenure conflicts to increase due to weak rule of law, deforestation, and food insecurity.
Page 32



3.3 Recommendations for business leadership

Create corporate water stewardship programmes at a watershed level.
Page 33

Support communities with the formalisation of their land ownership rights.
Page 33



3.4 Company case studies

ITC Limited, India
Page 34

Olam International, Gabon
Page 35



3.5 Future regional challenges and opportunities

Latin America
Page 36

Sub-Saharan Africa
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South East Asia
Page 36

Industry sector context

A snapshot of the development pressures that are shaping the operating context for agricultural companies in key countries



We have identified a group of developing countries that are strategically important to the profitability of the 25 largest publicly-listed corporations in the agriculture sector. These companies represent the largest companies by market cap across the food & tobacco, beverage, paper & forest products and agrichemicals sectors with manufacturing and production operations in developing countries.¹⁷⁰

They invest assets across these countries by establishing manufacturing facilities, plantations and mills, food production factories, bottling plants and breweries. The companies reviewed, given their presence in developing countries, are listed below.

The countries include top producers and exporters of key agricultural crops. For example, India is a top five producer of sugar, rice, maize, and wheat and attracted over USD 2 billion in foreign direct investment from 2000 to 2015.^{171 / 172}

Argentina, already a major global exporter of beef, soybeans, wheat and maize, has been selected as a key destination for investment from the newly agreed USD 2 billion Chinese and Russian agricultural investment fund.¹⁷³ On the other hand, the group includes countries like Vietnam, which has grown from being largely a rice producer to developing a USD 30 billion commodity export market for wood products, fishery products, coffee, rice and rubber.¹⁷⁴

Figure 15
Development pressures shaping the operating environment for agriculture companies across their top developing countries

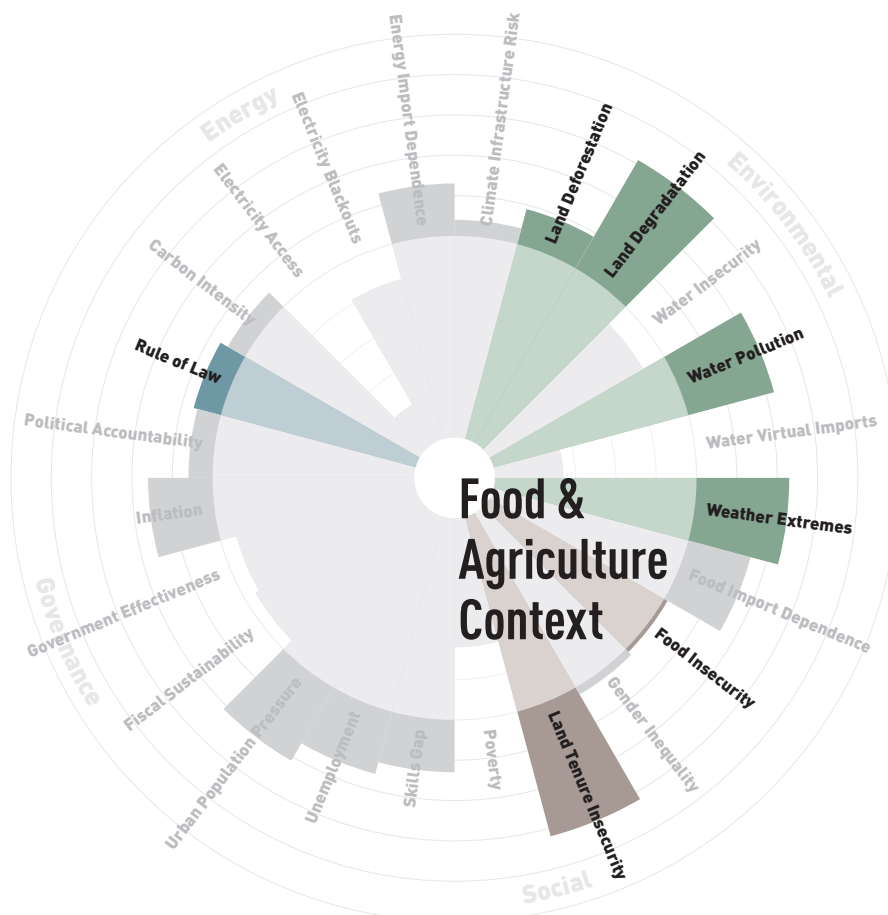
The global visual represents the average resource pressures of the developing countries that are key to the production, manufacturing and investments of 25 of the largest global food and agriculture companies. These are listed below.

Countries

Argentina
Brazil
Chile
China
Colombia
Egypt
India
Indonesia
Malaysia
Mexico
Peru
Philippines
Russia
South Africa
Tanzania
Vietnam

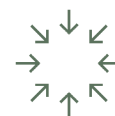
Companies

Anheuser-Busch Inbev (Belgium) to merge with SABMiller (UK)
Associated British Foods (UK)
British American Tobacco (UK)
Coca-Cola (US)
Danone (France)
Diageo (UK)
Fomento Economico Mexicano (Mexico)
General Mills (US)
Heineken (Netherlands)
Hormel Foods (US)
Imperial Tobacco (UK)
ITC (India)
Japan Tobacco (Japan)
Kellogg (US)
Kimberly-Clark (US)
Mondelez International (US)
Monsanto (US)
Nestlé (Switzerland)
Pepsico (US)
Pernod-Ricard (France)
Philip Morris (US)
Svenska Cellulosa Aktiebolaget (Sweden)
Unilever (Netherlands)
Weyerhaeuser (US)



Exposure to development pressures

Two societal challenges where companies should develop a resource leadership position to create long-term conditions for their operations



1 Competition over water to intensify due to pollution, land degradation and climate change

Two-thirds of the world's largest global companies in the sector are reporting exposure to water risks.¹⁷⁵ Corporate CEOs understand the need to routinely evaluate their water risks and implement water efficiency measures.¹⁷⁶ However, the greatest challenge to companies is ensuring that the competition with other users over water resources does not undermine their social license to operate.

In regions experiencing water stress, a company withdrawing water from rivers or aquifers may have the best water efficiency targets, but can still create a perception of threat in local communities.¹⁷⁷ For example, in India, between 2014 and 2015, Coca Cola is reported to have abandoned a USD 25 million bottling plant in Uttar Pradesh and an USD 81 million bottling plant in Tamil Nadu. In both cases local farmers had mobilised against the company over their concerns for the degradation and depletion of local groundwater.^{178 / 179}

By 2030, water scarcity will have caused shortfalls of at least 30% in global cereal production.¹⁸⁰ Three pressures are converging to exacerbate the tensions over access to water: water pollution, land degradation and climate change. 78% of global crop production relies directly on rainfall rather than irrigation, heightening the risk to changing rainfall patterns.¹⁸¹ At the same time, the FAO estimates that 33% of global agricultural land is degraded, mainly due to an overuse of fertilisers.¹⁸² Furthermore, 11% of the world's irrigated areas (34 million hectares) are affected by salinisation due to inefficient water use.¹⁸³

2 Land tenure conflicts to increase due to weak rule of law, deforestation and food insecurity

Land conflicts have increased by 300% since 2003.¹⁸⁴ Land issues are considered to be the next big human rights challenge for business.¹⁸⁵ At least 730 land conflicts involving agricultural commodities are currently active globally.¹⁸⁶ Weak land governance across Latin America, Africa and Asia leave millions of poor people unable to prove the land ownership and susceptible to land grabbing, expropriation and corruption.¹⁸⁷ According to the World Bank, up to 90% of rural areas in Africa are informally administered. Companies have developed policies of 'zero-tolerance' to land-grabbing, but the complexity of monitoring their supply chains in some countries creates continued exposure to reputation risks.¹⁸⁸

In most frontier countries where companies expect to grow their production or trade, land tenure insecurity coexists with other factors, such as weak rule of law, food insecurity and deforestation.

This is likely to undermine the commitments to 'zero-tolerance' made by companies unless more structural actions are taken to address the challenges. Without the security of land ownership, it is also more difficult for small-scale farmers to improve the productivity of their farming and access to finance. Therefore, land tenure security will be increasingly seen as a key obstacle for companies that are serious about sustainable agriculture models, as well as those that are concerned about reputational risks in frontier markets.^{189 / 190}

Recommendations for business leadership

Strategic responses to resource pressures that build trust with stakeholders and align a company strategy with sustainable growth



1 Create corporate water stewardship programmes at watershed level

Even companies that are improving their water efficiency, are finding that their exposure to water risks is being affected by factors that are beyond their control. For example, Bavaria (SABMiller's Colombian business) found that the diminishing water quality — and rising water treatment costs — for its brewery in Colombia, was largely caused by unsustainable farming practices upstream. Bavaria, in partnership with The Nature Conservancy, set up a fund in cooperation with the local water utility to pay farmers to use their land more sustainably. The company provided seed funding for USD 145,000. Once the pilot moved to the 60,000 hectares of the water catchment area, the improvement in water quality saved the company three times the money that would have been needed for treating the water.¹⁹¹

A water catchment approach is supported by the United Nations Global Compact's CEO Water Mandate. Adopting a 'water stewardship' role,¹⁹² it argues, means that companies must understand their context and surroundings; engage beyond their 'fence' to address shared water challenges; and align their water strategy with broader development objectives such as human rights.¹⁹³

Companies must develop corporate targets that focus on improving the water catchment area on which they depend, which encompasses both water and land governance. Engaging in initiatives such as the Alliance for Water Stewardship, provides companies with access to existing frameworks and lessons learnt from corporate engagement in the watershed.¹⁹⁴ Corporate strategies should seek to improve the availability of information, for example by sharing corporate data on water with other actors; helping to improve water policies and law enforcement; and supporting the capacity of government agencies to manage water effectively.

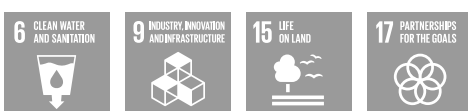
2 Support communities to formalise their land ownership rights

Global companies must go beyond creating 'zero tolerance' to land-grabbing policies. Instead, they can take an active role in improving land registration for small-scale, poor farmers within their value chains. In some cases, companies making land-related investments have enough leverage with local or regional governments, to make this part of their business plan. A company's clout, and in some cases the involvement of a company's legal team to support the process, can act as powerful catalyst. Even if companies are not making direct land investments, their relationship with suppliers can be a first step to pursue such models.

Strategic partnerships offer companies a clear pathway into this solution space. A range of civil society organisations provide legal services to poor communities, and make the formalisation of rights their core mission. Key civil society organisations to collaborate with are Landesa and Namati.

These are at the forefront of empowering women and men to obtain their land titles across developing countries, and are in a strategic position to work closely with companies.¹⁹⁵ The focus of such partnerships would include: supporting local authorities to survey existing land titles; the process of registering property rights and formalising customary land use; and other areas where a company's influence can speed up processes that for communities would take years.

As a first step, all companies in the agriculture sector facing some degree of exposure to land tenure insecurity — whatever their position in a supply chain — should ask themselves how they can take proactive steps to help formalise the situation of local people. This is a measurable objective that can form part of corporate efforts to address land tenure conflicts.



Guidance on the Global Goals for Sustainable Development

As companies take a proactive approach to managing this issue, they are advancing the Global Goals for Sustainable Development in the countries where they operate.

Case Study ITC Limited, India

A corporate water management programme at a watershed level



Country context

India's water crisis is inevitable. Its groundwater resources are already being withdrawn beyond their capacity to recharge.¹⁹⁶ Land degradation is an amplifying factor. 30% of all irrigated land in India is degraded, polluted or waterlogged due to the overuse of fertilisers and poor water management.¹⁹⁷ / ¹⁹⁸ As a result, India is losing 1 millimetre of top soil per year (roughly 5,334 million tonnes of soil).¹⁹⁹ The scale of land degradation is affecting the production of India's agriculture sector and the security of Indian family farmers.²⁰⁰ Climate change is the threat multiplier. 16% of total annual production for cereal, oilseed, and pulse crops is being lost in rain fed areas, at a cost of USD 2.51 billion.²⁰¹ These converging pressures require companies to develop an holistic approach to water management.

A resource leadership position

For ITC Limited, the Kolkata-based Indian food conglomerate, declining water quality and availability poses a significant challenge to its business. 'If we don't have a long-term perspective', said Ashesh Ambasta, Vice President at ITC, 'our raw material availability is at risk.'²⁰² Since 2015, ITC is working to double its agribusiness watershed management programme to address water governance challenges across 1 million acres of farmland by 2018.²⁰³ ITC foresees improvements in the reliability of water resources for farmers and a more stable supply chain.²⁰⁴ The company has worked with communities to set up village-level institutions, which have established more than 6,400 water harvesting structures and more than 1,480 functioning 'water user groups' in partnership with implementing NGOs.

These have brought half a million acres under soil and moisture conservation plans benefiting over 160,000 households.²⁰⁵ Water user groups are trained to formulate regulations and fix water user charges. These go towards creating a fund to maintain existing structures, build new ones and collaborate with existing government schemes. ITC's water model looks not only at achieving water conservation and soil enrichment, but also improving village-based management of water and other natural resources by evolving a culture of water use. Working in partnership with governments in five states, ITC says that its watershed development programme has so far generated over 4.7 million person-days of work.²⁰⁶

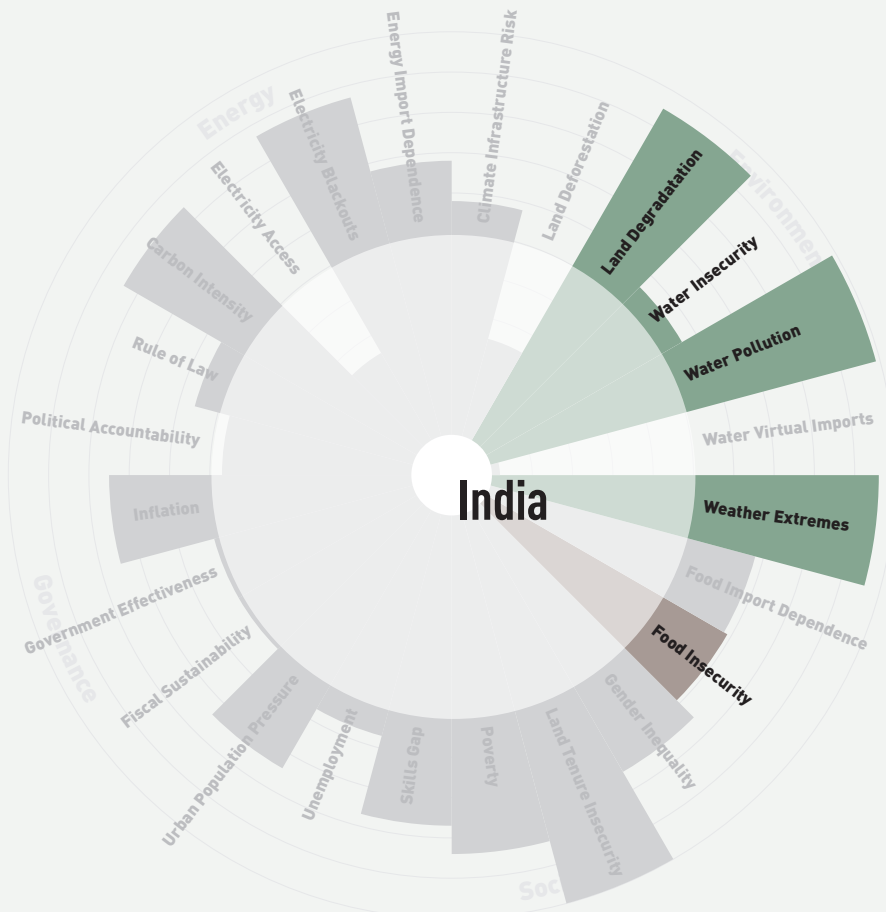


Figure 16
The combined forces of water pollution, land degradation and climate change create a bottleneck that will amplify India's water insecurity.

Case Study Olam International, Gabon

A private-public partnership to secure local peoples' land rights



Country context

The law in Gabon does not recognise local people's customary rights to their land. The state owns 85% of Gabon's land, with only 4,000 private titles existing mainly in urban areas. This leaves the majority of the rural population effectively landless occupants on state property.²⁰⁷ A push to attract USD 675 million in agribusiness investments is a priority to diversify government revenues, which depend 60% on crude oil exports.²⁰⁸ Gabon's food insecurity is high. The government spends some USD 565 million a year on importing food, which accounts for 85% of the total food consumed.^{209 / 210} The government has set itself the goal of food self-sufficiency and increased local employment by 2020.²¹¹ As part of this plan, 5,000 concessions have been assigned to foreign companies for timber, palm oil and rubber.

Chinese companies reportedly hold rights to one quarter of Gabon's forests – more than 5 million hectares.²¹² Land tenure security is a critical gap for prospective investors. The government has not managed to spearhead the reforms necessary to recognise communal and customary land ownership.²¹³ The rate of deforestation is likely to increase as the result of these pressures. The conditions are ripe for companies in these agricultural commodities to face protracted land conflicts.^{214 / 215}

A resource leadership position

Olam International, the global agribusiness company, partnered with the Gabonese government to develop rubber and palm oil plantations, with investments of USD 400 million and USD 236 million respectively.^{216 / 217}

Unlike most other companies facing the prospect of weak land tenure, Olam International took a proactive stand on land governance. Olam formed a public-private partnership with the government to support smallholder groups to formally own their land as part of an 'outgrower' production model. Facilitating the registration of land titles meant also that farmers would be in a better position to leverage Olam's training in good farming practices, greater access to markets and inputs and be more robust partners to ensuring a proper environmental due-diligence on the land and ongoing monitoring.²¹⁸

The joint venture, of which Olam owns 49% and the Gabonese government 51%, seeks to formalise the land titles of 6,000 Gabonese farmers. The programme has so far been implemented in two provinces. As of March 2015, 4,000 people had been already registered and land titles were issued for a total of 1,458 hectares. The land titles were issued in only 3 months, while it usually takes on average two years to do so across Africa.²¹⁹

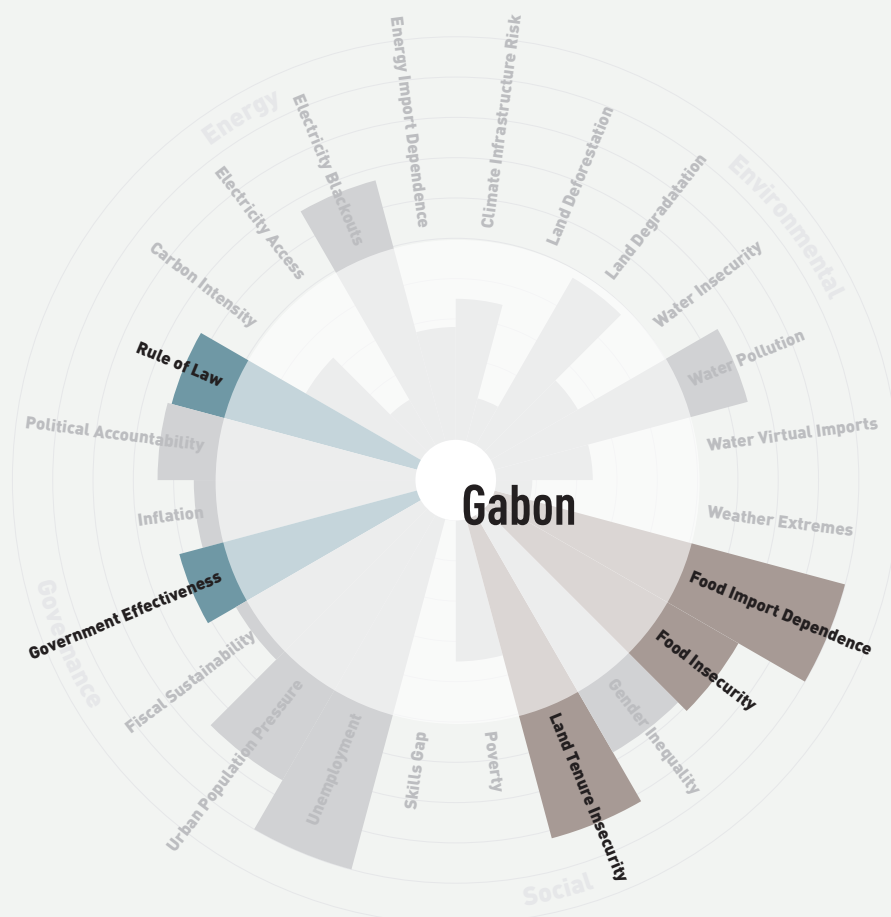


Figure 17
The combined pressures of food insecurity, land tenure insecurity, food import-dependence, government effectiveness and rule of law create a bottleneck that will amplify deforestation and land conflicts.

Future regional challenges and opportunities

Our regional forecast is based on an average of the developing countries that are most important to the sector's investment outlook. The forecasts are intended to be used by global companies to ensure that their regional strategies, implemented by regional executives and country subsidiaries, are anticipating the region-wide trends and adopting a resource leadership position.

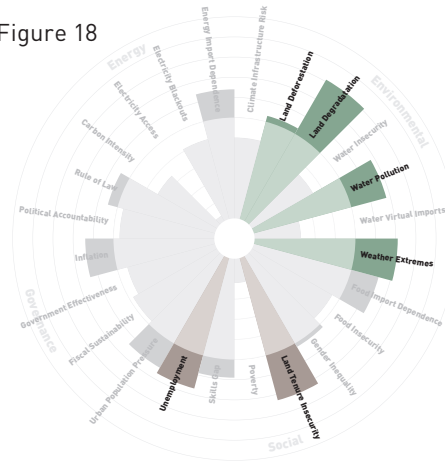
Region

Latin America Brazil, Mexico, Colombia, Argentina, Chile, Peru

What to expect

Water-land-food nexus drives local opposition to projects.

Figure 18

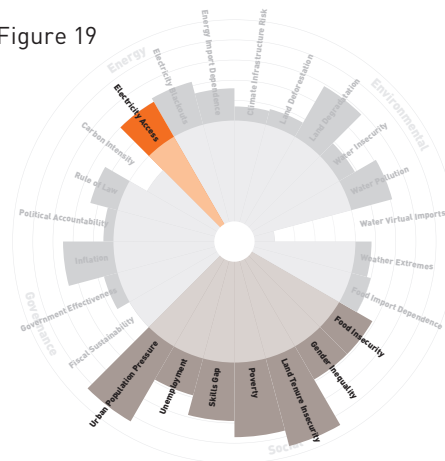


Half of the world's future potential for expanding food production is in Latin America, making the region an attractive investment destination.²²⁰ However, the high concentration of land ownership in large farms, and land insecurity by indigenous groups, increases the risks of social opposition to agricultural projects.²²¹ Land degradation, deforestation and exposure to extreme weather can trigger more unpredictable droughts, as Brazil, Peru, Mexico and Argentina have recently experienced.

Sub-Saharan Africa South Africa, Ethiopia, Nigeria, Kenya, Tanzania

Rural poverty and migration weaken future agribusiness investments.

Figure 19

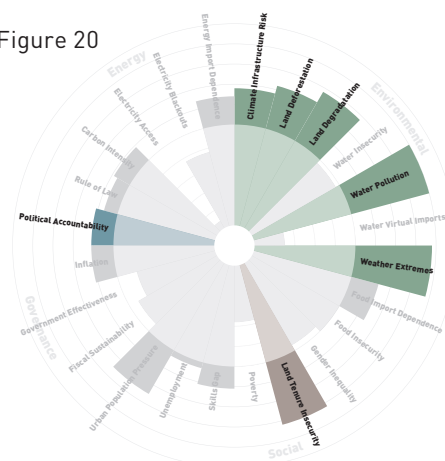


The lack of infrastructure has held back the development of Africa's abundant agricultural resources. Approximately 240 million hectares suitable for crop production remain uncultivated.²²³ 95% of the continent's farmland is rain-fed and therefore highly vulnerable to weather changes. By 2050 the average rice, wheat and maize yields could decline up to 14%, 22% and 5% respectively due to climate change.²²⁴ The biggest short-term challenges, however, will be social. Poverty, gender inequality, unemployment, and a gap in education and skills.

South East Asia Vietnam, Malaysia, Indonesia, Philippines, Thailand

Extreme weather and deforestation increase land conflicts.

Figure 20



Asia is one of the most highly exposed regions to extreme weather events and climate change.²²⁵ The projected increase of floods, droughts and typhoons pose a major threat to agricultural output, physical assets and people. For example, the region accounts for approximately 30% of global rice harvests. However, the rise in temperature and changes to precipitation have already led to a stagnation of rice productivity. Climate change is expected to lead to a further 3.8% decline in output.²²⁶

Future regional challenges and opportunities



Recommendations

Latin America

Water pollution in Latin American rivers is high. The overuse of fertilisers is partly responsible. The higher projected temperatures due to climate change will render many coffee-growing regions in Latin America inadequate, as crop pests grow in intensity.²²² With greater competition over water, and a more precarious food self-sufficiency and unemployment in local communities, the potential for social conflicts between communities and agribusinesses is expected to grow.

Inclusive farming models, stewarding land ecosystems.

Companies have to anticipate the social and environmental limits to large-scale intensive farming in Latin America. They should identify opportunities to implement new business models that favour co-production with family farmers and the protection of biodiversity as a source of ecosystem services.

Successful models in Latin America include export-oriented companies Native sugar²³⁰ in Brazil and Guayaki²³¹ in Paraguay and Argentina, which produce sugar and mate-tea respectively employing biodynamic principles in collaboration with local communities. Production models that integrate biodiversity and agriculture have shown a greater capacity to adapt to higher temperatures.

Sub-Saharan Africa

Rural populations face high levels of land tenure insecurity, poor access to electricity and land degradation that threatens food security and livelihoods. The deteriorating social conditions of rural populations is a threat to the long-term stability of large plantations, especially export-oriented crops. A shortage of skilled labour, coupled with the rapid migration process of younger generations towards African cities, poses a challenge for higher-value added investments such as processing plants and other facilities.

Using corporate supply chains to build rural livelihoods and skills

Companies should re-imagine their supply chains as engines of rural development in the region. A more integrated approach is centred around the livelihoods of rural families and their prosperity. This needs a multi-pronged approach to buy from small and medium enterprises, while leveraging partnerships to support skills training, women empowerment, agriculture productivity, land rights registration, and access to finance, technology and infrastructure.

SABMiller Uganda's business has created a sorghum-based beer. Its supply chain relies on smallholder sorghum farmers. The business thrives by helping farmers to move from subsistence farming. The improvement of livelihoods is key to the performance of the value chain.²³²

South East Asia

Climate pressures are aggravated by the declining quality of water and land resources due to industrial pollution. Large agriculture companies already face acute challenges of deforestation and land conflicts in the region. The exposure to climate change is set to intensify these challenges.²²⁷ While agricultural insurance penetration in the region is among the lowest in the world,²²⁸ the sector is expected to see rapid growth in the next decade.²²⁹

Agricultural insurance to reward sustainable planting and social inclusion

In order to anticipate the higher risks of climate change, companies need to move quickly to build the resilience of their operations. The social component of this resilience is just as important as the environmental one. The leading corporate effort by companies to advance 'climate smart' agriculture – organised by the World Business Council for Sustainable Development – focuses on three pillars: raising productivity and incomes, adapting and building resilience, and reducing emissions.²³³

Agricultural insurance will play an increasingly important role in the region given the acute levels of exposure. Partnerships between large agriculture companies and insurers should develop progressive products, that lower the risk premiums for companies that protect forests and empower smallholders.



04 Global depletion of aquifers

The exposure of multinational companies to depleting and degrading groundwater is increasing. The rapid depletion of aquifers is a systemic risk to one billion people in the world's growing economies. Aquifers are shared across national borders and have the potential to spark conflict. Companies must act beyond their site operations and help improve groundwater governance if they are to ensure their sustainable growth.

Introduction

The underground water crisis is hidden from corporate view, but companies are already acutely affected across three global sectors: food and agriculture, power and water infrastructure, and extractives.

Water wells are drying up in groundwater 'hotspots' and trade-offs between companies and locals are becoming acute. From northern China and India, to the Middle East, and the west coast of the United States, a more complex context is eroding the social license to operate of companies.²³⁴ We identify eight regional hotspots that pose an urgent risk to global companies and put forward a call to action for business leaders.

Our review of 75 of the world's largest resource-intensive companies shows that concerns vary across sectors: extractive companies are concerned with groundwater pollution, while agriculture companies are most concerned with security of supplies. While companies are acting at an operations-level on groundwater issues, their awareness of the materiality of this risk is low. These sectors must now work together to help advance a new generation of governance mechanisms that stabilise the use of groundwater resources in key hotspots.

Globally, groundwater provides almost half of water for irrigated agriculture, a third of supplies for industry and for drinking.²³⁵ Of the largest 37 aquifers in the world, 21 are being depleted. These reserves are still largely unregulated and unmonitored.

The challenge ahead is significant: these reserves lie invisible under the ground, in many cases crossing national borders. They involve multiple countries, supply many industries, and are subject to increasing pressures from intensive farming, new extractive technologies and booming population centres.

The spotlight on aquifers

Aquifers contain almost 96% of the planet's freshwater. The majority is held in 37 of the largest aquifer systems globally.^{236 / 237} Many fast-growing regions of the world that are subject to greater water stress are pumping their aquifers faster than these can replenish.²³⁸ 20% of the global agriculture that is irrigated is reliant on key aquifers that are showing falling water levels.²³⁹

Over the past 10 years, according to satellite data, 21 of the 37 major aquifers have declined at an unsustainable rate.²⁴⁰ Their replenishment, if at all possible, could take hundreds of years. Groundwater storage is declining across all continents.^{241/242}

More than 2.5 billion people depend on groundwater for their basic water needs.²⁴³ Some countries are more reliant than others: aquifers account for between 75%-95% of water use in Saudi Arabia, Tunisia and Morocco.²⁴⁴ Countries over-pumping their aquifers include China, India, United States, Pakistan, Iran, and Mexico.^{245 / 246}

Groundwater is an essential buffer in periods of drought.²⁴⁷ However, as climate change impacts intensify, aquifers are projected to undergo increased erosion and reduced recharge rates.²⁴⁸ Increased frequency of flooding of coastal areas will also augment the salinity of aquifers, reducing water quality and usability.²⁴⁹ In California's Central Valley, intense drought has increased the state's reliance on groundwater from 40% to 65%.²⁵⁰

The fastest depletion of aquifers is taking place in semi-arid and arid countries with a high dependency on irrigation for agriculture. These trends are most significant across Northern India, the United States, Saudi Arabia, North China and North Africa.²⁵¹ India alone draws 230 km³ of groundwater per year, more than a quarter of the global total, driven by agriculture and industry.²⁵²

Global estimates of the depletion of groundwater storage are uncertain.²⁵³ It is not just a question of their depletion: overuse can increase the rate of pollution and salinization of remaining groundwater reserves, increasing the costs of water supply.²⁵⁴ For example, in the Ganges basin in India, at least 70 million people are at risk from arsenic poisoning of groundwater due in part to increased fertiliser application, coal-fired power generation, leaching from coal ash tailings, and mining activities.²⁵⁵

Definitions

Groundwater

Water that is found beneath the earth's surface.

Aquifer

Underground layers of porous rock that act as usable reservoirs for groundwater.

Global aquifer hotspots

Companies face high exposure to the depletion of aquifers because groundwater resources are so poorly regulated. The absence of effective governance frameworks and enforcement has led to a free-for-all, pitting large companies against small farmers. Pollution due to the overuse of fertilisers and industry discharge are affecting drinking water for hundreds of millions of people. This confronts companies with existential threats.

Out of the 37 largest aquifers in the world studied recently using NASA's satellites, eight hotspots stand out for being in some of the most water-stressed areas globally. They provide freshwater reserves to at least one billion people, and are subject to growing industry and population pressures.²⁵⁶ The Earth Security Index highlights the most critical human-related pressures affecting the aquifer, covering water withdrawals and water pollution, land degradation and demographic pressure.

Linking aquifers to the Global Goals for Sustainable Development

An internationally agreed monitoring framework is currently being developed by UNESCO's International Hydrological Programme. The purpose is to track country-level progress towards the achievement of the Global Goal for Sustainable Development 6 (SDG 6) on Clean Water and Sanitation by 2030. The Target 6.5 of the SDG 6 is to 'implement integrated water resources management at all levels, including through trans-boundary cooperation as appropriate.'

The monitoring framework will assess operational arrangements for cooperation in transboundary aquifers, and is currently being tested in Jordan, Netherlands, Peru, Bangladesh and Uganda. The methodology will create an internationally-recognised approach to the development and assessment of targets on sustainable groundwater use and transboundary cooperation on aquifers. It will raise the issue with national governments, and help unify public and private sector approaches.

Featured: A big data approach

Big tech companies are weighing in on the issue to provide solutions to industry and governments that seek to overcome the data gap surrounding aquifers.

IBM's Digital Aquifer project being developed in Kenya with a university will map and analyse the status of underground water supplies, combining it with weather information to design management strategies for coping with periods of drought. To source data, IBM is seeking to collaborate with management operators, borehole drillers, donor organisations, insurance companies, government officials, and farmers.

In 2015, Qlik, a leader in big-data and visualisation partnered Twitter, Columbia University's Water Center, The Pacific Institute, Circle of Blue and UCI scientists to create a comprehensive groundwater data dashboard. With cutting edge data analytics it will inform crisis responses and infrastructure planning in the US State of California.

Further information
www.research.ibm.com
www.qlick.com

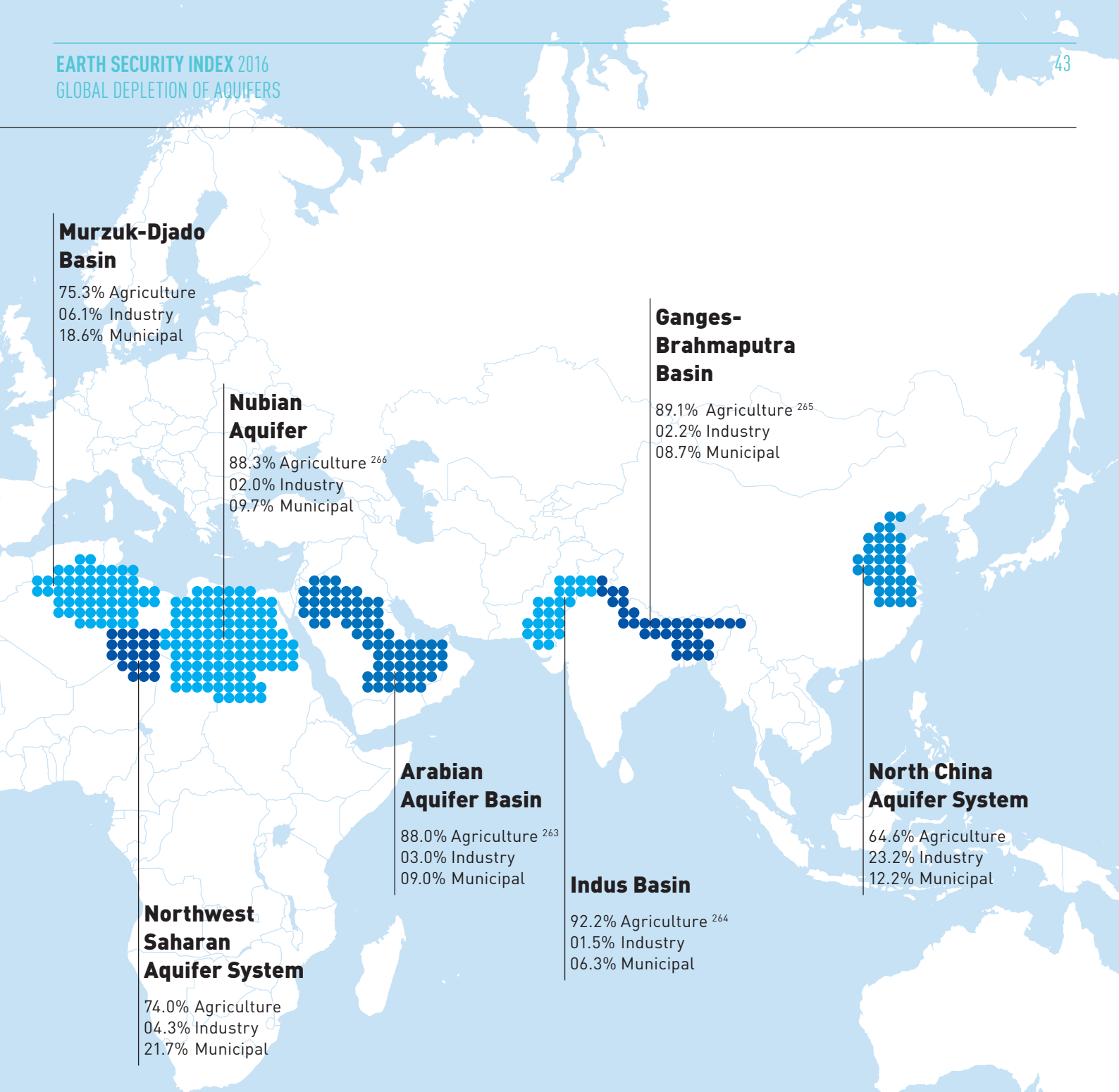
Figure 21
8 global aquifer hotspots

Key
Aquifer
Average % fresh water
withdrawal by sector ²⁶²

**Californian
Central Valley
Aquifer System**

36.1% Agriculture
51.2% Industry
12.8% Municipal

	Californian Central Valley Aquifer System	Murzuk-Djado Basin	Northwest Saharan Aquifer System	Nubian Aquifer
Countries Number involved ²⁵⁷	1	3	3	1
Recharge Rates Negative, Low, Medium, High ²⁵⁸	Medium	Negative	Negative	Negative
Stress Level Withdrawal versus Recharge ²⁵⁹	Variable	Extreme	High	High
Governance Transboundary framework ²⁶⁰	N/A	None	Cooperation Institution	Cooperation Agreement
Key Pressure Pressures affecting the aquifer's future according to the Earth Security Index	Land Degradation	Land Degradation	Water Withdrawal	Demographic Pressure



Murzuk-Djado Basin

75.3% Agriculture
06.1% Industry
18.6% Municipal

Nubian Aquifer

88.3% Agriculture ²⁶⁶
02.0% Industry
09.7% Municipal

Ganges-Brahmaputra Basin

89.1% Agriculture ²⁶⁵
02.2% Industry
08.7% Municipal

Arabian Aquifer Basin

88.0% Agriculture ²⁶³
03.0% Industry
09.0% Municipal

North China Aquifer System

64.6% Agriculture
23.2% Industry
12.2% Municipal

Northwest Saharan Aquifer System

74.0% Agriculture
04.3% Industry
21.7% Municipal

Indus Basin

92.2% Agriculture ²⁶⁴
01.5% Industry
06.3% Municipal

Arabian Aquifer Basin	Indus Basin	Ganges-Brahmaputra Basin	North China Aquifer System
10	4	4	1
Negative	Negative	High	High
Extreme	Extreme	Variable	Variable
None	None	None	N/A
Demographic Pressure	Land Degradation	Water Pollution	Land Degradation

Sources

'Quantifying renewable groundwater stress with GRACE' and 'Uncertainty in global groundwater storage estimates in a total groundwater stress framework', Richey et al, Water Resources Research [51], 14 July 2015.

'Transboundary Aquifers of the World: 2016 Update', IGRAC & UNESCO, 2012. Note: The NASA research has provided stark evidence of aquifer stress at very large regional scales, but is not as accurate for smaller aquifers.²⁶⁷ More observational data on aquifers and groundwater will be needed to ground-truth NASA's conclusions as well as to better predict the lifespan of the groundwater resources at operational scales.

8 global hotspots of aquifer depletion

<p>1 Arabian Aquifer System</p>	<p>2 Indus Basin</p>	<p>3 Ganges-Brahmaputra Basin</p>	<p>4 Nubian Aquifer System</p>
<p>Saudi Arabia, Bahrain, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, UAE, Yemen</p>	<p>India, Pakistan, China, Afghanistan</p>	<p>India, China, Nepal, Bangladesh, Bhutan</p>	<p>Egypt, Chad, Libya, Sudan</p>
<p>Groundwater accounts for 84% of total freshwater use in the Arabian Peninsula.²⁶⁹ Saudi Arabia stretches over most of this system.²⁷⁰ Almost 90% of water withdrawn from aquifers is used for agriculture, where oil revenues subsidise for pumping groundwater.²⁷¹ A mix of groundwater, and energy-intensive desalinated water, provides more than 55% of municipal water needs in Gulf states.²⁷²</p> <p>Over-exploitation of the aquifer has forced Saudi Arabia to halt wheat production, moving to secure land and agriculture investments abroad to import wheat. Recent agricultural investments have included Saudi projects in drought-prone states in the US, such as California and Arizona.²⁷³ Arab states in the Gulf and North Africa are drafting a 'Framework Convention on Shared Water Resources between Arab States' to address water scarcity, including their high dependence on this aquifer.²⁷⁴</p>	<p>300 million people rely on the aquifer, with the majority in Pakistan and India. These two countries rely on groundwater for 48% of their total water withdrawals.²⁷⁵ Almost all the region's agricultural area is irrigated, with groundwater providing half of the total.²⁷⁶ Subsidised electricity and poor regulation have led to the proliferation of water pumps and free-for-all water use. The water table has dropped up to 20 feet in some areas of Pakistan, threatening the future of agricultural production.^{277 / 278}</p> <p>The Indus Water Treaty signed by Pakistan and India in the 1960s does not include provisions on groundwater resources and there is no regional data sharing agreement. Furthermore, the ongoing territorial dispute over Kashmir is seen as a key threat to the existing fragile hydro-diplomacy between the two countries, both of which have nuclear weapons, and is cited by intelligence agencies as a major concern to regional and global stability.²⁷⁹</p>	<p>The Ganges-Brahmaputra Basin (GBM) is home to approximately 10% of the world's population. Irrigation accounts for 90% of the total water withdrawals in the basin, of which 68% is met through groundwater.²⁸⁰ The GBM has the highest depletion rates globally according to NASA-Grace data, but stress levels are currently buffered by a high annual recharge.²⁸¹ However, groundwater pollution has already degraded large areas of the aquifer system.²⁸²</p> <p>In Bangladesh, 97% of the population relies on wells to meet their drinking water requirements, exposing 75 million people to arsenic pollution in the aquifer.²⁸³ The stress levels of the aquifer are set to increase as climate change affects the aquifer's recharge rate.²⁸⁴ The GBM does not have a transboundary agreement or institution in place, while national groundwater regulations are poorly enforced at the local level. All countries involved lack an effective water quality monitoring network.²⁸⁵</p>	<p>The Nubian Aquifer has been referred to as a 'virtual liquid gold mine' because it is the largest non-renewable aquifer in the world.²⁸⁶ It is predominantly situated below Egypt and Libya, with Libya relying on the aquifer for 95% of its water needs.²⁸⁷ While Egypt has historically focused on the Nile as a water source, population growth and developments such as the Golden Triangle Mining project mean that Northern Egypt is set to increase its reliance on the aquifer.^{288 / 289}</p> <p>In 2013, the four countries above the aquifer signed the 'Regional Strategic Action Programme' to coordinate groundwater pumping and share management responsibilities for this transboundary aquifer. It is one of the world's only agreements for a transboundary aquifer.²⁹⁰ Political unrest and civil war in Libya meant that the country did not sign the renewal of the pledges in 2015, damaging the regional hydro-diplomacy effort to sustainably manage the region's shared resource.²⁹¹ Political instability across the region combined with demographic pressures and more severe droughts due to climate change will make this aquifer a critical feature of the region's future development.</p>

8 global hotspots of aquifer depletion

<p>5 North China Aquifer System</p>	<p>6 Californian Central Valley Aquifer System</p>	<p>7 Murzuk-Djado Basin</p>	<p>8 Northwest Saharan Aquifer System</p>
<p>China</p>	<p>United States</p>	<p>Libya, Chad, Niger</p>	<p>Algeria, Libya, Tunisia</p>
<p>The North China Aquifer sits below a region that comprises 11% of the Chinese population, including Beijing. The region supports 13% of China's agricultural production and 70% of the country's coal production.²⁹² Northern China relies on groundwater for half of its total water use, which is mostly used for agriculture and municipal supply.</p> <p>In Beijing (population 21 million), groundwater use accounts for around 60% of water supply.²⁹³ In non-renewable parts of the aquifer, water levels had dropped by over 100 metres in 2005.²⁹⁴ In response, the South-North Water Diversion project, the largest inter-basin transfer scheme in the world, is transferring 25 billion m³ of water from the Yangtze river along 1000 km to the northern area of China at a cost of USD 80 billion.²⁹⁵ Once complete, Beijing is set to phase out the city's 40,000 private water wells.²⁹⁶ China's Water Ten Plan has also been introduced to set strict groundwater targets to control extraction and pollution by 2020 by changing agricultural practices and targeting specific industries to reduce their water consumption.²⁹⁷</p>	<p>The Central Valley Aquifer area accounts for 25% of domestic food production and 75% of irrigated land in California, with an estimated value of USD 17 billion/year.²⁹⁸ /²⁹⁹ During drought periods, groundwater supplies 65% of California's freshwater demand compared to 40% during normal periods.³⁰⁰ Since the 1960s, heavy aquifer depletion has been primarily driven by irrigation use during droughts.³⁰¹ It is estimated that 1.5 million acres of agricultural land will go out of production in the coming years as a result.³⁰² Over-pumping of the aquifer has caused some areas in the Central Valley to sink by up to 10 metres, costing the state up to USD 1 billion in damage repairs.³⁰³</p> <p>Further stress is expected from the development of the Monterey Shale play beneath the aquifer, one of the largest in the country.³⁰⁴ California's 100,000 groundwater wells have to date been unregulated and unmetered. In 2014, the state introduced groundwater legislation for the first time, the Sustainable Groundwater Management Act to achieve sustainable management by 2042 followed by the 2016 Aquifer Protection Act for stricter permitting conditions and prohibitions.^{305 / 306}</p>	<p>The majority of the Murzuk-Djado Basin lies under Libya. The country considers it a strategic resource to supply cities, agriculture and industry projects but the lack of control and coordination over its use could exacerbate regional instability.³⁰⁷ Groundwater represents about 52% of total water consumption in Libya, of which 80% is for irrigation.³⁰⁸ /³⁰⁹ Water from the aquifer is being pumped for the USD 30 billion 'Great Man-made River Project', a 4,000 km network of pipes that provided 61% of the total freshwater supply in 2009, primarily to cities along the Mediterranean coast.^{310 / 311} Libya aims to ramp-up the development of irrigation, targeting a 40% increase in its agricultural area under irrigation by 2050.</p> <p>No requirements for water-saving have been properly recorded.³¹² There is no transboundary agreement in place between the countries to regulate the management of the Murzuk-Djado aquifer. Libya's recent civil war led to armed separatists controlling most of the country's aquifer areas, as a potential strategic leverage point, increasing the potential to disrupt regional stability.³¹³</p>	<p>Almost 5 million people are dependent on the Northwestern Sahara Aquifer System (NWSAS), which is a non-renewable aquifer.³¹⁴ Algeria stretches over the majority of the system (60%), with Libya (30%) and Tunisia (10%) minority aquifer States.³¹⁵ Between 2000 and 2008, the number of wells pumping water from NWSAS more than doubled to over 18,000, while total withdrawal increased from 300 million m³/year in 1950 to almost 2.8 billion m³/year in 2012.^{316 / 317} About 90% of total water withdrawals in the region are for agricultural irrigation, while industry accounts for up to 15% in Algeria, 4% in Tunisia and 4% in Libya.³¹⁸ As the climate continues to dry in the region, both Algeria and Libya are planning to increase their levels of extraction by 2030.³¹⁹</p> <p>The NWSAS is one of the few transboundary aquifers with active transboundary cooperation. The flagship project of the Sahara and Sahel Observatory prioritised the development of a joint database, basin modelling, and implementing a joint consultation mechanism for the NWSAS.³²⁰ While gaps remain on the data and monitoring priorities, the joint Consultation Mechanism was formalised and comprises a Council of Ministers of the riparian States.³²¹</p>

Industry sector context and cases of corporate action

Industry exposure to context pressures

Food & Agriculture

The food and agriculture sector is the largest user of water globally and the sector most dependent on groundwater. Up to 100 million hectares — or 40% of the world's total irrigated land, are supplied either fully or in part by groundwater.³²² Agricultural demand for water is expected to increase by 20% by 2050.³²³ At current rates, aquifer depletion threatens to undermine harvest production in three of the world's largest grain producers: the USA, China and India.

Combined, these countries produce half of the world's grain supplies. Grain production has already plateaued or declined in a number of countries that are over-pumping their aquifers, including Saudi Arabia, Syria, Iraq, Yemen and Iran.³²⁴ In India, 89% of irrigation systems depend primarily on groundwater resources, while 15% of India's food supply is produced by pumping groundwater.³²⁵

Falling groundwater levels have ignited conflicts over groundwater resources between farmers and food and agriculture companies across the country. Following years of protest from local farmers, in 2014, Coca-Cola's bottling factory in the north Indian state of Uttar Pradesh, was ordered to close by the Uttar Pradesh Pollution Control Board for over-pumping of groundwater, despite the company's insistence that they had the necessary permits for groundwater use.³²⁶

Power and water infrastructure

Approximately 90% of global electricity demand is already highly dependent on water. The water needs of thermal energy production alone are expected to increase by 140% by 2050.³³² Conventional thermal electricity production can be highly reliant on groundwater, depending on the location. Water consumption to generate electricity is expected to more than double over the next 40 years.³³³ At the same time, groundwater abstraction is highly energy-intensive.

Energy consumption of irrigation water wells is estimated at 15% of total global energy use.³³⁴ In 2012, power failures affected over 670 million people in northern and eastern India as a result of a weak monsoon that forced farmers to excessively pump groundwater resources using subsidised power for electric pumps, driving up electricity demand. In addition, the drought affected the availability of water to fossil and nuclear fuelled thermal power plants.³³⁵

In the US, groundwater accounts for roughly 30% of water used by municipalities, while 44% of the US population depends on groundwater for its drinking water supply.³³⁶ Water utilities in the US are increasingly facing water supply constrictions from decreasing groundwater availability and increasing levels of pollution or salt-water intrusion, leading to rising capital costs.³³⁶

Extractives

The sector's water risks are growing due to increasingly water-intense unconventional extraction methods, growing costs of treating water, growing water stress in extraction regions, and pressure to improve the sustainability of oil reservoirs.³⁴³ Unconventional fuel sources, such as shale and tar sands are expected to increase the sector's underground water exposure.³⁴⁴ For example, 38% of the world's shale resources face high to extremely high water stress or arid conditions, including the Lower Indus shale play

in the Pakistani part of the Indus basin.^{345/346} In 2014, state-owned China Shenhua Group, the world's largest coal producer, stopped abstracting groundwater resources at the Shenhua Ordos project in Inner Mongolia due to new government requirements and disputes with local farmers. Groundwater levels had dropped by 62% in comparison to 2004 due to its operations.³⁴⁷ Rio Tinto's USD 6.6 billion Oyu Tolgoi mine in Mongolia is set to use approximately 20% of the Gunii Hooloi aquifer.

The company has estimated that aquifers in the region could supply up to 500,000 m³ of water daily. However, by 2020, it is estimated that population growth will compete for these water sources.³⁴⁸ In 2013, the Umnugobi province, also in Mongolia, passed a resolution to prohibit groundwater extraction for mining purposes from 2016 onwards. However, following a court dispute between the national government and mining companies, the resolution was suspended.³⁴⁹

Industry sector context and cases of corporate action

Corporate action cases

Reducing impacts

In Mexico, Nestlé invested USD 7 million in 'zero water' technology at a dairy factory in order to reduce groundwater and surface water withdrawals. By extracting and recycling water from milk, the technology enabled the factory to reduce groundwater withdrawals to zero in 2014. The company is now implementing the technology at the Mossel Bay dairy factory in South Africa.³²⁷

Regeneration

Coca-Cola, in partnership with local NGOs and communities, has developed a series of 'water replenish projects' in India to improve groundwater supply reliability for local communities. This includes installing rainwater harvesting and artificial aquifer recharge structures, as well as restoring ponds and other natural bodies of water, and supporting agricultural improvements.³²⁸

Private-public cooperation

The California Water Action Collaborative (CWAC) was launched in 2014 by a group of major food and beverage companies (AB Inbev, General Mills, Nestlé, Coca-Cola) and NGOs (Alliance for Water Stewardship, The Nature Conservancy, The Pacific Institute and WWF) to scale watershed solutions in response to growing stress facing companies and communities in the state.³²⁹ CWAC has devoted one working group to improving groundwater management planning and supporting upstream projects to restore groundwater.³³⁰

Research

As part of an initiative to replenish local groundwater near its Aurangabad plant in India, PepsiCo conducted a water resource assessment study in partnership with a local civil society organisation. The study enabled the replenishment of 100 groundwater wells in the local area. The brewer group SAB Miller has also reported on commissioning similar studies on local aquifers in India.³³¹

Reducing impacts

In India, Caterpillar implemented a rainwater harvesting project in the water-stressed state of Tamil Nadu, in order to replenish the groundwater wells that supply the majority of the facility's water, as well as recharge and improve the area's groundwater supplies.³³⁸

Regeneration

Veolia Environment's Research and Development arm has been working with the Berlin Centre of Competence for Water, an international centre for water research and knowledge transfer, to develop artificial recharging systems for aquifers.³³⁹

Private-public cooperation

Duke Energy, together with the public water utilities in North and South Carolina, established the Catawba-Wateree Water Management Group (CWWMG) in order to improve water governance in the region.³⁴⁰ This includes improving the groundwater monitoring network for the basin to assist water supply assessments.³⁴¹

Research

General Electric undertook extensive groundwater data collection as part of its clean-up strategy of a former industrial site. GE's 76-acre Bridgeport Works property in Connecticut had been used for industrial purposes for 90 years.³⁴¹

Reducing impacts

In South Australia, BHP Billiton's Olympic Dam project is 100% reliant on the aquifer in the Great Artesian Basin. To ensure water abstraction did not affect the groundwater boreholes of other land users or the basin's natural springs, the company reassessed existing groundwater data-sets and implemented a series of water-use efficiency projects that improved industrial efficiency by 15% between 2004 and 2009.³⁵⁰

Regeneration

ConocoPhillips has committed USD 25 million to the joint development of the Global Water Sustainability Centre in Qatar. The Centre will pioneer technology for facilitating the use of treated water for irrigation in order to reduce the pressure on water supply in the country, where 36% comes from groundwater aquifers.^{351 / 352}

Private-public cooperation

Rio Tinto's Mongolian subsidiary, Oyu Tolgoi, has collaborated with the Government of Canada, the 2030 Water Resources Group, the International Council on Mining and Metals (ICMM), and 7 other mining companies operating in the Southern Gobi region committing to a voluntary 'Code of Practice' for improving water management practices at the catchment level. This includes the support of training and awareness-raising on groundwater protection.³⁵³

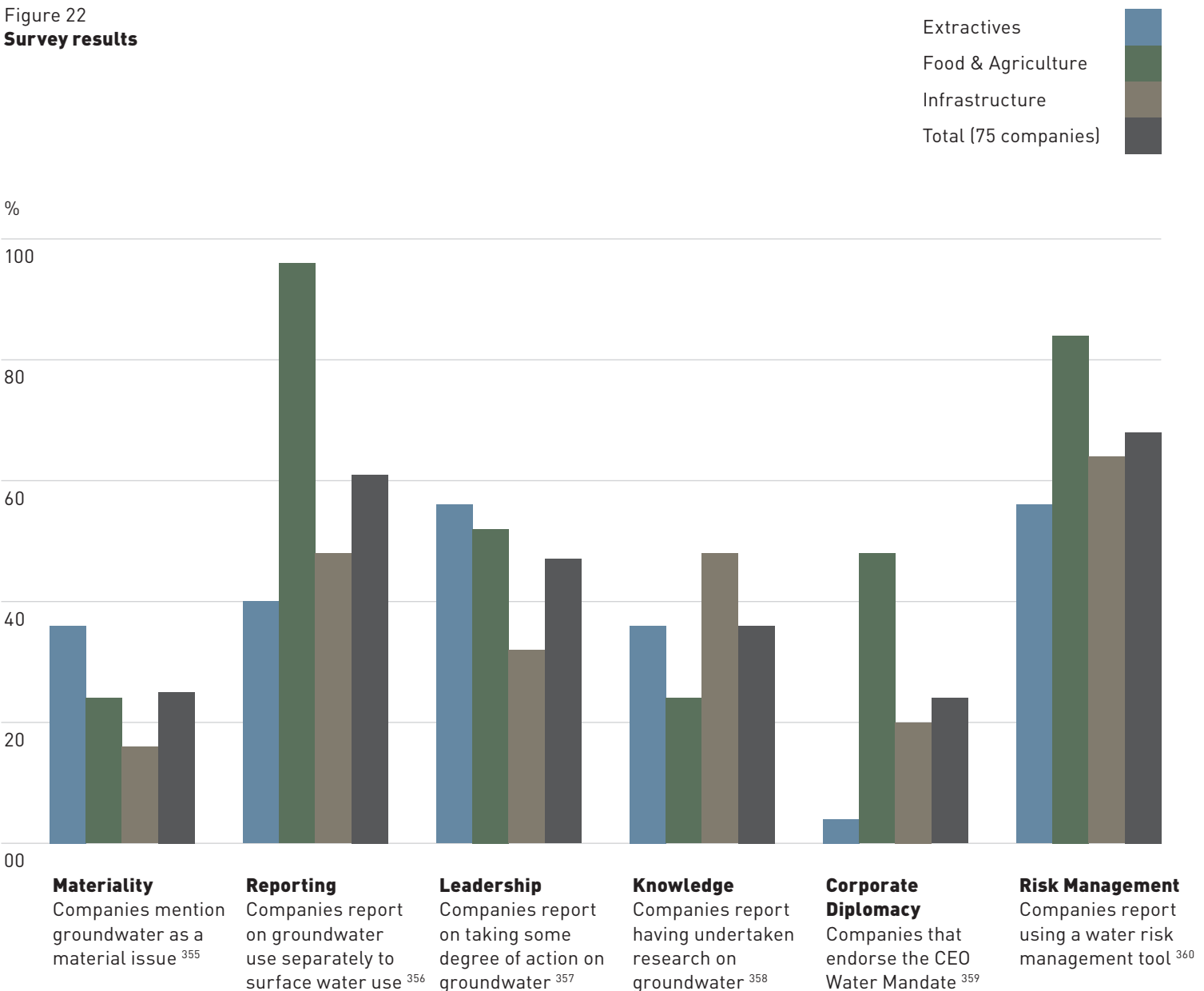
Research

Shell Global Solutions, in collaboration with the American Petroleum Institute, has developed the GroundWater Spatiotemporal Data Analysis Tool (GWSDAT) for the analysis of groundwater monitoring data and the design and management of groundwater monitoring or remediation activities.³⁵⁴

Business survey How are companies communicating groundwater risks?

We have reviewed the approach that large companies are taking towards communicating groundwater risks. The review included 75 of the largest publicly-listed multinationals in the extractives, power and infrastructure, and food and agriculture sectors. The study analysed corporate reporting on six strategic areas: materiality, reporting, leadership, knowledge, corporate diplomacy and risk management.

Figure 22
Survey results



Business survey Key findings

1 Companies should communicate more about the work they are already doing on groundwater risks.

Only 25% of the companies reviewed show that groundwater to be a material issue for their business. However, 47% of companies report on taking action to reduce groundwater use or remediate groundwater and aquifers at a site or watershed level. Companies should consider improving their external communication of the risks from groundwater depletion, as a means to educate their stakeholders on the nature of the problem and the solutions. Besides taking action on groundwater, more than half (61%) are monitoring and reporting on groundwater use separately from surface water use. The knowledge that is already available within companies should be used to communicate the position of companies on this matter more effectively.

2 Companies must collaborate to improve their understanding of their systemic risks from depleting aquifers.

61% of companies may monitor their groundwater withdrawals, but are likely to be missing the bigger picture on the systemic exposure of the aquifer itself. Companies are making important efforts to understand their water risks. Of the water risk management tools being used, only the WRI Aqueduct and WWF's Water Risk Filter integrate groundwater stress separately to overall water stress, but neither capture data on deep aquifers. Far fewer companies (36%) report on commissioning studies to understand groundwater and aquifer stress, such as groundwater quality surveys and monitoring, groundwater use monitoring and installing and sampling groundwater monitoring wells for specific projects (such as power plants, water production facilities, bottling plants, mines, oil-fields). For example, while 84% of food and agriculture companies use water risk tools, less than half (48%) say they have undertaken groundwater assessments.

3 Companies must prepare to increase their public engagement as public concern with aquifers grows.

There are significant variations by sector in how companies report their groundwater activities. Comparatively as a more consumer-facing industry, the food and agriculture companies reviewed lead in publicly-visible activities: reporting on groundwater (96%), use of corporate water risk tools (84%) and endorsing the CEO Water Mandate (48%). In comparison, only 1 out of 25 extractive companies reviewed has endorsed the CEO Water Mandate. However, extractives report the most actions to reduce their groundwater use or pollution impacts, given their direct exposure in project sites. On the other hand, while only 20% of infrastructure companies surveyed endorse the CEO Water Mandate, and just 48% report on groundwater use, they are ahead of the other sectors on reporting undertaking research on groundwater for their own and client operations.

4 Corporate concerns indicate groundwater pollution and depletion are leading material issues.

Of the extractive companies that consider groundwater a material issue, the majority (78%) are concerned with water contamination risks. By comparison, of the food and agriculture companies that report taking groundwater action, 92% are most concerned with supply security to their factories or supply chains. For extractive and infrastructure companies, pollution risks are mentioned in equal measure as depletion risks. This suggests that while companies recognise the risks from depleted groundwater reserves, the risks of pollution and associated water costs are also a core business concern that should be factored into corporate engagement.

Governance gaps affecting corporate strategies and international frameworks

The root cause of the problem of ground water depletion is a governance deficit. The regulation, oversight and understanding of groundwater systems have not kept pace with the extreme increase in their use over the past 50 years.³⁶¹

Unlike surface waters, groundwater is often not regulated, not monitored, and not paid for.³⁶² Three key gaps in governance that affect the operating environment for companies. For each of these we identify the leading international frameworks, which collectively form the basis to guide companies operating on a global scale.

1
Governance gap
Absent or weak institutions

Groundwater abstraction has happened faster than the rights and regulatory regimes needed to regulate it, leaving groundwater systems under-regulated, undervalued and poorly understood.³⁶³ Ownership rights have historically been linked to land rights.³⁶⁴ Where permit-based rights to groundwater have come into effect, challenges of law enforcement or baseline definition to allocate permits remain a challenge.³⁶⁵ Only a few countries have set up dedicated groundwater agencies for monitoring and permitting, such as India's Central Groundwater Board and Authority.³⁶⁶ However, implementation capacity is insufficient given the complexity of the systems.³⁶⁷

International framework
A Global Framework for Action

In 2015 the World Bank, the UN Food and Agricultural Organisation (FAO), UNESCO, the International Association of Hydrogeologists, and the Global Environment Facility concluded a 4-year programme to guide countries on a vision for groundwater governance. They have committed to integrate the framework into their country programmes.³⁶⁸ Key elements that drive their global vision for good groundwater governance include:³⁶⁹

- 1 A widely-shared understanding of groundwater systems.
- 2 A legal system that puts groundwater under public control.
- 3 Government agencies with authority and adequate resources.
- 4 Stakeholder participation mechanisms.
- 5 Co-management with surface water and land-use.
- 6 Coordination with urban, agriculture and energy sectors to address issues.
- 7 Science-based programmes that implement priority management plans.

2
Governance gap
Transboundary jurisdictions

There are over 500 transboundary aquifers, but only five of these are covered by formalised transboundary agreements or institutional arrangements. These include the treaties on the Geneva Aquifer between Switzerland and France, the Guarani Aquifer Agreement in South America, and the Al Sag/Al Disi layer between Jordan and Saudi Arabia. Non-treaty based cooperation frameworks include the Strategic Action Programme for the Nubian Sandstone Aquifer in North Africa, and the consultation mechanism for the North Western Sahara Aquifer System.³⁷⁰ Within countries agencies face the difficulty of managing trade-offs between multiple industries and populations using land and water.³⁷¹ The ability to process this complexity of issues and levels usually exceeds the capacity of individual agencies.

International framework
Law of Transboundary Aquifers

In 2009, the UN General Assembly endorsed the 'Law of Transboundary Aquifers'.³⁷² A non-binding framework prepared by UNESCO's International Hydrological Programme (IHP) and the UN International Law Commission. The resolution is intended to guide governments to develop bilateral or regional arrangements for the peaceful and effective management of transboundary aquifer resources. It was first applied in the Guarani Aquifer System by Argentina, Brazil, Paraguay and Uruguay in 2010.³⁷³ The articles provide guidance on the equitable and reasonable use of water resources and the exchange of data and information, which is to be overseen by a dedicated multilateral commission.³⁷⁴ In addition, in order to improve cooperation across transboundary aquifers UNESCO-IHP's Internationally Shared Aquifer Resources Management (ISARM) project brings together an inventory of transboundary aquifers and their challenges, with an online GIS-based website.^{375 / 376}

3
Governance gap
Insufficient data

The limited availability of data and information on groundwater reserves, abstraction and quality is a major obstacle to their management.³⁷⁷ The cost and complexity of groundwater monitoring systems means that information on groundwater and aquifers remains a frontier challenge.³⁷⁸ Even where governments do collect data on groundwater, the information may not be made public given concerns for national security. Californian legislation still prohibits public access to logs compiled by drilling companies and does not mandate data collection on groundwater withdrawal, quality or aquifer characteristics.³⁷⁹

International framework
Hydrogeological Mapping and Assessment Programme

UNESCO-IHP, in collaboration with its centre on groundwater (UNESCO-IGRAC), has been developing the Global Groundwater Information System (GGIS)³⁸⁰ an interactive, web-based portal to groundwater-related information and knowledge; and the Global Groundwater Monitoring Network (GGMN), a network to facilitate periodic assessments on groundwater quantity and quality by aggregating data from existing groundwater monitoring networks and knowledge.³⁸¹ However, many countries still fail to collect, maintain or publish groundwater data. NASA's Gravity Recovery and Climate Experiment (GRACE) has allowed scientists to track groundwater levels in basins that do not have access to monitoring wells or where groundwater data is not shared publicly.³⁸² While the research has provided stark evidence of aquifer stress at very large regional scales, it is less accurate for smaller aquifers.³⁸³ More observational data on aquifers and groundwater will be needed to ground-truth NASA's conclusions as well as to better predict the lifespan of the groundwater resources at operational scales.

Recommendations for business leadership

1 Business endorsement of principles for groundwater governance

The lack of effective policies and regulations for groundwater leaves companies exposed to a complex context. Business must send a clear signal to national governments that the effective, equitable and sustainable management of groundwater resources is vital to their sustainable growth and investment. We recommend companies to come together under the auspices of a major global corporate network, to develop a 'business declaration on groundwater governance'. Through it companies will endorse the Global Framework for Action on Groundwater Governance, developed by multilateral agencies, including the World Bank, FAO and UNESCO. The pledging companies would have a common framework to engage with national governments for them to integrate the principles into national policy and regulatory frameworks.

A useful precedent for this already include two companies, Thames Water and Vitens, that have participated in the Groundwater Governance Project's Permanent Consultation Mechanism.³⁸⁴ Also, Nestlé Waters, Vitens, Heineken, EDF, Thames Water, Schlumberger Water Services and Shell have participated in a UNESCO regional consultation in 2013.³⁸⁵ A community of global companies endorsing the declaration can then focus on exchanging knowledge, helping individual companies to set corporate targets, and develop working groups that bring companies together to focus on key countries or regions.

The scale and complexity of the crisis surrounding aquifers requires companies to take a leadership position in working with governments at national, transboundary, and global scales to improve the governance of aquifers.

2 A business leadership role in transboundary aquifer governance

Transnational companies can play a positive role in the governance of transboundary aquifers. Companies that are already operating in countries that are part of the same aquifer system (e.g. India and Pakistan) can create enabling conditions for governments to engage across borders. They should start by creating an internal working group that involves the sustainability and corporate affairs teams across the subsidiaries of the countries involved. Subsequently, through these cross-border business teams, companies can define cross-border corporate targets across the businesses and improve their coordination of their existing policy initiatives and government relations in each country. UNESCO's International Hydrological Programme (IHP) is driving a global project to advance the management of internationally shared aquifer resources.

These are key resources that can inform corporate strategy on a transboundary level. Companies can deepen their collaboration with UNESCO-IHP on a case-by-case basis, as well as second company staff to UNESCO's team to act as a focal point. On the other hand, by cooperating with companies through a private sector coordinating mechanism, UNESCO-IHP can act as an interface helping improve the engagement of companies with multiple governments on transnational aquifers.

An initial set of steps can be taken to bring companies, corporate networks and government initiatives closer together in addressing this challenge.

3 A global open data partnership for aquifers

The depletion of aquifers creates shared risks for all water users and should therefore create incentives to cooperate and share information. Large technology companies, like IBM and Qlik, have shown models to help to solve the data gap that stifles action on aquifers. Coca-Cola set a global precedent when it shared their global water risk data in order to improve global public water management. Many other companies in the extractives sector (mining, oil & gas), power utilities, and food and beverage companies have data on groundwater which is not currently public.

A pre-competitive global partnership facility is needed to coordinate these approaches organised around geographically-specific groundwater 'hotspots'. A dialogue is needed that helps to overcome the competitive dynamics and foster communication and collaboration. The 2030 Water Resources Group (WRG) is already operating in a number of key groundwater hotspots to facilitate collective action between government, the private sector and the civil society. Its work, for example, includes water data gathering projects in Mongolia, Jordan and Bangladesh. WRG could serve as a convening platform for an open data partnership, bridging interests and data capabilities, and creating common data sharing protocols that build on existing groundwater monitoring and data-sharing initiatives, including UNESCO-IHP's groundwater monitoring network and data sharing platforms.

The scoping stages of such a partnership should build out of a core group of companies interested in advancing this agenda, which could include those companies that have already shared data on groundwater with public agencies. The initiative should involve industry and engineering companies that are developing data on aquifers as well as technology companies that are advancing the analytics of aquifer data.

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Methodology Selection of sectors, companies and countries

1 Sector Definitions

The Earth Security Index 2016 report focuses on three industry sectors that are significantly exposed to resource pressures in developing countries: extractives, infrastructure and agriculture. Their investments are also critical to destination countries' development. The definition of sectors and subsectors has drawn on the Thompson Reuters Business Classifications (TRBC),³⁸⁶ a market-based classification that is similar to the Global Industry Classification Standard (GICS).³⁸⁷ The sub-classification of sectors used for this report is as follows:

Extractives Companies in the oil & gas and mining sectors, covering the extraction of both fuel and non-fuel raw materials from the earth.³⁸⁸ This includes companies engaged in exploration and production, refining and marketing and storage and transportation of oil, gas, coal, uranium, consumable fuels, renewables as well as non-fuel minerals such as copper, gold, iron ore and platinum. It also includes companies that are integrated into the extractives supply chain, by offering equipment and services to oil & gas and mining companies.³⁸⁹

Infrastructure Companies that own, operate, manage or maintain physical structures or networks used to process or move goods, services, information, people and energy.^{390 / 391} This includes electric, multiline³⁹² and water utilities (hydro, thermal, wind, solar, geothermal, transmission and distribution, water supply and wastewater management infrastructure), transportation (roads, railways, ports, and other transport infrastructure) as well as the industrial, construction and engineering companies that design, manage or supply machinery and materials for the construction of infrastructure.^{393 / 394 / 395} Sectors that were excluded from the definition were related conveyance services (shipping, trucking, delivery, airlines) and communications services (companies that lease capacity on the network to provide services to consumers). The telecommunications sector was excluded for the purposes of analytical consistency, in term of the similarity of the resource pressures faced by companies in the sector.

Food & Agriculture Companies involved in the processing, production, transformation and manufacturing of raw materials from agriculture, forestry and fisheries into food and related agricultural products. This includes the food and tobacco, beverages and pulp and paper industries, as well as companies with agro-processing and chemicals activities related to the food and agriculture sector (i.e. chemicals companies that derive a large percentage of their revenue from agricultural inputs).³⁹⁶ While the definition includes the agricultural commodity companies that produce, process and transport food ingredients, animal feeds and feed ingredients, biofuels and other products, many of these companies are privately owned or not large enough to appear in the final listing.

2 Company selection

The 2016 report focuses on publicly-listed companies for purposes of access to information. Of the sectors described above, the selection of the largest publicly listed companies operating in developing countries was done according to the financial information provided by the Thompson Reuters ASSET4 database.³⁹⁷ A two-step screening process was undertaken to define a final list of 25 companies for each of the three sectors, totaling 75 companies altogether.

Market Capitalisation Companies were first filtered by market cap in order to identify the largest companies within each sector. Only their primary listing was used.³⁹⁸ For companies in the process of mergers that have not yet been finalised, both companies remain listed (e.g. BG group and Shell, SAB Miller and AB Inbev). Holding companies have not been included as they do not produce goods or services but rather own shares of other companies to form a corporate group. For the extractives sector, oil & gas companies tended to have far larger market caps than those in the mining sector. Therefore, in order to ensure a mix of companies across the two sectors, the final listing was weighted to include 15 companies from oil & gas and 10 from metals & mining.

Developing-country footprint Only companies with high exposure to developing countries were included.³⁹⁹ Companies that did not show evidence of exploration, production or manufacturing operations outside of advanced economies were excluded.

3 Country mapping

A review of the companies' operations and asset distribution was done using publicly available information in order to determine the aggregate group of developing countries that are relevant to the companies' investments. The sources used included company annual reports, financial statements, investor presentations and company websites. The final selection of countries for each sector are those countries in which the most companies are present.

Extractives Upstream exploration, development and production locations were identified. Data was drawn from analysing country information given for exploration, production and development capital expenditure (CAPEX)⁴⁰⁰ and fixed assets.⁴⁰¹ Where no financial information was given, details of exploration and production sites were taken from company websites and reports.

Infrastructure For utilities (electric, multi-line and water), countries were included where generation and transmission facilities exist as an indication of long term fixed assets and of markets served. For companies in the 'industrial conglomerates' and 'machinery and equipment' business sectors, operations and facilities where manufacturing, distribution and remanufacturing takes place were selected for inclusion. For companies in the 'construction, engineering, materials' business sector, the location of major projects was identified.

Food & Agriculture: For this sector we considered the countries where the companies' manufacturing facilities are located. The manufacturing assets (manufacturing facilities, factories, bottling plants, distilleries, breweries and mills) of the different food and agriculture companies were considered. The final list of countries was cross-referenced against a listing of the producers and exporters⁴⁰² of the main global agricultural commodities.⁴⁰³

Methodology Construction of Index

The Earth Security Index 2016 Report, developed by the Earth Security Group, introduces and applies a country framework that captures the magnitude and scope of a series of country pressures using official country data that is publicly available.

The dashboard allows the Earth Security Group to conduct a multi-dimensional risk assessment of countries, markets and global inter-dependencies, to provide leading decision-makers in business, government and civil society with holistic view on sustainability risks and opportunities.

The ESI 2016's indicator framework has been substantially revised and improved from the previous year, with inputs from our Global Expert Group and other thematic experts (see acknowledgements). In this year's report, the index is applied to a series of cases that cover a total of 45 countries from the ESI database of 216 countries. The ESI 2016 framework assesses and visualises 4 themes that are deemed critical for a country's sustainability and development agenda: energy, environment, social and governance.

The structural changes to the 2016 Index include the reconsolidation of the previously eight themes into four themes. The four themes are divided into a total of 24 dimensions composed with 30+ underlying indicators from 28 public sources.

The Data

The selection and processing of the data for the ESI 2016 has followed five criteria:

- 1 **Coverage** Data that allows for the assessment of country-level trends and for a comparison between countries.
- 2 **Relevance** Data that is relevant to assess resource-related risks in an unambiguous way.
- 3 **Accessibility** Data that is publicly available, either through peer-reviewed scientific data or data compiled by international organisations.
- 4 **Quality** Data whose quality can be controlled and represent the best measure of the issue currently available globally.
- 5 **Recency** The most up-to-date datasets available for all data points up to January 2016.

Index construction

The transformation of raw data into the index scores involves several steps. The following section discusses how the data in the ESI 2016 has been transformed and normalised:

Transformation

Due to the existence of outliers in the data, three methods were employed for the transformation of the data. If the skewness of the data was greater than 2 or the kurtosis was greater than 3.5, the outliers of the data have been treated. If the variable exhibited one to five outliers, the data has been winsorised. In the case of six or more outliers, the data has been either transformed with the natural log or, in extreme cases, with a natural log formula.

Normalisation

To allow for aggregating and comparing different data on a common scale, the data points were normalised on a 0–100 scale, where 0 is the lowest pressure and 100 the highest pressure. The normalization was calculated based on the min-max method, whereby the minimum and maximum of the indicator serve as the lower and upper bound of the normalized data, respectively.

In a few cases, the k-th percentiles of values in a particular range were chosen to create new minima and/or maxima. These decisions were always based on thorough research or expert interviews. The percentiles range from excluding the lower 10th percentile of the data to excluding the upper 80th percentile. Depending on the direction of the data, the following formula was used:

- 1 For indicators for which higher values are better outcomes:

$$\frac{\text{max} - \text{value}}{\text{max} - \text{min}} \times 100$$

- 2 For indicators for which higher values are worse outcomes:

$$\frac{\text{value} - \text{min}}{\text{max} - \text{min}} \times 100$$

Weighting and Aggregation

After the transformation and normalisation of the data, the data points were aggregated and weighted into dimensions (the visual wedges on the graph). The following section describes this aggregation and weighting process. The aggregation of data points has taken place on the level of dimensions. The dimension score is calculated from the weighted average of all its underlying data points. The dimensions generally use an equal weighting, except for the Fiscal Sustainability dimension, where weightings have been allocated based on expert interviews. In particular, the data point 'Probability of sovereign debt default' has been given a greater weight than the other data points within the Fiscal Sustainability dimension to reflect the importance of this indicator. Finally, in case of missing values for underlying data points, the weightings of missing scores were redistributed equally across other data points, so that the overall weighting within the dimension did not change. If no data was available for a dimension, no score was calculated.

Methodology Construction of Visual

The Visual

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.

Scale and visualisation

The visuals provide a risk profile that highlights 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. The wedges should be read in the same way as the scores: the bigger a wedge is, the higher the pressure of that dimension. To aid the use of the visuals, a visual benchmark has been added that draws a highlight to those wedges that have a higher score than 50. This is a purely visual aid and does not imply a value judgement or statistical calculation, which does not mean that dimensions scoring 50 or less are not relevant to the risk profile of the country. However, this device allows the observer to focus on the smaller number of dimensions that surpass the 50 mark.

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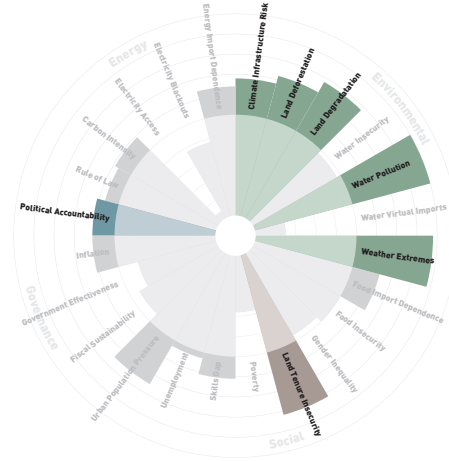
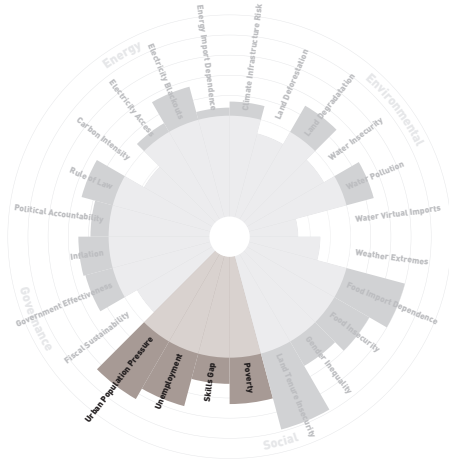
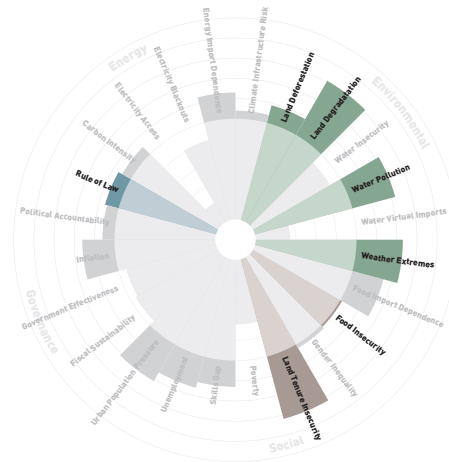
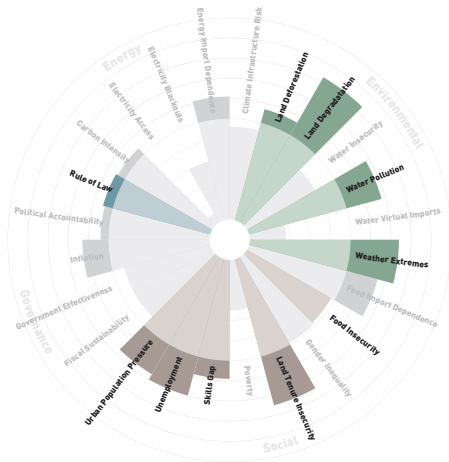
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- ³⁵⁵ Including the specific mention of groundwater/aquifers/sub-surface waters/underground waters as a risk or key issue; and the need to monitor or address company impacts on groundwater (pollution and use). Sources used include company's sustainability reports, CDP reports and company webpages.
- ³⁵⁶ Sources used include company's sustainability reports, CDP reports and company webpages.
- ³⁵⁷ Includes a review of any initiatives to reduce site/company dependence on groundwater; project/programme/policy with implication for groundwater management; development of a product that addresses groundwater for clients or in supply chain. Sources used include company's sustainability reports, CDP reports, company webpages and media articles.
- ³⁵⁸ The company describes having undertaken, funded, or commissioned studies of groundwater resources which could impact their operations or as a service to another company. Sources used include company's sustainability reports including CDP reports, company webpages and media articles.
- ³⁵⁹ The mandate's advanced corporate water disclosure guidelines suggest that location-specific performance data should include water withdrawals by source type, including groundwater, and analysis of risk at location-specific facility level includes aquifers. See: 'Corporate Water Disclosure Guidelines', UN Global Compact, 2014; Guidance for companies reporting on water on behalf of investors & supply chain members 2016', CDP, January 2016.
- ³⁶⁰ Tools considered include: WBCSD's Global Water Tool, IPIECA Global Water Tool for Oil & Gas, GEMI Local Water Tool, GEMI LWT™ for Oil and Gas, WWF's Water Risk Filter, WRI's Aqueduct, CERES Aqua Gauge or other internal/alternative tools. The main corporate water risk assessment tools currently capture groundwater withdrawal as part of the data-points provided on total water withdrawal and overall water stress levels. The Water Risk Filter and Aqueduct are providing further indicators of groundwater stress and are actively developing the integration of more advanced groundwater metrics, such as groundwater table decline to advance the analysis of this issue within their tools (see Gleeson et al, 2012 and www.watgap.de). This data captures groundwater and shallow unconfined aquifers, but not deeper and confined aquifers.
- ³⁶¹ 'Managing the invisible: Understanding and Improving Groundwater Governance', Wijnen et al, World Bank, June 2012.
- ³⁶² 'Groundwater governance a call to action: A shared global vision for 2030', FAO, 2015.
- ³⁶³ 'Legal & Institutional Frameworks', Mechlem, K., June 2012.
- ³⁶⁴ 'Managing the invisible: Understanding and Improving Groundwater Governance', Wijnen et al, World Bank, June 2012.
- ³⁶⁵ 'Instruments and Institutions for Groundwater Management', Kemper, K.E, World Bank, 2007.
- ³⁶⁶ 'Legal & Institutional Frameworks', Mechlem, K., June 2012.
- ³⁶⁷ 'Managing the invisible: Understanding and Improving Groundwater Governance', Wijnen et al, World Bank, June 2012.
- ³⁶⁸ 'Global Framework for Action to achieve the vision on Groundwater Governance', FAO, 6 March 2015.
- ³⁶⁹ 'Groundwater governance a call to action: A shared global vision for 2030', FAO, 2015.
- ³⁷⁰ 'Past, Present and Future of International Law of Transboundary Aquifers', Mechlem K., International Community Law Review (13), 2011.
- ³⁷¹ 'Legal & Institutional Frameworks', Mechlem, K., June 2012.
- ³⁷² 'UN General Assembly adopts resolution on the law of transboundary aquifers', UNESCO, 2009.
- ³⁷³ 'The Agreement on the Guarani Aquifer: Cooperation without conflict', Villar, P. & Ribeiro, W. Global Water Forum, 2013.
- ³⁷⁴ 'Draft articles on the Law of Transboundary Aquifers', United Nations, 2008.
- ³⁷⁵ 'Transboundary Aquifers of the World', IGRAC. <https://ggis.un-igrac.org/ggis-viewer/viewer/tbmap/public/default> [accessed 12 April 2016].
- ³⁷⁶ 'Atlas of Transboundary Aquifers', UNESCO-IHP ISARM Programme, 2009.
- ³⁷⁷ 'Groundwater Depletion Stresses Majority of World's Largest Aquifers', Walton, B., Circle of Blue, 16 June 2015.
- ³⁷⁸ 'Legal & Institutional Frameworks', Mechlem, K., June 2012.
- ³⁷⁹ 'Groundwater Data: California's Missing Metrics', Choy et al, Stanford University, 31 July 2014.
- ³⁸⁰ <http://www.un-igrac.org/global-groundwater-information-system-ggis>
- ³⁸¹ 'Global Groundwater Monitoring Network', International Groundwater Resources Assessment Centre. <http://www.un-igrac.org/special-project/ggmn>
- ³⁸² 'Satellite perspectives: NASA's GRACE program sees groundwater from space', Ivanova, N., Circle of Blue, 28 March 2012.
- ³⁸³ 'Uncertainty in global groundwater storage estimates in a total groundwater stress framework', Richey et al, Water Resources Research (51), 14 July 2015.
- ³⁸⁴ 'Permanent Consultation Mechanism - Groundwater Governance Project', GEF-FAO, 6 January 2015.
- ³⁸⁵ 'Groundwater Governance Project: Fifth Regional Consultation UNECE Region', UNESCO, March 2013.
- ³⁸⁶ A market-led approach commonly classifies companies into industries based on the consumption of the products and services they produce, rather than what they are producing per se. TRBC, GICS and Industry Classification Benchmark (ICB) all use market-based classification systems as a means to clearly identify the major source of a company's income and consumer demand as a means for understanding performance. Source: <http://thomsonreuters.com/en/products-services/financial/market-indices/business-classification.html>

- ³⁸⁷ 'TRBC sector classification', Thompson Reuters. <http://financial.thomsonreuters.com/en/products/data-analytics/market-data/indices/trbc-indices.html> (accessed 15 April 2015).
- ³⁸⁸ EITI definition of the extractives industry. <https://eiti.org/faqs#extractivecompany>. (accessed 28 May 2015)
- ³⁸⁹ 'Global Industry Classification Standard', MSCI and S&P. <https://www.msci.com/resources/pdfs/GICSSectorDefinitions.pdf> (accessed 28 May 2015).
- ³⁹⁰ 'The FTSE Infrastructure Series: defining infrastructure', FTSE Russell, 2015.
- ³⁹¹ 'Better Growth, Better Climate: New Climate Economy Report', New Climate Economy, 2014.
- ³⁹² Multiline industry consists of utilities that primarily produce and distribute electric power and natural gas. The industry includes utility companies with significant operations in multiple utility operations consisting of electric, natural gas, water and other regulated utility operations.
- ³⁹³ 'IFC and infrastructure at a glance', International Finance Corporation. September 2014.
- ³⁹⁴ 'Infrastructure to 2030: Telecom, Land Transport, Water and Electricity, OECD, June 2006.
- ³⁹⁵ 'The FTSE Infrastructure Series: defining infrastructure', FTSE Russell, 2015.
- ³⁹⁶ 'Greening the economy with agriculture: Taking stock of potential, options and prospective challenges', United Nations Conference on Sustainable Development, 2012.
- ³⁹⁷ The Asset4 database includes 4,300+ global companies including MSCI World, MSCI Europe, STOXX 600, NASDAQ 100, Russell 1000, S&P 500, FTSE 100, ASK 300 and MSCI Emerging Market. Data was initially extracted on April 2, 2015 and a final update to the companies and market capitalisation data was conducted on 11 March 2016.
- ³⁹⁸ A dual-listed company is a corporate structure in which two corporations function as a single operating business through a legal equalization agreement, but retain separate legal identities and stock exchange listings. Cross-listed companies list their stocks across more than one stock exchange.
- ³⁹⁹ Defined as outside of advanced economies: Australia, Canada, Czech Republic, Denmark, Eurozone, Hong Kong, Israel, Japan, Korea, New Zealand, Norway, Singapore, Sweden, Switzerland, Taiwan Province of China, United Kingdom, and the United States. Available at: <http://www.imf.org/external/pubs/ft/weo/2015/01/pdf/text.pdf> (accessed April 30 2015).
- ⁴⁰⁰ Capital expenditures (CAPEX) are expenditures altering the future of the business. A capital expenditure is incurred when a business spends money either to buy fixed assets or to add to the value of an existing fixed asset with a useful life extending beyond the taxable year.
- ⁴⁰¹ Fixed assets are assets that are purchased for long-term use and are not likely to be converted quickly into cash, such as land, buildings, and equipment.
- ⁴⁰² 'Food and Agricultural commodities production and trade data'. FAOstat. http://faostat3.fao.org/browse/rankings/countries_by_commodity/E (accessed 28 September 2015).
- ⁴⁰³ These include sugar cane, maize, rice, wheat, milk, potatoes, soybean, sugar beet, barley, pork, chicken, cocoa, oil palm, coffee, oats, wood pulp, round wood, tobacco, tea and hops. In order to construct the list, a review of FAOSTAT's top 50 agricultural commodities was conducted alongside an analysis of main raw material inputs of selected companies from the Food, Beverage, Tobacco and Pulp and Paper sectors.



An aerial photograph of a densely populated city, likely Istanbul, taken from a high vantage point. The sun is low on the horizon, creating a warm, golden glow over the entire scene. The city's architecture is a mix of traditional and modern buildings, with many featuring red-tiled roofs. The foreground shows a dense cluster of buildings, while the background is hazy, suggesting a large urban area extending to the horizon. The sky is a gradient of orange and yellow, with some light clouds.

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