



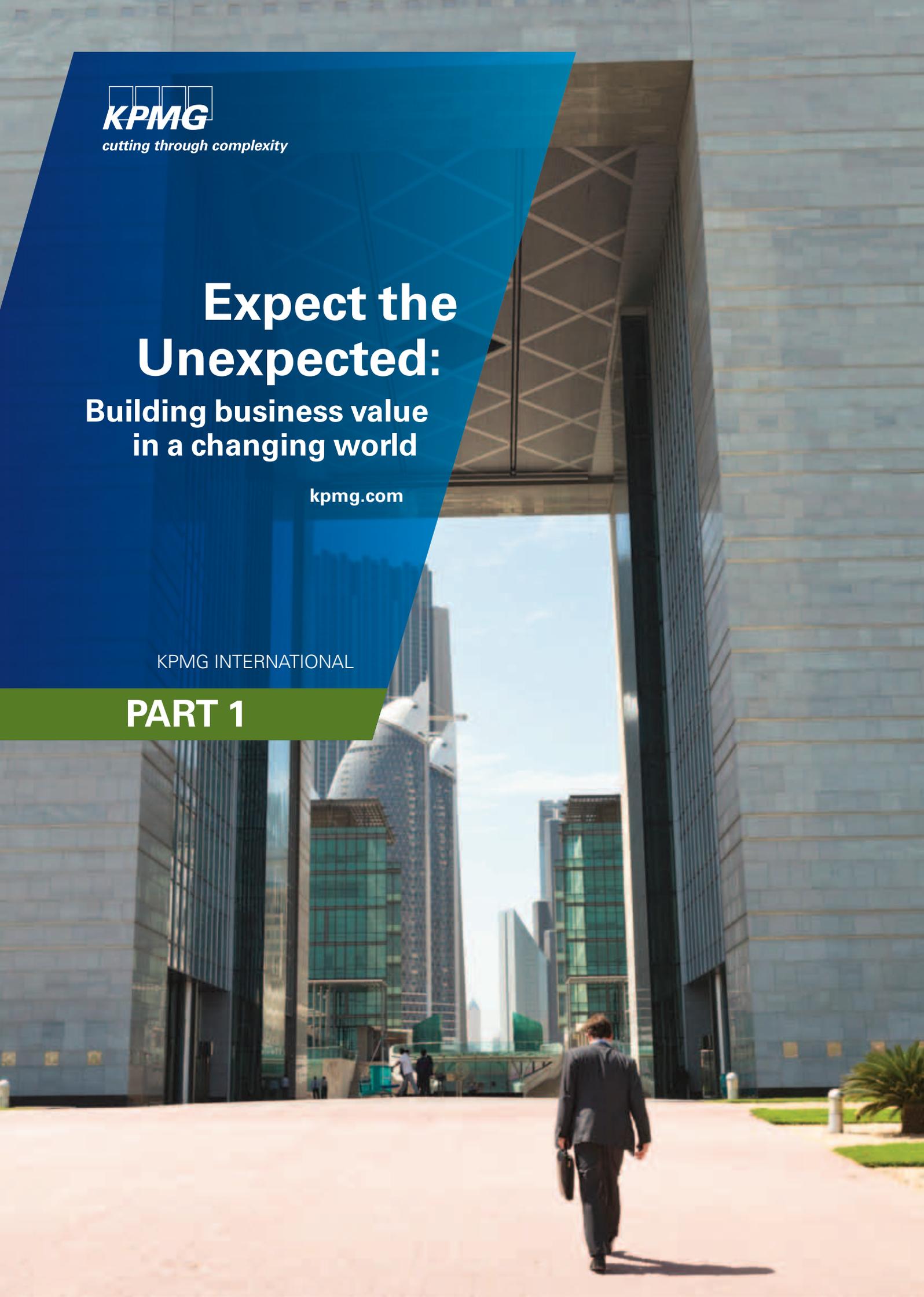
cutting through complexity

Expect the Unexpected: Building business value in a changing world

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KPMG INTERNATIONAL

PART 1



In this report we offer a starting point for discussion. We present a system of ten sustainability megaforges that will impact each and every business over the next 20 years. We want to build awareness that these forces do not act alone in predictable ways. They are interconnected. They interact.

Disclaimer:

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Foreword

Businesses today are operating in an ever more interconnected and globalized world. Supply chains stretch across continents and are vulnerable to disruption. Consumer demands and government policies are changing rapidly and will impact your bottom line if your business does not respond.

Against this background of complexity we face a new set of challenges. For 20 years or more we have recognized that the way we do business has serious impacts on the world around us. Now it is increasingly clear that the state of the world around us affects the way we do business.

This report shows that population growth, exploitation of natural resources, climate change and other factors are putting the world on a development trajectory that is not sustainable. In other words, if we fail to alter our patterns of production and consumption, things will begin to go badly wrong. How wrong and for whom, is also explored in the report.

Intergovernmental treaties are yet to solve the issues and, at a national level, the transition to sustainable growth remains a goal rather than an achievement. The concept of “green growth” has gained ground but we still lack a precise understanding of how we can achieve it along with higher standards of living within the limits of our planet.

Corporations are, of course, not passive bystanders in any of this. Our report shows that global megaforges are likely to bring significant threats and opportunities.

The resources on which businesses rely will become more difficult to access and more costly. There will be increasing strain on infrastructure and natural systems as patterns of economic growth and wealth change. Physical assets and supply chains will be affected by the unpredictable results of a warming world. And businesses will be confronted with an ever more complex web of legislation and fiscal instruments.

But this is not the whole story. Consumer and investor values are changing. And as they change more corporations are recognizing that there is profit and opportunity in a broader sense of responsibility beyond the next quarter’s results. The bold, the visionary and the innovative recognize that what is good for people and the planet will also be good for the long term bottom line and shareholder value. Competitive advantage can be carved out of emerging risk.

At KPMG’s network of firms we have always been at the forefront of developments that shape business behavior. We are working with organizations to help them understand the forces at work that will influence markets and impact profitability in the medium to long term.

This means moving on from old notions of corporate responsibility focused purely on protecting and enhancing reputation. It means being aware that your business stand to be affected as supplies of fresh water decrease and costs of energy rise and ecosystems decline. Knowing what those effects will be and how your business can manage them successfully means developing a sophisticated understanding of these factors and how they work.

In this report we offer a starting point for discussion. We present a system of ten sustainability megaforges that will impact each and every business over the next 20 years. We want to build awareness that these forces do not act alone in predictable ways. They are interconnected. They interact.

At KPMG, we encourage businesses to understand this system of forces; we help them assess the implications for their own organizations and to devise strategies for managing the risks and harnessing the opportunities. We can never know the future. But it is good business sense to be prepared for the possibilities: to expect the unexpected.

This report cannot provide all the answers, and does not set out to, but it does suggest approaches that we believe will help to build business value in a changing world. We hope it provides a useful springboard for new thinking, debate and above all business action to deliver a future that is both sustainable and profitable.



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A business environment **more complex and fast-moving than ever**

Globalization, digital connectivity, accelerated consumption and disparate prosperity have combined with ecological decline, a lack of global sustainability governance and resource scarcity to transform the playing field for businesses. As a result, today's global business environment is more complex, uncertain, volatile and fast-moving than ever before. We begin this report by exploring major changes to the business environment since the Rio Earth Summit in 1992.

A global system has emerged from local economies, accompanied by a shift in the balance of power from the economic powerhouses of the industrialized world to emerging market giants. The world's population has grown hugely and most people now live in cities. Hundreds of millions have moved out of extreme poverty and similar numbers have joined the global middle class, adopting in the process more resource-intensive diets and lifestyles.

There are significant opportunities for business as a result of these changes but climate change, resource constraints, water scarcity and many other factors also remind us that we are approaching – if we have not already exceeded – the planet's ability to satisfy our appetite for growth.

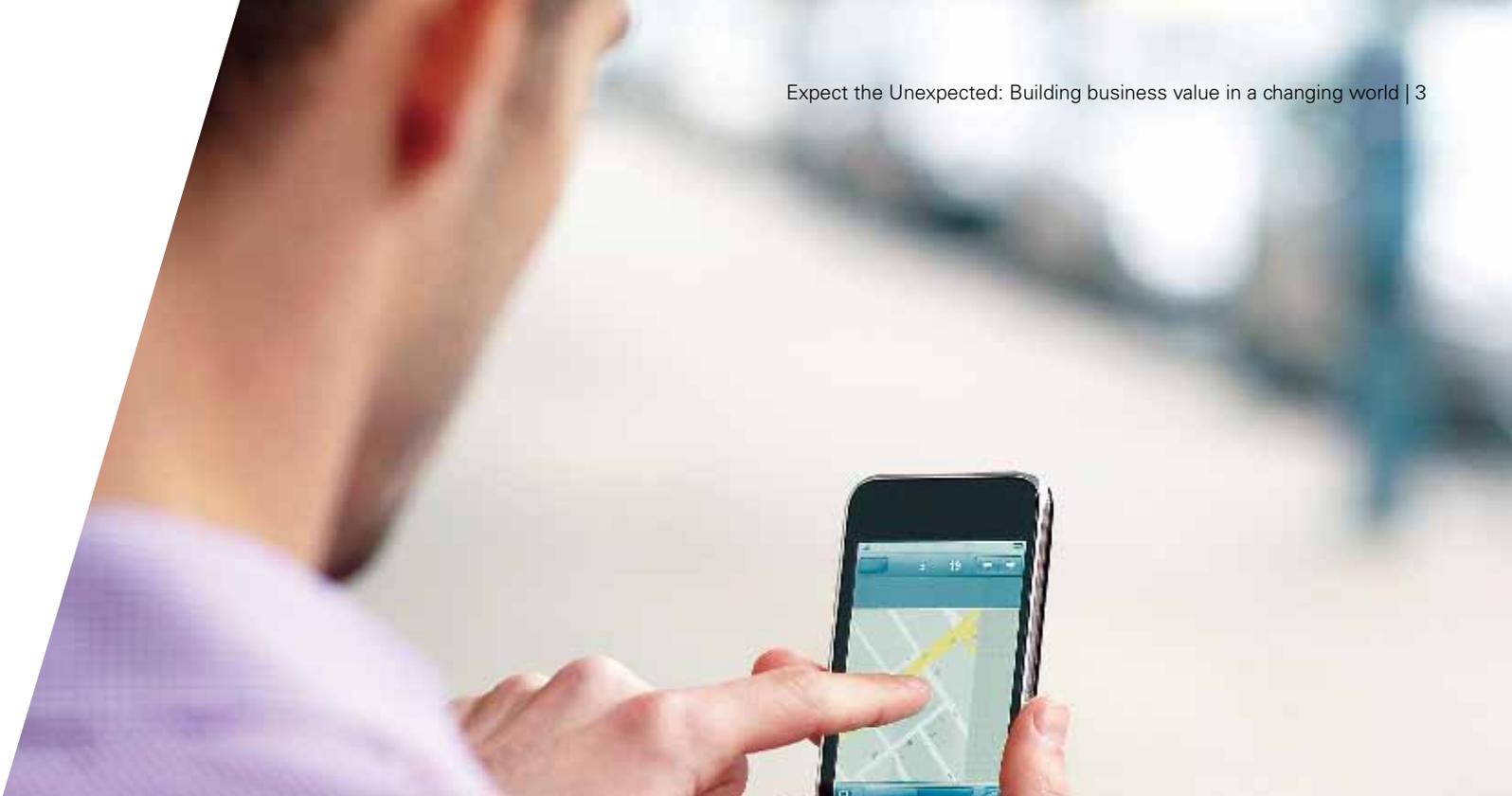
That is why the central challenge of our age – decoupling human progress from resource use and environmental decline – will also be one of the biggest sources of future success for business. The corporate world was involved in creating these challenges and needs to know how to deal with them, not least because we now live in a hyper-connected and more transparent world where corporate behavior is increasingly held to account in the court of public opinion.

Globalization

Over the last 20 years, the amount of money flowing across borders grew at more than three times the rate of global GDP.¹ International trade and foreign investment more than tripled;² trade in

¹ United Nations Environment Programme, *Keeping Track of Our Changing Environment, From Rio to Rio +20 (1992-2012)* (Nairobi: UNEP, 2011).

² The World Bank, *World Development Indicators 2010* (Washington DC: World Bank, 2010)



natural resources grew six-fold;³ and internationally-traded financial assets such as bank loans, bonds, and portfolio equity soared by a factor of 12.⁴

These dry figures translated into stronger economic growth across the world and enormous opportunities for business through the development of new markets and access to labor. Businesses benefited from exceptionally low interest rates, which allowed them to borrow cheaply and drove a major increase in trade, mergers and acquisitions. Cheap commodities and cheap labor led to a surge in economic growth in the industrialized world without the inflation that usually accompanies such growth.

At the same time, the emerging markets providing these resources also grew much more quickly, taking millions of people out of poverty and creating new markets for companies in both the developed world and emerging markets. Living standards rose rapidly, but they did so unequally and to the detriment of the environment in many areas.

However, globalization also made the financial sector more volatile as illustrated by the 2008 US subprime mortgage market shock, international

credit collapse and global recession the impacts of which continue to be felt. The financial crisis accelerated the shift of economic, financial and political power toward the developing world, in particular to dynamic emerging market nations such as China, India and Brazil. Being present in these low-cost and high-growth middle-income economies has come to be seen as increasingly central to corporate success.

Digital connectivity

The digital age began in earnest around 1995. Some 15 years later, it is an everyday fact of life for most of mankind. The combination of this digital revolution and globalization has shaped the world more profoundly and more rapidly than any other technological development.

It has created new markets and transformed old ones, enabling companies to cut costs and become more efficient. However, it has also made corporate reputations more fragile than ever. News of corporate fallings can reach an audience of millions within minutes and the damage done can last for years: witness the Gulf of Mexico oil spill.

“ Digital connectivity has created new markets and transformed old ones, enabled companies to cut costs and become more efficient. ”

³ World Trade Organization, *World Trade Report 2010: Trade in Natural Resources* (Geneva: WTO, 2011).

⁴ The World Bank, *Multi-Polarity: The New Global Economy* (World Bank, 2011).

rose by 23,000 percent

Mobile phone subscriptions rose by 23,000 percent from 1992, to 5 billion by 2010

Source: United Nations Environment Programme, *Keeping Track of Our Changing Environment: From Rio to Rio +20* (1992-2012) (Nairobi: UNEP, 2011).

added 300 million

India and China together added 300 million mobile phone subscribers during the year 2010 alone

Source: International Telecommunication Union (ITU), Global Mobile Cellular Subscriptions Data, 2009-2010.

grew by 29,000 percent

The number of Internet users grew by 29,000 percent from 1992 to 2 billion people in 2010. Facebook, launched in 2004, had more than 800 million active users by 2011.

Source: United Nations Environment Programme, *Keeping Track of Our Changing Environment: From Rio to Rio +20* (1992-2012) (Nairobi: UNEP, 2011).

expanded by 50 percent

Global data flows expanded by 50 percent during 2010 alone, and Cisco forecasts a 26-fold increase in global mobile data traffic by 2015.

Source: Cisco Global Cloud Index: Forecast and Methodology 2010-2015 (San Jose, CA: CISCO, 2011); Cisco Visual Networking Index: Forecast and Methodology, 2010-2015 (San Jose, CA: CISCO, 2011).



A new generation of “digital natives” have become far more active and discriminating consumers – companies need to be seen to do the right thing and are under growing pressure to be more transparent and accountable about what they do and why.

Many corporations are still wary of this development, but by making information available to others, they are often seeing it themselves for the first time and are discovering opportunities to improve business models.

Accelerated consumption

Consumption has gone into overdrive since Rio 1992 as *Figure 1* illustrates.

Resource use has grown faster than the population, which itself surged by 1.5 billion people since 1992, reaching 7 billion by 2011.⁵ Over a billion people

moved into cities during this time and a new middle class emerged, especially in Asia, with more resource intensive diets and life-styles.⁶ Even though the world economy became about 20 percent more efficient per unit of output over the past two decades, this could not counter the absolute growth of resource use and CO₂ emissions.⁷

According to World Wildlife Fund (WWF) and Global Footprint Network, we used resources and produced CO₂ during this 20 year period at a rate 50 percent faster than the Earth can sustain.⁸ If we are already “living beyond our means” but at the same time 3 billion people need to rise out of poverty, then the central challenge of our age must be to decouple human progress from resource use and environmental deterioration.

⁵ United Nations Population Fund, *The State of World Population 2011* (New York: UNFPA, 2011).

⁶ United Nations Environment Programme, *Keeping Track of Our Changing Environment: From Rio to Rio + 20* (1992–2012) (Nairobi: UNEP, 2011).

⁷ United Nations Environment Programme, *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012) (Nairobi: UNEP, 2011).

⁸ World Wide Fund for Nature, Institute of Zoology and Global Footprint Network, *Living Planet Report 2010: Biodiversity, Bio-capacity and Development* (Gland, Switzerland: WWF International, 2010).



This challenge creates significant opportunities for business, partly within their own operations. But the real prize comes through helping others to “decouple.” Examples include renewable energy, which enables the production of low-carbon energy, drip irrigation technologies that help farmers to produce more crops using less water, electric vehicles that facilitate low-emissions motoring and software that helps everything from aircraft to buildings to work more efficiently.

Disparate prosperity

Since 1992 there has been unprecedented human social and economic progress, even among the worst-off. While some indicators worsened, such as rates of HIV infection and numbers of slum-dwellers, people have mostly become healthier,

wealthier, better educated, better fed, more empowered and live longer (see *Figure 2*). The lives of women and girls changed dramatically during this period, with research indicating progress in the areas of literacy, health and economic participation.⁹

At the same time, gaps in gender equality persist, especially with regard to child mortality, school enrollment, access to economic opportunities, and voice and agency within society. The World Bank has emphasized that gender equality lies at the heart of smart development given its central role in “enhancing productivity, making institutions more representative, and improving development outcomes for the next generation.”¹⁰ Prosperity has eluded 1.5 billion people living in countries affected by conflict.¹¹

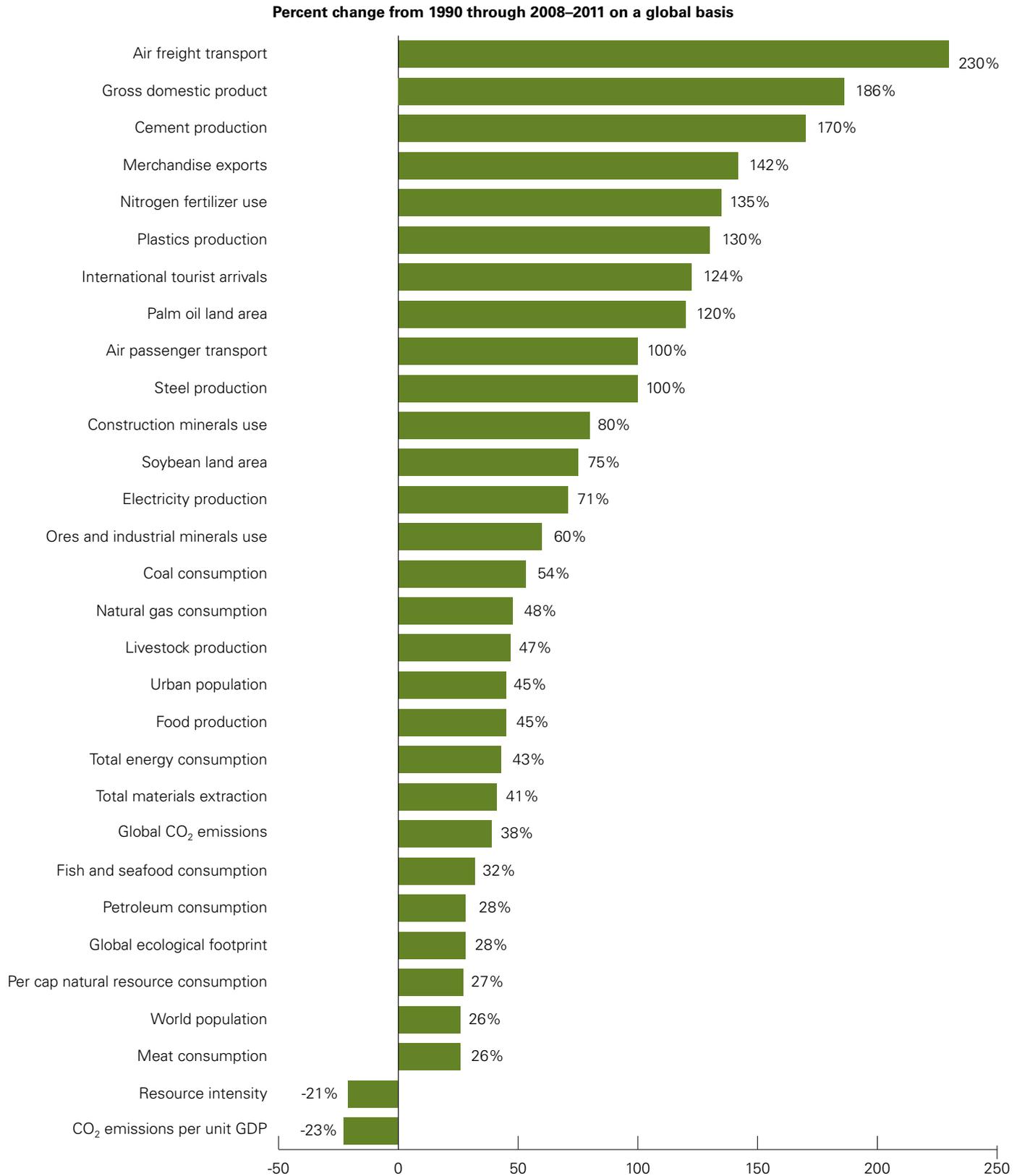
“The central challenge of our age must be to decouple human progress from resource use and environmental deterioration.”

⁹ United Nations Department of Economic and Social Affairs, *The World’s Women 2010: Trends and Statistics* (New York: UN, 2010).

¹⁰ The World Bank, *World Development Report 2012: Gender Equality and Development* (Washington, DC: World Bank, 2011).

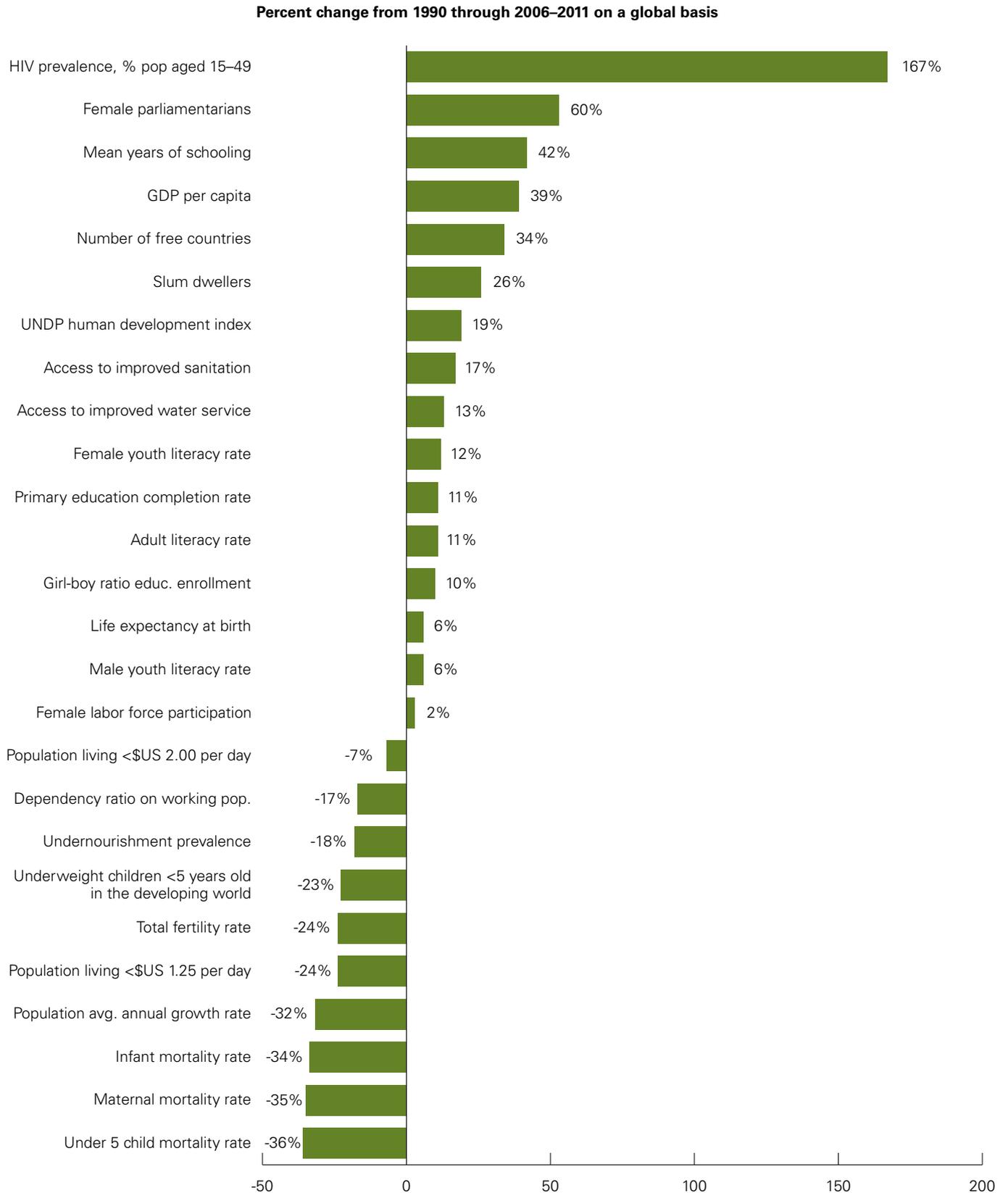
¹¹ The World Bank, *World Development Report 2011: Conflict, Security and Development* (Washington, DC: World Bank, 2011).

Figure 1: Accelerating human footprint on natural systems and resources



Sources: UNEP, World Bank, Worldwatch Vital Signs, WWF, SERI, UNDP, FAO, IEA, EIA.
See *General Selected Bibliography* (p. 160–165) for detailed source listings.

Figure 2: Human social and economic progress



Sources: UNEP, World Bank, UNDP, Freedom House, WHO, ILO, UN-Habitat
 See *General Selected Bibliography* (p. 160–165) for detailed source listings.

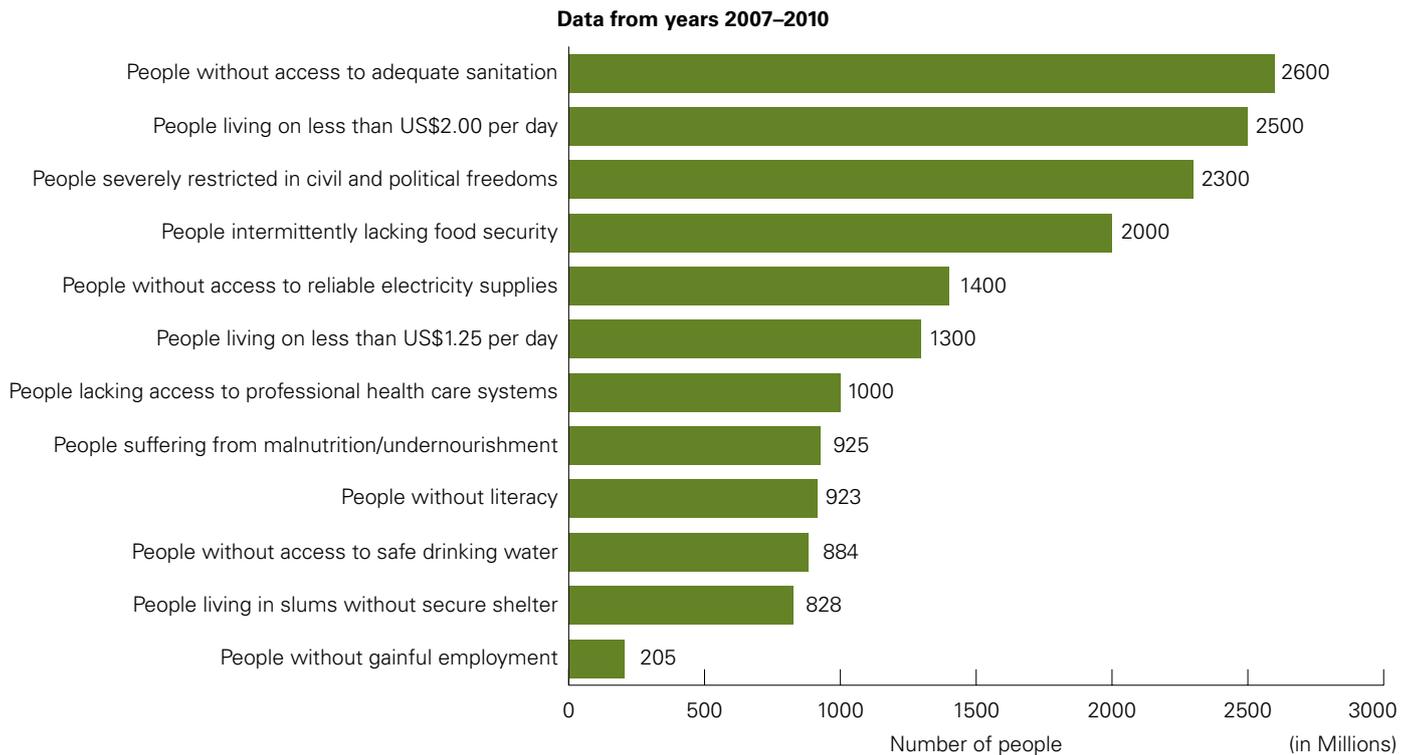
Between one quarter and one third of the world's population remains in a state of persistent deprivation, especially in Sub-Saharan Africa (see *Figure 3*). It is not only the least developed countries that are suffering; an estimated 72 percent of the world's poor now reside in populous middle-income countries such as Pakistan, India, China, Nigeria and Indonesia where they confront malnutrition, disease, illiteracy, and other challenges of extreme poverty.¹²

In the advanced economies, there has been a growing call for a more inclusive system of global capitalism as evidenced

by the "Occupy" movement that spread around the world in 2011. Persistent inequality is not only wrong, it is bad for business – it prevents huge swathes of the population from being workers and customers and it increases the risks to business from the type of instability and unrest that were seen in the Middle East and North Africa in 2011.

Today business is being asked to do more to fight global poverty and has responded with pioneering micro-credit and "base-of-the pyramid" (BOP) corporate initiatives. Much of the movement involves "social entrepreneurs"

Figure 3: Persistent human deprivation



Sources: FAO, World Bank, UNDP, UN-Habitat, ILO, Freedom House, WHO, UNESCO
 See *General Selected Bibliography* (p. 160–165) for detailed source listings.

¹² Andy Sumner, *The New Bottom Billion: What if Most of the World's Poor Live in Middle-Income Countries?* (Washington, DC: Center for Global Development, March 2011).

experimenting at the local level.¹³ Larger multinational companies exploring the growth and innovation opportunities of more inclusive business models include CEMEX, Danone, DuPont, Proctor & Gamble, SC Johnson, Unilever and Vodafone.¹⁴

Ecological decline

Mankind has caused more extensive and rapid changes to ecosystems in the last 20 years than at any other time in human history, thanks to ever-growing demand for resources. There is substantial evidence that ecosystems are struggling to provide the needed services that

populations have assumed will always be there. The UN's Millennium Ecosystem Assessment warned that "human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted."¹⁵

The damage includes loss of biodiversity, acidification of oceans, less productive cropland, desertification, tropical deforestation, and declines in wetlands, mangrove forests, sea-ice habitats, salt marshes, coral reefs and more.¹⁶ This hits the world's most disadvantaged and vulnerable people hardest.

“Persistent inequality is not only wrong, it is bad for business.”

Figure 4: Climate change since 1992

The 20 years since Rio 1992 according to UNEP¹⁷ have witnessed:

- a **36 percent** increase in global CO₂ emissions
- a **9 percent** increase in average CO₂ concentration in Earth's atmosphere
- an increase of **0.4–0.6 degrees** Celsius in mean surface temperature relative to historical means (1951–1990)
- 18 of the **20 hottest** years on record
- melting of ice sheets and thawing of permafrost in northern latitudes
- steady warming of ocean waters by nearly **0.5 degrees Celsius**
- global sea level rise of **2.5 mm** per year from thermal expansion
- growing acidity of the world's oceans threatening marine life
- rapid diminishment of mountain glaciers in terms of annual mass balance, and
- steady decline in the annual minimum extent of Arctic sea ice.

¹³ United Nations Development Programme, *Creating Value for All: Strategies for Doing Business With the Poor* (New York: UNDP, 2008) and Muhammad Yunus, *Building Social Business: The New Kind of Capitalism That Serves Humanity's Most Pressing Needs* (New York: Public Affairs Books, 2010).

¹⁴ Ted London and Stuart L. Hart, *Next Generation Business Strategies for the Base of the Pyramid* (London: FT Press, 2010).

¹⁵ Millennium Ecosystem Assessment, *Living Beyond Our Means: Natural Assets and Human Well-Being: Statement from the Board* (New York: MEA/United Nations, 2005).

¹⁶ Secretariat of the Convention on Biological Diversity, *Global Biodiversity Outlook 3* (Montreal: CBD, 2010).

¹⁷ United Nations Environment Programme, *Keeping Track of Our Changing Environment: From Rio to Rio + 20 (1992–2012)* (Nairobi: UNEP, 2011).

“ Companies in all sectors need to prepare themselves for a world where raw materials may be in short supply. ”

Scientists are growing more concerned that the Earth is approaching thresholds or tipping points that could have abrupt, irreversible and catastrophic consequences. These include combined sea level rise, impacts of monsoon interference on India, Amazon drought and die-back, increased aridity in Southwest North America, loss of glacial freshwater supplies especially in Central Asia, and conversion of coral reefs to algal dominated systems.¹⁸

Business is both heavily involved in causing this damage and likely to be increasingly affected by the consequences. It is clear that responses to these challenges must include reducing greenhouse emissions and becoming more resource-efficient. As a result, carbon and ecosystem service-intensive industry sectors such as energy, heavy industry and agriculture are likely to face increasing regulatory and consumer pressures to reduce their impact. At the same time, “clean technologies” such as renewable energy are likely to be among the biggest industries of the future.

Resource scarcity

Shortages of a number of key resources are becoming apparent, from arable land, fresh water and metals to fossil fuels. Companies in all sectors need to prepare themselves for a world where raw materials may be in short supply and subject to price volatility, including large price rises and increased disruption to supplies.

For example, by 2008, 80 percent of marine fish stocks were considered over-exploited or fully exploited,

prompting a massive surge in aquaculture, especially in Asia.¹⁹ Soil erosion has been taking place at several times the natural replacement rate, the amount of available arable land per person has dropped substantially and agricultural productivity has slowed.²⁰

At the same time an area the size of Western Europe – has been sold or leased to international investors in order to produce crops or biofuels for export back to wealthy, food and fuel-insecure nations.²¹

These factors contribute to instability and volatility in food and biofuel supplies, but also create opportunities for companies that can, for example, improve crop yields, reduce land degradation or sustain fish stocks.

In 2009, almost 3 billion people were living in water-stressed (defined as less than 1700 cubic meters of water available per capita/year) and water-scarce (defined as less than 1000 cubic meters per capita/year)²² regions while water tables, soil moisture levels and water quality levels are declining rapidly in many dry-land areas.

There are also concerns about supplies of hydrocarbons, fertilizing minerals such as potassium and phosphorous and rare-earth minerals (such as neodymium, yttrium and cerium) as well as the capacity of the world’s forests and oceans to absorb carbon.²³

After a century of persistent and steady falls in real commodity prices, analysts began to suggest that the world had entered into a prolonged “super-cycle” of rising and more volatile commodity prices. The knock-on effects included

¹⁸ Johan Rockstrom, et. al., “A Safe Operating Space for Humanity,” *Nature*, Vol. 461 (September 2009, pp. 472-475) and Tim Lenton, et.al., for Allianz and the World Wide Fund for Nature, *Major Tipping Points in the Earth’s Climate Systems and Consequences for the Insurance Sector* (Gland, Switzerland: WWF, 2009).

¹⁹ United Nations Food and Agriculture Organization, *World Review of Fisheries and Aquaculture* (Rome: FAO, 2010) and United Nations Food and Agriculture Organization, *The State of World Fisheries and Aquaculture* (Rome: FAO, 2011).

²⁰ Pimentel, David. “Soil Erosion: A Food and Environmental Threat.” *Journal of Environment, Development and Sustainability*, Vol. 8, No. 1 (February 2006, p. 119-137).

²¹ Bertram Zagema, *Land and Power: The Growing Scandal Surrounding the New Wave of Investments in Land* (Oxford, UK: Oxfam International, September 2011).

²² World Economic Forum, *The Bubble is Close to Bursting: A Forecast of the Main Economic and Geopolitical Issues Likely to Arise in the World during the Next Two Decades* (WEF, 2009).

²³ Richard Heinberg, *Peak Everything: Waking Up to the Century of Declines* (Gabriola Island, BC, Canada: New Society Publishers, 2007).



supply disruptions, lower growth, higher inflation, export restrictions, new regulations, conflicts over resources and currency instabilities.

This age of resource constraint²⁴ is set to be a fact of life for all businesses in years to come. Companies need to prepare for this and have a strategy to deal with it, through measures such as reducing resource use, increasing recycling of resources, identifying alternative sources of supply or finding substitute materials. The argument is most commonly seen in the case for improving energy efficiency but in the future companies will have to improve resource productivity across a range of inputs. They will also need to improve efficiency in the use and disposal phases of products and services.

Lack of global governance continues

The number of signatories to multilateral environmental agreements has increased by 330 percent since 1992²⁵ and yet many of the agreements achieved at the Rio Earth Summit 1992 and Johannesburg 2002 UN conference have still not been implemented or enforced. Attempts to establish global rules have been outpaced by the growth of global challenges such as climate disruption, declining fisheries, biodiversity loss and health pandemics, along with the increasing interconnectedness of global finance, agriculture and resource extraction.²⁶

“This creates opportunities for companies that can improve crop yields, reduce land degradation or sustain fish stocks.”

²⁴ Peter Schwartz, et. al., *Winners and Losers in the New Commodity Price Regime* (San Francisco: Monitor, 2011).

²⁵ United Nations Environment Programme, *Keeping Track of Our Changing Environment: From Rio to Rio + 20 (1992–2012)* (Nairobi: UNEP, 2011).

²⁶ Brian Walker, et. al., “*Looming Global-Scale Failures and Missing Institutions*,” *Science*, Vol. 325 (September 11, 2009, pp. 1345-1346).

“ The business community needs clear global rules, powerful regulatory incentives and a level-playing field to support it in moving to sustainable growth. ”

Policymakers have been able to tackle thorny but often domestic-rooted problems such as the state of the automotive market but not yet system-wide problems such as global imbalances of trade or the eurozone crisis. The difficulties in securing coordinated global governance on sustainability have been clearest in the 20 years of negotiations that have attempted to forge a global approach to tackling climate change.

Although progress on low carbon technologies has been made in individual countries and regions, most notably in Europe, the levels of investment required for worldwide change have been missing.

At the same time, government subsidies for carbon-intensive industries have continued despite a G20 commitment to phase them out by 2020.

The business community needs clear global rules, for example on carbon emissions, powerful regulatory incentives and a level-playing field to support it in moving to sustainable growth. These incentives should include financing solutions that allow the longer term benefits of sustainability

to compete with other programs with a higher short-term payback; a way to measure the impact of sustainability programs; and clearer and more rigorous international regulation that will allow companies to plan with confidence.²⁷

How has business adapted to these global changes?

Twenty years after the Rio Earth Summit in 1992, sustainability has become a more important issue for companies and sustainability-related investments have grown substantially – Bloomberg New Energy Finance recently reported that the trillionth dollar of investment in clean energy had been made.

Furthermore, sustainability is increasingly being seen as a source of innovation and growth rather than simply cost reduction and risk management.²⁸ The Carbon Disclosure Project reported this year that companies with a strategic focus on climate change provided investors with approximately double the average total return of the Global 500 from January 2005 to May 2011.²⁹

²⁷ United Nations Environment Programme, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication: A Synthesis for Policy Makers* (Nairobi: UNEP, 2011).

²⁸ KPMG International in cooperation with the Economist Intelligence Unit, *Corporate Sustainability: A Progress Report* (April 2011) www.kpmg.com

²⁹ Carbon Disclosure Project. (2011) *Global 500 Report*.

Recent polls of senior executives reveal that many of the world's largest 250 corporations are increasingly embracing sustainability as a core foundation of successful business and publicly report about their performance.³⁰

However, there remains a long way to go. In 2008, the world's 3,000 largest public companies by market capitalization were estimated to be causing US\$2.15 trillion of environmental damage, equivalent to 7 percent of their combined revenues and 50 percent of their combined earnings

(measured as EBITDA: earnings before interest, taxation, depreciation and amortization). Some 60 percent of these negative impacts were concentrated in the electricity, oil and gas, industrial metals and mining, food production and construction and materials sectors.³¹

The next section of this report presents the ten sustainability megaforges that over the next 20 years will exert increasing pressure on businesses in all sectors and economies around the world.

“ In 2008, the world's 3,000 largest public companies were estimated to be causing US\$2.15 trillion of environmental damage. ”



³⁰ KPMG International in cooperation with The Economist Intelligence Unit, *Corporate Sustainability: A Progress Report* (April 2011) and KPMG International, *KPMG International Survey of Corporate Responsibility Reporting 2011* (2011), at www.kpmg.com.

³¹ United Nations Environment Programme Finance Initiative and Principles for Responsible Investment Association, *Universal Ownership: Why Environmental Externalities Matter to Institutional Investors* (New York: UNEP Finance Initiative, October 2010) at www.unepfi.org.

02

Global Sustainability Megaforces

Over the next 20 years, businesses will be exposed to hundreds of environmental and social changes that could bring both risks and opportunities in the search for sustainable growth. For this report more than two dozen forecasts have been analyzed from international agencies, global think-tanks, national agencies and noted futurists in an attempt to identify those changes likely to have the greatest impacts on business. (See Appendix 2 for a list of sources).

“These megaforces act as a complex and unpredictable system, feeding, amplifying or ameliorating the effects of others.”

Emphasis was placed on the availability of quality numerical projections, key pressures causing global environmental and social problems and the most significant consequences of those pressures for natural and human security. The result is a set of ten global sustainability megaforces that will impact every business over the next two decades. They are:

1. **Climate Change**
2. **Energy & Fuel**
3. **Material Resource Scarcity**
4. **Water Scarcity**
5. **Population Growth**
6. **Urbanization**
7. **Wealth**
8. **Food Security**
9. **Ecosystem Decline**
10. **Deforestation**

A summary of these global sustainability megaforces follows. Each has important implications for business which must be understood, assessed and built in to long term strategic planning. Awareness and comprehension of each is vital but, as the next section of this report demonstrates, it is only the first step.

These megaforces do not function in isolation from each other in predictable ways. They act as a complex and unpredictable system, feeding, amplifying or ameliorating the effects of others. Business leaders seeking to manage the risks and harness the opportunities of the future must understand how these megaforces function and how they might affect their own organizations.

Climate Change

Climate change is the one global megaforce that directly impacts all others discussed in this report.



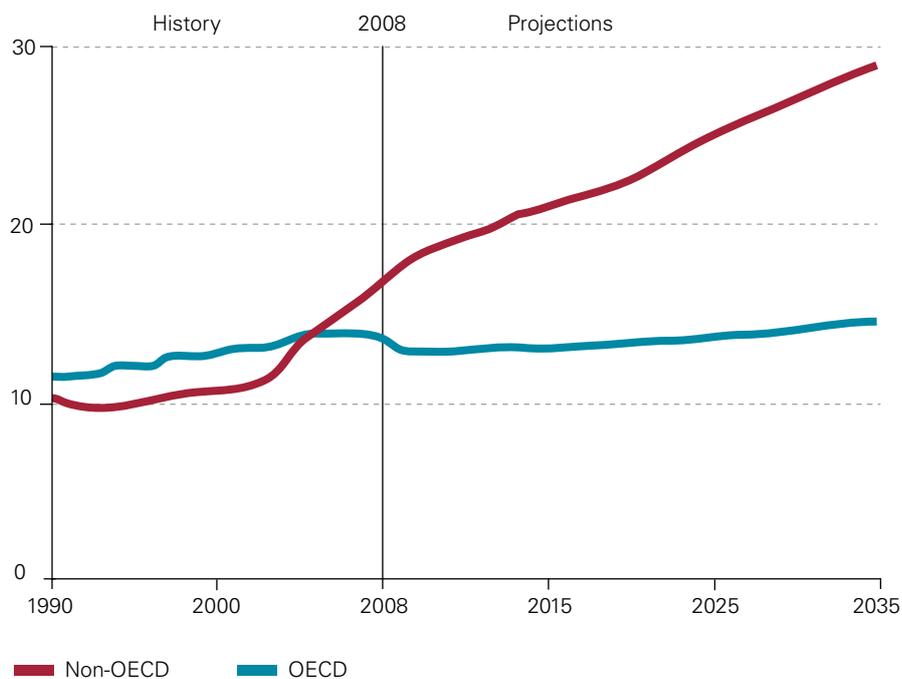
There are six key types of risk to business from climate change: physical risk, regulatory risk, reputational risk, competitive risk, social risk and litigation risk.

These risks include new laws and government initiatives to tackle climate change such as energy efficiency requirements and standards, carbon taxes, emissions cap and trade systems and fuel tariffs. Businesses may also be at risk of damaging their brands if they are seen to do the wrong thing, with the added threat of litigation if they fail to comply with legislation, or to disclose their carbon impacts.

Predictions of annual output losses from climate change range between one percent per year, if strong and early action is taken, to at least five percent a year if governments fail to act.¹

However, it is developing countries and the businesses that operate in them that are most vulnerable to climate change impacts even as their rapid industrialization increases their contribution to global CO₂ emissions (Figure 5, Figure 6).

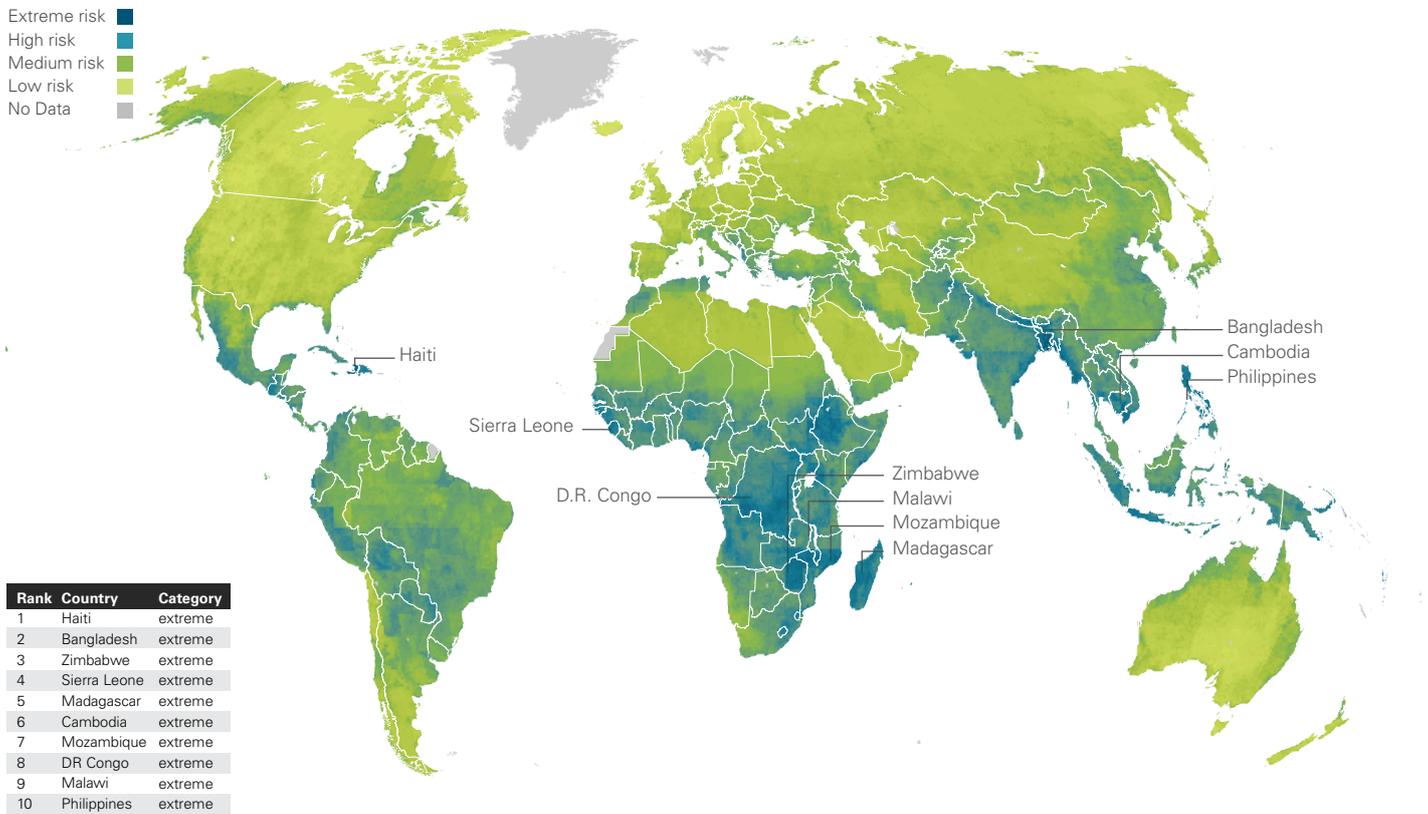
Figure 5: World energy-related carbon dioxide emissions, 1990–2035 (billion metric tons)



Source: U.S. Energy Information Administration (EIA). (2011). International Energy Outlook 2011. EIA, Washington D.C.

¹ United Kingdom *Stern Review on the Economics of Climate Change*, Executive Summary (2006).

Figure 6: Climate change vulnerability index 2012



Source: Maplecroft. (2012). The Climate Change and Environmental Risk Atlas. Available at <http://maplecroft.com>

The physical risks are considerable. In World Energy Outlook 2011, the International Energy Agency (IEA) said that we are on course for a long-term global temperature rise of 3.5°C. This could cause ‘irreversible’ impacts including near-total deglaciation in the long term, contamination of groundwater supplies, water shortages for hundreds of millions of people, lower agricultural yields in many places and more malnutrition, infectious diseases and deaths from heat waves, as well as increasingly severe floods, droughts and storms.²

Extreme weather events are set to become more frequent and up to one sixth of the world’s population could face disruption to water supplies and an increased risk of flooding from melting

glaciers, mainly in the Indian subcontinent and areas of China and South America – regions that are seen as the new driving force for the global economy. While agricultural yields could increase in higher latitude areas such as Northern Europe, elsewhere, particularly in Africa, falling yields could leave hundreds of millions of people without enough food.³

Sea level rises could cause flooding in low-lying coastal areas, displacing “tens to hundreds of millions of people” in places such as Southeast Asia, particularly Bangladesh and Vietnam, and small Caribbean and Pacific islands. Some of the world’s largest and richest cities, such as Tokyo, New York, London and Shanghai could also be affected. Human health could be affected as more people become vulnerable to mosquito-

² IPCC, Climate Change 2007: *Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press, 2007).

³ IPCC, Climate Change 2007: *Synthesis Report. Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva: IPCC, 2007).

borne diseases, air quality worsens, and more extreme weather events occur.⁴ Climate change is expected to also affect ecosystem health and biodiversity, in turn reducing land productivity and adding to food security stress and water scarcity.

Urgent action is needed to avoid such a global temperature rise, but because energy-related facilities such as power stations, buildings and factories last for many decades, “80 percent of the cumulative CO₂ emitted worldwide between 2009 and 2035 is already “locked-in” by capital stock that either exists now or is under construction and will still be operational by 2035,”⁵ according to the IEA.

Individual countries have started acting to cut emissions – China, Australia and South Korea plan to create carbon markets by 2015, for example, while many more have carbon reduction targets – but fragmented national responses require business to understand and comply with a complex and unpredictable patchwork of carbon legislation around the world. Meanwhile, international action on climate change has been slow and disjointed. A price on carbon has been established through trading systems such as the EU Emissions Trading System and the UN’s Clean Development Mechanism, but the

carbon markets have been dogged by political interference and the economic crisis. Progress was made at the 2011 UN climate conference in Durban, with all the world’s major emitters agreeing that they must cut emissions, but a new global deal – if it eventuates – will not be agreed until 2015 and will not come into force until 2020.

Nonetheless, the need to tackle climate change brings opportunity to innovators. The US\$100 billion-a-year Green Climate Fund (GCF) should make it easier to cut emissions and help developing countries to adapt to the effects of climate change. The GCF could lead to the creation of public-private partnerships in developing nations that can build green industries, create jobs, reduce poverty and improve infrastructure as well as tackle climate change.

Energy & Fuel

Fossil fuel markets are set to become more volatile and unpredictable because of higher global energy demand; changes in where fossil fuels are consumed; supply and production uncertainties; and increasing regulatory interventions related to climate change. All companies – regardless of sector, size, or location – will find it difficult to plan for and manage energy costs, especially those related to fossil fuel use.

“A new global deal – if it eventuates – will not be agreed until 2015 and will not come into force until 2020.”



⁴ IPCC, *Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press, 2007).

⁵ International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*

“Vehicle and electrical appliance suppliers, manufacturers, and retailers must prepare for increased demand for their products at a time when policy is likely to raise energy prices.”

Companies that become more energy efficient and/or use more alternative and renewable sources of energy, however, would be able to lower their exposure to fossil fuel-related risks and improve their financial performance. The Carbon Disclosure Project last year highlighted the link between cutting emissions and financial outperformance.

While some businesses are moving slowly towards alternative and renewable sources of energy, most corporations continue to depend heavily on oil, coal and gas for power, fuel and raw materials. Just three percent of electricity generation came from non-hydro renewable sources in 2010 – including hydro, the total is 13 percent while 81 percent of power is fossil-fuelled.⁶ “There are few signs that the urgently needed change in direction in global energy trends is under way,” the IEA says in its *World Energy Outlook 2011*.⁷

Energy businesses must prepare for shifts in fuel mix due to policy, supply, and fuel prices. These businesses, particularly those involved in renewable energy, must also remain actively involved in policy debates that will impact both total global energy demand and the fuel mix through carbon or renewable energy policies. But other industries need to pay attention to the issue as well. Fossil fuel-dependent transportation industries such as aviation, shipping and manufacturers that use petroleum as a process input,

such as plastic or chemical producers, will need robust strategies and plans to address fuel price volatility and potential shortages. Vehicle and electrical appliance suppliers, manufacturers and retailers must prepare for significant energy consumption increases in the developing world, and adjust product design and development strategies accordingly.

All of these drivers create a market for companies that can help customers to become more energy efficient. Equally, companies that can bring low-carbon power to the world’s poorest people by “leapfrogging” large-scale utility infrastructure are well-placed.

The energy mix is likely to slowly change in coming years, but fossil fuels will continue to dominate world energy supply to 2035 (*Figure 7*), making up 75 percent of the energy mix – and in absolute terms, more fossil fuel will be consumed than today.

“World primary demand for energy increases by one-third between 2010 and 2035 and energy-related CO₂ emissions increase by 20 percent,” the IEA adds. It also projects that over the next 25 years, 90 percent of the projected growth in global energy demand will come from non-OECD economies.⁸

Businesses in the OECD therefore face a situation where the dynamics of the global energy market are increasingly decided elsewhere.

⁶ International Energy Agency. *World Energy Outlook 2011 Press Release* (November 2011).

⁷ International Energy Agency. 2011, *World Energy Outlook 2011 Executive Summary*

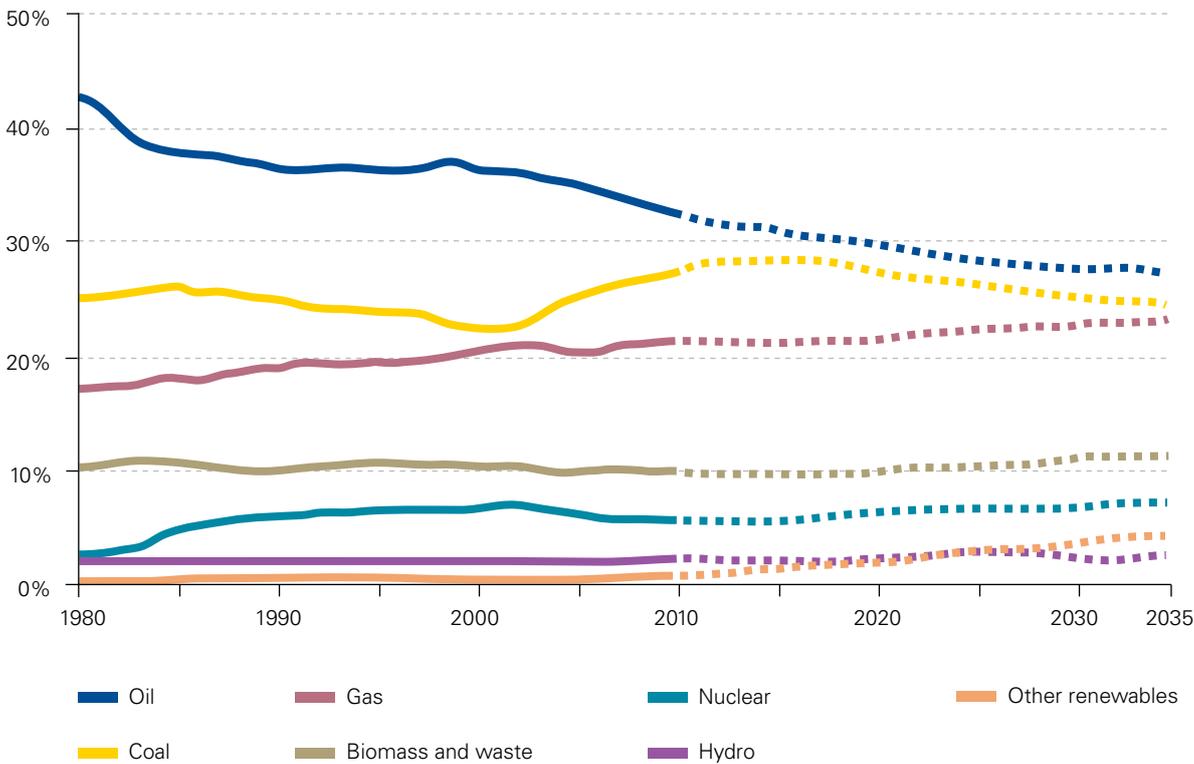
⁸ International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*

The IMF's World Economic Outlook in April 2011 stated: "The increases in the trend component of oil prices suggest that the global oil market has entered a period of increased scarcity. The analysis of demand and supply prospects for crude oil suggests that the increased scarcity arises from continued tension between rapid growth in oil demand in emerging market economies and the downshift in oil supply trend growth."⁹

Proportionally, oil remains the leading source of fuel, but demand for natural gas is expected to rise most strongly. Nuclear energy is likely to grow by about 70 percent to 2035, led by China, Korea and India.¹⁰ The relative share of renewable energy sources, led by hydropower and wind, should grow faster than other energy forms but in absolute terms, total supply of renewables – at 18 percent – remains well below the level of any single fossil fuel by 2035.¹¹

“Increased scarcity [of crude oil] arises from continued tension between rapid growth in oil demand in emerging market economies and the downshift in oil supply trend growth.”

Figure 7: Proportion of various energy sources in world primary energy demand



Source: International Energy Agency (IEA). (2011). World Energy Outlook 2011 © OECD/IEA, Figure 2.7, page 79. IEA, London

⁹ International Monetary Fund (April 2011) *World Economic Outlook*

¹⁰ International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*

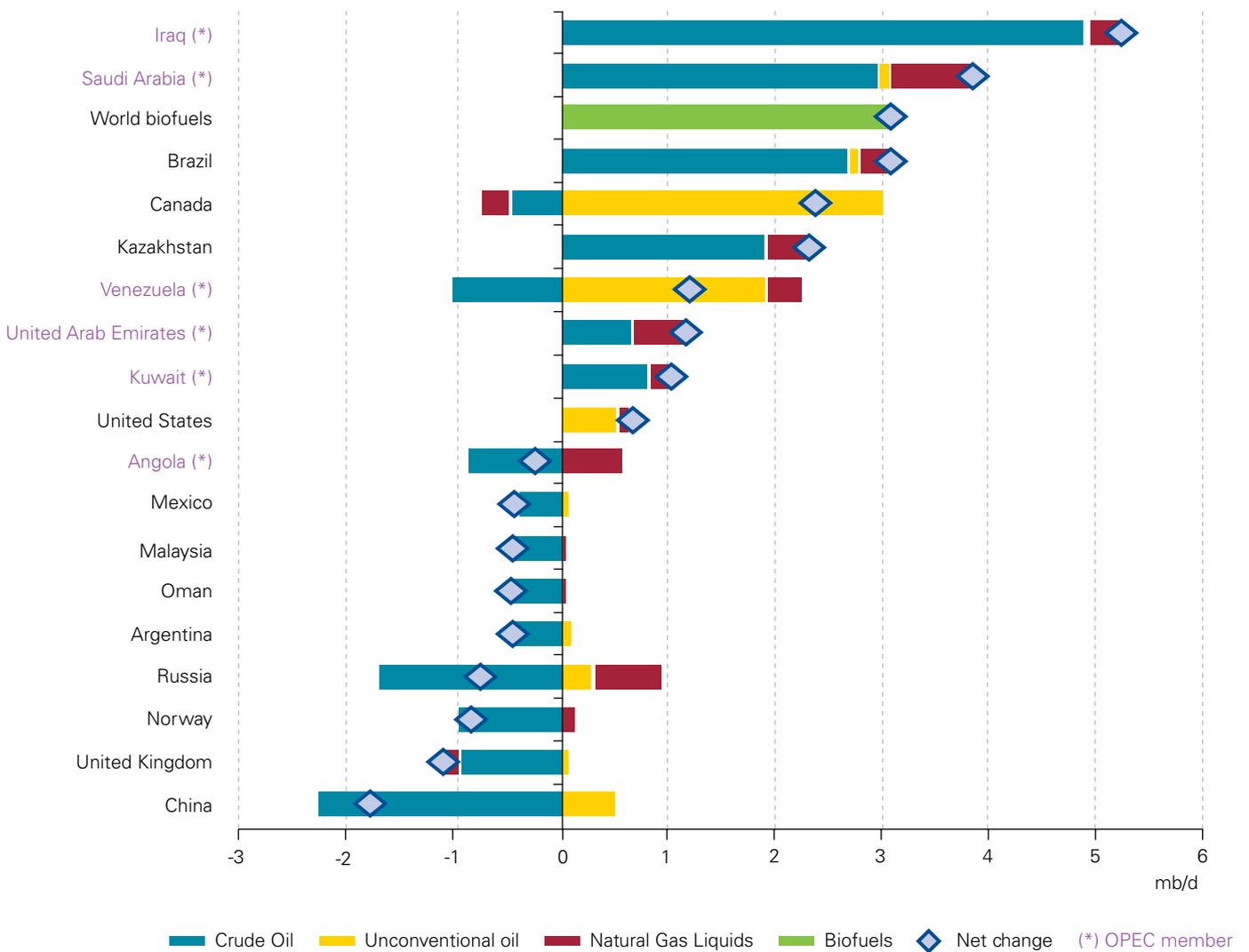
¹¹ International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*

“The IEA predicts that the price of crude oil will rise to US\$120/barrel by 2035.”

The IEA predicts that the demands of transportation in emerging economies will lift oil consumption by 15 percent between 2010 and 2035.¹² World oil production is predicted to reach 96 million barrels per day (m b/d) in 2035, 13m b/d up on 2010 levels, with a growing share coming from natural gas liquids and other unconventional

sources.¹³ The Middle East and North Africa are set to provide most of the growth in oil output during this period, while other locations will turn to more costly and difficult sources (Figure 8). The IEA also predicts that the price of crude oil will rise to US\$120/barrel (in year-2010 dollars) by 2035.¹⁴

Figure 8: Major changes in global liquids supply, 2010–2035



Source: International Energy Agency (IEA). (2011). World Energy Outlook 2011 © OECD/IEA, Figure 3.17, page 124. IEA, London

¹² International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*

¹³ International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*

¹⁴ International Energy Agency. 2011, *World Energy Outlook 2011 Factsheet*



One reason for the continuing dominance of fossil fuels is energy subsidies, which are large and widespread. Without further reform, the IEA reports that “the cost of fossil-fuel consumption subsidies is set to reach US\$660 billion in 2020, or 0.7 percent of global GDP.”¹⁵ Yet all users of fossil fuels need to be aware of the increasing pressure to eliminate fossil fuel subsidies, which totaled US\$409 billion in 2010 about US\$110 billion more than in 2009 as a result of the increase in oil prices. Subsidies for renewable energy are predicted to continue growing, reaching almost US\$250 billion in 2035.¹⁶

Material Resource Scarcity

As developing countries industrialize rapidly, global demand for material resources looks likely to continue to increase dramatically. Over the next

20 years business is likely to face global competition for a wide range of material resources that become less easily available. The risks presented by resource scarcity also create opportunities to develop substitute materials, and to recycle and recover resources from waste products. Other opportunities include entering new markets, collaborating with other sectors, universities or government and discovering of new techniques or processes.

In 2030 it is predicted that some 83 billion tons of minerals, metals and biomass will be extracted from the earth: 55 percent more than in 2010 (Figure 9).

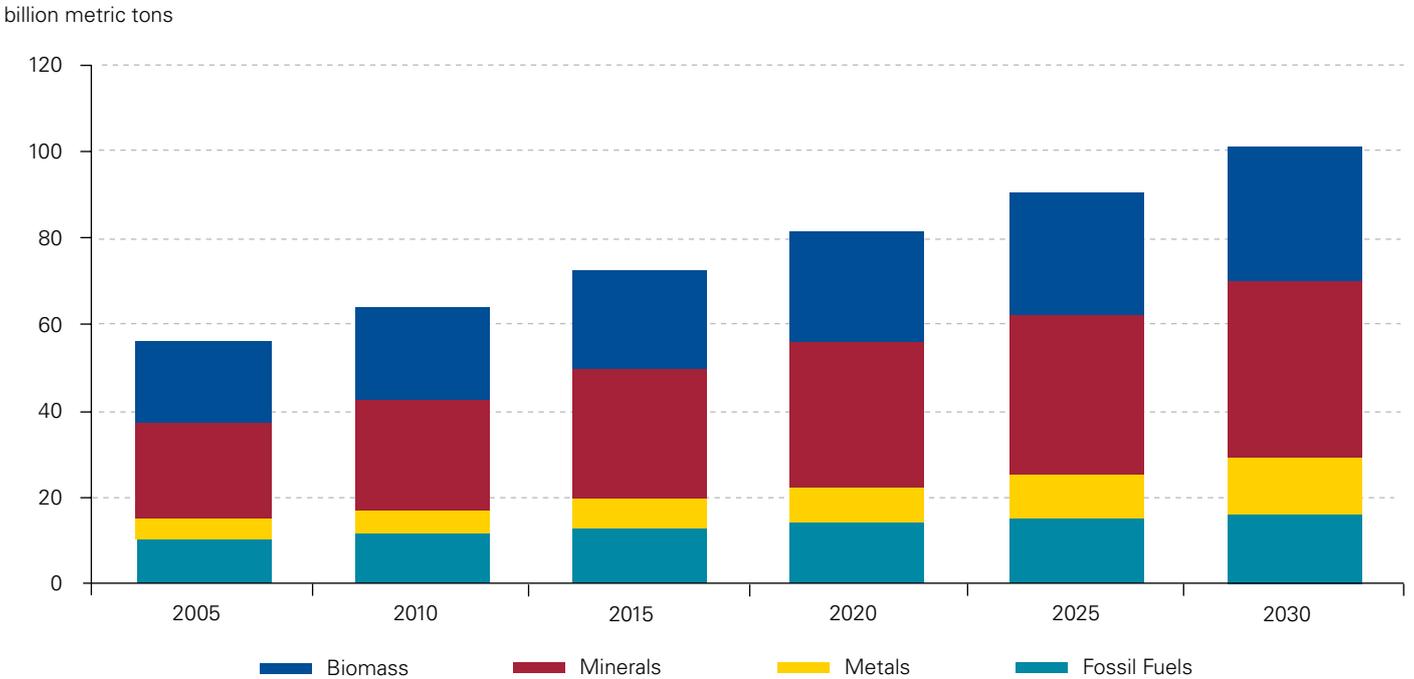
The message is clear: over the next 20 years, demand for material resources will soar while supplies will become increasingly difficult to obtain.

“ Demand for material resources will soar while supplies will become increasingly difficult to obtain. ”

¹⁵ International Energy Agency, 2011, *World Energy Outlook 2011 Factsheet*

¹⁶ International Energy Agency, 2011, *World Energy Outlook 2011 Factsheet*

Figure 9: Business-as-usual scenario on worldwide resource extraction, 2005 to 2030



Source: Sustainability Europe Research Institute (SERI), GLOBAL 2000, and Friends of the Earth Europe. (2009). *Overconsumption? Our use of the world's natural resources.*

“As supplies decrease, governments are likely to protect domestic interests by restricting exports.”

The uneven global distribution of material resources, from oil to land to fresh water, makes planning for the future even more complex. Countries without large domestic supplies must rely on imported materials; as a result investors could increasingly seek to acquire large scale land rights elsewhere in the world – particularly in Africa and South America – to secure supplies of minerals, biomass, agricultural production and even water.

As supplies decrease, governments are likely to protect domestic interests by restricting exports. This is already happening in China, which has tightened control on exports of rare earth elements. China supplies 97 percent of current rare earth demand.¹⁷ By restricting global supply and using more of these materials domestically, it has increased uncertainty around the security of future supplies but increased opportunities for other countries with rare earth resources such as the US.

¹⁷ British Geological Survey (2011). *World Mineral Production 2005-2009* (Keyworth, Nottingham: British Geological Survey).

Water Scarcity

Water scarcity for many businesses can be a major risk to growth and development (Figure 10).

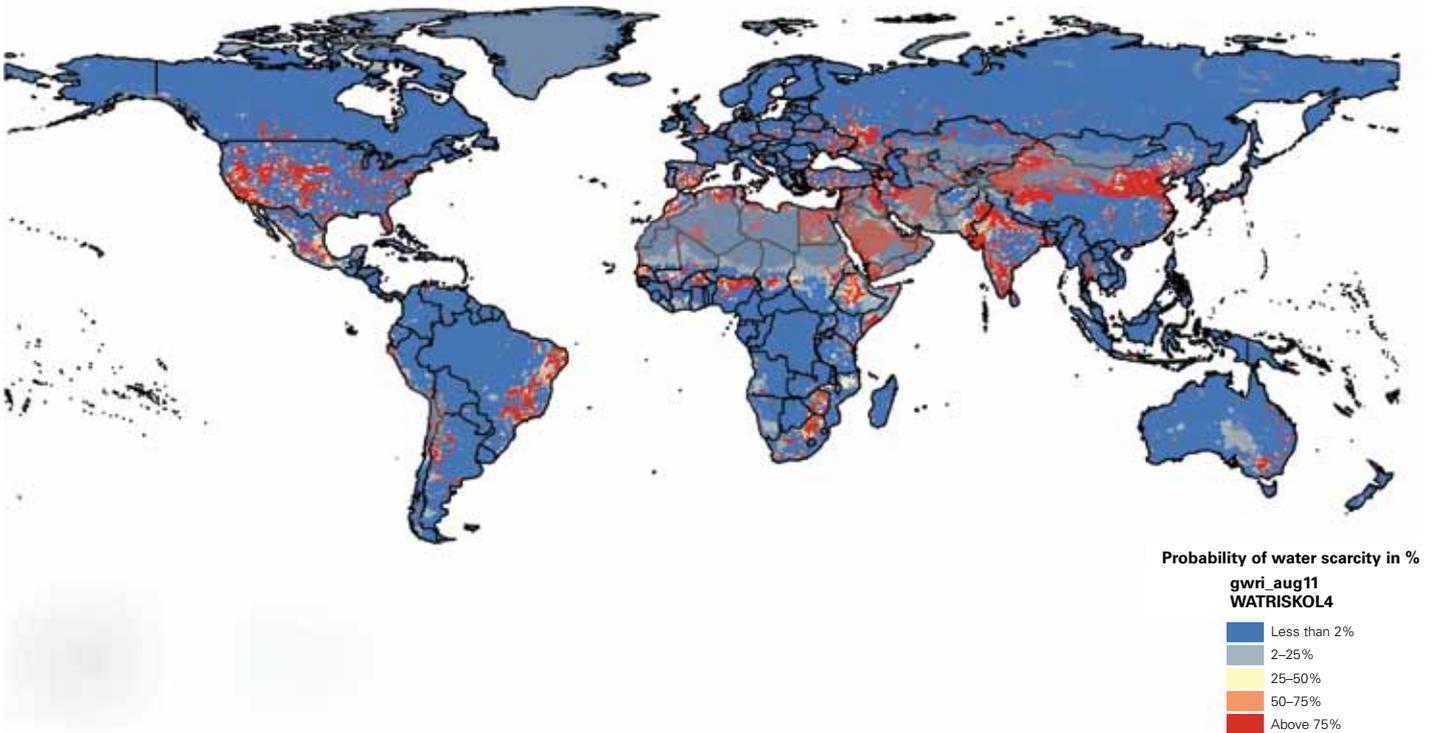
Businesses operating where freshwater is scarce may be vulnerable to water shortages, declines in water quality, water price volatility and reputational issues. They will have to share access to limited or dwindling water resources with municipalities through detailed water management plans and efficiency requirements, and are likely to be subject to regulations that aim to ensure adequate supply for local populations. Potential water shortages pose a threat to business growth and expansion, and conflicts over water supplies may create a security risk to both business operations and markets.

Indeed, according to the World Economic Forum, the projection for freshwater availability in 2030 bears potential for crisis and conflict, since water lies at the heart of everything that is important for human life: food, sanitation, energy, production of goods, transport and the biosphere. "The impact of a changing climate on water availability and quality is, in many regions, an immediate, tangible and local risk," the WEF says.

Increasing stress on the world's water supplies threatens to affect food and energy systems around the world due to the interlinked nature of the global economy. The 2030 Water Resources Group (2010) estimates that the global demand for freshwater will exceed supply by 40 percent by 2030 assuming average economic

“ Potential water shortages pose a threat to business growth and expansion, and conflicts over water supplies may create a security risk. ”

Figure 10: Water risk in 2030: probability of water scarcity in 2030



Source: Global Water Risk Index, Global Water Intelligence. (2011). Available at <http://www.water-risk-index.com/index.html>

“Lack of clean water in rural areas could reduce the amount of viable agricultural land, which would add to the pressure for people to migrate to cities.”

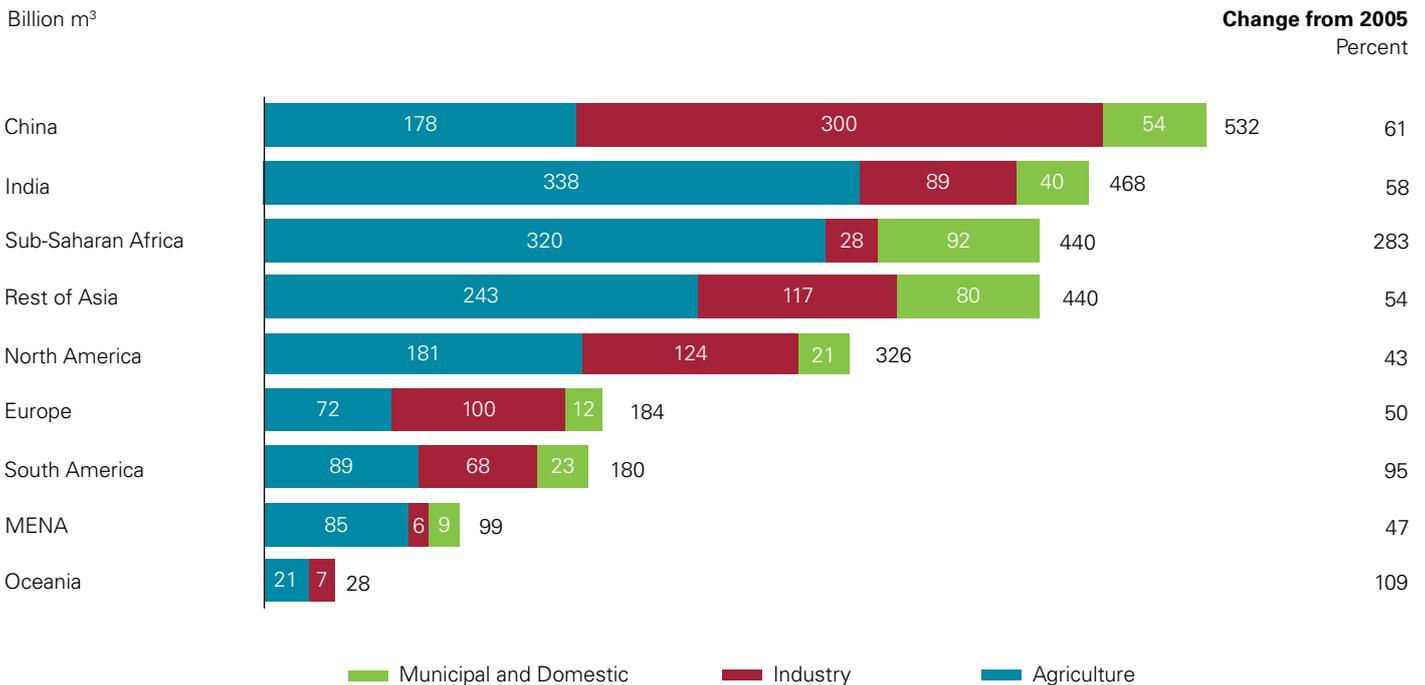
growth and no efficiency gains.¹⁸ The increasing demand for water is driven by population growth, increased industrialization in emerging economies such as China, and urbanization.

Figure 11 shows where water demand is predicted to rise most, both geographically and in terms of type of usage: municipal and domestic, agricultural or industrial. Agriculture in India, sub-Saharan Africa, and Asia (excluding China) is forecast to create the most additional water demand to 2030. In China, industrial demand for water will dominate to 2030; the country could account for 40 percent of extra industrial water demand globally.

Climate change puts further pressure on water availability and quality. More frequent extreme weather events caused by climate change, such as droughts and floods, are predicted to accelerate the deterioration of local freshwater supplies. Lack of clean water in rural areas could reduce the amount of viable agricultural land, which would add to the pressure for people to migrate to cities.

Companies that use water more efficiently or eliminate water use entirely through closed-loop processes and water recycling can save money and resources and reduce business risks.

Figure 11: Increase in annual water demand 2005–2030



Source: The 2030 Water Resources Group. (2009). Charting Our Water Future.

¹⁸ United Nations Environment Programme. (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*

Water-intensive sectors at the greatest risk from water scarcity include clothing, automobile, food and beverage, biotech/ pharmaceutical, chemical, forest products, electronics, mining, refining and electric utilities.¹⁹

Population Growth

The number of people on our planet is predicted to increase to 8.4 billion by 2032 in a moderate growth scenario: a rise of some 20 percent from 2011.²⁰

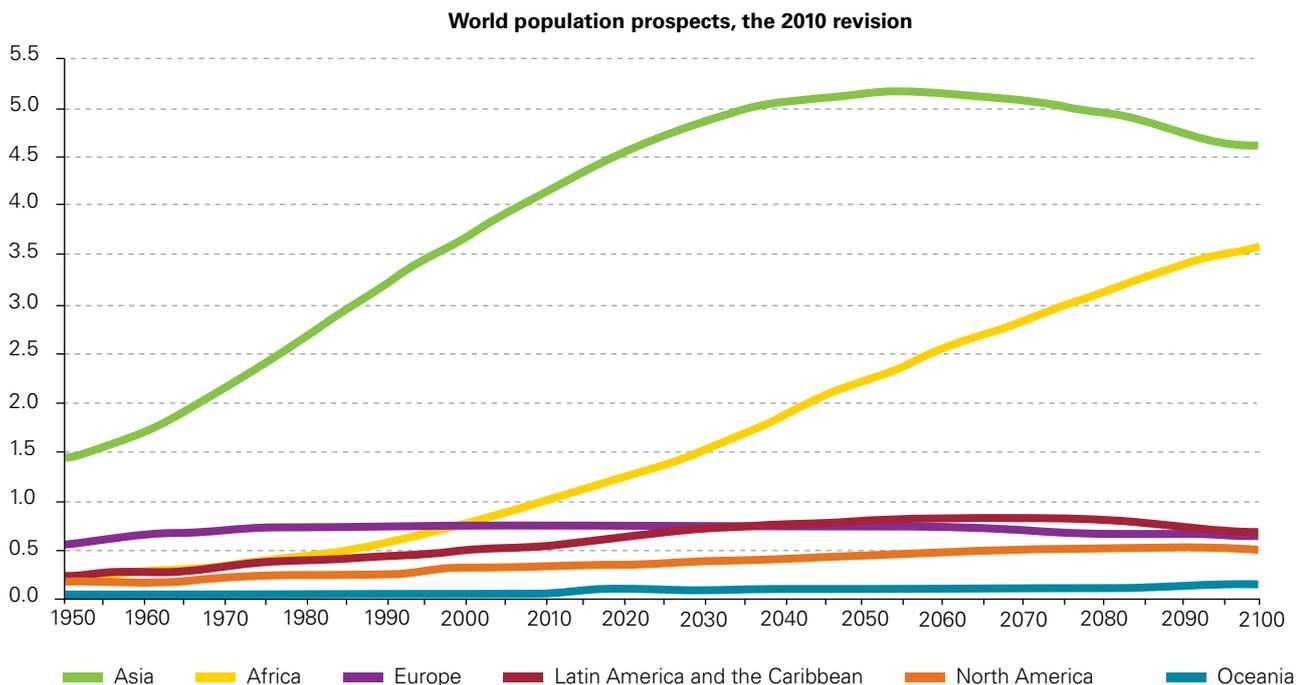
The populations of developing countries are expected to grow the most while

those of more developed regions, including North America and Europe, are expected to hold roughly steady. In 2032, almost two thirds (58 percent) of people will live in Asia and around one fifth (19 percent) in Africa (Figure 12).

Businesses can expect significant supply challenges and price volatility as a result of such a rapid growth in the number of people coupled with an increased use of resources.²¹ Population Growth will place intense pressures on ecosystems and the supply of natural resources such as food, water, energy and materials.

“Businesses can expect significant supply challenges and price volatility as a result of such a rapid growth in the number of people.”

Figure 12: Projected world population growth 1950–2100²² (billions)



Source: United Nations, Department of Economic and Social Affairs, Population Division. (2011): World Population Prospects: The 2010 Revision. UN, New York. Available at http://esa.un.org/wpp/Analytical-Figures/htm/fig_2.htm

¹⁹ Pacific Institute. (2007). *Pacific Institute’s Corporate Reporting on Water: A Review of Eleven Global Industries*.

²⁰ United Nations, Department of Economic and Social Affairs, Population Division. (2011). *World Population Prospects: The 2010 Revision*.

²¹ Behrens, A., Giljum, S., Kovanda, J., Niza, S. (2007). *The material basis of the global economy. World-wide patterns in natural resource extraction and their implications for sustainable resource use policies*. Ecological Economics 64, pp. 444-453.

²² United Nations, Department of Economic and Social Affairs, Population Division. (2011). *World Population Prospects: The 2010 Revision*.

“Businesses will find opportunity in the increasing demand for affordable, accessible pharmaceuticals and healthcare.”

A lack of employment opportunities for growing young populations in developing nations could result in social unrest and instability. While this is a threat for business, there are also opportunities to create commerce and jobs, and to innovate to address the needs of growing populations for agriculture, sanitation, education, technology, finance and healthcare.

Meanwhile, in developed countries with stable populations but a growing proportion of elderly and retired citizens, businesses will face a shrinking workforce and fiercer competition for skilled workers. Financial challenges related to employee retirement benefits and pension funding will become more common as smaller workforces struggle to support the rising costs of ageing populations. As people live longer, conventions around working life, retirement and personal finance will be

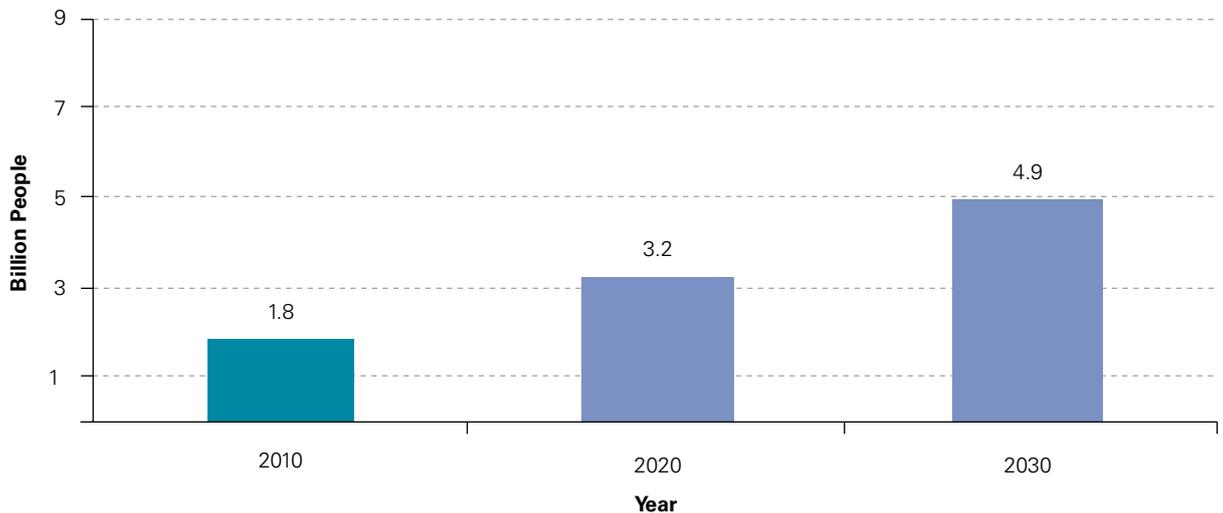
challenged. Businesses are likely to find opportunity in the increasing demand for affordable, accessible pharmaceuticals and healthcare, along with housing and mobility services for older people.

Wealth

The OECD defines the global “middle class” as those with purchasing power of between US\$10 and US\$100 per capita per day.²³ This section of the global population is predicted to grow 172 percent between 2010 and 2030 (Figure 13)²⁴ resulting in a rise in overall global wealth over the next 20 years.

The challenge for businesses is to serve these new markets at a time when resources will become scarcer and more price-volatile. The greatest opportunity awaits those businesses that can provide products and services for a more resource-constrained world.

Figure 13: Growth of the global middle class



Source: KPMG International. (2012). Based on the data published in: OECD Development Centre. (2010). Working Paper No. 285: The Emerging Middle Class in Developing Countries © OECD, page 27

²³ OECD Development Centre (2010). Working Paper No. 285: The Emerging Middle Class in Developing Countries.

²⁴ OECD Development Centre (2010). Working Paper No. 285: The Emerging Middle Class in Developing Countries.

As workers in the developing world develop higher expectations and become more closely connected with the rest of the world, disparities between working conditions and wages in different countries are likely to become increasingly apparent. There have already been several industrial disputes in developing countries with workers demanding improved conditions and pay, and these are likely to become more common.

As a result, the advantages that many companies have experienced from “cheap labor” in developing nations are likely to be eroded by the growth and new power of the global middle class.

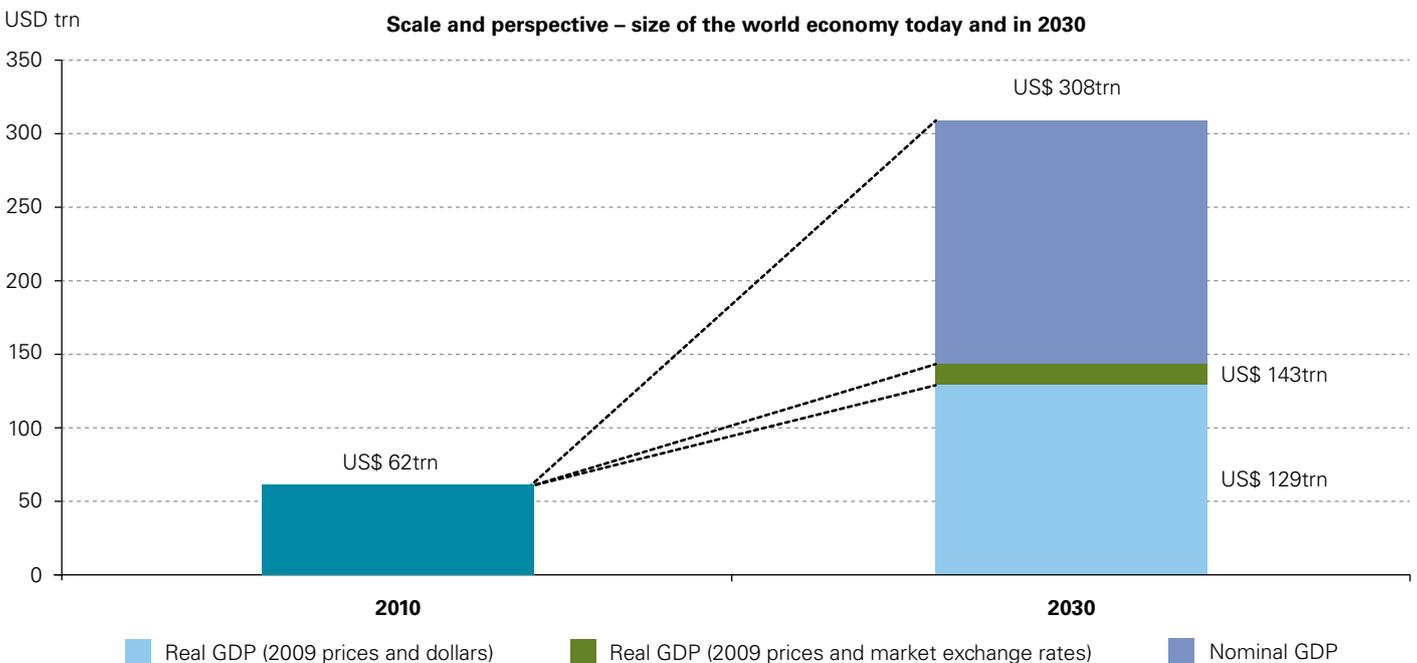
The emerging economies – especially China, Brazil, India, Mexico and Russia – could become increasingly influential²⁵ as their middle classes grow and their share of global output is

predicted to grow from 36 percent to 45 percent between 2010 and 2025.²⁶ In China, for example, consumption is expected to rise from 41 percent of the country’s GDP in 2011 to 55 percent in 2025.²⁷ This shift in spending power and lifestyle ambition presents huge opportunities for businesses, whose emerging market strategies are moving from a focus on foreign direct investment and offshoring to serving the demands of these newly empowered consumers.

Such growth projections are impressive, However, as incomes rise, resource use per capita also grows. Billions more middle-class consumers will emerge over the next 20 years driving demand for water, energy, food and material resources. Resource supplies, infrastructure and ecosystems will come under increasing stress.

“As incomes rise, resource use per capita also grows. Billions more middle-class consumers will emerge over the next 20 years.”

Figure 14: World economy (GDP) from 2010–2030



Source: Standard Chartered Bank (SCB). (2010). The Super-Cycle Report

²⁵ World Bank (2011). Multipolarity: *The New Global Economy (Global Development Horizons 2011)*.

²⁶ World Bank (2011). Multipolarity: *The New Global Economy (Global Development Horizons 2011)*.

²⁷ World Bank (2011). Multipolarity: *The New Global Economy (Global Development Horizons 2011)*.

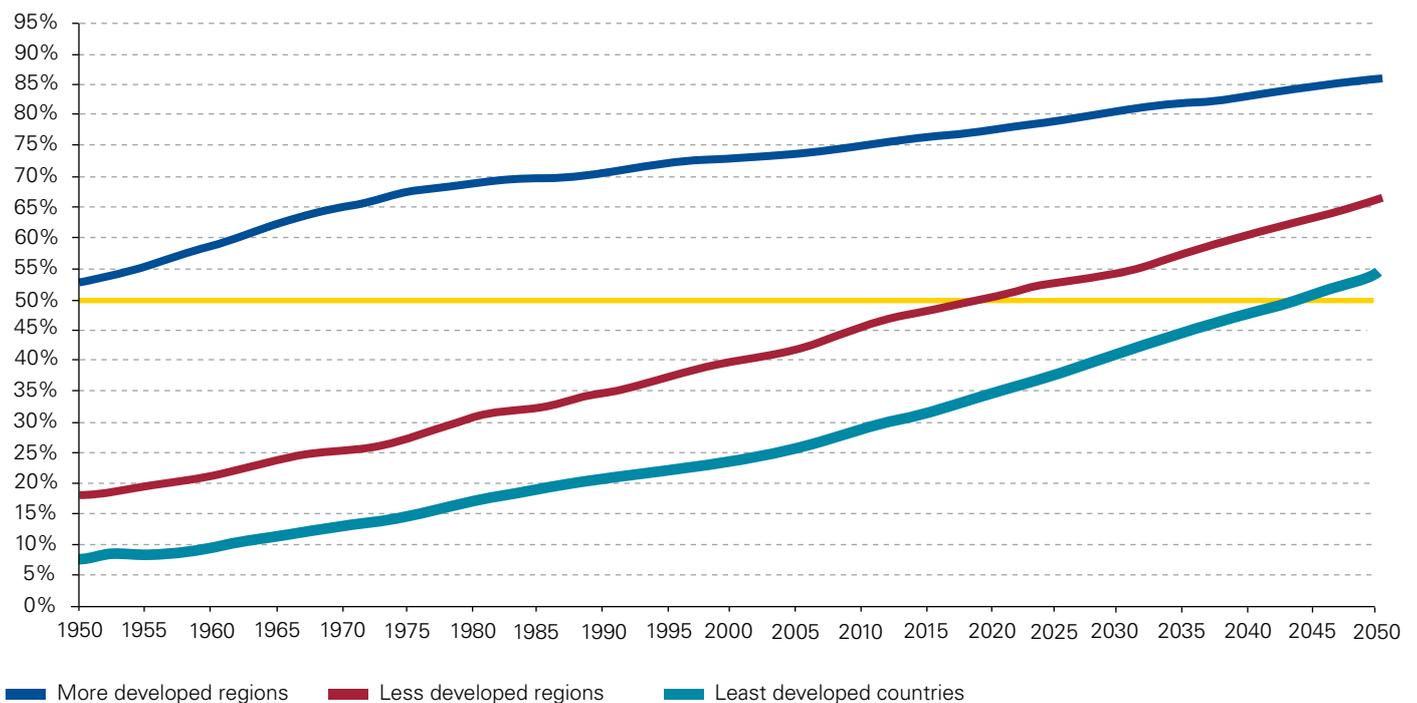
“Where improvements in urban infrastructure lag behind population and economic growth, slums expand and the gap between rich and poor widens.”

Urbanization

In 2009, for the first time ever, more people lived in cities than in the countryside.²⁸ By 2030 all developing regions including Asia and Africa are expected to have the majority of their citizens living in urban areas²⁹ and virtually all population growth over the next 30 years is predicted to be in cities.³⁰ The world’s urban population is predicted to reach almost 4.9 billion people by 2030 (Figure 15).

For these growing cities to be habitable, they will require vast improvements in infrastructure including construction, water and sanitation, electricity, waste, transport, health, public safety and internet and cell phone connectivity. Moving people and goods safely and efficiently through larger, densely populated urban areas will become more challenging and expensive and as cities grow there will be greater demands on scarce resources such as clean water and open green space.

Figure 15: World urbanization prospects, the 2009 revision (% of total population)



Source: United Nations, Department of Economic and Social Affairs, Population Division. World Urbanization Prospects: The 2009 Revision (New York: UN, 2010).

²⁸ UN Habitat. (2010). *State of the World’s Cities 2010/2011 – Cities for All: Bridging the Urban Divide*.
²⁹ UN Habitat. (2010). *State of the World’s Cities 2010/2011 – Cities for All: Bridging the Urban Divide*.
³⁰ UN Habitat. (2010). *State of the World’s Cities 2010/2011 – Cities for All: Bridging the Urban Divide*.



These requirements create opportunities for companies that can provide innovative ways to boost eco-efficiency, mitigate climate change, improve transit, alleviate poverty and reduce ecological footprints in areas of high residential and employment density. Cities also provide potential for business in terms of the number and diversity of available human resources.

Yet the integrated nature of the modern city requires companies to collaborate with each other, their suppliers, their customers, local and national governments and maybe even their competitors to provide the optimum solutions. IT could allow resources to be used more efficiently. Smart health systems that allow patients to consult their doctors over the Internet, for example, not only free up resources in the health service, they also reduce the amount of traffic on the roads. City-wide building management

systems and smart grids would be able to reduce power demand at peak times, reducing the need for expensive and polluting peak power plants.

Higher population densities in urban centers are likely to change economic and political dynamics, however, creating new challenges for businesses. Where improvements in urban infrastructure lag behind population and economic growth, slums expand and the gap between rich and poor widens. While the proportion of urban populations living in slums is slowly declining, the absolute number is predicted to rise to an estimated 889 million by 2020, an increase of 7 percent from 2010 levels.³¹ Slums breed social instability and human conflict, yet even here, business can help by providing access to improved water, sanitation, housing, healthcare, education and employment opportunities.

“ Higher population densities in urban centers are likely to change economic and political dynamics. ”

³¹ UN Habitat. (2010). *State of the World's Cities 2010/2011 – Cities for All: Bridging the Urban Divide*.

“Global food prices are predicted to rise by 70–90 percent by 2030.”

Food Security

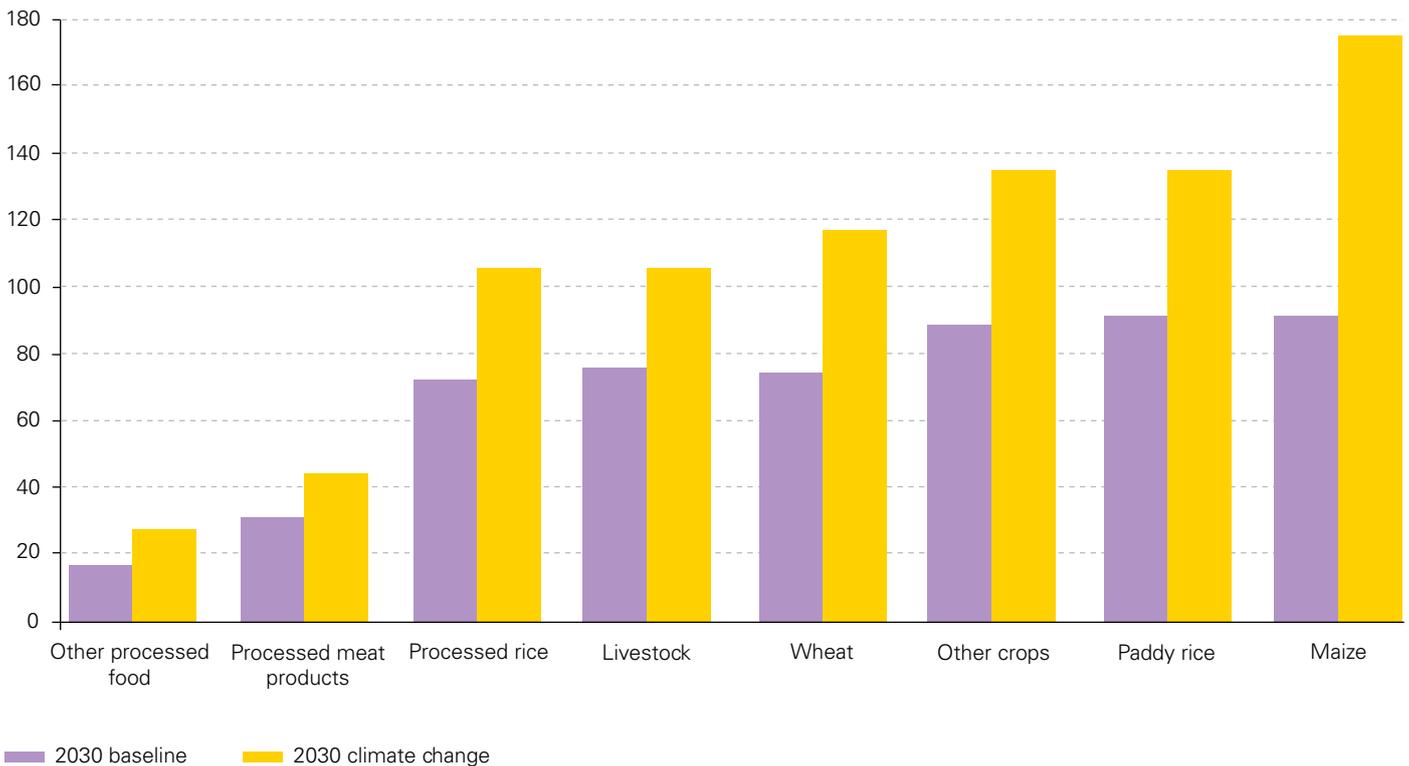
In the next two decades the global food system is set to come under increasing pressure from other megafactors including Population Growth, Water Scarcity and Deforestation. As a result, global food prices could rise by 70–90 percent by 2030. When the potential effects of Climate Change are factored in, prices could rise even higher (Figure 16).³²

In water-scarce regions, agricultural producers are likely to have to compete for supplies with other water-intensive industries such as electric utilities and mining and with consumers.

Large agricultural producers will likely find a ready market in the growing global middle class, and the resulting increased demand for more expensive products such as meat and dairy. Modernizing agricultural techniques in

Figure 16: Real food price changes predicted over the next 20 years

Increase in world market export prices relative to 2010 (%)



Source: Oxfam International. (2011). *Growing a Better Future: Food justice in a resource-constrained world*.

³² The material from *Growing a Better Future: Food justice in a resource-constrained world*, 2011, is reproduced with the permission of Oxfam GB, Oxfam House, John Smith Drive, Cowley, Oxford OX4 2JY, UK, www.oxfam.org.uk. Oxfam GB does not necessarily endorse any text or activities that accompany the materials. Please see also the research notes here: <http://policy-practice.oxfam.org.uk/publications/download?id=442758>

the developing world, particularly Africa, may provide opportunity for producers of fertilizers and other agricultural inputs.

Demand for food is expected to increase most in developing countries with their fast-growing populations and this will spur an increase in domestic production to mitigate the rising cost of food imports. Patterns of production are likely to be driven by crop yields, water availability, governance and consumer preferences. However, food security depends not only on the amount of food produced, but also on access to that food. Access will be driven by economic

development, especially for the poorest people, who spend roughly half their income on food.³³

If they enjoy strong economic growth, political stability, increased agricultural production and integration into the world market, developing countries should be able to improve food security. Such conditions are by no means certain, however. Another challenge will be to redistribute food surpluses in developed countries to areas with greater need. The number of chronically under-nourished people rose from 825 million in 1995-97 to over one billion in 2009.³⁴

“ Demand for food will increase most in developing countries with their fast-growing populations. ”



³³ Oxfam International. (2011). *Growing a Better Future: Food justice in a resource-constrained world*.

³⁴ Food and Agriculture Organization of the United Nations, FAO Media Centre (2009). *1.02 billion people hungry*. <http://www.fao.org/news/story/en/item/20568/icode/> (accessed 4 May 2012)

“ More companies are realizing how dependent their operations are on the critical services these ecosystems provide. ”

Ecosystem Decline

Historically, the main business risk of declining biodiversity and ecosystem services has been to corporate reputations. In recent years, food producers and retailers in particular have been targeted over the damage to ecosystems of their sourcing of certain products or raw materials, such as fish and timber.³⁵

However, as global ecosystems show increasing signs of breakdown and stress, more companies are realizing how dependent their operations are on the critical services these ecosystems provide. The decline in biodiversity and ecosystems is making natural resources scarcer, more expensive and less diverse – increasing the costs of water and escalating the damage caused by invasive species to sectors including agriculture, fishing, food and beverages, pharmaceuticals and tourism.

Continued degradation of global biodiversity and ecosystem services could increase the pressure on these and other industry sectors. It would add to operational risk and, in certain locations, potentially jeopardize the long-term profitability and survival of some of the most-affected sectors such as forest products, agriculture and fisheries. Companies further up the supply chain or that operate “upstream” may be more susceptible to operational and regulatory challenges, while companies down the supply chain

often have a greater degree of public exposure and therefore to potential reputation risks.³⁶

By paying attention to biodiversity and ecosystem health, companies can recognize the risks and opportunities, anticipate new markets, mitigate their impacts, improve stakeholder engagement, and demonstrate leadership.³⁷

Pharmaceuticals is one sector that is increasingly focused on the implications of biodiversity and ecosystem decline.

Healthy ecosystems and diverse species are essential to many valuable and difficult-to-replace services ranging from fresh water and food to pollution filtration, carbon storage and pollination.³⁸ The benefits of ecosystem services are increasingly recognized – the UN initiative entitled The Economics of Ecosystems and Biodiversity (TEEB), estimates that the value of avoided greenhouse gas emissions from conserving forests is US\$3.7 trillion, for example, while insect pollinators contribute US\$190 billion a year to agricultural output.³⁹ The Convention on Biodiversity’s 2010 Nagoya Protocol commits governments to value biodiversity and integrate it into their strategic decisions.⁴⁰ As a result, almost 200 countries have committed to produce plans to stop the loss and degradation of natural habitats. Business will be in the front line of implementing these plans.

³⁵ KPMG Climate Change and Sustainability Services. (2011). *Sustainable Insight: The Nature of Ecosystem Service Risks for Business*.

³⁶ KPMG Climate Change and Sustainability Services (2011). *Sustainable Insight: The Nature of Ecosystem Service Risks for Business*.

³⁷ World Resource Institute. (2008). *The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks and Opportunities Arising Among Ecosystem Change, Version 1.0*.

³⁸ The Economics of Ecosystems and Biodiversity (TEEB), 2010, *Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions, and recommendations of TEEB*

³⁹ The Economics of Ecosystems and Biodiversity (TEEB), 2010, *Executive Summary*

⁴⁰ Convention on Biological Diversity. (2011). *The Nagoya Protocol on Access and benefit-sharing*.

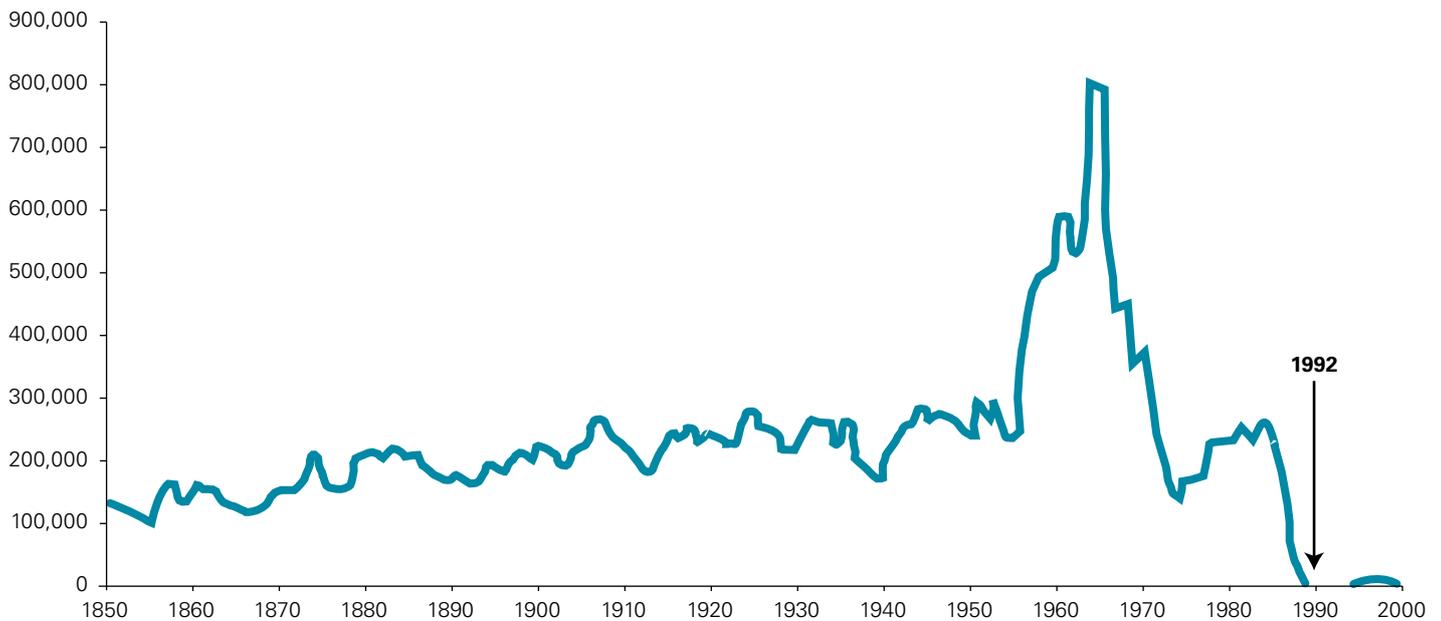
Exact biodiversity tipping points are uncertain. However, once this threshold is breached it is difficult, if not impossible, to return ecosystems to their former conditions. One of the most famous examples of this is the Newfoundland cod fishery, once so plentiful that fishermen joked you could step into the water and walk on

the backs of the fish. But having been fished for centuries, the area saw stocks collapse in the 1970s and then still further decline in the 1990s after decades of overfishing and they have still not recovered, partly because the ecosystem that previously supported the cod has changed in their absence (Figure 17).⁴¹

“Once this threshold is breached it is difficult, if not impossible, to return ecosystems to their former conditions.”

Figure 17: Atlantic cod stocks

Fish landings in tons



Source: UNEP/GRID-Arendal. (2005). Collapse of Atlantic cod stocks off the East Coast of Newfoundland in 1992. UNEP/GRID-Arendal Maps and Graphics Library. (Accessed 2012). Available at: <http://maps.grida.no/go/graphic/collapse-of-atlantic-cod-stocks-off-the-east-coast-of-newfoundland-in-1992>

⁴¹ Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being*. Washington, DC, USA: World Resources Institute.

“Cutting down forests – for agriculture, commerce or housing – directly reduces the supply of valuable natural resources and ecosystems services for business and the global community.”

Deforestation

Forests cover 31 percent of the world’s land surface and supply essential resources to local communities and the global economy, including timber, fruits and medicinal products.⁴² They also provide intangible but equally important services such as soil and water conservation, avalanche control and sand dune stabilization, as well as playing a vital role in reducing greenhouse gas emissions.

The timber industry and downstream industries such as pulp and paper are vulnerable to potential future regulation and market-based mechanisms such as Payments for Ecosystem Services (PES), which incentivize farmers and landowners to manage land for an ecological purpose. They may also find themselves under increasing pressure from customers to prove that their products are sustainable through the use of certification standards such as the Forest Stewardship Council (FSC), the Sustainable Forestry Initiative (SFI) and the Program for the Endorsement of Forest Certification (PEFC).

Agricultural industries seeking to meet higher demand for land-intensive products such as meat, dairy and even biofuels also need to be aware of the need to avoid sourcing products farmed on deforested land and to be able to prove they do so. Many developing countries are located in tropical forest zones where primary forests are uprooted to support the cattle, timber and paper, and palm oil industries.⁴³

Forests are crucial to the global carbon cycle – in 2010, they stored an estimated 289 gigatons of carbon, more than all the carbon in the atmosphere. However, deforestation means that this is 2.5Gt less than in 2005.⁴⁴ Cutting down forests – for agriculture, commerce or housing – directly reduces the supply of valuable natural resources and ecosystems services for business and the global community. It also removes a vital carbon sink and reduces the world’s ability to contain climate change. It hits agricultural productivity, human and animal health and economic activities such as ecotourism. It also increases land degradation and desertification by destabilizing soils, increasing erosion and reducing the cycling of nutrients through soils, according to the Intergovernmental Panel on Climate Change.⁴⁵

Deforestation is increasingly being driven by the consumption needs of developed economies and rapidly expanding developing economies, according to The Prince’s Rainforest Project. “In Indonesia and Brazil, the two countries accounting for nearly two-thirds of tropical rainforest loss between 2000 and 2005, a growing proportion of forest loss can be attributed to export-led commercial agricultural expansion. Palm oil, cattle and soybean production are the key commodities, but in other areas, cocoa, coffee and rubber production play a role, while mining and biofuels can indirectly contribute to forest loss. The global wood products industry is also a significant driver, both directly and indirectly by opening up the forest to other uses.”⁴⁶

⁴² Food and Agriculture Organization of the United Nations (FAO) (2010). *Global Forest Resources Assessment 2010*.

⁴³ Union of Concerned Scientists. (2011). *The Root of the Problem: What’s driving tropical deforestation today?*

⁴⁴ Food and Agriculture Organization of the United Nations (FAO) (2010). *Global Forest Resources Assessment 2010*.

⁴⁵ Joint Liaison Group of the Rio Conventions. (2007). *Forests: Climate Change, Biodiversity, and Land Degradation*

⁴⁶ The Prince’s Rainforest Project (2009). *An Emergency Package for Tropical Forests*.



Forests are big business – wood products contributed US\$100 billion per year to the global economy from 2003–2007.⁴⁷ The value of non-wood forest products, mostly food, is estimated at about US\$18.5 billion in 2005, although this is likely to be an underestimate because of the difficulty of valuing subsistence use of the forest.⁴⁸

The area covered by primary forests – those undisturbed by human activity – has fallen by more than 40 million hectares (an area larger than Germany or Japan) since 2000, mainly because of logging and other human intervention.⁴⁹ If the destruction of forests continues on its current trajectory, the OECD projects that forest areas will decline globally by 13 percent from 2005 to 2030, mostly in South Asia and Africa.⁵⁰

Reforestation with plantation forests is encouraging, but it does not support the rich biodiversity of a primary forest. Furthermore, most reforestation is happening in temperate zones. Primary boreal and tropical forests are most

vulnerable to unsustainable forestry practices and land conversion.⁵¹

While agriculture could drive an increase in deforestation, industries that depend on biodiversity for innovation, such as pharmaceuticals, could suffer from continued primary forest loss and have an incentive to prevent it. Business opportunities may arise through the development of market mechanisms and other economic incentives through PES and the REDD+ (Reducing Emissions from Deforestation and Degradation) process.⁵²

The UN REDD+ initiative has the potential to create a global forest carbon market and system of incentives to keep forests standing. However, it remains unclear exactly what impact REDD+ will have because an international framework has still not been agreed, even though some progress was made at the 2011 COP17 conference in Durban.

“The area covered by primary forests – those undisturbed by human activity – has fallen by more than 40 million hectares (an area larger than Germany or Japan) since 2000.”

⁴⁷ Food and Agriculture Organization of the United Nations (FAO) (2010). *Global Forest Resources Assessment 2010*.

⁴⁸ Food and Agriculture Organization of the United Nations (FAO) (2010). *Global Forest Resources Assessment 2010*.

⁴⁹ Food and Agriculture Organization of the United Nations (FAO) (2010). *Global Forest Resources Assessment 2010*.

⁵⁰ OECD. (2008). *OECD Environmental Outlook to 2030*.

⁵¹ OECD. (2008). *OECD Environmental Outlook to 2030*.

⁵² United Nations Environment Programme (2011). *Sustaining Forests: Investing in our common future. Part of the UNEP Policy Series (Ecosystem Management)*.

“ Many predictions extrapolate current rates of change without fully taking account of the impacts of other sustainability megaforces. ”

Summary

The set of ten global sustainability megaforces presented in this report are set to significantly affect the way the world does business over the next 20 years. However, while existing trend projections provide some insights about a possible future, they should not be relied upon to tell the whole story. Many predictions extrapolate current rates of change without fully taking account of the impacts of other sustainability megaforces that will reinforce, compete with, or balance particular factors.

For example, increasing wealth and the growth of the global middle class will accelerate demand for consumer goods and services, putting further pressure on the natural and material resources needed to produce them. Regional freshwater availability will struggle to keep pace with the increased agricultural production necessary to feed the growing population. Urbanization predictions do not account

for the potential impacts of climate change refugees migrating from areas where water and food scarcity hit hardest. Food production projections rarely factor in deteriorating soil quality and the competing demands for agricultural land.

Individual trend projections prepared without consideration of the entire system of sustainability megaforces no longer provide an adequate basis for strategic business decisions or government policies.

The world is too uncertain and too complex to rely on linear forecasts; therefore, business leaders and policy makers should prepare for the unexpected. This means learning to look at the world in a new way that takes account of globally interconnected megaforces, the causal relationships between megaforces, feedback loops, effective intervention points and complex scenarios.

Figure 18: Summary of business-as-usual global projections

(Variously from 2008/2010 through 2030/2035)

Megaforce	Indicator	% Change	Source
CLIMATE CHANGE	Energy-related CO ₂ emissions	+20	IEA
	Mean temperature rise	0.5-1.0 °C	IPCC & Others
ENERGY & FUEL	Primary energy demand	+33	IEA
	Net electricity generation	+84	EIA
MATERIAL RESOURCES	Raw materials extraction (excluding fossil carriers)	+55	SERI
WATER	Demand for water withdrawals	+53	2030 Water Resources Group
	% Population under water stress	+39	WEF
POPULATION	Total population	+20	UN
	% Population 65 and older	+50	UN
WEALTH	Middle-class purchasing power	+172	OECD
	Real gross domestic product	+130	Standard Chartered
URBANIZATION	Urban population	+44	UN
	Urban land cover km ²	+110	Seto, et. al. (2011)
FOOD SECURITY	Aggregate food demand	+50	FAO
	Key staples food prices	+70 to +90	Oxfam
ECOSYSTEMS	Terrestrial mean species abundance	-9 to -17	CBD GLOBIO
	Human ecological footprint	+33	GFN
DEFORESTATION	Net forest cover	-13	OECD
	Amazon forest loss	+55	WWF

See *General Selected Bibliography* (p. 160–165) for detailed source listings.

03

Acknowledging complexity – how sustainability megaforges interact

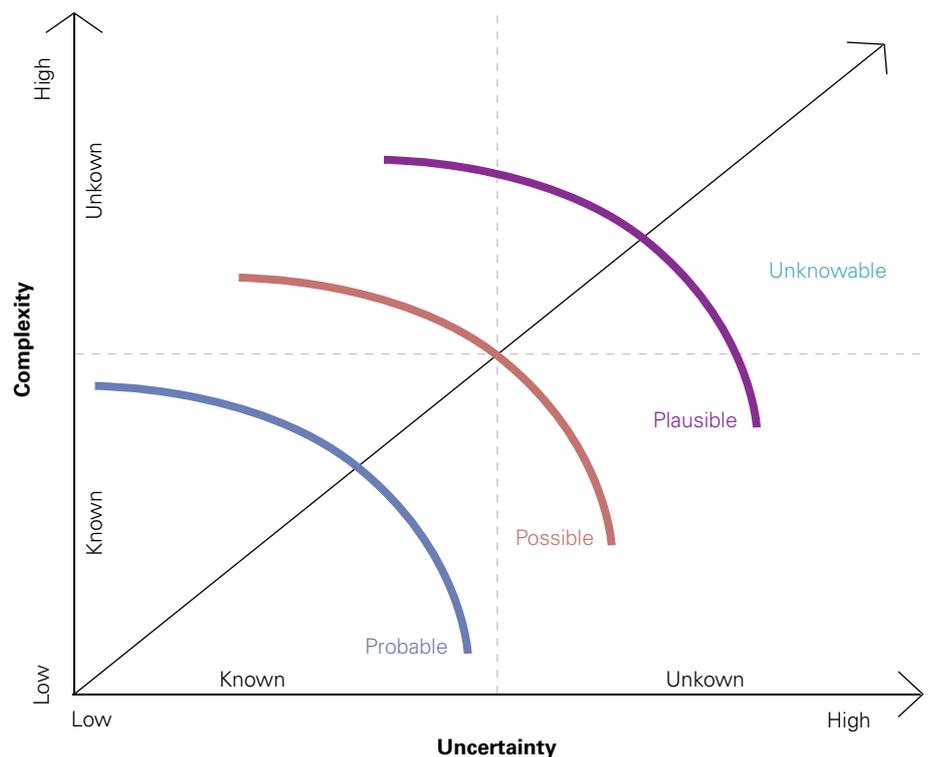
“ Many will find themselves increasingly in the challenging zone of improbable and unpredictable events. ”

The world is becoming more complex and uncertain

As outlined earlier in this report, factors such as globalization, digital connectivity and resource scarcity are forcing businesses to operate in an ever more complex world. This complexity is multiplied by unprecedented uncertainty, imperfect

information and rapid rates of change. The diagram below represents the loss of predictability as complexity and uncertainty increase. Few businesses still operate in the bottom left quadrant: “The Zone of Probability” defined by order, data, measurable risks and probabilities. Many will find themselves increasingly in the challenging top right zone of improbable and unpredictable events.

Figure 19: Going North-East



Source: Expect the Unexpected: Building business value in a changing world, KPMG International 2012



Businesses around the world are acknowledging complexity

To gain greater insight into how increasing complexity is impacting business around the world, KPMG International undertook a comprehensive study¹ of 1,400 senior corporate decision makers from 22 countries. The research clearly shows that the issue of complexity has risen to the top of the business agenda, with 94 percent of the executives saying that managing complexity is important to the success of their organization. The vast majority of executives say complexity has increased in the recent past, and most expect it to increase over coming years. These executives see complexity not only as a source of additional risk and cost, but most also believe that it is also creating new opportunities.

Interacting sustainability megaforges

While each of the global sustainability megaforges presented in the previous section of this report is significant in its

own right, it is important to understand that they are also closely interwoven with each other. To give just a few examples:

- Population Growth and Wealth increase Energy use which drives Climate Change
- Climate Change increases Water Scarcity and Food insecurity which combine to drive Urbanization as more people head for cities to escape deprivation
- Climate Change and Material Resource Scarcity drive Deforestation which in turn causes Ecosystem Decline
- Deforestation circles back to drive Climate Change as there are fewer trees to absorb carbon in the atmosphere.

The causes and effects of these complex relationships between sustainability megaforges are rarely proportionate, making it difficult to predict outcomes accurately; one cause can lead to many different outcomes, leading to surprises and unforeseen chain reactions.

“The causes and effects of these complex relationships between sustainability megaforges are rarely proportionate.”

¹ KPMG International presented the results of the *Confronting Complexity* study in 2011 at the World Economic Forum in Davos. As part of this research 1,400 senior executives were interviewed. They included CEOs, CFOs, and finance directors in a wide range of industries in 22 countries: Australia, Brazil, Canada, China, Denmark, France, Germany, India, Ireland, Italy, Japan, Mexico, Netherlands, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, the UK and the US. The complexity research data can be viewed from different angles via an interactive database at <https://www.kpmg.com/Global/en/WhatWeDo/Special-Interests/Confronting-Complexity/complexity-research-data/Pages/default.aspx>

“To thrive, or even just to survive, businesses increasingly need to understand the root causes of what affects their operations, not just the symptoms.”

Companies need to develop resilience and flexibility for this unpredictable future and build capacity to anticipate and adapt. Good management used to be about preparing for the expected, now it is just as much about preparing for the unexpected. To thrive, or even just to survive, businesses increasingly need to understand the root causes of what affects their operations, not just the symptoms.

Systems thinking around sustainability embraces the entire structure of megaforges rather than its individual constituents. It looks at patterns of change and acknowledges the growing importance of low probability but high impact events.

Problems experienced with first generation biofuels provide an example of how actions taken without a full understanding of the interconnected system can result in unintended consequences. Biofuels made from corn or palm oil, which were intended to reduce greenhouse gas emissions, have contributed to higher food prices by competing with food crops for land, are expensive and produce only limited GHG reduction benefits, according to a report by the International Energy Forum.² They also accelerate deforestation, compete for scarce water resources in some areas and can have a negative impact on biodiversity. Furthermore, they are reliant on the dynamics of the agricultural commodities sector for the price of their inputs but on the oil market for the price of their outputs, which has led to price volatility.

“In most countries, policies that encourage the rapid growth of biofuel production have outpaced our understanding of the potential impact of biofuels on the environment, sustainable utilization of natural resources and food security,” says the International Energy Forum.³

Systems thinking is an important way to assess and manage new risks comprehensively and uncover risks that were previously unidentified. For example, a company may understand its direct dependency on water, but may not have thought about how the supply of its material resources could be impacted by increasing water scarcity.

Companies may already be using systems thinking in the business, for example in strategic planning, revenue management or supply chain planning but in our view it should be more applied as part of a proactive sustainability strategy. Because all businesses operate within their own set of variables, the individual systems approach will be unique to each business but the simplified examples given in this report serve to demonstrate the principles.

The systems approach to sustainability

A coherent picture of how sustainability megaforges interact and impact business can be built through the technique of “causal loop diagramming” (CLD).

In CLD, forces are linked by arrows labeled “S” – implying movement in the same direction and “O” implying movement in the opposite direction. If two forces are moving in the same direction, then an increase in one will cause an increase in the other. If they are moving in opposite directions, then an increase in one will cause a decrease in the other. Dotted lines represent relationships between forces that will take time to develop and therefore have a delayed impact. With links between forces mapped out, “causal loops” can be identified where a chain of forces circles back to increase or decrease the power of the original force. For example, more Wealth and Urbanization increases consumption of Water and Food. This

² International Energy Forum (February 2010). *Assessment of Biofuels Potential and Limitations*.

³ International Energy Forum (February 2010). *Assessment of Biofuels Potential and Limitations*.

reduces Water and Food Security, which then circles back to further increase Urbanization as more people migrate to cities to escape deprivation in rural areas. Several of these loops can be in train at any one time, further complicating the picture for business.

The nexus approach

The nexus approach has been widely used by the World Economic Forum, the German Federal Government and others to explore the driving forces behind the challenge of water security and its relationships with climate change, food and energy production.

For the purposes of this report we have developed three nexuses which together represent the challenges of sustainable growth. We believe companies will

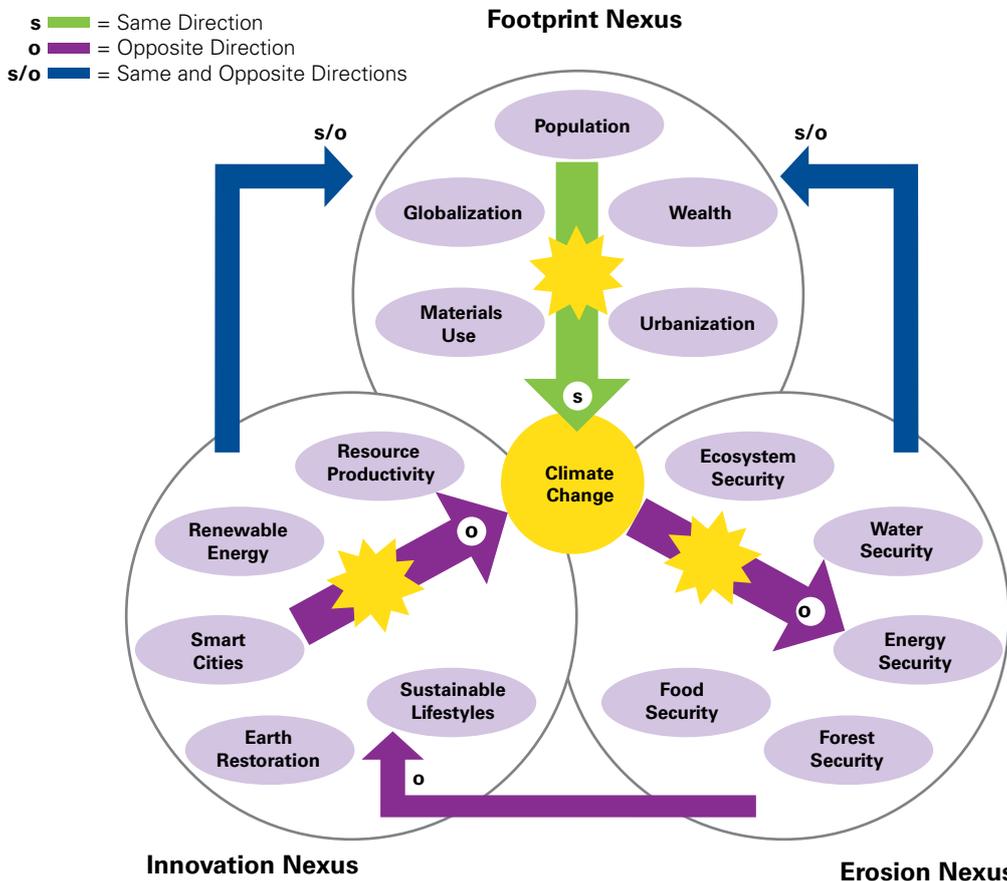
benefit from exploring these nexuses in their own organizational context:

- 1) The Footprint Nexus: the forces driving the escalating “footprint” of mankind on the planet
- 2) The Erosion Nexus: the resulting changes in the natural systems on which we depend
- 3) The Innovation Nexus: the opportunity to address sustainability challenges through business innovation

The Footprint and Erosion nexuses together create an imperative to increase resource efficiency and reduce dependency on commodities that are likely to suffer supply restrictions and price volatility. The Innovation Nexus provides the solutions that may enable businesses to do so. *Figure 20* below illustrates how the three nexuses are linked by Climate Change.

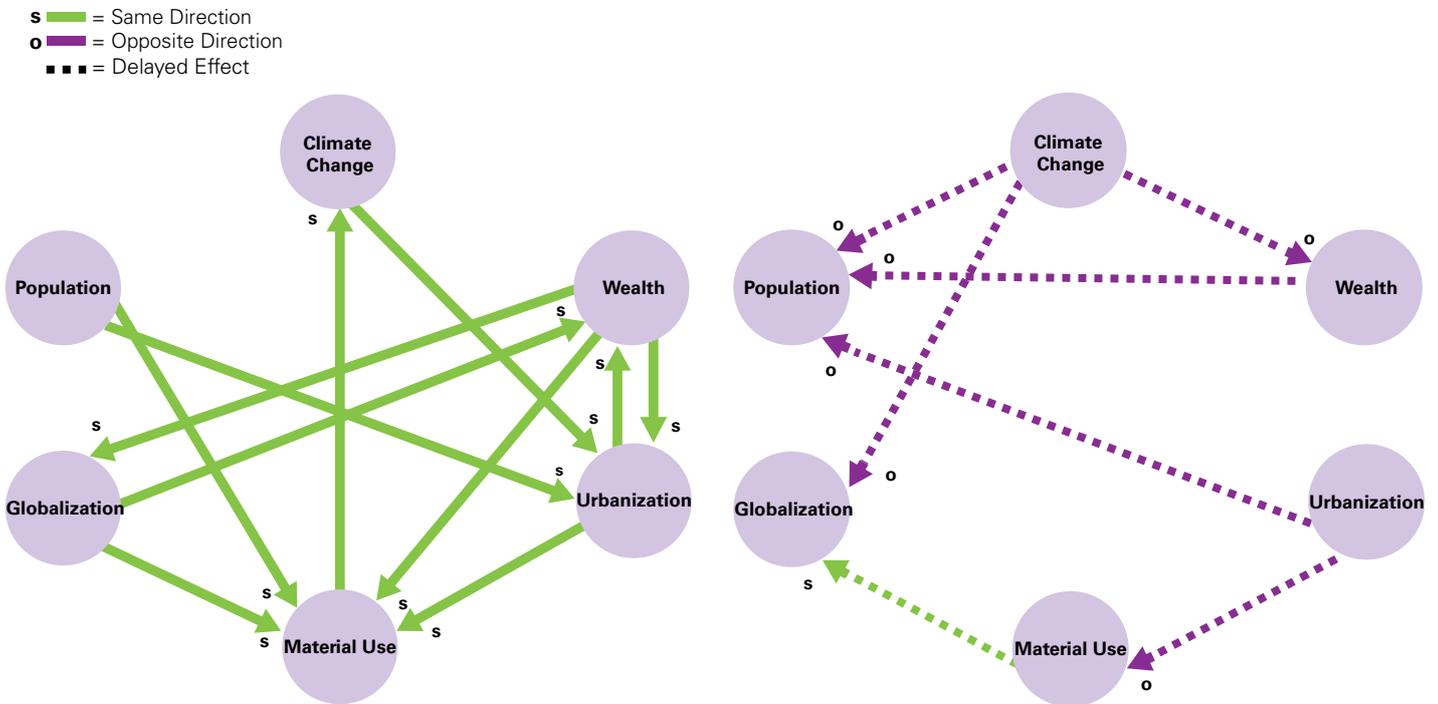
“The Footprint and Erosion nexuses together create an imperative to increase resource efficiency and reduce dependency on commodities that are likely to suffer supply restrictions and price volatility.”

Figure 20: The Nexus Approach



Source: *Expect the Unexpected: Building business value in a changing world*, KPMG International 2012

Figure 21: The Footprint Nexus



Source: Expect the Unexpected: Building business value in a changing world, KPMG International 2012

“As a result, the relationships between megaforges in the system will shift over time in often surprising ways that companies need to try to anticipate.”

The Footprint Nexus

The Footprint Nexus (*Figure 21*) helps companies to grasp emerging risks and opportunities, build resilience and flexibility to deal with surprises, and capacity to exploit unpredictable opportunities. The nexus helps us to understand that physical expansion for ever is impossible – something has got to give, and when it does business, will inevitably be affected.

It is a system whose causal relationships are mainly non-linear, meaning that the impact of events is neither certain nor predictable. As a result, the relationships between megaforges in the system will shift over time in often surprising ways that companies need to try to anticipate.

Central to this nexus are the mutually reinforcing relationships between Globalization and Wealth; and between Wealth and Urbanization. All three of those megaforges serve to drive up the use of Energy and Material Resources which in turn increases Climate Change. Shocks that could come from this nexus include:

- The failure of global commodities and resources to keep pace with demand from the growing Asian middle class, leading to substantially higher costs for these products;
- Declines in global GDP and trade flows if the adverse impacts of climate change emerge more severely or much earlier than predicted;

- An increase in the number of climate change refugees leading to an increase in slum dwellers and a consequent large scale shift from biomass to fossil fuel use; and
- More land purchases in Africa and South America by foreign investors seeking to secure food and raw materials.

Without interventions, this system increases Energy and Material Resource use and Climate Change until in the very long term balancing forces would come into play. For example, increasing Wealth leads to smaller families, slowing or even reversing Population Growth but creates new challenges such as the increased cost of healthcare as people live longer and the incidence of health conditions such as obesity and diabetes rises. Similarly, adverse impacts of Climate Change such as major rises in sea level could also act to reduce Wealth.

Companies can use the Footprint Nexus to understand how the world's future sustainability challenges may affect them – putting them in a stronger position to manage risks and seek out opportunities. Also, because radical interventions are required to stabilize the system, using the Footprint Nexus can help businesses to anticipate how government policy may develop and how they can prepare for and influence those policies.

The Erosion Nexus

The Erosion Nexus (*Figure 22*) helps companies to foresee the many ways in which climate change and its linked megafactors could affect their business. It helps to identify Climate Change future risk and develop strategic

responses, to reduce exposure to higher environmental costs and to discover potential synergies.

As with the Footprint Nexus, the Erosion Nexus also helps to anticipate future government policy. For example, with less water available, will governments legislate to increase prices, compel water-intensive industries to use less water or revoke licenses?

A key element of the Erosion Nexus is the complex sub-nexus linking energy, food, water and climate change. Difficult tradeoffs abound here.⁴ For example, using more coal and natural gas, and converting more agricultural land to biofuel production increases energy security but diverts water use toward energy production. It is also likely to accelerate forest and ecosystem loss, increase carbon emissions and impact global food supplies.

Moving, distributing and purifying water requires large amounts of energy; large amounts of water are needed to generate energy through the extraction, mining and processing of coal as well as in the cooling of power station generation systems. Huge amounts of both energy and water are required to prepare, fertilize, irrigate and harvest land in modern resource-intensive farming (accounting for approximately 70 percent of the world's freshwater use).⁵

Assessing the Erosion Nexus in a business context may generate insights such as:

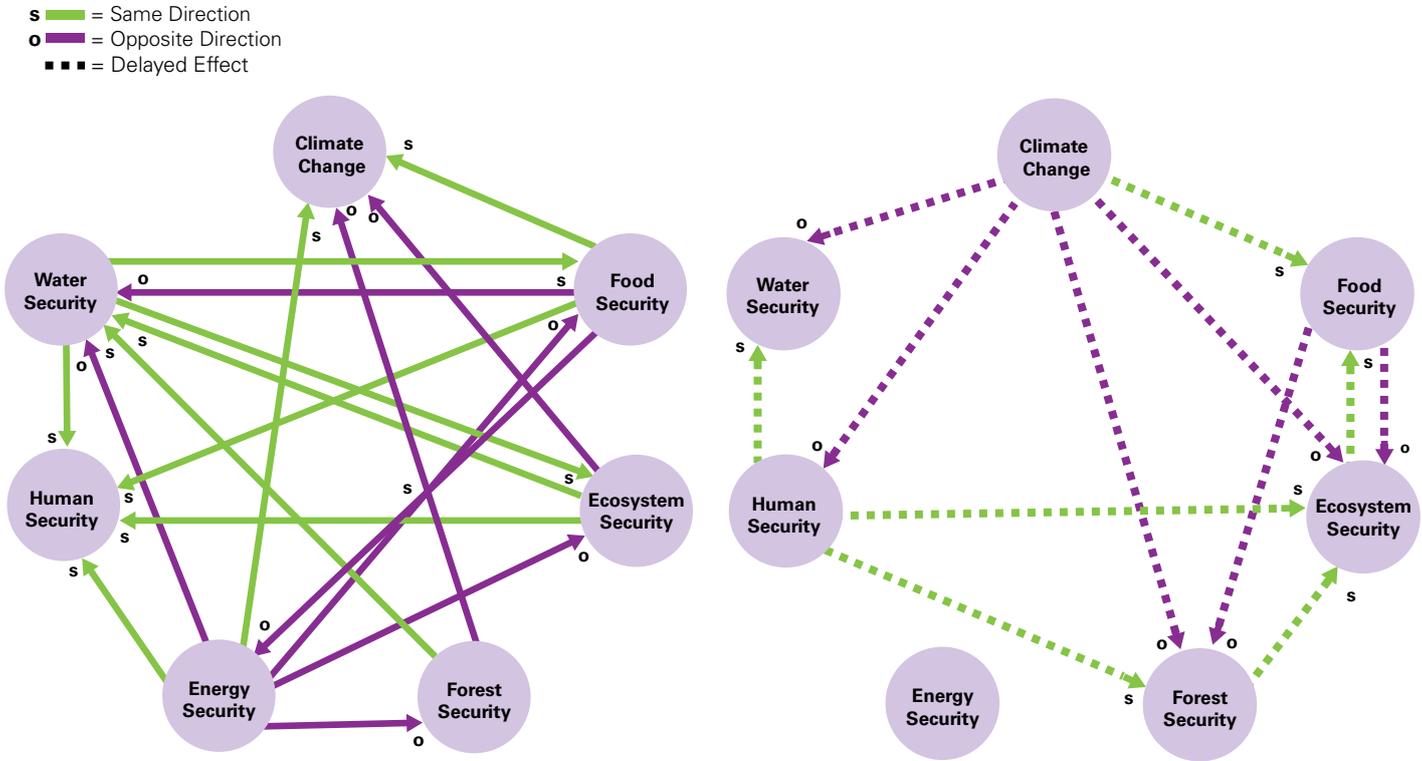
- Demand and supply stresses are likely to be concentrated in areas such as China and India that already experience massive challenges of water availability and agricultural productivity;

“Without interventions, this system increases Energy and Material Resource use and Climate Change until in the very long term balancing forces would come into play.”

⁴ Hoff, H., Stockholm Environment Institute, *Understanding the Nexus: Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Nexus* (Stockholm: Stockholm Environment Institute, 2011).

⁵ FAO Natural Resources Management and Environment Department, *Water NEWS: Climate Change and Water*, <http://www.fao.org/nr/water/news/clim-change.html> (accessed 10 May 2012)

Figure 22: The Erosion Nexus



Source: Expect the Unexpected: Building business value in a changing world, KPMG International 2012

“By considering the full system of sustainability megaforges, companies are more likely to avoid “quick fixes” that result in unforeseen problems.”

- Volatility in energy and food prices is likely to increase.
- Economic activity in areas vulnerable to high water, food and climate risks may struggle to secure insurance cover.
- Global economic activity would gravitate toward areas of greater freshwater abundance and arable land, and lower climate disruption.
- There are opportunities for innovations that reduce the resource intensity of goods and services.

Companies seeking to manage risks by reducing their environmental footprints can use the Erosion Nexus to assess the broader and longer term

impacts their proposed actions may have. By considering the full system of sustainability megaforges, companies are more likely to avoid “quick fixes” that result in unforeseen problems and greater risks in the long term.

The Innovation Nexus

The previous two nexuses have shown how businesses can more fully understand the risks their organization faces from the system of sustainability megaforges. The Innovation Nexus (Figure 23) shows how companies can use the same systems approach to develop business opportunities by innovating solutions to sustainability problems.

“It is not so much the nature of the complexity a company faces that will determine its success, but the extent to which a company can effectively analyze its situation and bring resources to bear.”

The same will hold true for companies. Understanding the risks and opportunities highlighted by the sustainability systems approach should not only create new business opportunities, it should enable them to better navigate the challenges of the future.

Staying simple or using complexity as a stimulus

As it is unrealistic to expect complexity to decline in an increasingly sophisticated world, companies need to decide how to confront complexity. The KPMG International Confronting Complexity study suggests that broadly there are two strategies for dealing with complexity. You can either try to avoid it or embrace it.

There are organizations in every sector that have done well by keeping their business models simple. They do what they know, provide a valued set of goods or services in an efficient way, and avoid markets they don't understand.

The alternative view is that complexity is a necessary part of a vibrant and rapidly developing market. It drives innovation by presenting a constant stream of new problems to solve. It highlights areas of outdated thinking and forces businesses to improve constantly. This is a common view held by many of the emerging economy businesses. For these companies, cutting through complexity to focus sharply on the opportunities it presents is a major part

of their corporate strategy. These may not be comfortable strategies, and they require a personal commitment from managers determined to keep pace with rapidly changing environment.

KPMG's Confronting Complexity study also indicated that in the end it is not so much the nature of the complexity a company faces that will determine its success, but the extent to which a company can effectively analyze its situation and bring resources to bear. To this end companies need to seek ways to understand the impact of the system of sustainability megafactors. One way of doing this is to apply both quantitative and qualitative foresight techniques.

Potential disruptors: The climate-water-energy-food nexus

One potential disruptive systemic event is the possibility that Climate Change and Water Scarcity will combine with rising Energy prices to create a Food crisis.

Recent research indicates that crop yields decline at an increasing rate once temperatures rise above 84°F (for corn) to 86°F (for soybeans).⁶ In fact, just one day with temperatures 10°F above the optimal level is estimated to be as harmful to crop yields as 10 days that are 1°F above optimal.⁷ As both average and extreme temperatures continue to increase, crop yields in many parts of the world could fall.

⁶ Wolfram Schlenker and Mark J. Roberts. 2009. "Non-linear Temperature Effects Indicate Severe Damages to U.S. Crop Yields under Climate Change," Proceedings of the National Academy of Sciences, 106(7): 15594-15598.

⁷ Schlenker, Wolfram (2011). *Research on Climate Change Impacts and Associated Economic Damages*. Columbia University and the U.S. National Bureau of Economic Research (NBER).

Furthermore, climate change threatens to exacerbate water scarcity in much of the world. The combination of climate change and water scarcity could lead to a severe reduction in both food and beverage production. At the same time, water scarcity could raise costs and reduce production in several other water-intensive sectors, including electricity, chemicals and industrial metals. If energy prices continue to rise – which is likely as rapid economic growth continues in China, India, Brazil and other emerging nations – this would raise the costs of food production further.

In turn, declining food security is likely to have a series of serious consequences including rising healthcare costs, labor shortages, higher labor costs and more homelessness. Such factors are likely to increase global tensions over resources, and water wars could develop in water-stressed regions such as the Himalayas and Sub-Saharan Africa. Economic growth would be threatened by the increasing costs of labor and energy, and unemployment would grow. Social stability could be at risk.

This set of changes could create difficult challenges for many industries, as costs increase on several fronts at once. At the same time, certain sectors will find new opportunities to provide climate adaptation solutions, to offer potable water in innovative ways, and to better monitor and manage water usage and food production. The exact mix of risks and opportunities will depend upon how public policy responds to the emerging trends.

Climate change mitigation as well as adaptation, potentially driven by global agreements, should provide an array of opportunities for industry, although it will also impose additional costs on energy-intensive sectors. A lack of global policy action is likely to mean that climate-related innovation opportunities will be primarily linked to adaptation.

In dealing with change some firms will find it difficult to innovate effectively under challenging circumstances. Others will exploit the emerging opportunities, and disruptive technologies may overturn the existing order in the sector.

“ Certain sectors will find new opportunities to provide climate adaptation solutions. ”

04

Future Scenarios

“ Successfully navigating this turbulent future will require businesses to develop anticipatory awareness, adaptive capacities and resilient strategies and structures. ”

The previous sections of this report suggest that the next few decades will be marked by rising complexity, uncertainty, volatility and an accelerating pace of change. The future is set to become increasingly less predictable and full of surprises. Successfully navigating this turbulent future will require businesses to develop anticipatory awareness, adaptive capacities and resilient strategies and structures. Moving into a world of “unknown-unknowns” demands a shift of thinking away from predictable and single futures to plausible and multiple alternative futures.

Quantitative modeling can help to generate and explore varied scenarios of the future under conditions of moderate complexity and uncertainty. In this zone, our understanding of relationships is high and assumptions can be analyzed with the help of reliable data. With data, models can be calibrated and simulations and sensitivity analyses can be performed using methodologies such as systems dynamics or integrated assessment models.

Rigorous quantitative models can only be simplified representations of reality but they do enable businesses to explore the consequences of alternative assumptions, pinpoint uncertainties and define probabilities. They can also help

in examining trade-offs, understanding core dynamics and generating new questions and perspectives.

Figure 24 shows a sample of recent quantitative scenario exercises exploring futures for biodiversity loss, climate adaptation costs, energy policy and other sustainability issues.

The usefulness of formal mathematical modeling diminishes as horizons extend further into the future. The future essentially becomes unknowable but not unthinkable. Under these conditions, futurists generally turn to scenario methods based on qualitative story-telling or narratives. These are carefully crafted, plausible and coherent stories about the future which intertwine powerful driving forces, key uncertainties, shocks and transformational dynamics.

Businesses can use these stories to design strategies and take decisions which are robust under a wide range of possibilities. Hundreds of multiple qualitative scenarios have been created and are publicly available. *Figure 25* provides a brief overview of a dozen recent scenarios of value to corporate sustainability strategy. Some are general and useful to all industry sectors; others are of greater use to particular sectors.



Figure 24: Multiple scenarios based on quantitative modeling (For a full list of source documents see Appendix 3).

Topic:	Author:	Report Date:	Time Horizon:	Key Message:
Biodiversity	Secretariat of the convention on Biological Diversity	2010	2100	Tipping points for large, rapid and irreversible loss of biodiversity; high variability in long-term projections
Climate adaptation	World Bank	2010	2050	Adaptation costs huge, especially in East Asia and the Pacific; need for robust strategies given climate uncertainty
Climate change	Moss, et. al.	2010	2100	The next generation of scenarios for climate change research and assessment by the IPCC
Energy policy	International Energy Agency	2011	2035	Without bold policy changes, great risk of “locking” into an insecure, inefficient and high carbon energy system
Food system	Foresight UK	2011	2050	Global food system must be transformed on the scale of the industrial revolution
Freshwater	United Nations	2011/2012	2050	Managing water on a global scale has become extraordinarily uncertain and risky given climate change
Green economy	UNEP	2011	2050	Investing two percent of global GDP into 10 sectors annually could greatly assist the transition to a low-carbon, resource efficient global economy
Population	United Nations	2011	2100	With only a small variation in progress toward lower fertility, world population in 2050 could be 10.6 rather than 9.3 billion
Renewable energy	WWF Intl.	2010	2050	A provocative scenario by which all of the world’s energy supply could be met by renewable energy by 2050 in an effective and cost-efficient manner
Resource decoupling	UNEP	2011	2050	Three scenarios for future global materials use; radical innovations needed to achieve resource and impact decoupling from economic growth and human welfare

Figure 25: Multiple scenarios based on qualitative narratives (For a full list of source documents see Appendix 3).

Topic:	Author:	Report Date:	Time Horizon:	Key Message:
Climate/development	Forum for the Future	2010	2030	Scenarios for low-income countries in a climate-changing world
Climate futures	Forum for the Future	2008	2030	Strategies that will work in a complex and uncertain world dominated by climate change
Global energy	Shell International	2008/11	2050	World has entered a huge “zone of uncertainty” on the gap between energy demand and supply
Global ecosystems	Millennium Ecosystem Assessment	2005	2050	Pressures on ecosystem services will increase globally with increased risk of nonlinear change
Global environment	UNEP	2007	2050	Risks of crossing thresholds and need to account for inter-linkages
Global mega-crisis	Halal/Marien	2011	2033	Classic debate between a global optimist and pessimist
Global pathways	Tellus Institute	2010	2100	The fundamental forces driving world development away from or towards sustainability
Map of the decade	Institute for the Future	2010	2020	How the near-term will be shaped by discontinuities and dilemmas
Urban mobility	Forum for the Future, et.al.	2010	2040	The future of mega-cities and solutions for urban mobility and accessibility
Technology/development	Rockefeller/GBN	2010	2030	The transformative role of technology in positive and negative ways in shaping resilience and equitable growth
Vision 2050	WBCSD	2010	2050	Vision of a sustainable world in 2050 with pathways that will require fundamental changes in governance structures, economic frameworks, business and human behavior
Water and business	WBCSD	2006	2025	Three stories about the potential role of business in navigating the rapidly changing world of water

The qualitative scenarios in *Figure 25* vary according to purpose, time horizon and content. Most of them, however, extend at the extremes from pessimism to optimism about the future. *Figure 26* classifies the scenarios referenced in *Figure 25* according to whether they emphasize collapse, growth, constraint or transformation. These four categories have emerged as the central organizing principles in many recent multiple scenario exercises.

Adding some “color,” the growth scenario could be considered to be brown; it represents conventional business-as-usual dominated by growth ambitions, market logic, complacency and natural system erosion. The world of constraint could be construed as green, implying regulations and reforms aimed at decoupling growth from natural resource consumption and adverse environmental impacts; this is a world of resource substitution, efficiency, conservation and protection. Much sustainability foresight work focuses on the consequences of brown versus green economic futures.

The most negative world of collapse is best captured by the color red and associated images of breakdown, conflict, crises, corruption, suffering, disorder and weak institutions. The most uplifting world of transformation is best contemplated as blue, with associated positive visions of revolutionary transitions toward harmony with nature, social justice, community, innovation and resilience.

These four possibilities for the future are not mutually exclusive. They are likely to mix in a variety of patterns, manifest and shift over time, and differ substantially across regions. Each plausible world is full of different risks and opportunities. Business leaders should ask three tough questions about the emergence of alternative brown, green, red and blue global futures:

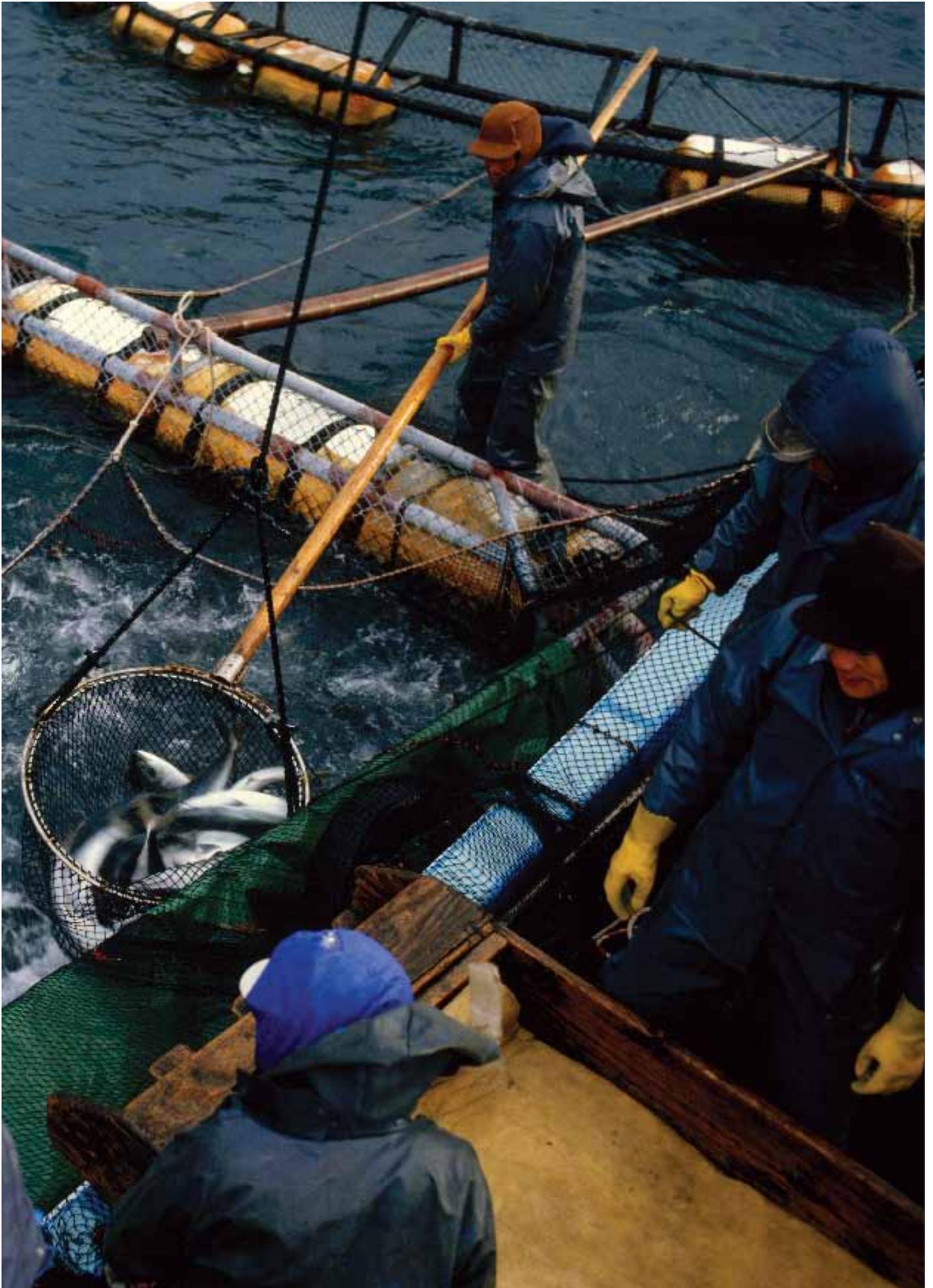
- 1) How is our organization contributing, in positive or negative ways, to each of these possible futures?
- 2) Are our current strategies and structures robust to the consequences of these diverse futures?
- 3) Do we have the necessary learning, innovation and risk management capacities in place to navigate these possible futures effectively?

Using scenarios to build resilience is key to business survival in the presence of complexity and uncertainty and helps companies discover strategies for a range of plausible futures. Scenario analysis helps to identify systemic risks that may emerge from the interactions of sustainability megaforges and provides a context for identifying growth opportunities before they become mainstream. It deepens organizational learning by pushing beyond conventional wisdom and shifts thinking from specifics to generalities, and from what we know to what we don't know. A bibliography of scenario sources used to compile this section can be found in Appendix 3.

“ Scenario analysis helps to identify systemic risks that may emerge from the interactions of sustainability megaforges. ”

Figure 26: Scenario themes from qualitative narratives (For a full list of source documents see Appendix 3).

Brown world: <i>Growth</i>	Blue world: <i>Transformation</i>
<ul style="list-style-type: none"> • “Markets First” (UNEP, 2007) • “Market Forces” (Tellus, 2010) • “Muddling Down” (Halal/Marien, 2011) • “Lock-Step” (Rockefeller/GBN, 2010) • “One Step Ahead of Disaster” (IFTF, 2010) • “Global Orchestration” (MEA, 2005) • “Reversal of Fortunes” (FFF, 2010) • “Environmental War Economy” (FFF, 2008) • “Planned-Opopolis” (FFF, 2010) • “Hydro-Efficiency” (WBCSD, 2006) • “Turbulent Teens” (WBCSD, 2010) • “Scramble” (Shell, 2008/11) 	<ul style="list-style-type: none"> • “Sustainability First” (UNEP, 2007) • “Great Transitions” (Tellus, 2010) • “Rise to Maturity” (Halal/Marien, 2011) • “Clever Together” (Rockefeller/GBN, 2010) • “Super-Structured Systems” (IFTF, 2010) • “Adapting Mosaic” (MEA, 2005) • “The Greater Good” (FFF, 2010) • “Redefining Progress” (FFF, 2008) • “Communi-City” (FFF, 2010) • “Ocean: Interconnectivity” (WBCSD, 2006) • “Transformation Time” (WBCSD, 2010)
Red world: <i>Collapse</i>	Green world: <i>Constraint</i>
<ul style="list-style-type: none"> • “Security First” (UNEP, 2007) • “Fortress World” (Tellus, 2010) • “Decline to Disaster” (Halal/Marien, 2011) • “Hack Attack” (Rockefeller/GBN, 2010) • “Local Disasters/Regional Conflicts” (IFTF, 2010) • “Order From Strength” (MEA, 2005) • “Coping Alone” (FFF, 2010) • “Protectionist World” (FFF, 2008) • “Sprawl-Ville” (FFF, 2010) 	<ul style="list-style-type: none"> • “Policy First” (UNEP, 2007) • “Policy Reform” (Tellus, 2010) • “Muddling Up” (Halal/Marien, 2011) • “Smart Scramble” (Rockefeller/GBN, 2010) • “Sustainable Paths” (IFTF, 2010) • “Techno-Garden” (MEA, 2005) • “Age of Opportunity” (FFF, 2010) • “Efficiency First/Service Transform” (FFF, 2008) • “Renew-Abad” (FFF, 2010) • “Rivers: Security” (WBCSD, 2006) • “Blueprints” (Shell, 2008/11)



Appendix 1: Methodology

Global Sustainability Megaforges

The global sustainability 'megaforges' identified as key drivers of future change in Part 1 of this report are: Climate Change; Energy & Fuel; Material Resource Scarcity; Water Scarcity; Population Growth; Urbanization; Wealth; Food Security; Ecosystem Decline; Deforestation.

The megaforges were identified through a review of over 30 external future trend projections a list of which can be found in Appendix 2.

Scenarios Interpretation

The scenarios interpretation in Part 1 of this report is based on a review of over 20 external future scenario research documents a list of which can be found in the bibliography included in Appendix 3.

Sector Definitions

The analysis in Part 2 of this report covers industry sectors defined according to the Industry Classification Benchmark (ICB) structure: a definitive system categorizing over 70,000 companies and 75,000 securities worldwide and maintained by FTSE International Limited. The ICB system recognizes four levels of industry aggregation: industry, supersector, sector, and subsector.

Most of the analysis was conducted at the sector level, but in a few cases data was analyzed at the industry level to capture an important industry fully, or at the subsector level in order to capture detail. This report covers:

Airlines (subsector): Companies providing primarily passenger air transport. Excludes airports.

Automobiles & Parts (sector): Makers of motorcycles and passenger vehicles, including cars, sport utility vehicles (SUVs) and light trucks. Manufacturers and distributors of new and replacement parts for motorcycles and automobiles, such as engines, carburetors and batteries. Manufacturers, distributors and retailers of automobile, truck and motorcycle tires. Excludes makers of heavy trucks and makers of recreational vehicles (RVs and ATVs).

Beverages (sector): Manufacturers and shippers of cider or malt products such as beer, ale and stout. Producers, distillers, vintners, blenders and shippers of wine and spirits such as whisky, brandy, rum, gin or liqueurs. Manufacturers, bottlers and distributors of non-alcoholic beverages, such as soda, fruit juices, tea, coffee and bottled water.

Chemicals (sector): Producers and distributors of simple chemical products that are primarily used to formulate more complex chemicals or products, including plastics and rubber in their raw form, fibreglass and synthetic fibres. Producers and distributors of finished chemicals for industries or end users, including dyes, cellular polymers, coatings, special plastics and other chemicals for specialized applications. Includes makers of colourings, flavours and fragrances, fertilizers, pesticides, chemicals used to make drugs, paint in its pigment form and glass in its unfinished form. Excludes producers of paint and glass products used for construction.

Electricity (sector): Companies generating and distributing electricity through the burning of fossil fuels such as coal, petroleum and natural gas, and through nuclear energy. Companies generating and distributing electricity from a renewable source. Includes companies that produce solar, water, wind and geothermal electricity.

Food Producers (sector): Companies that grow crops or raise livestock, operate fisheries or own nontobacco plantations. Food producers, including meatpacking, snacks, fruits, vegetables, dairy products and frozen seafood. Includes producers of pet food and manufacturers of dietary supplements, vitamins and related items. Includes manufacturers of livestock feeds and seeds and other agricultural products. Excludes producers of fruit juices, tea, coffee, bottled water and other non-alcoholic beverages, which are classified under Beverages. Excludes manufacturers of fertilizers or pesticides, which are classified under Chemicals.

Industrial Metals & Mining (sector): Companies that mine or process bauxite or manufacture and distribute aluminium bars, rods and other products for use by other industries. Producers and traders of metals and primary metal products other than iron, aluminium and steel. Manufacturers and stockholders of primary iron and steel products such as pipes, wires, sheets and bars, encompassing all processes from smelting in blast furnaces to rolling mills and foundries. Includes companies that primarily mine iron ores. Excludes manufacturers of finished aluminium products, such as siding, which are categorized according to the type of end product. Excludes companies that make finished products, which are categorized according to the type of end product.

Mining (sector): Companies engaged in the exploration for or mining of coal. Companies engaged in the exploration for and production of diamonds and other gemstones. Companies engaged in the exploration, extraction or refining of minerals not defined elsewhere within the Mining sector. Prospectors for and extractors or refiners of gold-bearing ores. Companies engaged in the exploration for and production of platinum, silver and other precious metals not defined elsewhere.

Marine Transportation (subsector): Providers of on-water transportation for commercial markets, such as container shipping. Excludes ports and shipbuilders.

Oil & Gas (industry): Companies engaged in the exploration for and drilling, production, refining and supply of oil and gas products. Integrated oil and gas companies engaged in the exploration for and drilling, production, refining, distribution and retail sales of oil and gas products. Suppliers of equipment and services to oil fields and offshore platforms, such as drilling, exploration, seismic-information services and platform construction. Operators of pipelines carrying oil, gas or other forms of fuel. Excludes pipeline operators that derive the majority of their revenues from direct sales to end users, which are classified under Gas Distribution. Companies that develop or manufacture renewable energy equipment utilizing sources such as solar, wind, tidal, geothermal, hydro and waves. Companies that produce alternative fuels such as ethanol, methanol, hydrogen and bio-fuels that are mainly used to power vehicles, and companies that are involved in the production of vehicle fuel cells and/or the development of alternative fuelling infrastructure.

Telecommunications (industry), Telecommunications Equipment (sector) and Internet (subsector): Providers of fixed-line telephone services, including regional and long-distance. Includes companies that primarily provides telephone services through the internet. Providers of mobile telephone services, including cellular, satellite and paging services. Includes wireless tower companies that own, operate and lease mobile site towers to multiple wireless service providers. Makers and distributors of high-technology communication products, including satellites, mobile telephones, fibres optics, switching devices, local and wide-area networks, teleconferencing equipment and connectivity devices for computers, including hubs and routers. Companies providing Internet-related services, such as Internet access providers and search engines and providers of Web site design, Web hosting, domain-name registration and e-mail services.

Further information on the ICB structure can be found at www.icbenchmark.com

Quantitative Analysis: Value at stake and environmental intensity

The quantitative data in Part 2 of this report is generated by Trucost, an independent environmental research agency. The data use a pricing methodology that calculates the cost to global society of environmentally-sensitive corporate activities. These include inputs such as resource use and outputs such as greenhouse gas and pollutant emissions. The data set is based on the operations of over 800 companies between 2002 and 2010 (2010 being the most recent available data) and representing the 11 key business sectors. The selection of companies is representative, as an exact comparison of companies between the two census dates is not possible due to alterations in the corporate landscape between 2002 and 2010.

The Trucost data price the damage that is done to society and human capital by pollutants and natural resource use. This external costs-based system draws on a library of prices for over 700 different natural inputs and outputs. The prices

are based on cost principles derived from a review of environmental economics literature, and the library is overseen by an independent international advisory panel of leading academics. A total of 22 key environmental impacts were evaluated for this report, including: greenhouse gases (carbon dioxide, HFCs, nitrous oxide, methane, perfluorocarbons, sulphur hexafluoride), water abstraction, pollutants including acid rain precursors, ozone depleting substances, and waste generation. The physical totals of these inputs and outputs incurred both directly and indirectly¹ were converted into financial values and aggregated to achieve a total environmental cost value. These costs which for the most part do not appear on corporate financial statements are known as external environmental costs.

In the quantitative analysis the external costs of these 22 environmental impacts have been compared with sector EBITDA. EBITDA data come from independent financial data providers, and are checked by Trucost analysts against company financial statements.

The conversion of environmental impacts into dollar sums of external environment cost is a relatively new practice. For this reason, the analyses and summary should be taken as indicative rather than absolute.

Qualitative: Risk and readiness

The perceived risk and readiness interpretation is based on KPMG's meta-review of over 60 external industry reports, which aggregates citations of sustainability risks and indicators of risk preparedness for all 11 sectors. Reports from sources including investment banks, business associations, insurance companies, consultancies, rating agencies and intergovernmental organizations were analysed in terms of risk types and sector preparedness. The risk categories used were physical risks; competitive risks, regulatory risks, reputational risks, litigation risks, and social risks. Expanded definitions of these categories of risk can be found in the Introduction to Part 2 of this report. The incidence and level of references to the six risks outlined were aggregated to provide an overall score of sectoral risk and readiness. In addition, the level of sector readiness has also been assessed using the results of the KPMG International Corporate Responsibility Reporting Survey 2011.

The qualitative findings of this review should be taken as indicative not absolute; risk exposure and readiness levels are perceived values, providing both a relative indicator across sectors, and a risk reading that is supplementary to the quantitative assessment.

¹ The external environmental cost data relate to both direct and indirect inputs and outputs – that is costs incurred by a surveyed company, plus costs incurred in the company's upstream supply chain. Trucost uses a global input-output model based on detailed government census and survey data on resource use and pollutant releases, industry data and statistics, and national economic accounts. The model can distinguish inputs and outputs at any level of the supply chain from the first-tier of suppliers through to total upstream supply chain requirements. The input-output methodology models the purchases a company makes and the resultant environmental impacts. This provides a means to differentiate between low impact supplied goods, such as renewable energy, and high impact supplied environmental goods, such as fossil fuel energy.

Appendix 2: Global sustainability megaforges bibliography

The identification of ten global sustainability megaforges was based on a review of over 30 external future trend projections:

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- World Business Council for Sustainable Development. (WBCSD). (2010). *Vision 2050: The New Agenda for Business*. WBCSD, Geneva.
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Appendix 3: Scenarios bibliography

The scenarios interpretation is based on a review of the following external future scenario research documents:

Convention on Biological Diversity (CBD). (2010). *Biodiversity Scenarios: Projections of 21st Century Change in Biodiversity and Associated Ecosystem Services: A Technical Report for the Global Biodiversity Outlook 3*. CBD, Montreal.

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The following sources were reviewed to compile the qualitative analysis of perceived sectoral risk and readiness:

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Glossary: Terms & abbreviations

ADB: Asian Development Bank.

APERC: Asia Pacific Energy Research Center.

ATC: Air Traffic Control.

Basel III: A set of banking regulations agreed in response to the financial crises that occurred at the end of the first decade of the 2000s. The regulations greatly increase the amount of capital banks must hold against their losses.

BAU: Business as usual.

BGS: British Geological Society.

Biomass: Biological material from living or recently-living organisms (usually in the context of a capability of being thermally, chemically or bio-chemically converted to energy). Examples include wood, grasses and crops.

BLS: US Bureau for Labor Statistics

BRIC: Brazil, Russia, India & China.

Carbon Trading: A system for pricing carbon emissions and trading the rights to emit carbon. Examples include the EU Emissions Trading System and the UN's Clean Development Mechanism.

CBD: Convention on Biological Diversity

CCS: Carbon Capture and Storage.

CDM: Clean Development Mechanism – a 'flexibility mechanism' defined in the Kyoto Protocol (2007) that allows industrialized countries to invest in emissions reductions in developing economies and thus gain carbon credits.

CDP: Carbon Disclosure Project.

Cefic: The European Chemical Industry Council.

Ceres: A coalition of more than 120 investors and public interest groups working towards global sustainability solutions.

CLD: Causal Loop Diagramming, a method of depicting the interaction of trends.

CO₂: Carbon dioxide.

CR: Corporate responsibility.

Crack Spread: The cost difference between a barrel of crude oil and a barrel of the petroleum products made from it, eg. jet fuel.

Cubic Meter: 1 cubic meter = 264.17 US gallons.

DEFRA: UK Department for Environment, Food, and Rural Affairs.

EBITDA: Earnings before interest, tax, depreciation and amortization.

EEDI: Energy Efficiency Design Index – a minimum standard of maritime energy efficiency established by the International Maritime Organization.

EIA: US Energy Information Administration.

EIU: Economist Intelligence Unit.

EPA: US Environmental Protection Agency.

EPHC: Environment Protection & Heritage Council.

ETS: Emissions Trading System.

EVs: Electric vehicles, including battery powered vehicles, full and plug-in hybrids, and fuel cell vehicles.

External Environmental Costs: A calculation of the total non-balance sheet value of environmentally-sensitive inputs and outputs in corporate operations, using the Trucost input/output price library.

FAA: US Federal Aviation Administration.

FAO: Food and Agriculture Organization.

FFF: Forum for the Future.

FSC: Forest Stewardship Council.

FWA: Fixed Wireless Access.

G20: A forum for 19 countries representing the world's leading economies, plus a representative of the European Union, meeting annually.

G250: Global Fortune 250 ranking of companies.

G8: A forum for eight countries, Canada, France, Germany, Italy, Japan, UK, US, and Russia, meeting annually.

GAO: US Government Accountability Office.

GCF: Green Climate Fund.

GDP: Gross Domestic Product.

GeSI: Global e-Sustainability Initiative, an ICT industry membership organization.

GFN: Global Footprint Network, an international sustainability think-tank.

GHG: Greenhouse gas.

GM: Genetically modified.

GRI: Global Reporting Initiative. GRI's Sustainability Reporting Guidelines have gained widespread adoption as the *de facto* global standard for CR reporting.

GtCO₂e: Gigatonne of CO₂ equivalent.

IATA: The International Air Transport Association.

IBA: Indian Beverages Association.

ICT: Information & Communications Technology.

IEA: International Energy Agency.

IFPRI: International Food Policy Research Institute.

ITF: Institute for the Future.

IMF: International Monetary Fund.

IMO: International Maritime Organization.

IOC: International oil company.

IPCC: Intergovernmental Panel on Climate Change.

ITU: International Telecommunication Union.

JLG: Joint Liaison Group of the Rio Conventions.

Living Planet Index: An indicator of the state of global biodiversity, developed by the WWF.

LNG: Liquefied natural gas.

MARINTEK: Norwegian Marine Technology Research Institute.

MDO: Marine diesel oil.

Metric Ton: 1 metric ton (or tone) = 1.1 US (short) tons.

Millennium Ecosystem Assessment: A United Nations-sponsored research project undertaken 2001-2004 designed to identify the implications of global ecosystem change.

MRV: Monitoring, reporting and verification.

MSA: Mean Species Abundance, a biodiversity indicator.

MWh: Megawatt hour.

N100: The largest 100 companies by country.

NAMA: Nationally Appropriate Mitigation Action.

NGN: Next Generation Network.

NGO: Non-Governmental Organization.

NOC: National oil company.

OECD: Organization for Economic Cooperation and Development.

PEFC: Program for the Endorsement of Forest Certification.

PES: Payments for Ecosystem Services, incentives for ecological management of agricultural resources.

PPP: Private Public Partnership.

RED: EU Renewable Energy Directive, a 2009 directive designed to ensure that the EU produces 20% of overall energy and 10% of transport energy from renewable sources by 2020.

REDD: Reducing Emissions from Deforestation and Degradation.

REM: Rare Earth Mineral.

SEI: Stockholm Environment Institute.

SERI :Sustainable Europe Research Institute.

SFI: Sustainable Forestry Initiative.

SIK: Swedish Institute for Food and Biotechnology.

SITM: Symbiosis Institute of Telecom Management.

Smart building: A building that embodies a group of embodied ICT systems that maximize energy efficiency.

Smart grid: An electric power grid that integrates ICT applications throughout the grid to enable efficiency and optimization solutions.

SOX: The Sarbanes–Oxley Act (also known as the Public Company Accounting Reform and Investor Protection Act), a 2002 US federal law.

TEEB: The Economics of Ecosystems and Biodiversity, a United Nations Environment Program research initiative designed to explore the economic benefits of biological diversity.

UCSUSA: US Union of Concerned Scientists.

UII: Urban Infrastructure Initiative.

UN DESA: United Nations, Department of Economic and Social Affairs.

UNCTAD: United Nations Conference on Trade and Development.

UNDP: United Nations Development Programme.

UNEP: United Nations Environment Programme.

UNFCCC: United Nations Framework Convention on Climate Change.

UNFPA: United Nations Population Fund.

UN-Habitat: The United Nations agency for human settlements.

USDA: US Department of Agriculture.

USGS: US Geological Survey.

VOIP: Voice Over Internet Protocol.

WBCSD: World Business Council for Sustainable Development.

WEF: World Economic Forum.

Wimax: Worldwide Interoperability for Microwave Access, a wide-area high-speed internet delivery technology.

WRG: Water Resources Group.

WRI: World Resources Institute.

WWF: The World Wildlife Fund (known outside the US and Canada as the World Wide Fund for Nature).

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External Sources: Figures 1, 2, 3, and Figure 18

External Sources: Figures 1, 2, 3, and Figure 18

*Figure 1: Accelerating human footprint on natural systems and resources
(Percent change statistics ranging from 1990 through 2011 on a global basis)*

1. *Air freight transport*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
2. *Gross domestic product*: World Bank, World Development Indicators 2005 (1990 World GDP); United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012) (2010 World GDP).
3. *Cement production*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
4. *Merchandise exports*: World Bank, World Development Indicators 2011.
5. *Nitrogen fertilizer use*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
6. *Plastics production*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
7. *International tourist arrivals*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
8. *Palm oil land area*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
9. *Air passenger transport*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
10. *Steel production*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
11. *Construction minerals use*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
12. *Soybean land area*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
13. *Electricity production*: World Bank, World Development Indicators 2011.
14. *Industrial minerals use*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
15. *Coal consumption*: Energy Information Administration (EIA), International Energy Outlook 2011.

16. *Natural gas consumption*: Energy Information Administration (EIA), International Energy Outlook 2011.
17. *Livestock production*: World Bank, World Development Indicators 2011.
18. *Urban population*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
19. *Food production*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
20. *Energy consumption*: Energy Information Administration (EIA), International Energy Outlook 2011.
21. *Total materials extraction*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
22. *Global CO₂ emissions*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012) (1990 global CO₂ emissions); International Energy Agency (IEA), World Energy Outlook 2011 (2010 global CO₂ emissions).
23. *Fish and seafood consumption*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
24. *Petroleum consumption*: Energy Information Administration (EIA), International Energy Outlook 2011.
25. *Global ecological footprint*: World Wildlife Fund, Living Planet Report 2010.
26. *Per capita natural resource consumption*: Sustainable Europe Research Institute (SERI), Global Materials Flow Database (www.materialflows.net).
27. *World population*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
28. *Meat consumption*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
29. *Resource intensity*: Sustainable Europe Research Institute, Under Pressure (Nov. 2011).
30. *CO₂ emissions per unit GDP*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).

Figure 2: Human social and economic progress

(Percent change statistics ranging from 1990 through 2011 on a global basis)

1. *HIV prevalence, % pop aged 15-49*: World Bank, World Development Indicators 2011.
2. *Female parliamentarians*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
3. *Mean years of schooling*: United Nations Development Programme, Human Development Reports (various years).

4. *GDP per capita*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
5. *Number of free countries*: Freedom House, *Freedom in the World 2012: The Arab Uprisings and their Global Repercussions*.
6. *Slum dwellers*: United Nations Development Programme, Human Development Reports (various years).
7. *UNDP human development index*: United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20* (1992-2012).
8. *Access to improved sanitation*: World Bank, World Development Indicators 2011.
9. *Access to improved water service*: World Health Organization (WHO) Fact Sheet 290 (May 2011).
10. *Female youth literacy rate*: World Bank, World Development Indicators 2011.
11. *Primary education completion rate*: World Bank, World Development Indicators 2011.
12. *Adult literacy rate*: World Bank, World Development Indicators 2011.
13. *Girl-boy ratio, education enrollment*: World Bank, World Development Indicators 2011.
14. *Life expectancy at birth*: World Bank, World Development Indicators 2011.
15. *Male youth literacy rate*: World Bank, World Development Indicators 2011.
16. *Female labor force participation*: World Bank, World Development Indicators 2011.
17. *Population living <\$US 2.00 per day*: World Bank, World Development Indicators 2011.
18. *Dependency ratio on working population*: World Bank, World Development Indicators 2011.
19. *Undernourishment prevalence*: World Bank, World Development Indicators 2011.
20. *Underweight children <5 years old in the developing world*: United Nations, Millennium Development Goals Report 2011.
21. *Total fertility rate*: World Bank, World Development Indicators 2011.
22. *Population living <\$US 1.25 per day*: World Bank, World Development Indicators 2011.
23. *Population average annual growth rate*: World Bank, World Development Indicators 2011.
24. *Infant mortality rate*: World Bank, World Development Indicators 2011.
25. *Maternal mortality rate*: World Bank, World Development Indicators 2011.
26. *Under 5 child mortality rate*: World Bank, World Development Indicators 2011.

*Figure 3: Persistent human deprivation
(Percent change statistics ranging from 1990 through 2011 on a global basis)*

1. *People without access to adequate sanitation:* United Nations Environment Programme (UNEP), *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*, 2011.
2. *People living on less than \$US 2.00 per day:* World Bank PovcalNet (online database of global poverty statistics).
3. *People severely restricted in civil and political freedoms:* Freedom House, *Freedom in the World 2010: Global Erosion of Freedom*.
4. *People intermittently lacking food security:* United Nations Food and Agriculture Organization (FAO).
5. *People without access to reliable electricity supplies:* United Nations Environment Programme (UNEP), *Keeping Track of Our Changing Environment, From Rio to Rio +20 (1992-2012)*.
6. *People living on less than US \$1.25 per day:* World Bank PovcalNet (online database of global poverty statistics).
7. *People lacking access to professional health care systems:* World Health Organization (2008), *The World Health Report 2008*.
8. *People suffering from malnutrition/undernourishment:* United Nations Food and Agriculture Organization (FAO), *FAO World Livestock 2011: Livestock in food security*.
9. *People without literacy:* UNESCO Institute for Literacy Statistics (2011).
10. *People without access to safe drinking water:* United Nations, *Millennium Development Goals Report 2011*.
11. *People living in slums without secure shelter:* United Nations, *Millennium Development Goals Report 2011*.
12. *People without gainful employment:* International Labor Organization (ILO), *Global Employment Trends 2011*.

*Figure 18: Summary of business-as-usual global projections
(Variously from 2008/2010 to 2035)*

1. *Energy-related CO₂ emissions:* International Energy Agency (IEA), *World Energy Outlook 2011*.
2. *Mean temperature rise:* IPCC/UNEP/GRID-Arendal, *Graph: Projected Changes in Global Temperature (global average 1856-1999 and projection estimates to 2100)*.
3. *Primary energy demand:* International Energy Agency (IEA), *World Energy Outlook 2011*.
4. *Net electricity generation:* Energy Information Administration (EIA), *World Energy Outlook 2011*.
5. *Raw materials extraction (excluding fossil carriers):* Sustainability Europe Research Institute (SERI), *GLOBAL 2000, Friends of the Earth Europe (2009). Overconsumption? Our use of the world's natural resources.*

6. *Demand for water withdrawals*: The 2030 Water Resources Group, Charting Our Water Future (2009).
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9. *% Population 65 and older*: United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2010 Revision Highlights and Advance Tables*.
10. *Middle-class purchasing power*: OECD Development Centre (2010). *Working Paper No. 285: The Emerging Middle Class in Developing Countries*.
11. *Real gross domestic product*: Standard Chartered Bank (SCB) (2010). *The Super-Cycle Report*.
12. *Urban population*: United Nations, Department of Economic and Social Affairs, Population Division. *World Urbanization Prospects: The 2010 Revision*.
13. *Urban land cover km²*: Seto K.C., et. al. (2011). *A Meta-Analysis of Global Urban Land Expansion*.
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16. *Terrestrial mean species abundance*: Convention on Biological Diversity (CBD) (2010). *Biodiversity Scenarios: Projections of 21st century change in biodiversity and ecosystem services*.
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18. *Net forest cover*: OECD (2008), OECD Environmental Outlook to 2030.
19. *Amazon forest loss*: World Wildlife Fund (WWF) (2010). *WWF's Living Amazon Initiative, A comprehensive approach to conserving the largest rainforest and river system on Earth*.

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As sustainability and climate change issues move to the top of corporate agendas, KPMG firms advise organizations to better understand the complex and evolving environment, helping them optimize their sustainability strategy.

KPMG's Climate Change and Sustainability Services (CC&S) professionals provide sustainability and climate change Assurance, Tax and Advisory services to organizations to help them apply sustainability as a strategic lens to their business operations. We have more than 25 years experience working with leading businesses and public sector organizations which has enabled us to develop extensive relationships with the world's leading companies and to contribute to shaping the sustainability agenda.

The expanding CC&S network, across more than 50 countries, enables us to apply a consistent, global approach to service delivery and respond to multinational organizations' complex business challenges with services that span industry sectors and national boundaries. Our experienced teams assist organizations in the following areas:

- Sustainability risk and opportunity analysis
- Corporate responsibility strategy assistance
- Corporate Social Responsibility/Sustainability/GHG information systems design and implementation
- Regulatory framework assessment and optimization, including tax and carbon emission regimes
- Tax incentives and credits
- Sustainable supply chain enhancements
- Corporate responsibility reporting and assurance, including pre-audit assessments and Green House Gas emissions verification.

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