



LLOYD'S  
**360°**  
RISK  
INSIGHT

**CLIMATE CHANGE  
AND SECURITY:  
RISKS AND  
OPPORTUNITIES  
FOR BUSINESS**



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The Institute is independent, owing no allegiance to any government or any political or other organisation. The IISS stresses rigorous research and places particular emphasis on bringing new perspectives to the strategic debate.

## **ABOUT THE AUTHOR**

Gwynne Dyer has worked as a freelance journalist, columnist, broadcaster and lecturer on international affairs for more than 20 years. Born in Newfoundland, he held academic appointments at the Royal Military Academy Sandhurst and Oxford University before launching his twice-weekly column on international affairs, which is published by over 175 papers in 45 countries.

He has broadcast numerous award-winning television series and radio documentaries and written many books, including his major study "War" (first published in the 1980s and subsequently revised and re-published in 2004).

His most recent projects are a book and a radio series called 'Climate Wars', dealing with the geopolitics of climate change, which will be published and aired in the course of 2009.



# CLIMATE CHANGE AND SECURITY: RISKS AND OPPORTUNITIES FOR BUSINESS

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# FOREWORD

## FROM THE CHIEF EXECUTIVE OFFICER OF LLOYD'S



**“AS CLIMATE CHANGE TAKES HOLD, FEW BUSINESSES WILL BE ABLE TO ESCAPE THE IMPACT OF GREATER COMPETITION FOR RESOURCES.”**

We are currently experiencing the worst financial and economic turmoil in living memory. Across the world, our governments are having to refocus their priorities and re-evaluate their financial and economic policies. And yet, despite all this, climate change has never been far from the headlines.

In fact, spurred on by the enthusiasm of a new US regime, climate change is moving back up the global agenda. One of the key pledges in the communiqué agreed by the G20 group of world leaders in London was to reaffirm their commitment to address the threat of irreversible climate change. As we refocus on the threat of climate change, our awareness and understanding of the issues is developing too, particularly in relation to our growing scientific knowledge.

Difficult questions around how to achieve mitigation remain a key focus for the international community. However, one of the most notable trends to emerge recently is a growing emphasis on the ‘bigger picture’. How will climate change interact with the other super-trends influencing our society? And could climate change force the world’s nations into a struggle for advantage and even, in some cases, survival?

In order to understand what climate change means for our future security, this report identifies four key issues we need to focus on. These are water scarcity, food supply, energy and natural resource security, and demographic pressures.

We must also recognise that in many cases it is the poorer states that will be worst affected by climate change. Understanding the potentially destabilising effects on these countries will therefore be particularly important in maintaining security, not just in emerging markets, but right across our globalised 21st century world.

However tempting it may be to leave discussion of these complex issues to politicians and policymakers, it is clear that any climate-driven security concerns will have major economic and business implications.

Lloyd's 360 Risk Insight and the International Institute of Strategic Studies (IISS) have therefore joined forces to explore the issues from a business perspective, and we are delighted that Gwynne Dyer, journalist, broadcaster and lecturer on international affairs for more than 20 years, and author of *Climate Wars* (2008), has agreed to author this report.

As climate change takes hold, few businesses will be able to escape the impact of greater competition for resources. As nations become more protective of their assets, and markets become more volatile, it can no longer be business as usual. Business strategy and operations will be increasingly impacted and it is critical that companies and their insurers work to understand these interdependencies now, and begin to reflect them in their business plans and approach to risk management.

But it is not all bad news. Our report highlights that governments will become increasingly dependent on the creativity and skills of the private sector in tackling the security challenges that climate change will bring. Tangible business opportunities will emerge, in areas ranging from energy efficiency to water conservation, for those who are flexible enough to respond.

Climate change, and its impact on security, also brings some specific opportunities and responsibilities for the insurance industry. As the world's leading specialist insurance market, it is Lloyd's job to help society pick up the pieces when disaster strikes – whether that be weather-related catastrophes or political violence. We firmly believe that it is our role to help companies, their boards and their risk managers to plan and prepare for the future and we hope that this report will contribute to this process.

Dr Richard Ward  
Chief Executive Officer  
Lloyd's

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# EXECUTIVE SUMMARY

## **1. NO-ONE KNOWS HOW QUICKLY CLIMATE CHANGE WILL HAPPEN OR HOW SEVERE THE CONSEQUENCES WILL BE. COMPANIES MUST THEREFORE BUILD A STRATEGY TOWARDS CLIMATE CHANGE INTO THEIR PLANNING AND REVIEW THEIR THINKING REGULARLY.**

No-one can say with any certainty how serious the effects of climate change will be, but scientists increasingly believe that the consequences will be much worse than originally thought. Although the effects of climate change may develop gradually, it is more likely that we will experience abrupt and dramatic shifts in weather patterns. This makes long-term planning and risk assessment extremely difficult, and means that business plans will need to encompass a range of possible outcomes and to be revised regularly.

## **2. CLIMATE CHANGE NEED NOT PREVENT WELL-RUN ORGANISATIONS FROM SUCCEEDING, BUT IT CAN NEVER AGAIN BE BUSINESS AS USUAL.**

Climate change is likely to result over time in major changes to most areas of life: how cities and buildings are designed; how transport systems function; and how production and trading systems are organised. It will also result in greater competition for increasingly scarce resources such as water, food and energy. At worst, the world may see a rise in economic nationalism, increased inter-state conflict and higher levels of global insecurity, all of which will add to the costs and complexity of doing business. Companies must assess these risks and build them into their strategic and operational planning.

## **3. WATER WILL BECOME A SCARCE COMMODITY COMMERCIALY AND STRATEGICALLY, PRESENTING SUPPLY CHAIN AND OPERATIONAL CHALLENGES FOR BUSINESS.**

It will rain more in a warmer world, but rainfall patterns will change and some areas will become drier. Water will become a scarce and expensive commodity in many countries and in some parts of the world it could become a source of inter-state conflict. Developing systems for using water more efficiently will literally become a matter of life and death for the worst affected regions. Every business will be affected, but those whose production processes are heavily dependent on water will face particular challenges.

## **4. CLIMATE CHANGE MEANS FOOD PRODUCTION WILL INCREASINGLY FAIL TO MEET DEMAND AND GLOBAL FOOD MARKETS COULD CHANGE SUBSTANTIALLY. THE FOOD AND CATERING SECTORS WILL FACE SUPPLY CHALLENGES, WHILE AGRIBUSINESS WILL NEED TO FOCUS ON DEVELOPING SUSTAINABLE PRODUCTION TECHNIQUES.**

The greatest early impact of global warming will be on food supply, which even now is barely adequate to meet demand in many regions of the world. In anticipation of food shortages and price rises, a growing proportion of world grain trade will be linked to bilateral deals, never reaching the open market. As arable land becomes scarcer, the probability of state failure and conflict between states is likely to increase. Food will increasingly be produced close to where it is consumed. The development of bio-fuels could put further pressure on scarce arable land and could contribute to food shortages. However, there will be significant business opportunities for companies linked to water-efficient and sustainable farming techniques.

## **5. UNDER CLIMATE CHANGE, ENERGY MARKETS ARE LIKELY TO BECOME MORE VOLATILE AND UNPREDICTABLE. SHIFTS IN SUPPLY OR DEMAND COULD TAKE PLACE RAPIDLY AND BUSINESSES MUST PLAN TO MEET THEIR ENERGY NEEDS WITH THIS IN MIND.**

Fossil fuels – in particular coal and oil – are the biggest single source of carbon emissions and reducing dependence on these is critical to mitigating the impact of climate change. However, this change will take time. Mankind will continue to rely on fossil fuels for the foreseeable future and competition could lead to international friction, while developing countries may need time and financial assistance to adapt to alternative energy sources. Businesses must assess their energy needs and map these against likely scenarios for energy supply to ensure future security. Meanwhile, green energy offers substantial opportunities for companies that are flexible and nimble enough to capitalise on these. Energy efficiency will also become an increasingly important financial and reputational driver.

## **6. THERE IS A RISK OF MASS MIGRATION FROM THE DEVELOPING TO THE DEVELOPED WORLD, BECAUSE THE LESS ADVANCED ECONOMIES CLOSER TO THE EQUATOR WILL SUFFER MOST FROM CLIMATE CHANGE. BUSINESSES WILL NEED TO CONSIDER THE POTENTIAL IMPACT ON THEIR WORKFORCE AND OPERATIONS.**

Drought will be most intense in the sub-tropical regions, notably the Mediterranean, the Middle East and North China. Without effective adaptation programmes, migrant flows could swell dramatically, pressing against the borders of less affected countries. Building mechanisms to mitigate and manage such flows will increasingly become a preoccupation for countries in the developed world. This could involve large-scale and expensive humanitarian interventions well beyond anything seen to date. There will be workforce implications for companies with operations in the developing world, and social and political tensions could impact operations locally.

## **7. BUSINESS HAS A VITAL ROLE TO PLAY IN THE MITIGATION OF AND ADAPTATION TO CLIMATE CHANGE.**

There are limitations to what governments can do on their own. They will need to harness the creativity, inventiveness and organisational capacities of the private sector by developing specific technologies to mitigate and adapt to climate change and to change behaviour patterns among consumers. The latter is particularly important and business can play an important role. Unless people alter their priorities and their behaviour, efforts by government and the business sector to deal with climate change are likely to be unsuccessful.

# INTRODUCTION

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“People really need to understand that the average global surface temperature is like the temperature of your body – and if you have a fever of 40.5°C, even though that’s only three and a half degrees above normal, it’s potentially fatal. Everything that is expected to result from global climate change driven by greenhouse gases is not only happening, but it’s happening faster than anybody expected.”

**Dr. John Holdren**  
Chief Scientific Adviser  
to President Obama,  
6 February 2008

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## THE SCIENCE OF CLIMATE CHANGE

The earth’s climate has always been subject to fluctuations due to a range of naturally occurring factors. But it has become increasingly evident that mankind’s activities also contribute to climatic fluctuations. This dates back to the time when organised agriculture first began but has been greatly intensified over the past two centuries as industrialisation has led to significantly increased levels of carbon emissions.

The scientific evidence on climate change and mankind’s role in contributing to it is overwhelming and impossible to ignore. But predicting how climate change will evolve and what consequences it will have remains extremely difficult. At a global level the picture is relatively clear but there is still insufficient understanding of how exactly climate change will affect specific regions and countries. Climate change cannot be understood properly if considered in isolation. Other important factors must be taken into account – in particular, population growth. Climate change that may be manageable in a world with six billion people may not be controllable when the global population reaches nine billion – as the United Nations estimates may be the case by 2050<sup>1</sup>.

There are two main sources of uncertainty when it comes to predicting the speed and scale of climate change. The first is the future rate of man-made greenhouse gas emissions; will international efforts to mitigate emissions be effective, or will emerging economies go on growing well above historical rates and continue to generate most of their energy by burning dirty coal? The second is scientific uncertainty about the “sensitivity” of the climate system to additional man-made carbon dioxide emissions produced by the burning of fossil fuels; does doubling the amount in the atmosphere raise the average global temperature by two, three or four °C?

These uncertainties explain why the Intergovernmental Panel on Climate Change (IPCC), in its latest report in 2007, predicted that the temperature rise by the year 2100 would range from 1.8°C to 6.4°C. The lower number would mean a slow and surprise-free rise in temperature that would cause only moderate disruption in human societies – though even this scenario would involve more frequent extreme weather events and the possible submergence of low-lying island states; the higher number would result in most of the existing farmland on the planet turning into burning desert.

However, recent findings, notably the drastic shrinkage since 2005 of the summer sea ice in the Arctic, have led some scientists to conclude that the IPCC predictions may in fact be on the low side. Indeed, in February 2009, Professor Chris Field, one of the authors of the IPCC report, warned that temperatures are likely to rise beyond the levels predicted and that “the future climate is beyond anything that we

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<sup>1</sup>The UN has modelled a range of different outcomes for global population growth ranging from 7.8 to 11.9 billion by 2050. Nine billion is the median variant.

have considered seriously in climate policy". These comments were based on the emergence of new data about emissions from the industrialising world which had not been available when earlier IPCC assessments had been reached. This more pessimistic view was reinforced at the International Scientific Conference on Climate Change, which took place in Copenhagen in March 2009.

Moreover, while the IPCC's report acknowledges the potential importance of large "positive feedbacks", which would greatly speed up the warming process, it does not include them in its predictions because their complexity makes it impossible to incorporate them in climate models.

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## FEEDBACKS

"Positive feedbacks" are changes in natural systems, triggered by rising temperatures that intensify the warming process. The loss of Arctic sea ice, for example, means that highly reflective ice is replaced with dark, open water that absorbs most incoming sunlight as heat. One very serious feedback would be the melting of the layer of permafrost, which contains enormous quantities of trapped CO<sub>2</sub> and methane, a shorter-lived but much more potent "greenhouse gas". Another is the warming of the ocean's surface, which would reduce its ability to absorb carbon dioxide and would ultimately make it release some of the CO<sub>2</sub> that it currently stores. Both of these feedbacks are expected to become very powerful influences on the climate when the average temperature rises by between 2°C and 3°C.

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The ultimate implication of triggering the feedbacks could be that human beings lose control of the process: cutting our own greenhouse gas emissions might no longer be enough to stop the warming, regardless of our mitigation actions. For this reason, some scientists now suggest that the probable range for global temperature rise by the end of the century (unless we keep the warming below a rise of 2°C) will actually be between six and twelve °C. This wide range of possible outcomes, from less than two to twelve °C hotter, makes it very difficult for governments and businesses to prepare for climate change effectively. The security implications of these extreme estimates are such that doing everything possible to avoid such outcomes seems the only prudent course of action.

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**“THE US, WHICH NOW ACCOUNTS FOR 21% OF ALL GLOBAL EMISSIONS, HAS REDUCED ITS EMISSIONS BY 3% FROM 2000 TO 2006.”**

## **THE POLITICAL EFFORT TO REDUCE EMISSIONS**

Equally difficult to predict is the speed with which society responds to this threat. The European Union has already adopted a target of never exceeding 2°C above the pre-industrial global average temperature, and various member states are taking steps to cut their emissions accordingly. Germany, for example, is aiming to cut its emissions by 40% by 2020. It remains to be seen whether European governments will be able to achieve these targets, which are seen by some as insufficiently ambitious or rigorous, especially in the light of the global economic downturn. Although in the short term the downturn will result in decreased global energy consumption and hence a reduction in carbon emissions, shortages of funds and the need to create jobs now could result in governments continuing to invest in old, emission-heavy yet proven technologies rather than experimenting with cleaner but probably more expensive alternatives. Conscious of this risk, the United Nations has for some time been working on what is being called a “Green New Deal”, which is designed to encourage governments to use economic stimulus funding to develop an economy based on fresh technology, clean energy, sustainable agriculture and conservation.

The US, which now accounts for 21% of all global emissions, has reduced its emissions – by 3% from 2000 to 2006 – but has refused to ratify the Kyoto Accord on the grounds that the lack of binding commitments from other major industrialising nations has left the US at a significant competitive disadvantage. The incoming administration of President Obama has, however, made climate change a priority and aspires to take a leadership role in international efforts on the issue.

The Kyoto Accord will reach an end in 2012 and the international community will come together in Copenhagen in November 2009 to negotiate a successor agreement. A potential stumbling block is the need to make a deal that imposes some kind of limit on the emissions of emerging industrial powers, such as China, India and Brazil. It is an exceptionally difficult problem politically, because it must be a highly asymmetrical deal, and yet must be seen as fair by all parties.

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### **KYOTO PROTOCOL**

The Kyoto Protocol is an agreement to the United Nations Framework Convention on Climate Change (UNFCCC) that sets binding targets for reducing greenhouse emissions by 5% according to 1990 levels over the period of 2008-2012. The agreement, which came into force in 2005, has been ratified by 183 individual countries (not including the US) and by the European Union. Of those 183 countries, only 40 countries – so-called Annex

1 states – are subject to binding caps on their emissions. The Protocol aims to reduce emissions via three flexible mechanisms: emission trading, clean development and joint implementation.

### COPENHAGEN CONFERENCE

The Copenhagen Conference is the United Nations Climate Change Conference (COP15), to be held in Denmark on 7-18 December 2009. Parties to UNFCCC will be meeting in Copenhagen with the aim of signing a new agreement to succeed the expiring Kyoto Protocol. Among the issues likely to be agreed upon are new targets for the reduction of CO<sub>2</sub> emissions; methods for avoiding emissions; the expansion of means by which poorer countries can adapt to climate change and improvements to global architecture for trading emissions.

The core of the problem is that one part of the world – the rich part, with not much more than a billion people – accounts for most of the greenhouse gas emissions today. Furthermore, it also caused almost all the greenhouse gas emissions of the preceding two centuries of industrialisation, which increased the amount of CO<sub>2</sub> in the atmosphere by 100 parts per million (from 280 to 380 parts per million) – although at the time few appreciated or understood the consequences of this action.

The other parts of the world, with over five billion people, had no hand in creating the current climate crisis. But they are part of the problem now, in the sense that many are finally industrialising, and therefore increasing greenhouse gas emissions. On a per capita basis, emissions from these countries are still low – China, with four times as many people as the US, emits about the same amount of CO<sub>2</sub>. However, the only statistics that matter are total emissions, and they are rising quickly.

### CARBON TRADING

Sometimes referred to as “cap and trade”, carbon trading is a policy for reducing greenhouse gas emissions by establishing a market in tradable emission permits. The total amount of permits in the market (the “cap”) is controlled by a central authority. Companies are required to possess permits equal to their actual emissions and they can buy or sell permits on the market to match their carbon output. For example, a company that invests in new technology to reduce greenhouse gas emissions can subsequently sell its excess permits on the market, thus benefiting financially from the reduced carbon output. Carbon trading usually applies to large industrial companies, power companies and similar organisations with large fixed infrastructure.

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“I run research projects in collaboration with government organisations, think tanks and universities in India and China on climate change and what to do about it. What I can tell you is that the Chinese and the Indians are no less knowledgeable and no less worried about this problem than we are. In my view [they] are going to sign on to a global approach to reducing greenhouse gas emissions within three to five years of the US making the transmission from laggard to leader.”

**Dr. John Holdren**  
Chief Scientific Adviser  
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**“DEVELOPING COUNTRIES WILL CONTINUE TO ARGUE THAT THE RICH COUNTRIES CAUSED MOST OF THE PROBLEM, AND THAT THEY CAN BETTER AFFORD TO PAY FOR THE SOLUTION.”**

Currently the most notable example of a regional carbon trading system is the European Union’s Emissions Trading Scheme.

### **EMISSION STANDARDS**

The transport sector is an important source of greenhouse gases, and consequently various regulatory measures have been considered to curb carbon emissions, especially in the road transport sector. An emission standard is a regulation that sets a limit on the amount of pollutants that a single vehicle is allowed to produce. Many countries already have emission standards for pollutants, such as hydrocarbons, carbon monoxide, sulphur oxides and nitrogen oxide. CO<sup>2</sup>, the main greenhouse gas, is increasingly viewed as a target for regulation, for example in California where the state government has attempted to pass a carbon emission standard for cars (the subject of an ongoing legal dispute between California and the federal government). Although emission standards usually apply to motor vehicles, similar policies could in principle be considered in other sectors, such as air and sea transport or electricity generation.

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Given the history of emissions and the existing inequalities of both wealth and per capita emissions, it is highly unlikely that any international deal could be agreed that would commit all countries to make equal cuts in their emissions. Developing countries will continue to argue that the rich countries caused most of the problem, and that they can better afford to pay for the solution.

The leaders of the emerging industrial powers know that they will suffer too if climate change gets out of hand, but they also know the history of the problem. None of them think that the rich countries and the poor ones should have to make equal cuts, given their history and the fact that there is still a huge difference even now in per capita emissions. However, they will not agree to a new treaty unless they see the rich countries taking much bigger, much earlier cuts – and transferring technology and money to the poorer countries to enable them to clean up their emissions and go on growing their economies at the same time. But as the quote from President Obama’s chief scientific adviser makes clear, they would react quickly and positively to a lead from the developed world.

The richer nations, however, face political realities at home. The larger developing countries, such as China and India are their emerging rivals in the global market, and they cannot afford to be seen to be supporting industry there to the detriment of their own domestic workforces. This is likely to be all the more the case during the

current economic downturn when domestic pressure to create jobs is high. In the medium-term, a compromise that accommodates both of these points of view is probable, but the likelihood of it happening imminently is small. Any successful deal would need to involve a substantial transfer of technologies from the industrialised to the industrialising world, with a funding mechanism that adequately compensated the companies developing the relevant technologies, and a commitment by the industrialised states to make serious efforts to implement energy efficiency strategies.

## THE ROLE OF BUSINESS

Success in managing climate change does not just depend on national governments. The private sector has a critical role to play in achieving greater understanding of the nature of the problem, promoting public awareness of the issues and developing practical solutions.

There are a number of high-profile business organisations that are already engaged in looking at how the business community should respond to climate change. The Investor Network on Climate Risk ([www.incr.com](http://www.incr.com)), which has a \$7 trn network of investors, aims to promote a better understanding of the financial risks and opportunities provided by climate change, and has produced numerous reports on issues relating to water and energy.

The World Business Council for Sustainable Development (WBCSD; [www.wbcsd.org](http://www.wbcsd.org)), an organisation made up of the CEOs of some 200 companies, has taken a lead in promoting the debate on climate change and illustrating possible solutions, and has informed the debate at both the World Economic Forum in Davos and the G8. In 2009, the WBCSD produced a report entitled *“Water, Energy and Climate Change: A contribution from the business community”*, which brings together 60 companies in the mining, metals, oil and gas, food and beverage, infrastructure services and equipment sectors. The report, which recognises that in the years ahead all businesses will face water challenges, lists five key policy recommendations for improving water and energy use and gives 25 case studies of businesses, which are linking water, energy and climate change in their operations. The report emphasises that “market mechanisms such as payments for ecosystem services, trading systems or certification standards can be powerful complements to existing strategies for conserving ecosystems, if used in the right way”.

Within the insurance industry, Swiss Re has teamed up with the United Nations Development Programme and the Center for Health and the Global Environment

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at Harvard Medical School to form the Climate Change Futures Project, an interdisciplinary task force that formulates future scenarios and their consequences on the basis of a range of climate projections and development trajectories. In the UK, many top insurers, including Lloyd’s, have joined the ClimateWise project ([www.climatewise.org.uk](http://www.climatewise.org.uk)), an initiative supported by HRH the Prince of Wales, which commits them to taking responsibility for dealing with climate change in their corporate behaviours.

Meanwhile extensive research is being undertaken in the development of energy efficient and “clean” technologies. This activity is most evident in the developed economies, but industrialising nations are quickly catching up. China now aspires to become a world leader in the production of electrically powered and hybrid vehicles – a development that has the potential to benefit its environment and its economy.

## **CLIMATE CHANGE AND GLOBAL SECURITY**

The world will almost certainly experience close to 2°C of global warming before we can hope to bring emissions under control. This is due to the considerable time-lag between the emission of a given amount of greenhouse gases and the impact on global temperature. There is already enough excess CO<sub>2</sub> and other greenhouse gases in the atmosphere to produce a 1.4°C increase on today’s temperature, although the time-lag means that currently we are only experiencing about half that level of warming.

A 2°C temperature rise would cause serious disruption to almost all human systems, but most notably agricultural and political ones. One area of particular concern to military planners, policymakers and business strategists is the potential impact of climate change on global security. In 2008, the US Center for Naval Analysis published a report on the security implications of climate change with endorsement from a military advisory board of 12 retired senior US military officers. The introduction to the report makes the point that “climate change can act as a threat multiplier for instability in some of the more volatile regions of the world and it presents significant national security challenges for the US”. Later the same year, the European Council issued a report commissioned by High Representative Javier Solana, which drew similar conclusions and makes the point that “climate change is already having a profound effect on international security”. The Solana report points to resource-driven conflicts; economic damage and risk to coastal cities and infrastructure; loss of territory and resultant border disputes; environmentally induced migration; government fragility; political radicalisation; tensions over energy supplies and pressures on international governance as issues likely to be exacerbated by climate change.

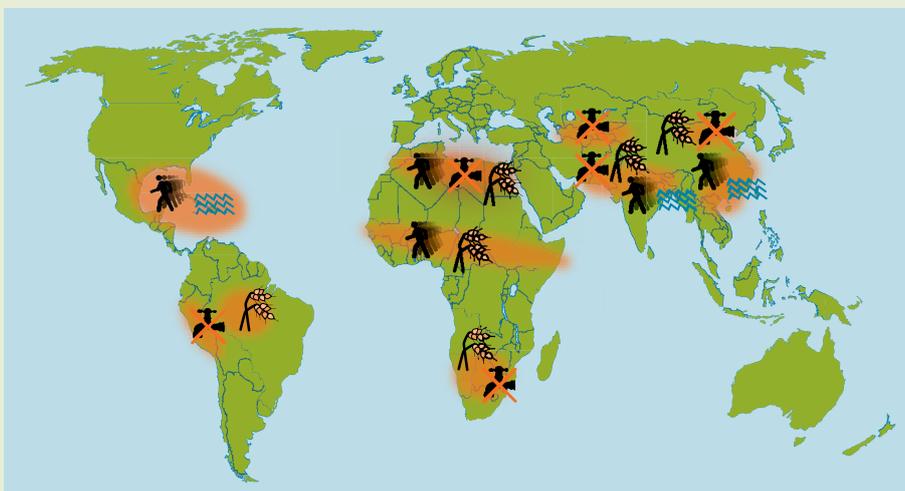
In the following sections of this report, we will examine four different scenarios, designed to illustrate some of the ways in which climate change may impact adversely on global security. In each setting, we will also explore what some of the major implications may be for businesses and specifically for company managers who are responsible for managing risk. These four different scenarios are:

- The risk of **water-induced conflict** with reference to competition between India and Pakistan over access to the diminishing supply of water from the Indus river basin.
- Issues of **food security** looking at the problems facing China, a country with a large population and declining water resources and arable land, and the prospect of tension with Russia, a country with excess arable land and water and a declining population.
- **Energy security**, with specific consideration of the Arctic, an area rich in oil and gas resources, which are becoming increasingly exploitable as the ice-cap melts, and which could be the subject of competing claims by five nations.
- **Migration**, with a particular focus on the problems potentially faced by the US in the event that climate change drives populations in Mexico to migrate northwards.

As anyone who has been involved in such planning will be aware, scenarios are hypotheses and not predictions of the future. However, mapping out a range of future possibilities can help policymakers and business executives involved in planning for the future to make informed judgments and decisions.

### SECURITY RISKS ASSOCIATED WITH CLIMATE CHANGE: SELECTED HOTSPOTS.

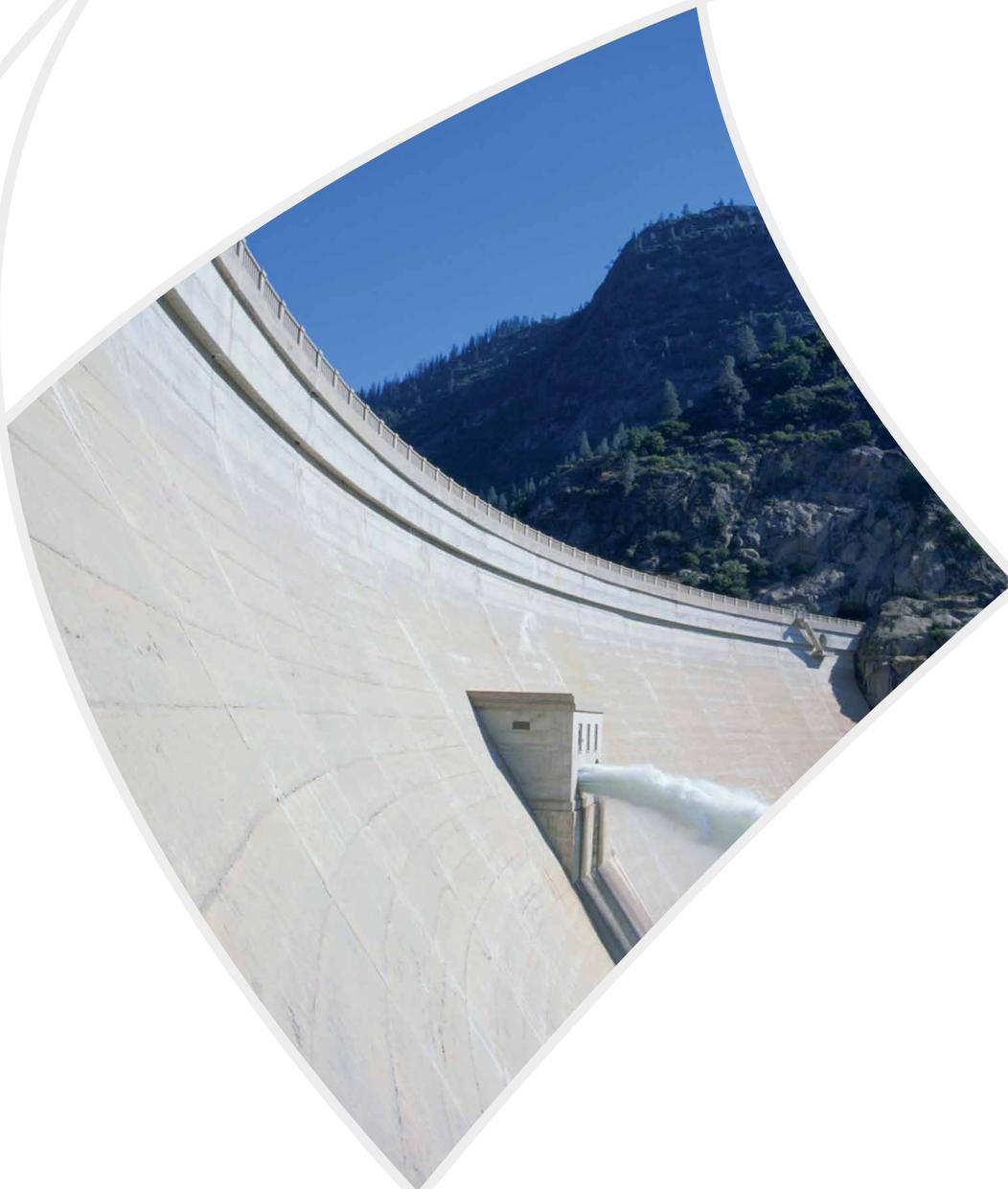
Source WBGU. The map only shows the regions which are dealt with in this report and which could develop into crisis hotspots.



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THE FUTURE TO  
MAKE INFORMED  
JUDGEMENTS  
AND DECISIONS.”**

-  Climate-induced decline in food production
-  Climate-induced degradation of fresh water resources
-  Climate-induced increase in storm and flood disasters
-  Environmentally-induced migration
-  Hotspots

**ACCESS TO WATER WILL INCREASINGLY BE SEEN AS A POTENTIAL STRATEGIC WEAPON, WHICH WILL HAVE AN IMPACT UPON BUSINESSES THAT OPERATE IN THESE NATIONS.**



# PART 1: WATER SCARCITY

Because of global warming, rainfall patterns are expected to change drastically. In some places, including high latitudes and the tropics, there will be more rain. However, rain will not always fall in the same places that rely upon it, and even if it does, it may come in torrential and hugely destructive downpours. That is not in itself a cause for conflict, but there are circumstances in which it could become one.

For the most part, people live where water is found. Previously, if water was no longer available, people had to move. Things are more flexible now, and whole societies live on imported food in places where water must come from desalination or be pumped up from underground aquifers – but such strategies can only succeed in small and wealthy communities. For most societies regular rain or reliable rivers remain a fundamental requirement for survival.

If the rain fails and people have to move, they will generally do so on an individual basis – although a massive failure in a particular place may lead to a substantial cumulative shift. But if you live within a large river system and there is no longer enough water in it, somebody upstream may be to blame – or at least, somebody upstream can be blamed. Almost all the conflicts over water that might lead to war are related to large rivers that flow through several countries.

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## EXAMPLES OF MAJOR RIVERS FLOWING THROUGH SEVERAL COUNTRIES

River	Upstream countries	Downstream countries
St. Lawrence	US	Canada
Amazon	Colombia, Ecuador, Peru, Bolivia	Brazil
Nile	Sudan, Ethiopia, Uganda, Rwanda, Burundi, Tanzania, Zaire, Kenya	Egypt
Tigris-Euphrates	Turkey, Syria	Iraq
Indus	India, China	Pakistan
Brahmaputra	India, China	Bangladesh
Mekong	China	Vietnam, Cambodia, Laos, Thailand

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“We know from climate models that rainfall patterns will change. If you look at the models for each river basin in Africa, for example, that could mean a 10% increase or a 30% decrease or anywhere in between. So if you are an upstream state, you start building dams to hold that water back. If you are a downstream state and you see somebody building a dam, which will hold all the water your farmers need for a year, that is an act of aggression.”

**Nick Mabey**  
Director,  
E3G Environmental  
Consultancy, London,  
14 April 2008

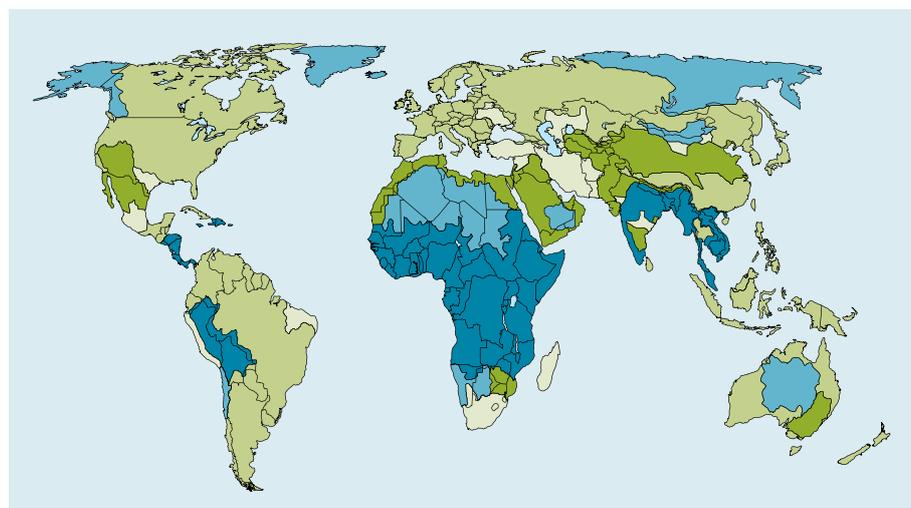
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It is easy to imagine escalating American demands on the major fresh-water system that the US shares with Canada in the Great Lakes region, since the entire western

**“THE REAL RISKS OF CONFLICT LIE ALONG FOUR MAJOR RIVER SYSTEMS IN ASIA AND AFRICA: THE NILE, THE TIGRIS-EUPHRATES SYSTEM, THE INDUS, AND THE MEKONG.”**

**AREAS OF 'PHYSICAL' AND 'ECONOMIC' WATER SCARCITY**

Source IWMI, 2007



- |   |  |
|---|--|
|  Little or no water scarcity |  Approaching physical water scarcity |
|  Physical water scarcity     |  Economic water scarcity             |
|  Not estimated               |  |

half of the US is already a water-deficit area, but it is hard to see those demands leading to open conflict. Canada has one-sixth of the world’s fresh water, and it will probably find ways in which to meet American needs in a commercial arrangement that does not severely damage the Great Lakes system.

There is also unlikely to be international conflict over the Amazon’s water resources, even though some Andean countries face a grim future when the glaciers that provide most of their water have melted. The Amazon’s headwaters are on the eastern side of the Andes, whereas the people, for the most part, occupy the western side.

The real risks of conflict lie along four major river systems in Asia and Africa: the Nile, the Tigris-Euphrates, the Indus and the Mekong. In the case of the Nile, the biggest downstream state, Egypt, is entirely dependent on the river’s water to grow the food for its 80 million people. Without the Nile, Egypt could not sustain any more people than neighbouring Libya (about 6 million). International agreements regulate the sharing of the river’s water, but they would probably not survive any serious decline in the amount of water reaching Egypt.

While the impact of climate change on rainfall in the Nile's drainage basin is unclear, the population of the upstream states is soaring. Ethiopia's population was 18 million in 1950 and is now 80 million. It is forecast to be 183 million in 2050. Uganda's population was five million in 1950 and is now 33 million. It is predicted to rise to 93 million by 2050.

Even if famine intervenes to curtail the high end of that population growth, it will require superhuman restraint for the upstream states not to take more than their agreed share of the Nile's water. Egypt, a much more developed and heavily armed country, might find that it cannot allow this to happen if it wants to support its own growing population.



△ Egypt is entirely dependant on the Nile's water to grow food for its people.

Similarly, the Tigris and the Euphrates have been the lifeblood of Iraq since Mesopotamian times, and the Euphrates also plays a key role in Syrian agriculture. But both rivers rise in Turkey, a far richer and stronger state. 90% of the water that fills the Euphrates, and half of the Tigris's water, falls originally in southeastern Turkey. Yet these rivers do not occupy a large place in the national consciousness of Turks, two-thirds of whom live far away in the western third of their country. As a result, there were no Turkish dams on the rivers until the 1960s, and the downstream states consumed all the water they wanted.

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*“Neither Syria nor Iraq can lay claim to Turkey’s rivers any more than Ankara could claim their oil. This is a matter of sovereignty. We have a right to do anything we like. The water resources are Turkey’s, the oil resources are theirs. We don’t say we share their oil resources and they cannot say they share our water resources.”*

**Suleiman Demirel**  
President of Turkey,  
1993-2000,  
25 July 1992

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**“‘WATER WARS’, SO OFTEN TOUTED IN THE MEDIA AS A PROBABLE SOURCE OF FUTURE WARS, ARE REALLY ONLY LIKELY ALONG A VERY FEW RIVERS EVEN WITH SERIOUS WARMING.”**



△ Irrigation canals draw water from the Euphrates River in northeastern Syria.

That changed with the foundation of the Southeastern Development Project Güneydogu Anadolu Projesi (GAP after the Turkish initials), which envisaged the construction of 22 dams and 19 hydroelectric power plants on the Euphrates and Tigris rivers and their tributaries. This enormous project was originally scheduled for completion by 2010 but that has now been put back to 2047. At full development, more than 1.7 million hectares of land will be irrigated by water from GAP dams and barrages (almost one-fifth of all the irrigated land in Turkey), and 27 billion kilowatt hours of electricity will be generated annually by the dams (more than a fifth of the country's hydropower potential). The next major stage, the Ilisu dam which is due for completion in 2011, could reduce the flow of summer water to Mosul in Iraq by as much as 50%.

There has never been an overt military confrontation between Turkey and its downstream neighbours, but the potential for war is ever-present. While there is little risk of that at the moment, should climate change shrink the amount of available water in the river system drastically, war between Turkey and the downstream states would become likely. If Turkey did not win immediately and decisively, the war might even expand to include its ally, Israel.

The endless disputes over India's operation of the Farakka barrage on the Ganges, upstream from Bangladesh, were largely ended by the 1996 treaty, a model of its kind

in which the two countries agreed that the water would be distributed each year on an agreed formula that used the average flow of the last 40 years as a guide. The agreement seems robust and flexible enough to survive even the stresses of climate change. In any case, India, the upstream state in this relationship, is so much stronger economically and militarily that Bangladesh is never likely to resort to force.

The Mekong, which is shared by China, Burma, Thailand, Laos, Cambodia and Vietnam, is unlikely to see open conflict for the same reason: the upstream state, China, is so much more powerful than all the others. All the downstream states, except Burma, belong to the Mekong River Commission, which complains bitterly about China's dam-building on the upper reaches of the river, because it is reducing the water level and the volume of fish in the river. In practice, however, there is nothing they can do about it.

"Water wars", so often touted in the media as a probable source of future wars, are only likely along a very few rivers, even with serious warming— the exception to this, the Indus river system between India and Pakistan, is examined in more detail in the case study.



## CASE STUDY ONE: THE INDUS RIVER

In India before 1947, the Indus river system provided water to the largest continuous tract of irrigated land in the world. More than 80% of the farmers who used that water lived in what became Pakistan after the partition in 1947, but because the whole system was supplied by flow from glaciers on the Tibetan plateau, the upper reaches of five of the six tributaries in the system ended up in Indian-controlled territory. The shooting had stopped by 1948, but for the next decade onwards the two successor states quarrelled incessantly over the division of the waters.

That ended with the signature of the Indus Waters Treaty of 1960, which did indeed allocate the bulk of the flow to Pakistan. India was to receive all the water from the three eastern rivers (which are relatively small) and a fixed volume from two of the others, while all the water in the main branch, the

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**“The sources of the rivers [Indus River System] are in India and India had made arrangements to divert the waters. Every factor was against us. The only sensible thing to do was to try and get a settlement. It might be the second best, but if we did not we stood to lose everything.”**

**Ayub Khan**  
Pakistani President  
1960

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**“CLIMATE CHANGE WILL BRING THE INDUS WATERS TREATY INTO QUESTION, AS THE GLACIERS THAT FEED ALL SIX BRANCHES OF THE RIVER ARE MELTING FAST.”**

Indus itself, went to Pakistan. Nevertheless, many Pakistanis felt cheated – which explains General Ayub Khan’s remarks, quoted on the previous page, after the treaty was signed – and the resentment grew with time as population growth made Pakistan ever more vulnerable to any diminution in the water supply.

Most of Pakistan is like Egypt from an agricultural point of view: more than three-quarters of its food is grown on land irrigated by a river system flowing across land that would otherwise be a desert. Three full-scale wars and several lesser clashes in the past six decades with their far larger neighbour, India, have made Pakistanis acutely sensitive to India’s potential use of the “water weapon”, exploiting its control of the Indus headwaters to starve Pakistan out.

This has never happened, even during the various wars, but Pakistanis never forget that it might be used. A paper by the Mumbai-based International Centre for Peace Initiatives recalls that during a confidence-building meeting in Karachi in 2001, one Pakistani suggested that India was planning to use the water weapon at last – and another instantly warned that any conflict over water would lead Pakistan to launch a nuclear first strike against India.

Unfortunately, the two countries can arrive at such a crisis without anybody choosing to behave in an unreasonably aggressive way. Climate change will bring the Indus Waters Treaty into question, as the glaciers that feed all six branches of the river are melting fast.

All the water in the Indus system is now used by human beings; for most days in the year, the river no longer reaches the sea. When the glaciers have evaporated and no longer keep the rivers full with their meltwater in the summertime, which may be in as little as 20 or 30 years time, the entire Indus system will become seasonal, and the rivers will be low precisely when agriculture needs them most.

For India, this will be a local inconvenience; less than 10% of its food depends on water from the Indus system. For Pakistan, however, it will become a matter of life and death. When Pakistan is no longer receiving enough water under the treaty provisions to sustain its own population, it is likely that Islamabad will challenge the old agreement.

Both Pakistan and India are nuclear-armed states, and nuclear weapons generally instil a sense of caution in both sides of any confrontation. Nevertheless, the potential for serious conflict over the Indus waters is high.

# IMPLICATIONS FOR BUSINESS

## WATER SCARCITY

- A large swathe of countries around the equator will fall victim to water stress. In some extreme cases, highlighted in the body of the report, this could result in inter-state tensions and even conflict. Intra-state conflicts are equally possible. Access to water will increasingly be seen as a potential strategic weapon, which will have an impact upon businesses that operate in these nations.
- Water stress may, in due course, render parts of the planet uninhabitable and not just in the developing world. Already plans are in place to relocate the inhabitants of some cities in the US, which may in the long run prove unviable.
- Water is essential for many manufacturing and production processes: power generation, semi-conducting, metals and mining, beverages, agriculture and bio-technology. In water-stressed areas, the viability of these processes will increasingly come into question. In parts of the US and Latin America droughts have led to substantial drops in hydroelectric power generation with major knock-on effects for business. Pepsi and Coca-Cola have lost their production licences in India due to concerns about water use. Many of the world's biggest semi-conductor plants are located in potentially water-stressed parts of the Asia-Pacific region. The availability or otherwise of water will increasingly determine where businesses should be located.
- In future, all businesses will need to be much more aware of water issues, in terms of how these affect the areas in which they are located and their own behaviour. They will need to be able to determine their own "water footprint" and assess the regulatory risks that are associated with it. Water will need to be integrated into the business planning process.
- The development of water-efficient production technologies will be at a premium and companies that develop such technologies can expect substantial rewards. Equally, firms seen as paying insufficient attention to water conservation can expect to pay a high reputational price. Nowhere is this more true than in the agricultural sector, which accounts for 70% of all water use.
- On a more positive note the potential to achieve greater efficiencies in agricultural water usage is considerable. Rational water pricing mechanisms alone can do much to discourage waste and alter behaviour – though they need to be implemented with political sensitivity in low-income countries. Irrigation systems – which currently suffer high levels of wastage from condensation and ground can also be made much more efficient. China for example plans to increase irrigation efficiency from 43% in 2000 to 55% by 2030. Drip irrigation could meet 10% of India's agricultural needs.
- In developed economies, relatively small changes in consumption patterns – eating ten or 20% less meat and dairy products a year – can translate into significant savings in the amounts of water used to produce such food.



**CLIMATE CHANGE WILL GENERATE SERIOUS PROBLEMS FOR GLOBAL FOOD SUPPLY, MANIFESTING FIRST AS SHARP PRICE INCREASES AND SUBSEQUENTLY AS ABSOLUTE SCARCITIES.**

## PART 2:

# FOOD SUPPLY

The world's population has tripled in the past 60 years, but it is all being fed from essentially the same land as before. A large proportion of the world's population is eating a much richer diet than its grandparents did – more meat and dairy products – and yet there is still enough to go around. There was a crisis in the 1970s when population growth threatened to outrun food production, but the “Green Revolution” averted it and food production grew faster than population for another three decades.

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### GREEN REVOLUTION

The “Green Revolution” had three key elements, only one of which was actually green; the introduction of hybrid strains of existing food plants that produced higher yields and/or were more resistant to drought, salinity or disease. Equally important was a huge expansion in the use of fertiliser worldwide, which has grown elevenfold since the end of the Second World War. The final element was the drilling of deep wells to tap underground aquifers, which allowed a threefold expansion in the amount of irrigated land. Even now, irrigated land only accounts for 15% of the farmed area worldwide, but it supplies 40% of the world's food.

It should be noted that nitrate fertilisers, for which the feedstock is natural gas, and irrigation water that is pumped up from deep aquifers, involve a heavy dependence on fossil fuels.

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Unfortunately, the key elements in the Green Revolution have largely exhausted their potential. The process of raising crop yields by hybridising plants has brought diminishing returns, and the technology used to manufacture genetically modified organisms (GMOs) has not yet been directed to this goal; almost all existing GMO crops have been engineered for greater resistance to pests or drought, not for higher yields. The use of fertiliser has also hit diminishing returns, at least in the developed world. Most importantly, irrigated farmland is a dwindling resource, as many of the aquifers will run dry in coming decades, partly due to climate change.

World grain production has been outrun by consumption in seven of the past eight years, and the shortfall has been made up by drawing on carryover stocks. As a result, the world grain reserve is now at a low of 54 days' supply, down from 116 days' supply ten years ago. The last time the reserve was as low as this was in 1973, when the world's population was half what it is now – and there is no new Green Revolution in sight this time.

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“What we had thought of as an abundant food supply is anything but. Western societies, in particular, have tended to take their food supplies for granted. The global system will reach breaking point unless action is taken.”

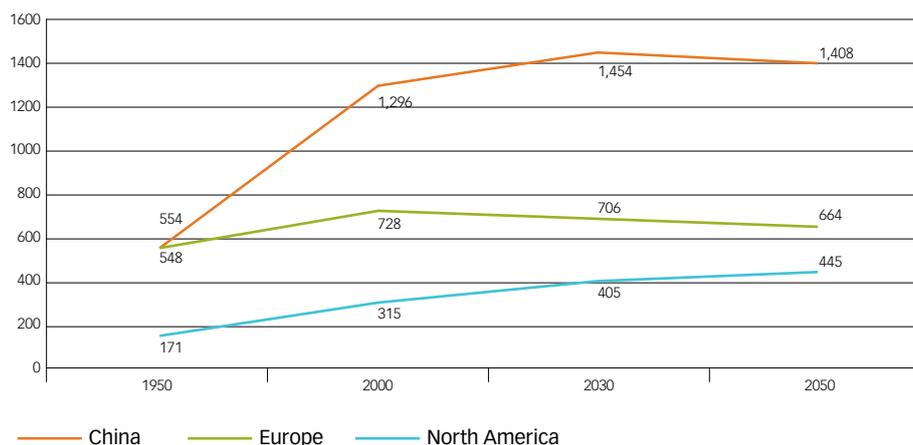
“Food Futures: Rethinking UK Strategy”  
Chatham House paper,  
2009

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**“A SERIOUS GLOBAL SHORTFALL OF FOOD PRODUCTION IS VERY PROBABLE UNDER A RISE OF JUST 2°C, AND QUITE POSSIBLE EVEN WITH AN INCREASE OF ONLY 1°C.”**

The tightness of the global grain supply was highlighted by the rapid doubling or tripling of wheat, rice and maize/corn prices during 2007-08 in response to some local and partial crop failures and the diversion of maize/corn into bio-fuel production. Grain prices have fallen back since then, but it is not clear how production can be increased by another 40-50% to feed an additional 2.5 billion to 3 billion people before the planet’s human population levels off at around 9 billion later in this century. We would face a grave problem even without climate change.

Population 1950-2050



The impact of global warming on food production will be largely negative. Any modest increases in crop yields in high-latitude temperate regions due to warmer weather would be more than cancelled out by losses in the sub-tropics and the tropics. In the sub-tropics, which are already relatively dry, the main problem will be further desiccation due to shifting rainfall patterns and higher evaporation of moisture from the soil. In the tropics, the higher temperature itself is a problem, because most crops there are already near the upper limit of their temperature tolerance.

For a country like India, which straddles both zones, the predicted loss of production with a 2°C increase in global temperature is 25%. Similar losses may be expected in other countries sharing the same latitude, which implies that a serious global shortfall of food production is very probable under a rise of just 2°C, and quite possible even with an increase of only 1°C.

If that occurs, we may expect to see a severe contraction in the amount of grain that ends up on the international market, making it more difficult for countries facing

domestic food shortages to buy their way out of trouble even if they have ample funds. This was the case in 2008, when suddenly the biggest exporters just stopped selling. Russia, Ukraine and Argentina added huge export taxes on wheat, and China, India, Brazil and Vietnam banned rice exports. Some exporters even broke contracts in order to ensure that the home population continued to have enough food at a reasonable price.



△ The world grain reserve is now at a low of 54 days' supply.

Anxiety about the future availability and price of food is already causing a rapid growth in bilateral deals. Relatively solvent countries that feel vulnerable to food shortages are buying up substantial chunks of the food production sector in land-rich but relatively poor countries. China's investments in Sudanese agriculture lead the field, but the richer Gulf states are following suit, acquiring land in other countries, where all food produced will all be destined for the owner abroad. Saudi Arabia is in discussions with Ukraine, Pakistan, Sudan, Turkey and Egypt to set up projects each of at least 100,000 hectares each to grow crops such as wheat, corn, rice, soya beans and alfalfa (a grass used for hay and as food for cattle), and the United Arab Emirates is developing 30,000 hectares in Sudan and looking at projects of similar scale in Uzbekistan and Senegal. More recently, South Korea concluded a deal with the government of Madagascar to lease 1.2 million hectares of land for food production. Such deals have raised concern about the implication for local domestic food supplies and the environmental impact on ecologically sensitive areas.

It was concern about the possible collapse of the open international market in food, with the overall supply seriously cut by climate change and much of the remainder locked up in bilateral deals, that motivated the 2009 UK Chatham House paper quoted above. Britain is in an unusually vulnerable position, with just over half its food imported from abroad (30% from other European Union countries and the rest from further afield). However, Britain is not alone in its concerns about the impact of climate change on future food supply.

Regions that face steep falls in food production if climate change progresses include all the sub-tropics: Mexico and the southwestern and southern US; both sides of

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“Global warming has an effect on commodities. The time may come when, even if you have the money, acquiring some commodities will not be easy.”

**Mohammed al-Suwaidi**

Director, Abu Dhabi Fund for Development,  
1 July 2008

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**“ONE OTHER FACTOR THAT CANNOT BE NEGLECTED IS SEA-LEVEL RISE, FOR A GREAT DEAL OF THE WORLD’S GRAIN IS GROWN IN LOW-LYING RIVER DELTAS THAT WOULD BE PARTIALLY FLOODED BY EVEN A ONE METRE RISE IN SEA LEVEL.”**

the Mediterranean; the Middle East; northern India; southern China; southern Brazil and northern Argentina and most of Australia. There is a case to be made that this desiccation is already having a profound effect on Australia, the driest continent, where many people suspect that the severe and prolonged “drought” that the country has been suffering may actually be the product of climate change – in which case it is not a drought at all, but the normal weather pattern.

One other factor that cannot be neglected is sea-level rise, for a great deal of the world’s grain is grown in low-lying river deltas (Yangtze and Yellow rivers in China, Mekong and Red rivers in Vietnam, Irrawaddy river in Burma, Ganges-Brahmaputra system in Bangladesh and India, Nile river in Egypt) which would be partially flooded by even a one metre rise in sea level. The most recent calculations suggest an increase of not much more than half a metre by the end of the century, but that assumes the rate of sea-level rise will not increase further during the rest of the century. There have been occasions in the past, however, when glacial melting has caused five metres of sea-level rise in a single century.

On balance, it seems likely that climate change will generate serious problems for global food supply, manifesting themselves as sharp price increases and subsequently as absolute scarcities. Many things could be done to alleviate these problems, from moving down the food chain (ie eating less meat and dairy) to developing new crop varieties that are more resistant to drought, heat and salinity, but there will be major impacts, and they will have political and strategic consequences, and ultimately implications for business.

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### **WORLD’S LARGEST FOOD CONSUMERS**

(million tonnes – 2001-2003 average consumption)

<b>Grains</b>		<b>Meat</b>	
China	216	China	69
India	164	US	36
Indonesia	43	Brazil	14
US	33	Russia	7
<b>Sugar</b>		<b>Root Vegetables</b>	
India	25	China	97
US	21	Nigeria	26
Brazil	10	India	25
China	10	US	19

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## CASE STUDY TWO: CHINA

At first glance, China should be one of the countries that suffer relatively little from global warming, at least in the early stages. The country occupies about the same latitudes as the US, so more of it lies in the temperate zone than in the sub-tropics. It has made enormous efforts to get its population growth under control, and will probably reach a peak of no more than about 1.5 billion people before falling back to 1.3 billion in about the middle of the century. Its rapid economic growth should give it the resources to cope with relatively large disruptions to its normal climate. Yet Chinese officials remain concerned.

One major concern is the Yangtze river that provides much of the water for southern China and which has its source in glaciers on the edge of the Tibetan plateau. As long as the glaciers are in mass balance, they accumulate snow and ice every winter and release about the same amount as meltwater each summer, thus keeping the river full even in a relatively dry summer. However, those glaciers are now losing mass at an average rate of 7% per year, according to the Chinese Academy of Science figures, which means that they will be largely gone in 20 years.

This will lead to a future of several decades of severe flooding on the Yangtze, followed by a steep fall in the volume of water available in the summertime once the glaciers have melted. (This is a problem shared by the Mekong river in Indo-China, the Salween in Burma, the Brahmaputra in Bangladesh, the Ganges in India and the Indus in Pakistan, all of which are similarly fed by rapidly shrinking glaciers and are also destined to become largely seasonal rivers by the 2030s or 2040s.)

Combined with hotter and drier conditions, the reduced summer volume of water in the Yangtze will probably make agriculture in southern China considerably less productive than it is now. In the north of China, where the principal crop is wheat, not rice, and agriculture depends heavily on rainfall and on irrigation from underground aquifers, the problems are different but the outcome will be similar. The East Asian Monsoon, which brings summer rain

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“Northern Eurasian stability could be substantially affected by China’s need to resettle tens, even hundreds of millions from its flooding southern coasts.

A small Russian population might have substantial difficulty preventing China from asserting control over much of Siberia and the Russian Far East. The probability of conflict between two destabilised nuclear powers would seem high.”

**R. James Woolsey, Jr.**  
Former Director  
of the US Central  
Intelligence Agency,  
November 2007

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“The Chinese central government says that it recognises our borders, but the Chinese provinces still claim that Chinese territory starts from the Urals (ie includes all of Siberia and the Russian Far East). Within 15 years, China can reach the level of (technological) development of Russia, and then I do not exclude that conflict will start.”

**Col. (Ret'd) Anatolii Tsyganok**

Centre for Military Forecasting, Moscow,  
23 April 2008

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to the North Chinese plain, is already weakening, and the underground water resources are depleting rapidly.

Unusually, there are two aquifers underlying the North Chinese plain, but the shallow one (which does gradually recharge) has effectively been pumped dry, and the deep one (which is a fossil aquifer and does not recharge) is now being pumped heavily. Both irrigation water and rainfall are likely to shrink significantly in the densely populated parts of northern China (except Manchuria) in the coming decades.

A final blow to the Chinese food supply is likely to be the larger storms, including more powerful typhoons that may be expected to strike its coasts, and the associated storm surges that may progressively inundate its agriculturally rich but low-lying delta lands. Taking all of these phenomena together, it is probable that China will be one of the worst-hit countries in terms of its ability to feed its people – and that will have political as well as social and economic consequences.

In a country undergoing such a rapid transition from being mainly poor and rural to predominantly developed and urban, the possibility of a crash is ever-present. This does not necessarily mean regime change, but it could easily lead to more nationalist policies as embattled leaders struggle to retain popular support. Widespread hunger would virtually guarantee an upheaval of that sort, especially if there were also large numbers of displaced people from flooded coastal areas. It is this sort of scenario that causes anxiety among strategic circles in Russia.

There are fewer than 35 million people in all of Siberia and the Russian Far East, an area much larger than that of all China. The region is already highly desirable in terms of its mineral wealth, but it is also one of the few parts of the world that is likely to become significantly more productive agriculturally in a warmer climate.

Nobody in authority in China has publicly expressed an interest in acquiring these Russian territories, nor is it to be expected that anybody would do so under normal circumstances. The question is rather what might arise in times of crisis of the sort that climate change may bring to China. Then the answer becomes much more difficult to predict, although it is likely that in the first instance China would attempt to do what it has done elsewhere, to lease land for agricultural production rather than seeking to occupy the area.

# IMPLICATIONS FOR BUSINESS

## FOOD SUPPLY

- Climate change is just one of a number of factors that influence food supplies. But it will become increasingly predominant over time. It is in the interests of the business community to help achieve a better understanding of how climate change will affect specific regions and countries by sponsoring scientific research which looks at patterns of rainfall, incidences of extreme weather events, the impact of rising sea levels and changes in temperatures. Development agencies are increasingly keen to commission such research.
- Competition for available food resources will become more intense and international food markets are likely to function in less predictable ways. Increases in the frequency of extreme weather events as a result of climate change will add to the unpredictability. Food nationalism will probably increase. Companies involved in food production and food processing will need to build higher levels of uncertainty of supply into their planning assumptions.
- International food markets involve complex interlinkages, whereby a change in one area can have far-reaching effects on the availability and pricing of food in completely different sectors of the market. Companies involved in food production and sales will need to be able to map through these interlinkages and introduce a range of mitigating strategies for developing alternative sources of particular commodities or persuading consumers to accept alternatives.
- Companies reliant on food produced overseas will need to assess the reliability of supplies and to consider whether food can be produced closer to the point of consumption. Where food is grown in the developing world for export, the companies involved will increasingly need to engage with local communities and other stakeholders to ensure that they derive some benefits from the process.
- Companies engaged in the hospitality and tourism industries will also need to consider sourcing food closer to where their operations are situated. The model of luxury resorts and restaurants in the developing world, flying in most of their food from overseas may not prove sustainable.
- Particularly in the developed world, companies involved in food production will need to develop sophisticated strategies for dealing with consumer demands (for example resistance in Europe to the consumption of genetically engineered foods) and companies will increasingly have to engage in an informed public debate on health, nutritional and ecological issues.
- Companies involved in first-generation bio-fuel production – on land which could be utilised for agricultural production – will need to be aware of the tensions to which this activity might give rise and to engage closely with local stakeholders to take account of their concerns.
- Climate change will impact directly on some areas of food production, notably animal husbandry, and this may also give rise to local tensions. Temperature rises will adversely affect animal health and increase the risks of infectious diseases. Companies involved in food processing will need to be alert to the associated public health and reputational risks.
- But with the risks come major opportunities. As peasant farmers increasingly abandon the land and move to cities, farming is likely to become ever more large-scale and mechanised, offering the potential for economies of scale and scope for greater investment by business in advanced agricultural techniques. Developments in biotechnology will also present opportunities, with a particular focus on water-efficient production and techniques.

**ENERGY EFFICIENCY WILL  
BECOME INCREASINGLY  
IMPORTANT AND WILL  
INCREASINGLY INFLUENCE  
COMPETITIVENESS AND  
REPUTATIONAL STANDING.**



## PART 3:

# ENERGY AND NATURAL RESOURCE SECURITY

The promise to cut the dependence of the US on foreign oil (which now accounts for 60% of American consumption) has been made many times before, most recently by former president George W. Bush, who vowed in 2006 to break the nation's "addiction to oil". However, there are now three technological options for drastically reducing or even eliminating the use of oil in most ground transportation, whereas it was previously seen as irreplaceable.

- Much higher fuel-efficiency standards enabled by new technologies. The average fuel efficiency of US motor vehicles increased by more than half between 1970 and 1990, but has virtually stagnated since. It is currently 21.4 miles per gallon (mpg). The existing federal target is that new vehicles should attain an average fuel efficiency of 35 mpg only by 2020, but a number of large states want to set an earlier deadline of 2016. If President Obama takes the latter approach, it will effectively impose that earlier deadline on the whole automobile industry. Together with tax credits for drivers who scrap "gas-guzzling" older cars, this strategy could cut US oil consumption by as much as 25% in ten years (the US vehicle population grows slowly, as the market is saturated.) Such a cut would nearly halve US oil imports and its implications for global demand and price would be almost as dramatic.
- In the past decade battery technology has advanced enough to make it possible to change much of the US vehicle fleet over from petroleum-based fuels to electrical power, conceivably within the next ten to 15 years. The need to avoid greenhouse gas emissions means that the electricity that runs the batteries in all those cars would have to be generated without burning fossil fuels (coal or gas) and this shift is underway.
- "Second- and third-generation" bio-fuels are now being researched intensively. If the new bio-fuels prove to be a commercially viable substitute for oil, then the change-over could occur without the need to modify existing engines or build new distribution systems.

Beyond the exchange cost and political risk of depending on "foreign oil", the threat of climate change now provides another strong incentive for shifting to non-petroleum-based energy in the transportation industry as fast as possible. All this means that it is now possible to imagine the US halving its oil consumption in ten or 15 years without consumers significantly changing their lifestyles. In such a situation, other industrialised nations could be expected quickly to follow suit and it is likely that industrialising nations like China, which are heavily dependent on imported oil, would not be far behind.

So the question arises: what would happen if the global demand for oil went into a permanent decline? Current concerns run in the opposite direction, with anxiety

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*"It will be the policy of my administration to reverse our dependence on foreign oil while building a new energy economy that will create millions of jobs."*

**President Obama**  
26 January 2009

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**“THERE IS STILL  
PLENTY OF OIL IN  
THE WORLD, BUT  
IT IS BECOMING  
HARDER  
AND MORE  
EXPENSIVE  
TO PRODUCE.”**



△ The speed with which fossil fuels can be replaced is uncertain.

about the imminent arrival of “peak oil” driving the oil price up to almost \$150 per barrel in mid-2008. This remains a concern, and despite the recent steep fall in the oil price there is a general expectation that oil will once again rise over \$100, once the recession that began in the last half of 2008 has run its course. But this assumes that global demand for oil will hold up indefinitely, and indeed grow each year.

If the demand for oil were to go into even a modest decline – say, three or 4% a year – the impact on the price of oil could be immediate and profound. Even assuming that “peak oil” has already arrived or is imminent, the typical rate of decline in mature oil fields in the early years, after they have passed peak production, is only two% a year.

If global oil production were to fall at the same modest rate, then serious fuel conservation measures in the industrial world, followed by the gradual introduction of alternative energy sources for transportation, could easily result in sustained falls in oil demand and oil price, and lead to the marginalisation of the world’s major oil exporters in only a couple of decades. What this means in terms of global stability is hard to predict. In the Middle East, governments might struggle to support growing populations if they did not have extra time and financial assistance to diversify away from dependence on oil revenues.

At the moment, however, all this is mere speculation, and most governments of industrial countries are deeply concerned about the price and availability of the oil that they depend upon. This has resulted in a sense that the world is about to embark on a desperate scramble for the remaining oil and gas resources of the planet. In fact, there is still plenty of oil in the world, but it is becoming harder and more expensive to produce, and some of the remaining major known fields will take some years to bring on stream even if investment starts now. Furthermore, many of the biggest unexploited deposits are owned by national oil corporations, which have been reluctant to permit outside investment. Meanwhile, the major oil-producing states are keen to maximise revenues to help them diversify from over-dependence on oil exports. So there are good grounds for thinking that as the world emerges from the present economic downturn, oil will remain a relatively scarce and expensive commodity.

**“A MOVE AWAY FROM OIL WOULD LEAVE MANY COUNTRIES FACING AN UNCERTAIN FUTURE.”**

In the longer term, a move away from oil would leave many countries facing an uncertain future. If the US ceased to be dependent on oil, it might arguably have much less incentive to remain engaged in the Middle East. In such a situation, Iran – although highly dependent on oil and gas revenues and therefore vulnerable in this scenario – might seek to exercise a long sought-after hegemony over the Gulf region. Most Arab states would find it hard to countenance such a move and could consequently lead to further regional tensions. Elsewhere in the world, a number of African states, such as Nigeria and Angola, and Venezuela would be vulnerable to instability due to falling revenues. Russia, too, would find itself substantially weakened and this would be likely to enhance its sense of external threat, leading to unpredictable consequences.



△ Developing green technology offers considerable commercial opportunities.

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“I will say it outright we [Russia] will not give the Arctic shelf to anybody else. Canada or the US may not like this but this is my stance. It is historically our [Russian] shelf.”

**Artur Chilingarov**  
Arctic adviser to  
Prime Minister Putin,  
December 2008

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There are thus concerns about whether energy independence for the US would be inherently desirable if that led to increased isolationism. Europe in particular might find such a development unwelcome if it meant that it had to become more directly engaged in the security of neighbouring regions.

Oil, of course, is not the only issue: coal is one of the major sources of carbon emissions. It is used extensively for power generation in the US and in the major industrialising nations of India and China. If emissions are to be brought down to manageable levels, then clean coal-burning technologies will need to be developed and made available to developing countries unable or unwilling to pay a market price for them. Finding ways to make the technology available, where it is most needed, without being disadvantageous to the commercial interests of companies developing it, represents a major challenge. As does the need to manage an inevitable rise in nuclear power generation in ways which do not add significantly to the risks of nuclear weapons proliferation. This is especially pertinent in the case of the Middle East, in view of the temptation for Arab states to hedge against Iran’s nuclear weapons ambitions, but is also true for Southeast Asia. Some centrally managed facility to provide states with enriched uranium for their nuclear power-generation programmes and to reprocess spent fuel would go a long way towards mitigating this risk<sup>2</sup>.

In terms of energy supply, one area stands out as still largely unmapped and with issues of ownership unresolved. This is the Arctic region which is discussed in detail in the case study below.



### CASE STUDY THREE: ARCTIC OCEAN

It was Artur Chilingarov, a former deputy speaker of the Duma and personal adviser to Vladimir Putin on Arctic affairs, who first drew global attention to the potential of the Arctic. He was the commander of the mini-sub that planted the Russian flag on the Arctic seabed, four kilometres below the ice at the North Pole, in the summer of 2007. The purpose of the adventure was to highlight Russia’s seabed claims in the Arctic, which extended to the North Pole.

<sup>2</sup>The IISS recently produced a Strategic Dossier on Nuclear Programmes in the Middle East: In the Shadow of Iran, which can be found here: <http://www.iiss.org.uk/publications/strategic-dossiers/nuclear-programmes-in-the-middle-east-in-the-shadow-of-iran/>

Canada made the noisiest response, announcing a new naval base in the high Arctic and the construction of six ice-strengthened patrol vessels to survey the country's ice-bound northern archipelago. This was curious, since it is the US, and not Russia, that regularly challenges Canada's claim that the still-frozen Northwest Passage between the Atlantic and Pacific Oceans is part of Canada's inland waters and not an international strait with free passage for all. Nevertheless, the assertion of sovereignty was expedient in terms of Canadian politics.

The new interest in the Arctic is not about shipping routes; it is about oil and gas. Americans, Norwegians and other claimants to portions of the Arctic seabed well understood that was what Chilingarov's claim was really about, and there is much to play for.

Technically, all the countries bordering the Arctic Ocean – the US, Canada, Russia, Norway and Denmark – are committed to abide by the rules of the United Nations Convention on the Law of the Sea (UNCLOS) in determining their seabed boundaries. There is a process underway by which all the nations with Arctic coastlines must submit geographic and geological data to the relevant United Nations committee to support their claims that certain parts of the continental shelf are legitimate extensions of their Exclusive Economic Zones (with the exception of the US, which has not ratified UNCLOS, although it largely abides by its provisions).

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## UNCLOS

In theory, the Law of the Sea treaty should settle who owns which parts of the Arctic seabed, but in practice the situation is more complex. There are two main reasons for disputes. The 200 nautical-mile (370 km) Exclusive Economic Zone (EEZ) that each littoral state can claim is measured from a "baseline", which sometimes follows the contours of the coast and is sometimes drawn between headlands or offshore islands. Moreover, the boundary between two adjacent EEZs can be calculated as a line perpendicular to the coast where the land frontier reaches the ocean, as a line perpendicular to the more general trend of the coastline, or arguably, in the Arctic case, along a straight north-south meridian of longitude extending to the Pole. The seabed disputes between the US and Canada, and between Russia and Norway, both depend on different interpretations of these rules – and both involve potentially oil and gas-rich areas. Beyond the EEZ, coastal states can also claim exclusive rights to exploit seabed resources all the way out to 350 nautical

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"We have some disagreements with the US over the extent of our sovereignty over Arctic waters. This government has been very clear. I have been very clear with President Bush. This government will assert its sovereignty over all of its land and sea territories."

**Stephen Harper**  
Canadian Prime Minister,  
January 2009

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“We think the situation is very dangerous and serious, and we also think that NATO will transform from a defensive alliance to a bloc that will fight for energy resources, and it will fight for its interests by military means.”

**Col. Anatoliy Tsyganok (ret'd)**

Centre for Military  
Forecasting, Moscow,  
23 April 2008

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miles if they can demonstrate that their continental shelf extends that far. Once again, the rules for determining exactly what constitutes continental shelf and what does not are open to various interpretations.

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At the moment, the various littoral countries, except the US, are gathering data about the topography and geology of the sea bottom (to the extent that the retreating ice permits) in order to support the continental shelf claims that they will be submitting to the United Nations in the next few years. However, the relevant UN committee is not scheduled to publish its decisions until 2020, and events may move a great deal faster than that. If the oil price surges again after the current recession, the ocean drilling rigs may begin to appear in both those zones. If the drilling results look promising, those disputed areas could become contested – and all the Arctic countries except Russia are members of the NATO alliance.

There may be much less oil and gas under the Arctic Ocean than originally thought, although the US Geological Survey estimates that up to 20% of the world's known remaining oil and gas reserves are located there. Or it may all be in areas that clearly belong to one or another littoral country and are not open to dispute. But local confrontations in disputed areas are certainly possible, and they might expand into something more general. Russia is convinced that there are substantial hydrocarbon reserves under the Arctic Ocean, which will ensure the energy future of their country, and the other Arctic nations are not immune to the same enthusiasm.

The danger is not of a nuclear war or even a conventional war over the Arctic, but rather of growing hostility between Russia and the NATO countries, fed by local clashes over seabed rights, that damages both trade and international diplomacy. A lengthy confrontation between the old adversaries is particularly undesirable in the near future because it would come at precisely the period when maximum global diplomatic cooperation is essential in order to agree on a coordinated and effective response to the threat of climate change.

# IMPLICATIONS FOR BUSINESS

## ENERGY AND NATURAL RESOURCE SECURITY

- International oil markets are likely to become tighter and more volatile as increasing demand meets constrained supply and oil-producing states seek to maximise revenues while the opportunity still exists. Companies will need to build increased uncertainty of supply into their planning assumptions. This is likely to be less true of gas, supplies of which are still relatively plentiful.
- All companies will need to be aware of their energy footprint and be able to assess the regulatory and other risks associated with it. Energy efficiency will become increasingly important and will increasingly influence competitiveness and reputational standing.
- Companies whose business depends on high-emission fossil fuels such as coal will come under increasing pressure to adopt measures to mitigate the greenhouse effects of these fuels. Firms involved in the production of clean-coal technologies will come under pressure to make these widely and cheaply available.
- The speed with which alternative and renewable energy sources come on stream will be hard to predict, and will be further complicated by the propensity for governments to “pick winners” and apply market-distorting subsidies as has happened in the US with first-generation bio-fuels. Companies will need to monitor closely developments in the alternative and renewable sectors to ensure that they don’t enter these markets too early or too late.
- Electricity generation is inadequate to meet current, much less predicted demand. In South Africa, a failure to anticipate electricity generation requirements is expected to have significant adverse implications for that country’s growth. Fluctuations in the supply from hydroelectric generation have created significant discontinuities in the US and Latin America. Companies operating in vulnerable countries will need to be aware of the potential constraints and consider mitigating options, such as independent generating capacity.
- Pressure on electricity generation will lead to an upsurge in nuclear power. This offers significant business opportunities for companies with the requisite expertise, of which there is currently a global shortage.
- There are considerable business opportunities for companies willing to invest in the development of energy-efficient technologies and alternative and renewable energy sources. The financial sector has a major part to play in providing investment capital for such developments. When, as is currently the case, such capital is in short supply, innovative financing techniques will be at a premium. The insurance industry has already begun to play a role here. According to a recent Ceres (a national network of investors and environmental organisations working to address sustainability challenges) report, insurance companies now offer close to 650 climate-change related products. These include cover for renewable energy developers in the event of their products generating lower than predicted levels of energy – thus making it easier for them to raise finance for such projects.



**MIGRANTS FROM AFRICA  
ARE CURRENTLY LABELLED  
“ECONOMIC MIGRANTS,”  
BUT AS TIME PASSES AN  
INCREASING PROPORTION  
WILL BE LABELLED  
“CLIMATE REFUGEES”.**

## PART 4:

# DEMOGRAPHIC PRESSURES

The European and European-descended peoples, who only comprised about 15% of the planet's population at the end of the seventeenth century, expanded to account for about 35% of the world's people by the early twentieth century. They have now fallen back to only about 15% of the population again, as their early population boom has been matched by an even faster rise in population in the "majority world" of Asia and Africa.

By the time that global population stabilises possibly at around nine billion people half a century from now, the European and North American peoples will have fallen further, in relative terms, to less than 10% of the world's population. At the same time, these parts of the world, together with Japan (the only other country to industrialise before the late twentieth century), are responsible for almost all the greenhouse gases emitted until now. Yet, because of their wealth and their geographical location in the earth's more temperate zone, these Western powers will have a greater ability to adapt to changes in the climate.

Climate change is likely to produce destabilising waves of refugees, between nations in the developing world, and around the borders of the developed, western world. This latter phenomenon is already clearly visible on the southern borders of Europe, where migrants from Africa daily risk their lives in crowded and unseaworthy open boats to make the crossing from Senegal and Mauritania to Spain's Canary Islands, or from Libya to the southernmost parts of Italy. They are currently labelled "economic migrants," but as time passes an increasing proportion will be labelled "climate refugees" and they will be equally unwelcome under that label. The same phenomenon can be observed along the US border with Mexico and its sea frontier with the Caribbean countries, and on Australia's northern sea frontier with Southeast Asia.

This is not to suggest that the countries of the "First World" will escape serious damage even in the early stages of global warming. Indeed, thinking is already underway about the eventual need to evacuate low-lying parts of southern Florida and the Gulf Coast permanently and re-settle the inhabitants elsewhere.

Policymakers and strategists in the European Union will already be aware that the northern littoral of the Mediterranean is as vulnerable to extreme climate change and desertification as the southern side, and that the principle of freedom of movement within the EU may ultimately come into question. The Mediterranean members of the EU, in addition to suffering a perhaps irresistible influx of climate refugees from further south, may ultimately become a major source of climate refugees themselves.

Population movements brought about by climate change are likely to exacerbate an issue that has been coming to the fore for some time, namely the rise of the

**"CLIMATE CHANGE IS LIKELY TO PRODUCE DESTABILISING WAVES OF REFUGEES, BOTH BETWEEN NATIONS IN THE DEVELOPING WORLD, AND AROUND THE BORDERS OF THE DEVELOPED, WESTERN WORLD."**

**“MASSIVE CONURBATIONS ARE PLACING HUGE AND LARGELY UNPLANNED DEMANDS ON INFRASTRUCTURE AND SERVICES, AS WELL AS PRESENTING SIGNIFICANT LAW AND ORDER PROBLEMS.”**



△ Much stricter immigration controls may be introduced in some regions.

megalopolis. Many of the world’s major cities already measure their population in tens of millions and these massive – and potentially ungovernable – conurbations are placing huge and largely unplanned demands on infrastructure and services, as well as presenting significant law and order problems. Large areas of cities, such as Mexico City and Lagos, have become effectively unpoliceable and have fallen under the control of organised criminal groups. Companies seeking to operate in such environments will need to be aware of the risks involved, such as the unreliability of utilities and services, and of the high costs of providing security for staff and premises. These megacities are also likely to act as hubs of organised criminal activity aimed at the developed world, such as cybercrime, financial fraud and counterfeiting – risks for which businesses need to plan.

Faced with the prospect of uncontrolled migration flows, countries in the developed world may need to consider funding large-scale adaptive measures, which would enable populations to remain where they were, including technology transfers and large-scale food aid. In more extreme cases, where states collapse, humanitarian

interventions on a scale beyond anything previously attempted may be required. For such approaches to be seen as politically or economically feasible would require societies in the developed world to fundamentally reassess their priorities in ways which would have far-reaching implications for lifestyles and patterns of consumption.

The alternative to such interventions – and one likely to have significant appeal for domestic political constituencies – is the imposition of much stricter immigration controls. In some cases, this could result in the erection of physical barriers to seek to prevent unauthorised migration and the placing of limitations on international travel, which at their most extreme would push the current trend of globalisation into reverse. Experience to date suggests that such measures are unlikely to be wholly successful and would give rise to some difficult security and policy dilemmas.



## CASE STUDY FOUR: US

The US-Mexican border is a bit peculiar: a heavily defended frontier between the First World and the Third World that is nevertheless very porous. In the towns and cities that straddle the 3,000 km frontier, it is an almost impenetrable barrier, but out in the desert it is only a few strands of wire. Several thousand people cross it from south to north each day and at least half of them either stay in the US permanently or at least until they have made enough money to go home with.

In recent years, US policy has been divided over the border. While polls show that the general US population wants the border shut against illegal immigrants, they also show that Americans strongly believe that immigration is positive for the country. A substantial chunk of American business has come to depend upon cheap labour provided by illegal Mexican and Central American immigrants. A compromise has survived for decades – but the impact of climate change on Central America and Mexico may mark its end.

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**“Mexico is already facing lots of stresses – social, economic, open market. People are already migrating because of those reasons. Add to that climate change, and you have a bomb.”**

**Paty Romero-Lankao**  
 Institute for the Study of Society and the Environment, National Center for Atmospheric Research, Boulder, Colorado,  
 7 May 2008

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**“CLIMATE CHANGE IN THE DEVELOPING WORLD WILL LEAD TO MIGRATORY SHIFTS FROM THE POORER REGIONS OF THE GLOBE TO THE WEALTHIER AREAS.”**

Mexico is the world’s tenth largest industrial power, but a great many of its own people are still desperately poor. The climate forecast is for severe desiccation right across the sub-tropics and, when the farms dry up and blow away, there will be nowhere for the ex-farmers to go but into the ever-spreading barrios around the big Mexican cities, or to the US border. Life in an overpopulated Mexican slum will hold few attractions and consequently a large proportion is likely to choose the latter option. The number of illegal border-crossers may double, and even double again, and the US Congress will come under huge public pressure to do something about it. Congress is likely to respond by providing the funds to build impenetrable and effective defences along the entire length of Mexican border.

The state-of-the-art model for such a border fence can be seen in the ones that are currently being built by Saudi Arabia to prevent infiltration by extremists across its 900 km border with Iraq and its 1,700 km border with Yemen. These barriers will consist of two wire-mesh fences, three metres high, separated by a three-metre-deep trench, ten metres wide. The fences can be electrified, and they will support a variety of day and night video cameras and motion detectors. Such fences can also be equipped with remote-controlled machine-guns, and land-mines can be laid in the trench.

The US could undoubtedly close the border with Mexico to illegal immigrants. What concerns American military officers and think-tank strategists who have considered the likelihood that the US Army will ultimately be tasked to close the Mexican border is not the difficulty of the task itself, but its probable side-effects.

The closing of the Mexico-US border would have political ramifications in both nations, and specifically among the Hispanic community in the US and their relations on the other side. The loss in remittances would lead to even greater poverty in Mexico, while the loss of the transient and cheap labour force in the US would have an economic impact in the US. Furthermore, the strength with which the US government chooses to close the border and impose its will may cause domestic political turmoil, as the Hispanic community grows angry at the removal of a porous border that many see as a birthright. This would also be reflected on the Mexican side, where the government might be obliged to react in a negative way to its powerful neighbour, leading to further potential impoverishment of the nation.

# IMPLICATIONS FOR BUSINESS

## DEMOGRAPHIC PRESSURES

- Climate change is likely to hit hardest those populations that are least able to deal with its disastrous impact. Poorer parts of the globe are likely to become poorer, while wealthier parts will suffer less.
- Climate change in the developing world will lead to migratory shifts from the poorer regions of the globe to the wealthier areas. This will involve both intra-regional migration from impoverished rural areas to cities and international migration. These shifts will possibly bring with them exotic diseases, as well as individuals with loyalties to political or religious groupings that are incompatible with the values of the nations to which they are migrating. This may lead to rising political violence, which will lead to a corresponding government reaction that businesses will need to consider in their planning.
- Understanding how these demographic shifts will affect domestic government policy is essential in order to be able to plan around it. Establishing good human resources and employment strategies early will be essential in helping mitigate some of the potential social tensions these human dislocations may cause in the developed world.
- Governments will need to consider whether humanitarian intervention in less developed parts has the potential to mitigate these flows. This could result in decisions to invest heavily in advanced technologies such as desalination projects in desiccated parts of the globe – presenting opportunities for companies developing such technologies (although the costs involved will be high and could be domestically unpopular).
- But the alternative of permitting large-scale migration from the developing to the developed world could be infinitely more costly, raising questions of economic sustainability, social cohesion and public order. It could also lead to a changing local political landscape with potential impacts for business in terms of greater security costs and concerns, and a more fragile political environment which will lead to instability and uncertainty.
- Faced with this prospect governments in the developed world may well resort to significantly enhanced border controls and other measures designed to deter large-scale migrations. Such measures may fundamentally impact on global patterns of travel. This will add costs of time and money to cross-border trade and travel, while greater defences will require a greater public expenditure and possibly higher taxes.
- At a more immediate and practical level for business, these human migrations may mean a growth in the potential pool of prospective workers in the developed world. On the other side of the coin, this may mean a brain and manpower drain in developing parts of the world, as able workers leave for more temperate climates.
- This will all have future implications for where businesses might be located. For example, those currently dependent upon outsourcing services based in the developing world, in countries such as India, may find they have to relocate operations. This is likely to cause increased tensions in the populations left behind in developing countries.
- The world will become more urbanised and swelling city populations will place increasing strains on urban infrastructures. Companies will also need to consider the implications of increased stress on public utilities, public transport and other factors that might influence where they base their operations.

# RISKS AND OPPORTUNITIES FOR BUSINESS

The extreme scenarios presented in the preceding chapters may not be inevitable. But what does seem inevitable is that the world will undergo between one and two °C of warming due to the amount of excess greenhouse gases that we have put into the atmosphere already. If prompt action is taken to curb emissions and to replace fossil fuels with alternative sources of energy, we may still be able to stop the temperature rise short of two degrees C. In that event, although much would still change, the disruptions would be less extreme and they might occur over a long enough period of time to allow for adaptation to take place in a relatively measured way.

Planning needs to take place on the assumption that some of the more extreme scenarios outlined in this report will actually happen. There is no way of predicting accurately which, out of a range of possible outcomes, will actually occur. But it is reasonable to assume as a general proposition that a combination of environmental degradation, resource constraints and population pressures will give rise to an environment in which there is greater competition between states and probably a reduced ability for governments to provide the kind of international or national security to which we have become accustomed.

Over time, climate change is likely to result in significant changes to how we live; how we design and build individual buildings, cities and transport systems; how we trade internationally and how we manage relations between states. We should certainly hope for the best, but we must plan for the worst.

There are many ways in which business can protect itself from the adverse effects of climate change and adapt to the new conditions, but business can also contribute to the goal of minimising climate change. Overall, boards should consider four main points:

## **AWARENESS AND INFORMATION**

Access to the best information and analysis on climate change and its impact is vital in making informed decisions. Governments, universities and think-tanks are all now heavily engaged in the study of climate change and its consequences. There will never be one single reliable source of information, which contains all the answers, but we have listed a selection of key websites on page 48.

## **RISK ASSESSMENT AND ANALYSIS OF VULNERABILITIES**

Global patterns of trade and transportation may undergo dramatic shifts as a result of climate change. Every organisation needs to have a clear understanding of its particular vulnerabilities and have in place a range of mitigation plans. Risk management strategies need to consider a wide variety of possible alternatives and should be refreshed on a regular basis to take into account a changing landscape. Possible future political tensions between and within states need to be considered when looking to locations for future investment and operations.

## **AWARENESS OF THE OPPORTUNITIES AS WELL AS THE RISKS**

Developing green technology to mitigate the worst effects of climate changes offers considerable commercial opportunities, particularly in the field of energy efficiency. Water is likely to become a tradable commodity and water-conservation

technologies will also be at a premium, while carbon trading is likely to develop into a global industry. Adapting to these new technologies will be critical for the survival of any organisation, but also presents significant potential business opportunities.

## SPREADING BEST PRACTICE

The role of business in setting a positive example on climate change will increasingly become a key differentiator of reputation. It is also an issue to consider when technology transfers are negotiated: as a deal is struck between developed and developing nations over climate change, governments may agree to transfer technology for free that will help developing countries to modernise in environmentally friendly ways. Companies that can understand these trends early will be best able to profit from the potential opportunities that climate change brings.

## CONCLUSIONS

- The world is likely to experience close to 2°C of warming for an extended period, with the possibility of much more if the feedbacks come into play. Business needs to plan for this now, factoring in potential shifts in availability of food, water, energy and staff, while long-term strategic thinking needs to be capable of adapting to potentially rapidly changing situations.
- Many processes in nature are non-linear, involving abrupt phase changes, and climate change is unlikely to be an exception. Sudden and perhaps irreversible shifts in what have been seen as “normal” conditions may be anticipated, and resilience will be a high priority for every organisation. Plans taking into account how companies are going to be affected by climate change will need to be re-visited periodically (at least once a year) in the light of fast-changing events.
- Large changes in the natural and political environment will place great stresses on businesses of every sort, but they will also create opportunities for the alert and the nimble. An ability to understand early what the impacts of climate change are going to be will open up new business opportunities or provide an opportunity to change existing practices while the cost of changing may be relatively low.
- The business community has an important role to play by supporting research on climate change, developing and promoting new technologies to mitigate and adapt to climate change, and encouraging informed public debate to improve behaviour patterns.

## **APPENDIX 1:** **USEFUL CONTACTS**

### **Intergovernmental Panel on Climate Change (IPCC)**

[www.ipcc.ch](http://www.ipcc.ch)

Telephone +41-22-730-8208/84

E-mail [IPCC-Sec@wmo.int](mailto:IPCC-Sec@wmo.int)

### **United Nations (UN)**

Gateway to the UN System's work on climate change:

[www.un.org/climatechange](http://www.un.org/climatechange)

UN Framework Convention on Climate Change:

<http://unfccc.int>

Contact information for UN related bodies looking at climate change

[www.un.org/climatechange/contact](http://www.un.org/climatechange/contact)

### **United Nations Climate Change Conference of Parties, Copenhagen (COP-15)**

For information regarding attending the December 7-18 conference

<http://en.cop15.dk>

Telephone + 45 33 92 33 00

### **European Commission (EC)**

Commissioner for Environment Stavros Dimas

[http://ec.europa.eu/commission\\_barroso/dimas/index\\_en.htm](http://ec.europa.eu/commission_barroso/dimas/index_en.htm)

Telephone +32 (0) 2 298 20 00

E-mail [stavros.dimas@ec.europa.eu](mailto:stavros.dimas@ec.europa.eu)

### **British Government**

Department for Environment, Food and Rural Affairs (DEFRA)

[www.defra.gov.uk](http://www.defra.gov.uk)

Telephone +44 (0) 8459 33 55 77

E-mail [helpline@defra.gsi.gov.uk](mailto:helpline@defra.gsi.gov.uk)

### **US Government**

Environmental Protection Agency (EPA)

[www.epa.gov/climatechange](http://www.epa.gov/climatechange)

Telephone +1 202 272 0167

E-mail [public-access@epa.gov](mailto:public-access@epa.gov)

A list of more specific "hotlines and clearinghouses"

for information on different aspects:

[www.epa.gov/epahome/hotline.htm](http://www.epa.gov/epahome/hotline.htm)

### **US Department of State**

[www.state.gov/g/oes/climate](http://www.state.gov/g/oes/climate)

Telephone +1 202 647 4000

### **World Bank**

[www.worldbank.org/climatechange](http://www.worldbank.org/climatechange)

E-mail [feedback@worldbank.org](mailto:feedback@worldbank.org)

### **Lloyd's**

[www.lloyds.com/360](http://www.lloyds.com/360)

E-mail [360@lloyds.com](mailto:360@lloyds.com)

### **International Institute for Strategic Studies (IISS)**

[www.iiss.org](http://www.iiss.org)

Telephone +44 (0) 20 7379 7676

E-mail [iiss@iiss.org](mailto:iiss@iiss.org)

IISS recently established the "Transatlantic Dialogue on Climate Change and Security" with the support of the European Commission. For more information:

<http://climatesecurity.blogspot.com>

## APPENDIX 2: GEO-ENGINEERING

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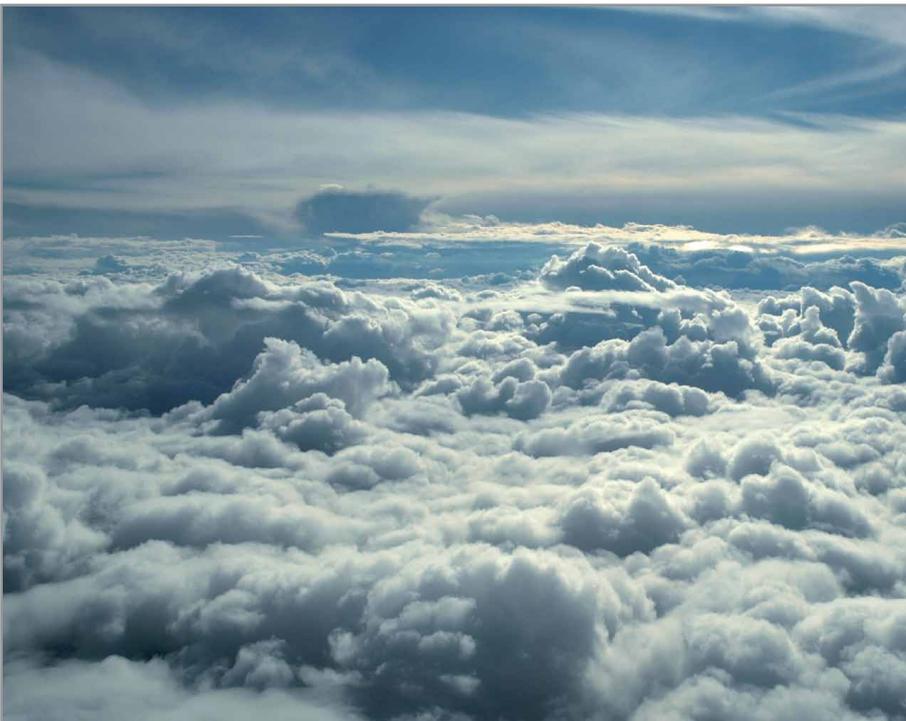
### GEO-ENGINEERING

The concept of geo-engineering is an ambitious one that means attempting to change the way in which the globe functions to cool temperature or reduce carbon already in the atmosphere. There are two main forms of geo-engineering currently under consideration: albedo management, which involves short-term measures that block or reflect some portion of the sunlight hitting the earth and can cool temperatures; and carbon management, which involves finding ways of capturing, storing or sequestering ambient carbon in the atmosphere, thus cooling the environment. Albedo management solutions (for example cloud brightening, stratospheric particle injection or orbiting space mirrors) are seen as measures to quickly lower the temperature by direct action in the short term, while carbon management techniques are designed to remove excess carbon dioxide and provide long-term solutions. The decision to deploy such globe-altering technologies currently remains an unlikely secondary option, but in the event of sudden climactic shifts, the need to do something may override scientific concerns about side effects.

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**“ IN THE EVENT OF SUDDEN CLIMACTIC SHIFTS, THE NEED TO DO SOMETHING MAY OVERRIDE SCIENTIFIC CONCERNS ABOUT SIDE EFFECTS. ”**



△ Cloud brightening could lower global temperatures in the short term.

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