Resilience

Reprinted from Resilience: A journal of strategy and risk

Business-not-as-usual: Tackling the impact of climate change on supply chain risk

By Richard Gledhill, Dan Hamza-Goodacre and Lit Ping Low

pwc

www.pwc.com/resilience

Contents

Business-not-as-usual: Tackling the impact of climate change on supply chain risk

By Richard Gledhill, Dan Hamza-Goodacre and Lit Ping Low

While climate change and increasing temperatures now seem inevitable, there are high levels of uncertainty about the manifestations and magnitude of their impact. What is certain, though, is that climate change will have a multiplier effect on supply chain risk. By looking closely at the nature of a sector and the concentration of supply, it is possible to gauge the magnitude of the impact, with agricultural commodities such as wheat, maize and especially rice more subject to supply change disruption than petroleum, gas, metal ores and scrap. Effective ways to manage the supply change disruptions created by climate change risks centre on three principles: 1) recognising that the risks cannot be viewed in isolation due to their interconnectivity; 2) ensuring that the appropriate risk management procedures are in place including scenario planning; and 3) developing global collaborative strategies to deal with heightened international resource scarcity.

In 2010, Russia suffered a severe heat wave. The resulting economic losses were estimated to be US$15bn as drought and wildfires destroyed crops, particularly wheat. The knock-on effect was export restrictions on wheat in Russia, which contributed to global price increases.

Anticipating and responding to risks is business-as-usual for all sectors. This example is from the agricultural sector. It is one of many one could choose from sectors that are dependent on physical produce, such as agricultural, fuel or mining and metals commodities. These industries are no strangers to dealing with the risks of supply-chain disruption (e.g. wheat shortages), both man-made (export restrictions) and natural (weather, drought, etc.). What is changing is the complexity of the risks, their interdependence with other risks and the wide-reaching, contagious impact they have (e.g. global price rises).

But the other major factor set to exacerbate supply-chain risk is climate change. Often overlooked, climate change adds to complexity. It amplifies or alters existing risks, for example raw material availability (e.g. water, energy) or transport disruption due to extreme weather events. The resulting shocks on the global supply chain can be severe and persistent.

Richard Gledhill *leads PwC's global climate change network. He specialises in climate policy, carbon markets and climate finance. Gledhill advised on some of the earliest, largest transactions in the Clean Development Mechanism and has remained active in the carbon markets, also advised a number of donor governments and multilateral agencies on climate finance. He is a member of the Network Council of the Climate & Development Knowledge Network and a director of the International Emissions Trading Association.*

Dan Hamza-Goodacre *is an Assistant Director in PwC's sustainability and climate change team. He has 15 years of experience working in the public and private sectors on strategies, policies and programmes for climate change. Dan is currently head of the £10m climate negotiations support programme for CDKN for the UK Government, and leads PwC's work on climate change and agriculture. Prior to PwC he spent six years with the UK Environment Ministry in various roles including Head of the Secretary of State's office, lead policy official for the government's adaptation legislation (Climate Change Act).*

Lit Ping Low *is an Assistant Director in PwC's sustainability and climate change group. Lit Ping is an economist working on climate change policy and regulatory issues with governments and the private sector. Lit Ping has also co-authored a number of publications aimed at business and policymakers on climate change including the Low Carbon Economy Index (PwC), Policy Maker's Guide to Green Growth (CDKN) and Business Leadership on Climate Change Adaptation (UNFCCC).*

So climate change is a 'risk multiplier'. But businesses have yet to gain the full measure of its effect on their supply chains. How serious? How soon? How likely? How wide? How to mitigate?

Too late for two degrees?

How serious is the risk of climate change from increased temperatures? It is not such a far-fetched issue as many thought. The latest update from the World Bank is that the global mean temperature has already increased by 0.8°C above pre-industrial levels. We can also look at estimates of global insured losses from major extreme weather events. In the last two decades losses have increased markedly, averaging tens of billions of dollars annually.[1]

Every year, government representatives from around the world meet at the UN Framework Convention on Climate Change (UNFCCC). They have agreed to limit the average global temperature rise to 2°C, and identified actions to mitigate, and adapt to, climate change. In spite of these efforts, carbon emissions have continued to rise. In 2011, emissions levels were the highest ever recorded. Can we really limit the temperature increase 2°C? PwC's latest Low Carbon Economy Index suggest that based on current progress, this is 'highly unrealistic'.

One thing is clear though, businesses and governments need to start planning for a world with a changed climate. In particular, industries dependent on food, water, energy or ecosystem services need to scrutinise the resilience and viability of their supply chains.

Which supply chains need to strengthen their links?

What is the likelihood that climate change risk could disrupt certain supply chains? To answer this question, we have analysed the threats posed by climate change to a selection of commodities:

- agricultural (wheat, maize and rice)
- energy (petroleum and gas)
- mining (metal ores)

We have looked at the two major factors that have the greatest influence on risk exposure:

A 2°C vs. 4°C world

How soon will things happen? The UN Intergovernmental Panel on Climate Change (IPCC) has projected that every continent will feel the impact of even a 2°C warming scenario by the 2020s.

Water availability and quality will be affected in many regions, with a domino effect on agriculture and health.

The frequency and intensity of extreme weather events may increase in many regions.

Small island states and lesser developed countries are least likely to be able to cope.

Scientists, for example those at the World Bank, are starting to map out what a 4°C warmer world would look like. The full scope of damages is still unclear, although implications on human security, economic and trade systems are all likely.

When the world experienced a 4°C global average temperature change in the past, it took millennia, not a century.

1 Munich Re: Great weather catastrophes worldwide 1950–2011, as of January 2012

1. **The magnitude of impact of climate change on the commodity:**

   This depends on: i) how susceptible a commodity is to the effects of changes in temperature and precipitation, rise in sea levels and occurrence of storms and flooding; and, ii) how able the supplying country is to cope with the potential effects of climate change. This is based on factors such as political stability, governance, macro- and socioeconomic development of a country.

2. **The concentration of suppliers:**

   In general, where a commodity can be sourced from a diverse range of suppliers, supply disruption can be lessened as buyers turn to alternative suppliers. Conversely, where a commodity is concentrated in a small number of suppliers, disruption for any one major supplier can have global implications.

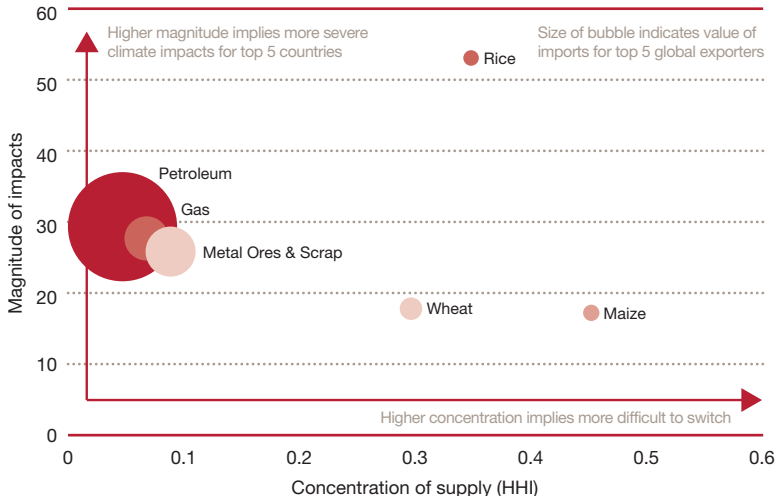
We have mapped these factors in Figure 1. It shows the extent to which the top five country exporters of these commodities are exposed to climate change impacts (vertical axis), and the degree of global supply concentration of these commodities (horizontal axis).

Rattling the supply chains of rice

Our analysis, which uses projections for the 2040s, indicates the following:

- The supply of **agricultural commodities** (maize, rice and wheat) is more concentrated than that of the other commodities considered (petroleum, gas and metal ores). This is dictated by the climatic conditions in Asia (rice), North America (maize, wheat) and South America (wheat).
- **Rice production** stood out as the commodity that is both expected to be affected by climate change and highly concentrated in production. As the impacts of climate change on rice are increasingly felt in South and South East Asia, the global supply of rice could be significantly affected, as buyers have little alternative sources of supply.
- **Maize and wheat** are also relatively concentrated in supply, but the effects of climate change on these crops are projected to be relatively less severe. A concentrated supply base for maize means that any disruption to its major producers (from climate change or otherwise) can have a pervasive global impact. Its role as feedstock also means that implications of supply disruptions on global food prices can be significant, as was evident in the US droughts in 2012.
- The diversified supply of **petroleum, gas and metal ores** means that supply issues in any one supplier are unlikely to trigger widespread disruptions. The supply availability of these commodities is more likely to be disrupted by other risks than by climate change. These include the finite nature of such resources, technological capacity and politics. But the effects of climate change are likely to interact with these other factors and lead to an amplification of risks globally. Commodity price volatility can be exacerbated not just by more frequent or severe extreme weather events, but also by the accompanying political or policy reactions.

Figure 1 Climate change: impacts and diversification, selected key commodities



Source: PwC

Figure 2 Commodity supply chains at a glance

Commodity	Global market 2011	Top 5 exporters	Exposure to climate change
Rice	$23.3bn	Clustered in South and South East Asia, led by Thailand (28% of global exports), followed by Vietnam, India and Pakistan. The US is the 5th largest exporter.	High water intensity and specific climate requirements make rice exposed to changes in temperature and precipitation. These elements, as well as extreme weather conditions such as storms, pose serious threats to the supply chain of rice. The key exporters are also vulnerable to rising sea levels.
Wheat	$48.3bn	North America (US, Canada), South America (Argentina), Europe (EU) and Australia.	Climate changes in temperature can have a positive effect on the wheat yields in North America but are likely to have the opposite effect in Europe, Australia and South America. However, rising sea levels and greater occurrence of heavy rains and storms threaten all top 5 exporters.
Maize	$23.6bn	US, Argentina, Brazil, Ukraine and India.	Increases in temperature are projected to improve harvests in the US as well as other leading maize exporters (the 2012 droughts in the US, however, defied this projection). However, extreme weather conditions and storms pose damage risks which could lead to volatility in supply and therefore global food prices. Maize plays an important role in the food chain, as it is used for feeding livestock. Its availability affects the agriculture sector significantly.
Metal ores	$389.4bn Including: High-volume bulk Commodities: copper, iron, bauxite Lower-volume, high value commodities: chromium, nickel	Australia, Brazil, US, Chile and Canada.	Mining operations display different sensitivities to environmental conditions depending on the type of material and the geographical location. Recent severe weather events have caused damage to mining infrastructure and transport disruption particularly for bulk products. Water shortages can also affect the costs of extraction, which is often water-intensive.
Petroleum and gas	$2667.5bn for petroleum and related products $319.5bn for gas	Largest exporting regions: the Middle East and Russia; additional suppliers: North America and parts of Europe, Africa and South East Asia.	Most of the key exporting countries have a combination of offshore and onshore extraction and transportation infrastructure e.g. oil rigs, oil wells, and pipelines and liquefied natural gas facilities. Extraction of oil and petroleum-related goods can be affected by extreme weather events. The melting permafrost and ice flow patterns in the Arctic can destabilise infrastructure foundations. Sea level rise (and associated changes in ocean swell height or storm surges) can also affect both onshore and offshore activities.

Source: PwC analysis

1 Munich Re: Great weather catastrophes worldwide 1950-2011, as of January 2012

The multiplier effect on a global scale

How far-reaching will the effects be? Although the analysis focused on projected impacts, recent events have already demonstrated the ripple-effect globally. Extreme heat waves in Russia and the US, and other extreme weather events such as flooding and hurricanes, showed how one event in a country or region can have repercussions globally.[2]

Figure 3 Supply chain disruptions: the contagion of impacts from a single event

Events	Contagion of impacts
Heat wave and drought in Russia (2010)	Estimated economic losses from Russian heat wave at US$15bn including the destruction of crops (mainly wheat) from the drought and wildfires.
Drought in the US (2012)	A combination of dry conditions and extreme heat including record-breaking temperatures over the summer months, led to destruction of agricultural crops. Scarcity of feed stock (corn) further affected meat and dairy prices. Global food prices soared by 10% between June and July 2012, according to the World Bank.
Flooding in Thailand (2011)	Forty percent of the global production of hard disk drives (HDD) is concentrated in Thailand. The flooding of manufacturing plants led to global price increases of HDD and the electronics dependent on them. The flooding of car manufacturing plants led to local and international disruptions, resulting in the postponement of the launch of new car models for some companies. Insured losses were estimated at $15–20bn. Much of this is covered by insurers (and reinsurers) outside of Thailand. Business continuity claims make up a significant proportion of losses.
Flooding in Australia (2010–11)	Forty mines were affected by floods, including disruptions in transporting coal from mines to coastal ports for exports. Major global coal mining companies declared *force majeure*, legally releasing companies the obligation of contracted deliveries.

Source: PwC analysis

2 Experts continue to debate if some of these events can be scientifically linked to climate change. Scientists suggest that in the absence of climate change, the extreme heat waves in Europe, Russia and the United States would happen only once every several hundred years, adding to the evidence base that climate change is having an impact. Meanwhile, the flooding in Thailand, while considered severe and low probability, is believed to be not related to climate change.

Multiplier effect needs multilateral efforts

How can organisations start to mitigate the potential disruption on supply chains due to climate change risk? This year, the UN negotiations in Doha concluded with limited progress, with current pledges still falling short of what is needed. Businesses and governments can improve readiness by adopting these three principles:

Don't view risks in isolation. Businesses need to identify not just the risks emerging from the impacts of climate change, but how the resulting impacts interact with existing risks.

Start scenario planning and put risk management procedures in place. Governments and the business community need to start considering risk management plans in a world with a climate change of not just 2°C, but also 4°C or even 6°C. Effects are already being felt in some regions and they are projected to worsen globally.

Collaborate and give greater attention to international resource security. Competition for scarce resources may intensify, and can be compounded by political and economic developments. Developing a collaborative and sustainable resource management strategy at a global level can help avoid the risks of 'resource grab' and conflicts.

Methodology and sources for analysis

We used projections from the UK Met Office which assessed the exposure of these commodities to impacts of changes in temperature, precipitation, rise in sea levels and occurrence of storms and flooding for each major supplier. The impacts are projected for the 2040s.

For each country, we derived a vulnerability index. This reflects the ability of a country to cope with the potential effects of climate change. This index is a composite index comprising the Worldwide Governance Indicators (WGI), the Human Development Index (HDI) and the GAIN Vulnerability index. It therefore provides an indication of the political stability, governance, macro- and socioeconomic development of a country.

The vertical axis gives a 'score' of magnitude of climate change impacts. This score is attributed to each commodity by weighting the exposure of the top five major suppliers by their share of exports, and is a measure of the magnitude of risk of climate impacts on the top five major suppliers and adjusted by their vulnerability index. A higher score suggests that the risk of disruption to supply from climate change is greater for the commodity.

The horizontal axis gives the Herfindahl index (HHI) for each commodity. The HHI measures the share of global exports from a source country relative to the total export market. The HHI is an indicator of the amount of competition. The index is between 0 and 1, and a high number suggests the supply is concentrated in a few source countries.

Sources: 2011 data from UNCTAD database (commodity specific data and HHI concentration indexes), 2012 BP Statistical Review (gas and petroleum trade), Met Office Hadley Centre (2010)

Resilience

Reprinted from Resilience: A journal of strategy and risk

Authors

Richard Gledhill
PwC UK
richard.gledhill@uk.pwc.com
+44 (0) 20 7804 5026

Dan Hamza-Goodacre
PwC UK
dan.hamza-goodacre@uk.pwc.com
+44 (0) 20 7804 1133

Lit Ping Low
PwC UK
lit.ping.low@uk.pwc.com
+44 (0) 20 7804 0345

Special thanks to the following parties for their production and editorial assistance:
John Ashworth, Chris Barbee, Lisa Cockette, Ashley Hislop, Angela Lang, Sarah McQuaid, Roxana Opris, Malcolm Preston, Alastair Rimmer, Suzanne Snowden, Tracy Fullham and Guatam Verma

DT-13-0064