

the 1990s, the number of publications on the topic has increased steadily, and the number of authors has increased from 1 to 100.

There are a number of reasons for the increase in research on the topic. One reason is the growing awareness of the importance of the topic. Another reason is the increasing availability of data and methods for research on the topic. A third reason is the increasing interest in the topic by the general public.

The research on the topic has been carried out by a number of different groups of researchers. Some of the groups are based in the United States, while others are based in Europe, Asia, and Australia. The research has been carried out in a number of different disciplines, including psychology, sociology, and education.

The research has shown that there are a number of factors that are related to the topic. Some of the factors are the age of the child, the gender of the child, and the social class of the child. Other factors are the child's IQ, the child's personality, and the child's environment.

The research has also shown that there are a number of interventions that can be used to help children with the topic. Some of the interventions are cognitive-behavioral therapy, family therapy, and medication. Other interventions are social skills training, self-help, and support groups.

The research has shown that there are a number of challenges that are associated with the topic. Some of the challenges are the lack of information, the lack of resources, and the lack of support. Other challenges are the stigma associated with the topic, the lack of understanding, and the lack of acceptance.

The research has shown that there are a number of opportunities that are associated with the topic. Some of the opportunities are the growing awareness of the importance of the topic, the increasing availability of data and methods for research on the topic, and the increasing interest in the topic by the general public.

The research has shown that there are a number of areas that need further research. Some of the areas are the long-term effects of interventions, the effectiveness of different interventions, and the role of the environment in the development of the topic.

The research has shown that there are a number of things that can be done to help children with the topic. Some of the things are to provide information, to provide resources, and to provide support. Other things are to reduce the stigma, to increase the understanding, and to increase the acceptance.

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# Part 1

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# Progress today without compromising tomorrow

ERM's specialist global climate change team works with businesses to identify risks and opportunities related to climate change.

For climate change advice please contact:  
**[charles.allison@erm.com](mailto:charles.allison@erm.com)**  
**[www.erm.com/climatechange](http://www.erm.com/climatechange)**

**Ranked No. 1 All Environmental Firm:**  
ENR Magazine (2004 – 2007)

**Environmental Adviser of the Year:**  
Acquisitions Monthly (2005, 2006 and 2008)

**EDIE Awards for Environmental Excellence:**  
CSR, EIA & SEA, Due Diligence (2007)





# 1 Keeping weather on the corporate radar

“Extreme weather is changing the parameters of risks”, says Tim Geyer at ERM.

Extreme weather events causing loss of life and major economic damage continue to be front page news. According to the World Meteorological Organization, January to July 2007 “was marked by record weather extremes in many regions across the world.” Inevitably, the associated phenomena are starting to impact business and investments, not so much as deal breakers, but in changing the parameters of risk management and the approaches required to devise mitigation measures.

The debate has changed from arguments about whether we need to act, to how quickly we must act, and to determining the most appropriate adaptation strategies. However, this requires knowledge of how and where a business can be impacted by climate change. To date, only a minority of companies have attempted to quantify the risks from climate change. However, investors are seeking greater disclosure of climate change related risks and opportunities, and it is expected companies that can demonstrate they are prepared for climate change will attract higher market valuations.

In terms of typical physical risk issues, companies that are heavily reliant on water may find significant risks associated with changes in the patterns and level of rainfall. In some areas of the world, glacial melt water which has provided a source of fresh water is expected to disappear by 2030. Similarly, companies involved in growing (e.g. crops, fruit) may be impacted by the changes in patterns of drought and flooding. What was a once every 100 years event may become a once every 20 year event and such a frequency of severe impact may be unacceptable for the company concerned. The financial sector should see a failure to quantify the physical risks as a major deficiency in a company’s strategy, as the risks to the portfolio of assets being held as collateral may be particularly significant. Understanding and

adapting to the challenge of climate change to maximise any opportunities and reduce an organisation's risk profile is likely to be one of the most important tasks facing companies today.

## Examples of extreme weather events

In August 2003, a heat wave with temperatures as high as 42°C (108°F) struck Europe. As summer temperatures in much of northern Europe rarely exceed 30°C (86°F), the area was unprepared for the disaster, and many thousands of deaths occurred. In August 2005, Hurricane Katrina caused catastrophic damage along the Gulf Coast of the United States, forcing the effective abandonment of south-eastern Louisiana (including New Orleans) for up to two months and damaging oil wells that sent gas prices in the U.S. to an all-time record high. Katrina killed over 1,800 people and caused at least \$75 billion in damages, making it one of the costliest natural disasters of all time. This was followed in September by Hurricane Rita, which left 119 people dead along the U.S. Gulf Coast, causing \$US 9.4 billion in damage. In January 2006, hundreds of people were killed when Russia, Eastern Europe and Scandinavia experienced the coldest weather for decades. In summer 2007, dramatic floods in the south central region of England, UK left 350,000 people without drinking water and many without electricity. Transport infrastructure was severely disrupted. Combined with floods which occurred earlier in the summer in Yorkshire (north England), the damage is estimated to total over £2 billion.

## Assessing the risk of climate change

Methods are being developed to help respond to the need to understand and assess the potential impact of climate change. Such assessments may be focussed on physical risks (e.g. which cause asset damage, supply chain disruption and project delays) that arise from an increasing frequency and severity of extreme weather events. Alternatively, an assessment may include regulatory threats which increase production costs such as energy tax, subsidy removal, imposed energy efficiency standards and limits on energy use and emissions. There can also be market threats affecting financial

performance (for example, revenue/price changes from changing demands due to emissions constraints), changes in consumer behaviour, and other financial threats such as the cost of borrowing and insurance.

In terms of physical, regulatory and policy developments, an impact assessment should involve a systematic review of the risks and opportunities facing a company based on the current academic consensus on climate change scenarios for different parts of the world. The inputs and outputs from a typical assessment model are illustrated in Figure 1:

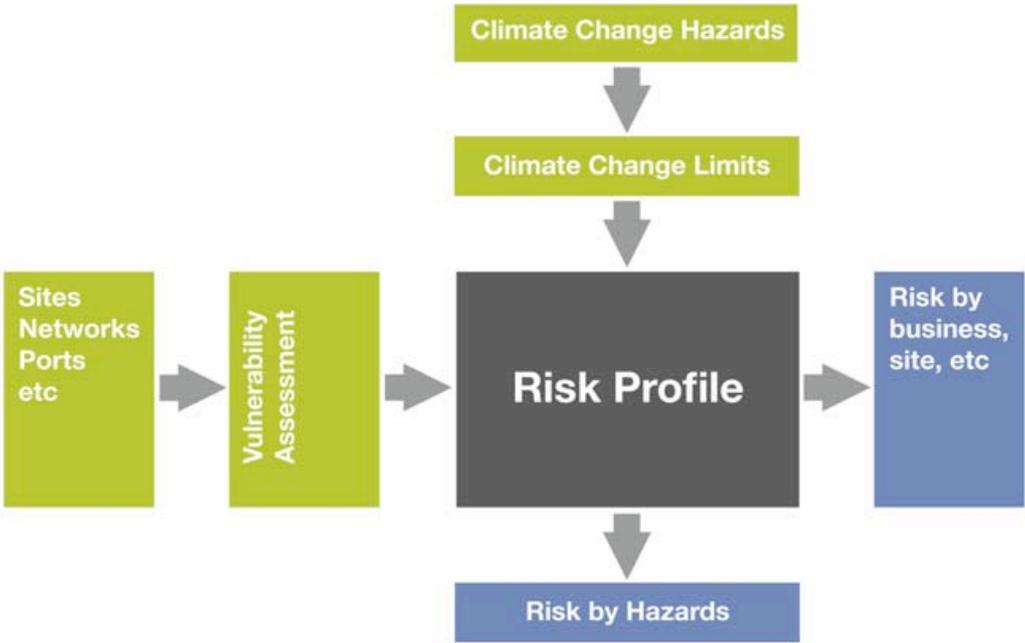


Figure 1: Climate change impact assessment: model elements

The key inputs when evaluating physical risks are:

- The regional location and site specific characteristics of the company’s assets and transport networks.

For example, environmental and operational data about each of the agreed assets/operations, transport networks, ports etc. in terms of their location/climatic region, energy consumption, elevation, proximity to rivers/coast, average rainfall, temperature profiles, water availability, production volumes, transport networks, etc.

- The climate change hazards, for example:

Primary threat	No.	Secondary threat
Extreme precipitation events	1	Flooding
	2	Increased erosion, run-off and risk of landslides
Cyclones/Hurricanes/Storm Events (wind impacts only, water addressed in “Extreme precipitation”)	3	Storm surges
	4	High winds/storm damage
Rising sea levels	5	Coastal and fluvial flooding
	6	Saline penetration of freshwater aquifers, rising groundwater
Increased temperature	7	Heatwaves
	8	Increased incidence, severity and geographic spread of drought
	9	Bush fire
	10	Loss of glaciers
	11	Increased number of frost free days
	12	Loss of permafrost/sea ice
Ecosystem adaptation	13	Human adaptation/migration
	14	Distribution of diseases

- Climate change limits based on accepted predictions of the changing frequencies and severities of the hazard events (in a chosen reference year).

Generally only order of magnitude categories are used here, commensurate with the uncertainties in the scientific predictions for specific regions. For example, a 10% increase in risk corresponds to a 5% increase in both frequency and severity, whereas a 100% increase

in risk equates to around 40% increase in both frequency and severity. However, there may also be similar decreases in risk.

Although some hazards can be addressed in this way, i.e. there is a historical frequency and severity of impact, which can be predicted to change in the future, there are other non-cyclical events which need to be addressed slightly differently. These include rising sea levels, loss of permafrost and loss of glaciers, which are gradual changes over time rather than discrete events. Nonetheless, these can be included in the impact assessment by estimating the probability of a specific impact for a particular reference year.

- Review of historic losses from weather-related events at the company's sites and/or in the relevant industry sector.

This involves the scrutiny of company and or regional information about previous weather-related events, such as insurance claims, underwriting reports, etc. The purpose is to support judgements about typical business interruption delays, or proportion of assets damaged, etc. It is important to take account of the specific vulnerability to a given threat. For example, a transport network that has already suffered significant delays from flooding would be considered highly vulnerable.

- The key calculation combines event frequency, vulnerability, financial consequence and predicted climate change to determine the level of risk to a company's overall asset portfolio.

A similar approach is taken to evaluating regulatory risks. A range of potential regulatory change scenarios are postulated, with upper and lower bands used to define the changes based on the best available knowledge. The impact of the regulatory change is then estimated for the particular business under study, allowing broad indicative overall cost impacts to be estimated.

This kind of assessment method allows the potential climate change risk to be examined in a number of different ways:

- By business: this would be the sum of the risks for all sites/assets and transport networks associated with each business unit.

- By climate change threat: summing risks by threat would show which climate change threats have the greatest overall impact on the business, allowing common mitigation strategies to be developed.
- By region: this would reveal which particular regions are most impacted.
- By individual site/transport network (see note below).

**Note:** the certainty associated with the results is generally greater at an aggregated level (e.g. business unit, country, climatic region or threat) than at the individual site/issue level, as any judgments of probability are unlikely to have been systematically under or overestimated across an aggregated group (e.g. business, climatic region).

In order to account for the inherent uncertainty in some of the key variables (e.g. the extent of business interruption per threat or the extent of predicted climate change), Monte Carlo simulation can be used to allow certain variables to be represented as distributions (providing reasonable data exist to define such distributions). This provides an understanding of the variability of the aggregated losses (e.g. for the entire business). An example of a cost probability curve using a log-normal distribution is shown below.

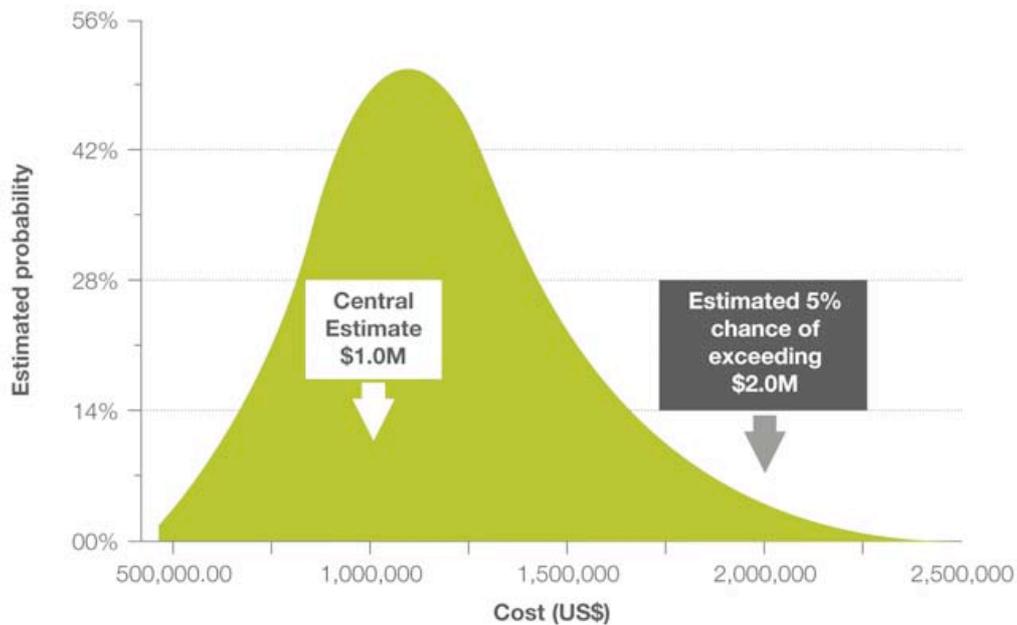


Figure 2: Plotting the cost of an event against its probability

Net present value calculations can also be undertaken to allow potential losses in future years to be considered in the present day equivalent. This can be important when looking at the costs and benefits of different mitigation strategies.

Increasingly, such approaches are being used by business as a first step towards the development of a carbon risk management strategy. They can be applied using a semi-quantitative approach, relying heavily on the operational knowledge and on judgements of an organization's staff, or in a more quantitative manner, based on extensive and detailed data analysis.

The operational impacts can be converted to future financial consequences – such as increased production costs or reduction in a company's equity value. Furthermore, the same outputs can be used by the operating units and incorporated into their business planning processes to support the medium to long-term business strategy.

In summary, a business which understands the risks posed by climate change to its operations and assets is able to act in a considered and proactive manner, rather than reacting to a serious climatic impact or to the actions of competitors who have acted first and garnered first mover advantage.

ERM's climate change and risk teams offer services to help clients answer the following questions:

- How will climate change impact my businesses?
- What are the key climate change threats?
- Where are the greatest climate change impacts?
- What is the likely magnitude of impact?
- What climate change mitigation and adaptation options should be considered?

Tim Geyer is a Partner who leads ERM's specialist risk management team based in London. He specialises in providing analysis, advice and support to management, focused on discharging legal obligations and improving safety, safety culture and commercial performance. This has included developing systematic risk assessment methods for the quantification of the financial impacts of climate change.

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