WORLD ECONOMIC FORUM

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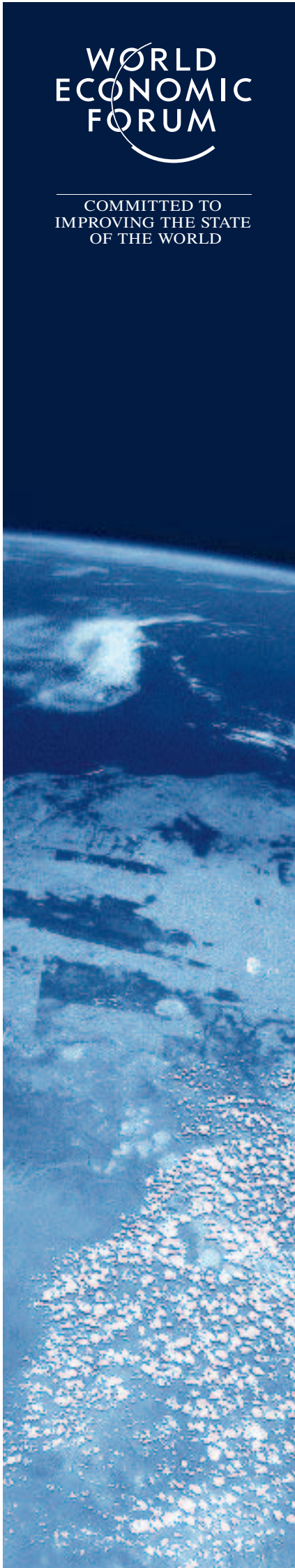
Global Risks 2006

A World Economic Forum Report,
in collaboration with
MMC (Marsh & McLennan Companies, Inc.)
Merrill Lynch and
Swiss Re

and in association with the Risk Management and Decision Processes Center at the Wharton School of the University of Pennsylvania



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1. Executive Summary: Towards a more sophisticated understanding of global risks

This document summarizes the output of a collaboration between the World Economic Forum, MMC (Marsh & McLennan Companies, Inc.), Merrill Lynch and Swiss Re, in association with the Risk Management and Decision Processes Center of the Wharton School at the University of Pennsylvania, on the topic of Global Risks. A longer document containing more information on the genesis of the World Economic Forum's Global Risk Programme, on the methodologies employed and detailing the scenarios constructed is available at www.weforum.org.

The purpose of this collaboration, building on work undertaken in 2004, was to:

- identify and assess current and emerging global risks in the 2006 and 2015 time horizons;
- study the links between them and to assess their likely effect on different markets and industries; and
- advance the thinking around more effective mitigation of global risks.

The global risk landscape

The 2006 risk landscape is dominated by high impact headline risks, such as terrorism and an influenza pandemic, which top the global risk mitigation agenda and are increasingly well understood. Other risks, like climate change, whose cumulative impact will only be felt over the longer term, have begun to move to the centre of the policy debate and may offer the greatest challenges for global risk mitigation in the future. Finally, we consider a number of potential risks whose outcomes are as yet very unclear, such as those associated with new technologies. These risks are thought about by few, but have the potential to be highly disruptive in the future. In many ways 2005 was a wake-up call. What is needed now are positive responses, innovation and an understanding of potential business opportunities implicit in a rapidly changing environment.

Impacts can be greater than the sum of their parts

Identification of individual global risks, however, is only one part of the story. In reality, global risks rarely manifest themselves in isolation. The combination of speed (the effects of global risks travel fast), the interconnectivity of the global system as well as its deepening complexity can lead to rapid and unexpected contagion of global risks across industries and geographical areas. The interplay of multiple global risks and their combined ripple effects can create potentially disastrous "perfect storms" – cumulative events which cause damage far in excess of the sum of each individual risk event. In 2005, Hurricane Katrina provided a powerful example of conflation that will have long-term impacts. Avian flu may present similar global challenges, should widespread human-to-human transmission occur.

Global solutions to global risks

Internationally collaborative approaches like those coordinated by the World Health Organization and public-private cooperation on global risk mitigation can help to improve the way the world deals with risk. Similarly, there is scope for more widespread and effective initiative by the private sector. Incentives need to be properly aligned to make risk mitigation as much about proactive prevention as about reactive recovery.

In some cases, as in the increasing contribution of business to disaster relief and the growth of innovative financial instruments to price risk, more sophisticated mitigation approaches are developing.

However, our collective ability to mitigate global risks is still seriously hampered by divergent perceptions of the nature and importance of such risks; differing agendas; and the inability of any government, business or international institution to address these risks independently.

Looking to a better future

The World Economic Forum's Global Risk Programme has identified three core areas where these problems can be addressed and risk mitigation improved:

- enhancement of the quality of information on risk and its flow amongst stakeholders;
- reassessment of risk priorities and reallocation of resources and incentives accordingly; and
- strengthening the capacity and resilience of business and political and administrative institutions at all levels.

No one can succeed alone in dealing effectively with global risks. An integrated multistakeholder approach offers the best hope of increasing our capacity to pre-empt, manage and mitigate global risks.

2. Today's global risk landscape

Over the past 13 months the world has suffered a spate of major risk events, from the Indian Ocean tsunami, through a string of hurricanes in the Gulf of Mexico, to the suicide bomb attacks in London during the G-8 Summit and the earthquake in Pakistan. At the beginning of 2006, the global risk most preoccupying global business and political leaders is the H5N1 avian flu virus.

But these were only the most prominent features of the changing risk landscape. Since the 2005 World Economic Forum Annual Meeting in Davos, the participants in the Global Risk Programme have worked to refine their understanding of global risks through expert workshops, with the aim of identifying and assessing truly global risks and moving forward the global discussion on risk mitigation. A summary of 25 global risk scenarios generated by the Global Risks Programme can be found in the appendix to this document. The scenarios are available on-line at www.weforum.org.

Some of the risks identified are those that generally top the list of risk concerns of states and businesses because they are considered to be highly likely or highly damaging, or both. These include terrorism, oil-price spikes, fiscal crises, pandemics and earthquakes. These risks were rarely out of the headlines in 2005.

Many of the headline risks of 2005 will continue to dominate headlines in 2006…

The geopolitical risk landscape is still dominated by the risk (real and perceived) of **terrorism**. The capacity of terrorist organizations to act globally in a coordinated way has diminished, but the risks of localized terror remain high. Should an attack incorporate chemical, biological or nuclear weapons, or target critical infrastructure (such as transport networks, critical information infrastructure (CII) or water and electricity supplies), the human and economic costs will bring new pressures to bear on public policy. The world suffered an **oil-price spike** above US$ 70 in 2005. The spike was lower (in real terms) than those of the 1970s, but the world's reliance on hydrocarbons and growing concerns about the geopolitics of supply mean that oil prices will inevitably be an issue of concern in 2006 and beyond. Some parts of the world have been living with **fiscal crises** for a number of years, but, in the year in which the "baby boomer" generation starts reaching retirement age, the risks to global prosperity are apparent. The long-term economic health of developed countries, as well as the medium-term values of their currencies, may depend on how fiscal reforms are undertaken. The fear of an avian flu virus mutating to enable human-to-human transmission and sparking an **influenza pandemic** has caused acute concern both in the developed and developing world; the long-term human, societal and economic effects of diseases such as **HIV/AIDS, TB** and **malaria** continue to debilitate large parts of the developing world. Finally, the Pakistan **earthquake** provided a lesson as to our current incapacity to respond sufficiently to major humanitarian crises and a warning that many parts of the world remain highly vulnerable to natural disaster.

Other risks, such as those stemming from climate change, are still emerging. Consensus on the nature of this risk and its consequences for global society and for the global economy has not yet been reached, though a growing body of scientific evidence points to the seriousness of the long-term challenge. The spread of liability regimes is already causing concern. Still other potential risks – like those deriving from Electro-Magnetic Fields (EMF) or counterfeiting, to take two examples – are on the radar screen of only a small section of the international business and political community. They may yet develop into the headline risks of tomorrow.

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…while a range of other risks may move up the global agenda

Climate change has long been viewed as a source of risk, and may become irreversible over the next 10 to 20 years. There is growing consensus that the phenomenon is real, even if there are wide differences of opinion over its effects. As research improves and as the global community reaches a better understanding of the relationship – or lack of it – between extreme weather events and climate change, the issue will move up the risk mitigation agenda. The spread of **liability regimes** from the United States, representing a growing societal aversion to risk and placing an increasing cost on business through large and unpredictable claims, will attract increasing attention. The manufacture and spread of **counterfeit** (pirated) goods is already a political issue between states with knowledge-based economies and certain countries growing their manufacturing sectors. Companies in the entertainment, software and pharmaceutical industries are taking steps to prevent the erosion of the value of their investments, but the risk with many counterfeit products is defects and damage to reputation rather than just the loss of profit. The phenomenon of illicit trade remains only partly understood – and its increasingly widespread nature poses risks which go well beyond the industries that are presently affected. Risk-related expectations need to be clarified and better managed in the realm of **Electro-Magnetic Fields** (EMF), generated by a large (and increasing) number of 21st century electronic devices, including mobile phones. If it were to transpire that EMF had widespread harmful health effects at relatively low exposure levels, this would have huge societal and economic impacts.

Outliers: potentially significant risks that did not make it onto the watch list for 2006 and beyond

There are some potential risks that have not yet penetrated public consciousness, but which might have severe consequences. **Space weather** is one example: unseen and unknown to most people. The sun is the main source; its output varies normally over a period of 11 years and the recent high of solar activity occurred in 2000. Solar flares produce radiation bursts across the electromagnetic spectrum, from radio waves to x-rays and gamma-rays, while solar winds buffet the earth's magnetic field and can produce storms in the magnetosphere. Space weather constantly has low-level effects on technology, interspersed with occasional dramatic events. Given ever-present solar activity and an increasingly technology-dependent society on earth, space weather disturbances are likely to grow in importance. They can affect power supplies, radio communications, navigation equipment and geophysical exploration, impacting public safety, information services, defence, industrial processes and transport networks. To give one example: radiation doses received by passengers and crew of airplanes at cruising altitudes are 20 to 30 times higher than they are on the ground, and major solar particle events can significantly increase this dose, especially over the polar regions. The loss of **biodiversity** is another example: the rapid loss of species may reduce our ability to use nature as a template for pharmaceutical remedies and could have profound negative effects on environmental sustainability.

Four key risk scenarios

These four risk scenarios, drawn from the extensive list available on-line at www.weforum.org, illustrate different manifestations of global risk in the decade ahead. They include risks whose probability is high in the short term, such as an oil price spike and localized terrorist incidents, for which companies and governments are relatively well-prepared. They also include risks whose impact is potentially very severe, such as an influenza pandemic – if mutation of an avian virus enables human-to human transmission – and, over the longer-term, climate change.

Oil Price Shock – price spike above US$ 80-100/bl

Hydrocarbons drive the world economy. As demand grows, with economic growth in India and China in particular, there are fears that prices will rise and geopolitical competition to secure resources for future supply will sharpen. There is certainty that higher emissions will cause further environmental damage. The scenario is that of an oil price spike above US$ 80/bl in the short term, which has both a very high probability and a very severe impact. An oil price spike results principally in the transfer of funds from oil-consuming countries to oil-producing countries, as happened in 2005. However, the ancillary effects include damage to business confidence and higher inflation which may contribute to a global economic slowdown. In the relatively unlikely event that oil prices remained above US$ 100/bl for an extended period over the next decade, the costs would be on a par with the oil price shocks of the 1970s, which led to geopolitical shifts and caused economic disruption and social unrest in oil-consuming countries.

Influenza pandemic

The risk of a pandemic flu, particularly one caused by human-to-human transmission of the H5N1 or another avian flu virus, is now a dominant theme in the global conversation on risk. While the spread of a pandemic can be modelled, we do not know when, where (or whether) the H5N1 virus will mutate so as to allow it to spread easily from one person to another. Humans have little or no immunity to H5N1 and no vaccine to protect against it currently exists. Present supplies of antiviral drugs are insufficient to deal with a major pandemic outbreak. If person-to-person infection were to become commonplace, the vulnerabilities of our interconnected global systems would intensify the human and economic impact. A lethal flu, its spread facilitated by global travel patterns and uncontained by insufficient warning mechanisms, would present an acute threat. Short-term economic impacts would include severe impairment of travel, tourism and other service industries, as well as manufacturing and retail supply chains. Global trade, investor risk appetites and consumption demand could suffer for more extended periods. Deep shifts in social, economic and political relations are possible. A flu pandemic further presents complex mitigation challenges, including difficult trade-offs (for example, mass vaccination now may protect against the spread of a pandemic now, but mass vaccination also carries a heightened risk of mutation of the virus into more resistant strains later), and posits an obvious need for multistakeholder coordination of both prevention and response. The longer it takes for a pandemic to emerge – as long as we maintain awareness of the risk – the better prepared we are likely to be.

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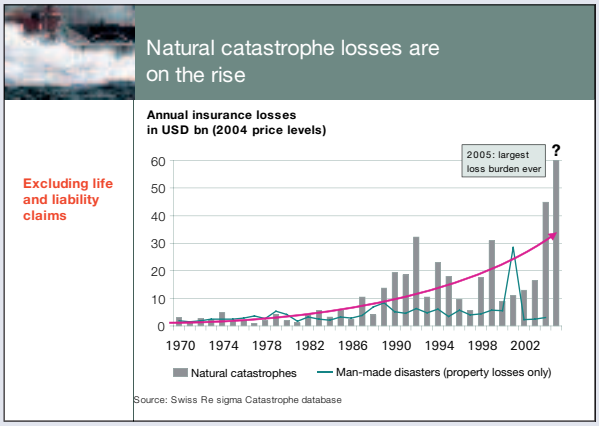
Terrorism

Terrorist attacks involving aircraft and high explosives have already had a massive global impact politically, socially and on several business sectors including financial services – especially insurance – and the airline and travel and tourism industries. Beyond more "conventional" attacks, experts fear the detonation of a radiological bomb (a "dirty bomb"), a small nuclear device, or the use of chemical or biological agents by terrorist groups in a major city, reinforcing an era of *asymmetrical warfare*, where small and relatively uncoordinated groups can strike at the heart of otherwise well-defended states and societies. The phenomenon of terrorism will not be eradicated soon and locally-based terrorism, including that variant which claims credibility from religion, is likely to continue along current trends. The world will suffer from a number of small-scale terrorist attacks in 2006. The major threat from terrorism stems from the risk of one or more major attacks on fragile nodes in the international system with large conflation effects. Over the longer term, there is a moderate risk of such an event – with very high human, political and economic consequences.

Climate Change

As the December 2005 UN Montreal climate change conference demonstrated, many, but not all of the human-induced risk factors are now identified, carefully tracked and modelled. Climate change has moved, over the course of the last century, from the realm of the *unknowable* (U) to the *unknown* (u) (See KuU box on next page). There is still uncertainty as to how the risks will manifest: rises in sea levels, gradual temperature shifts and intensifying weather patterns have the potential to impact heavily on both society and the global economy, and are increasingly well understood as risks to business. The effects will become more evident on a longer time horizon (chiefly beyond 10 years) so the severity of the risk is not fully captured in either the 2006 or 2015 horizons, but the accumulative nature of greenhouse gases and the feedback delays in the climate demand a response to the putative causes today. The risks presented by climate change are fundamentally intertwined with other key risks, from storms and ecosystem degradation to regulation and long-term energy prices.



Several conceptual frameworks can be applied when considering global risks – a discussion of these can be found in the broader Global Risks document at www.weforum.org. A practical framework, relevant for mitigation, considers the "knowability" of the risk and its effects.

Knowability and risk – the KuU framework

This simple typology, developed by Professor Diebold and others at The Wharton School, suggests a continuum of risk from known (K) through unknown (u) to unknowable (U) risks.

Some risks, particularly natural disasters, can be said to be "known". Their causes, probability of occurrence and likely impacts are understood and well defined, although there is still some uncertainty surrounding these estimates. Known risks can be measured and managed.

Other risks are "unknown". The risk events are well-defined, but it is not possible to assign probabilities of specific events occurring. Terrorism and systemic financial risk are good examples of this. Another way of looking at "unknown" risks is to think of them as risks where there are several competing plausible models of how reality might unfold, but no accepted paradigm. Unknown risks require governments or businesses to build resilience into their risk models – through continuity-planning, stockpiling, slack in the system or diversification of sources of vital goods.

The last class of risks are those which are "unknowable". Unknowable risks have not yet emerged, and our understanding the systemic linkages of unknowable risks is speculative. Unknowability is a key consideration in the context of risk conflation, where a large number of possible combinations of risks and vulnerabilities can lead to a vast array of possible outcomes, some of which are "perfect storms".

3. Impacts can be greater than the sum of their parts

Most major risk events occur initially in one part of the global system: an earthquake in Iran or Pakistan, a Class 4 hurricane in the Gulf of Mexico, a war in Iraq, or terrorist incidents in Manhattan and Washington DC. Most can be categorized within one of the five risk areas defined in the Global Risk Programme: economic, environmental, geopolitical, societal and technological. However, some do not fit easily into any of these categories. The degradation of critical infrastructures is a geographically widespread risk, with potential economic, societal and political impacts. The pace of technological advance, the availability of finance and social and political priorities at local government level are key issues in determining the rate at which infrastructure is degraded and the speed at which it is repaired or replaced. Terrorist attacks on power, water, transport or communication networks could have widespread impact on business activities, particularly if focused on weak links in the system, causing major ripple effects. There are often multiple factors at work in the way in which a risk plays out.

When certain risk events occur, their impacts are not constrained by geographical or systemic boundaries. The level of interconnectivity in the world system increasingly lends itself to risk contagion across both, spreading the effects of a risk well beyond those initially expected. While interconnectivity helps to drive global prosperity, it can bring with it increased vulnerability to risk. It facilitates the flow of goods and information, and the distribution of aid delivered in response to humanitarian crises. But the efficiency of these systems often depends on a limited number of vulnerable links, and understanding what these are is vital.

In today's world, more than ever before, risks travel.

To take a simple example, the volume of shipped goods through the Malacca Straits has increased hugely over the last 10 years as globalization has led to an increase in trade and reconfigured manufacturing supply chains. A successful terrorist attack blocking the Malacca Straits would not only cause substantial disruption of oil supplies to East Asia, but could also result in severe dislocation of the supply chains of manufacturers around the world

whose plants depend on the raw materials and semi-finished goods transiting the Straits every day.

The primary challenge arising from this insight is risk conflation: ripple effects and the possibility of contemporaneous risk events interacting with one another to amplify their individual effects, thereby generating dangerous unforeseen consequences, exposing pre-existent weaknesses in systems and degrading our ability to respond effectively. The less resilient a system, the more likely it is that an inadequate response to a risk event will amplify the initial impacts.

Taken together, these factors make possible so-called "perfect storms", causing damage far exceeding that which would have been caused by the sum of each individual event.

Meanwhile, a lack of information or misinformation leading to a breakdown in public trust in the ability of governments, international institutions or business to manage risk can lead to the spread of fear in ways that greatly amplify the consequences of a particular threat. Fear is a potent risk amplifier. So-called "infodemics" may have impacts as grave as risk events themselves.

Hurricane Katrina

Hurricane Katrina provides an excellent example of the way in which conflation of multiple risk factors can produce varied and sometimes unanticipated outcomes. The damage that might be wrought on the Gulf Coast by a category 5 hurricane had been identified a decade earlier as the most severe potential risk faced by the US. Taking the tropical storm as the core risk in this series of events, we can see how it conflated with longer-term environmental risks to produce damage unseen in the United States since the Great Depression. Tropical cyclones are influenced by natural climate variability such as hurricane cycles. High sea surface temperatures in the Gulf of Mexico may have further intensified Katrina (and a number of other tropical storms) to category 4-5 levels. In the future, human-induced climate change may intensify tropical cyclones. Degradation of marshlands and silt deposits along the coast worsened the flooding. Meanwhile, tight markets for oil and gas, driven by

Victims of Hurricane Katrina given shelter in the Houston Astrodome, 9th September 2005

Asian demand, boosted by US indebtedness and a low-valued dollar, as well as instability in other oil-producing countries, caused price spikes disproportionate to the supply constraints actually inflicted when Katrina slammed into the oil and gas terminals and refineries on the Gulf Coast.

Impact of Katrina

The effects of Hurricane Katrina have been economic, societal and (potentially) geopolitical as well as environmental. These impacts have been concentrated in the US, but are also borne by other parts of the world.

Impacts beyond the environmental system

- **Economic:** US$ 200 billion in local economic damage, and increased short-term vulnerability to other risk events.
- **Societal:** Loss of faith in crisis management ability of government.
- **Geopolitical:** Potential increase of US dependence on non-US refining capacity, decline in positive US image, and loss of faith in federal government in other policy areas.

Example of impacts beyond the US

- Higher global oil price.
- Re-focusing of US expenditures on domestic reconstruction projects.
- The portion of insurance costs borne by non-US insurers.

The socio-political outcomes were even less well anticipated. To that point, US fiscal imbalances and the diversion of resources to address the war on terrorism both domestically and in Iraq had not been identified as short-term risks that had degraded Federal, state and local disaster response capability; it took Katrina to expose this. The response infrastructure was further weakened by the impact of the storm, in turn opening up the frightening possibility that another risk event (e.g. an outbreak of avian flu or a major terrorist incident) could deliver a devastating blow. Finally, the image of the US was harmed around the world by the apparent ineptness of the government response, with implications not yet fully understood.

For further discussion of the impacts of Hurricane Katrina on the oil and gas industry, please see the Mercer Oliver Wyman report, which can be found at www.mow.com

Pandemics

Over the past year, the risk of an H5N1 or other avian flu pandemic has generated increasing anxiety in much of the world. If the avian flu H5N1 virus mutates to enable human-to-human transmission, it may disrupt our global society and economy in an unprecedented way and claim human life at levels close to the 1918-1919 Spanish Flu pandemic. The 1918 flu infected half the world and between 40 and 50 million people died. The other two flu pandemics of the last century – in 1957 and 1968 – were less severe. The World Health Organization has disclosed estimates of potential deaths in a full-fledged avian flu pandemic of between 2 and 7.4 million, up to a worst-case of between 20 and 40 million deaths. But this is dependent on the mutation of the virus allowing it to be spread rapidly from human to human.

Researcher displays avian flu vaccine, 14 November 2005

A conflation scenario for H5N1

New pandemics such as SARS (before its emergence) and human variants of avian flu lie on the continuum between unknown (u) and unknowable (U) risks. Unlike human flu or animal foot and mouth disease – where it is known that outbreaks will reoccur and past experience provides a reasonably accurate guide as to their impact – new viral diseases evolve and cause death and secondary economic damage in unpredictable ways. Global interconnectivity has vastly increased the opportunities for the emergence and rapid transmission of disease and the myriad linkages in the global economy enable systemic economic, social and political contagion as well.

The following is a brief sketch of the possible conflationary impacts of a major human outbreak.

> Several cities in East Asia suffer major outbreaks of human-to-human transmission. International travel is severely affected, pandemic-specific vaccine supplies are secured and security authorities prepare for external contingencies and domestic insurgency. Emergency supply chain management is instituted, based on the possibility that 50% of those infected die. Commodities and services needed to survive for one to three years are identified. Non-critical industries reduce output or close. Even with full-scale vaccine production in nine countries with 12% of the global population, fewer than 500 million people (14% of the world's population) can be vaccinated in a year.
>
> An outbreak of H5N1 human-to-human transmission could have devastating impacts globally across all social and economic sectors, disrupting efficient processes, severely degrading response capabilities and exacerbating the effects of known weaknesses in different systems. These impacts might include: the disruption of supply chains and trade flows; an exacerbation of financial imbalances and the transformation of intellectual property regimes for pharmaceutical products; rioting to gain access to scarce supplies of antivirals and vaccines; a collapse of public order; partial de-urbanization as people flee population centres; the extinction of trust in governments; decimation of specific human skill sets; and forced, large-scale migration, associated with the further collapse of already weak states.
>
> In such a scenario, the impact on society might be as profound as that which followed the Black Death in Europe in 1348. That plague caused a fundamental transformation of socio-economic relations in Europe. The deaths of an estimated one third of the European population of the time created a shortage of labour, undermining an economy based on serfdom, and effecting a shift in the relative values of capital and labour. Scarcity of labour resources brought about a wage-based economy in which the value of skills was efficiently priced.

4. Global responses to global risks

Different risk events can have radically different impacts on industries and on geographical areas. At the time of writing (January 2006) the US stock-market average had recovered fully from Hurricane Katrina, though this hid a wide disparity in outcomes in different industries.

However, the mitigation of global risks is inherently a collective endeavour, in which different parts of the private sector, governments, intergovernmental organizations and parts of civil society have different and complementary roles to play.

Mitigation covers a range of actions, from prevention – where possible – and preparation for risk events,

to response and recovery from them if they occur. The current international architecture of global risk mitigation is built around insurance, financial instruments, business continuity planning, private sector enterprise risk management and government action. All are necessary; none is sufficient.

- The financial services industry provides a wide range of instruments to mitigate the economic consequences of global risks. Insurance and financial instruments can put a price on risk, providing information, stimulating incentives for action and enabling decisions on prevention measures, the development of new technologies or on business location.

  Recent events have demonstrated the critical role of the financial industry in mitigating the economic consequences of risk events, from the collapse of LTCM to the fallout from the 11 September terrorist attacks. Insurance capacities have been expanded recently by securitizing peak insurance risks, such as tropical storms and earthquakes. Government actions, however, may reduce insurance capacity when, for example, premium rates are capped artificially low, or when juries hand out unpredictable compensatory and punitive awards. In some countries, the protection of national financial institutions, or the lack of internal financial systems, presents further barriers to the extension of the insurance role.

- Enterprise Risk Management (ERM) – the ongoing attempts by individual businesses to identify, research and manage their risks – is about moving risks down the "knowability" scale, from unknowable risks to unknown risks, which require strategic decision-making, and finally to known risks which can be managed through insurance, financial derivatives, diversification and internal controls.

- Governments are often the insurers of last resort, as we saw in the *Terrorism Risk Insurance Act of 2002 (TRIA)* passed by the US Congress after the September 11 attacks, to protect consumers by maintaining the "availability and affordability of insurance for terrorism risk" and to allow private markets time to adjust to the new risk environment. Deeper discussion between public and private sectors of the sort now underway will enhance the effectiveness of their cooperation. Local governments, while often in the front-line of risk mitigation and risk response and recovery, are often too frail to cope alone.

- International organizations, while vital for proper public coordination of some risk mitigation strategies, are often constrained by political disputes, as well as inadequate resources.

Global risks require all the potential risk mitigating groups – individuals, companies, the financial services industry (notably the insurers), governments and international organizations – to act collaboratively. A long-standing problem in dealing with risk has been matching up those who bear the costs of mitigation with the potential beneficiaries. With global risks, the number of those ultimately affected is much greater than commonly perceived. *Divergent perceptions* and *different political agendas* have to be overcome in the interests of more effective mitigation.

On a practical level, the private sector, with its experience of risk identification, assessment and Enterprise Risk Management, has much to offer to governments in helping to integrate risk management into government procedures and to advance collaborative mitigation. Governments have much to contribute as well, principally by providing the framework and conditions to increase the marketization of risk and extend the limits of insurability.

5. Looking to a better future

The World Economic Forum and its partners in the Global Risk Programme have identified three core areas where risk mitigation may be improved through collaboration between the private and public sectors. As the Global Risk Programme unfolds in 2006 and beyond, exploring the characteristics of current and emerging risks to build common understanding, improving the allocation of resources and incentives to address them and building institutional and societal capacity and resilience, offer a challenging programme of work and a promising agenda of action.

1/ Information: deepening insight and building the risk community

The role of information in mitigating risk and in prompting swift recovery is crucial. There are essentially two elements: deepening insight into the characteristics of the risks and improving the flow of information between the different stakeholders. The first may deepen understanding, the second is crucial to improving responsiveness.

Companies, individuals and governments often perceive risk events – and their interconnectedness – as creating negative externalities. Improving insight should allow for greater internalization of risks and help to improve the risk communities on which risk mitigation depends for its legitimacy and support. In particular, companies and governments need to invest in deepening insight into "unknown" and "unknowable" risks – to help shift them to the "known" and "unknown" categories respectively.

Better understanding of the vulnerable interconnections in the global system which can act as amplifiers of risk events is critically important in addressing the problem of conflation. Companies, governments and academic institutions need to improve identification of the points in complex causal chains where intervention can either reduce the probability of a risk materializing or reduce its impact severity if it does.

Enhancing the flow of information between stakeholders is a key. There are several elements to this:

- Top-down surveillance of threats at the global level (such as satellite monitoring of the environment);
- Effective dissemination of information from the bottom-up (such that transparency allows for the quick responses needed to contain, for example, SARS or avian flu);
- Early-warning mechanisms (for example, to provide early warning of future earthquake-induced tsunamis in the Indian Ocean);
- Appropriate mechanisms to inform the public about risk (such as the Centers for Disease Control and Prevention – http://www.cdc.gov – of the US Department of Health and Human Services) to prevent "infodemics" and create appropriate expectations of risk;
- Exchanges on global best practice (including through trade associations), and advice that can be shared between governments and businesses on their risk assessments and mitigation strategies.

In general, innovative and flexible organizations are better able to manage the flow of knowledge effectively in their environments and to produce better and simpler metrics for cost-benefit analyses. In some cases, the private sector is ahead of the public sector in its mitigation of risks; harnessing private sector expertise in risk mitigation is a key to improving the discussion on mitigating global risk.

Example: As an example of potential private sector input into improving insight into the global risk landscape, in 2005 Swiss Re collaborated with the UN Development Program and the Harvard Medical School to produce *Climate Change Futures: Health, Ecological and Economic Dimensions*, a report, available at: www.swissre.com. The World Economic Forum, as the prime international multistakeholder platform, was closely involved in preparing a briefing for the Gleneagles G-8 Summit's on climate change issues, providing a number of opportunities for the interaction of governments and business leaders.

2/ Resources: reordering priorities, improving allocation and providing private sector incentives

Resources are scarce – in business as in government. Insight into global risks can help reallocate resources to those areas where risk mitigation is likely to be most effective. But managing resources, providing economic incentives and releasing resources for risk management will often depend upon cooperation between the private and public sectors.

The private sector can play a much stronger role in risk mitigation if the framework is set correctly. Where governments offer to cap insurance losses (as with the US Terrorism Risk Insurance Act), the ability of insurers to take on a part of global risk is increased. Where certain types of insurance are made compulsory, risk costs can be spread effectively throughout society and free-riding can be prevented. Where elements of risk can be marketized – such as carbon trading in conjunction with government limits on carbon emissions – the private sector can offer flexible responses to risk issues. In many developing countries, financial services companies and the private sector are relatively weak – improving their ability to take on risk will broaden risk mitigation capacity. The development of microfinance solutions may offer another promising way to mitigate the financial consequences of major risk events more efficiently.

Many businesses are already taking a lead in providing the resources for risk mitigation to reduce future risk. These range from Google's commitment to developing a duplicate internet backbone and Toyota's investment in the Prius, to responses by a number of pharmaceutical companies to HIV/AIDS, and joint governmental, business, NGO and community efforts to offer disaster relief and recovery aid, following the December 2004 tsunami and the 2005 Pakistan earthquake.

New financial instruments such as the securitization of insurance risks or extreme weather derivatives for extreme events (such as unusually cold winters or hot summers) may point to another expanding class of risk mitigation measures where the private sector can take on a considerably stronger role.

Governments may seek to avoid the "moral hazard" associated with the impression that they will always provide a back-stop in disaster situations, thereby discouraging sensible risk mitigation strategies through a combination of regulatory and insurance-based measures.

Example: The World Economic Forum's private-public partnership and associated Initiatives – including the Global Risk Network, the Global Health Initiative and the Disaster Response Network – see Forum members and partners investing time and resources into developing improved understanding and delivering tangible mitigation measures.

3/ Institutions: building business and societal resilience

Key public elements of the international governmental architecture of risk mitigation already exist (the UN institutions, the World Bank, international financial services corporations and others). These elements need to be reinforced and built on, with a greater involvement of the international business community in helping to understand and mitigate global risk.

At the national and local level, governments may be able to learn from business ERM models in improving the management of risk portfolios and integrating private sector risk management techniques into national administration. In many emerging markets, the key requirement is to build good governance structures which will reduce financial volatility, improve the consistency of risk expectations and build confidence in the ability of the state to respond to risk events – and also help economic development. In many developed countries, the interplay between building business resilience and state resilience may require a more permanent dialogue between business and governments in order to understand perceptions of risk and to help build best practice from both sectors.

Improving information flows and understanding about global risks and increasing the global capacity for pre-emption, management and mitigation depend upon an effective multistakeholder approach, which the World Economic Forum is uniquely placed to facilitate and will pursue in 2006 through the Global Risk Programme.

A Global Risk Network will be established to take this forward. The collaborative recasting of the institutional global risk mitigation landscape will only take place within an approach that recognizes the systemic nature of many global risks and the need for a holistic response to the challenge of mitigation.

Appendix

1. Global Risks

The issues of global concern have been grouped in five classes – **economic, geopolitical, environmental, societal and technological**. The criteria used to determine what constitutes a global risk can be found on-line at www.weforum.org.

Economic
- Oil prices/energy supply
- Asset prices/Indebtedness
- US Current Account deficit and US dollar
- Coming fiscal crises
- China
- Critical infrastructures

Societal
- Regulation
- Corporate governance
- Intellectual Property rights
- Organized crime
- Global pandemics
- Slow and chronic diseases (industrialized world)
- Epidemic disease (developing world)
- Liability regimes

Environmental
- Tropical cyclones
- Earthquakes
- Climate change
- Loss of ecosystem services

Technological
- Convergence of technologies
- Nanotechnology
- Electromagnetic fields
- Pervasive computing

Geopolitical
- Terrorism
- European dislocation
- Current and future hotspots

2. Assessment

The Global Risk Programme adopted a future-oriented, scenario-based approach in two time horizons: the **short-term** to the end of 2006, and the **long-term** to 2015. Two brief scenarios were developed for each risk in each horizon. The **base-case** describes the likely evolution of the risk along its current trend lines, while the **worst-case** represents the most pernicious plausible outcome.

The risk defined by each scenario was assessed in terms of the **likelihood** of the scenario occurring and the **severity** of the impact if it does. In addressing likelihood, actuarial principles were applied where sufficient data existed, though in many cases only qualitative assessments based on expert opinion were possible.

In assessing severity, three indices were considered: asset damage, human impact and impact on aggregate global GDP growth. The highest of the potential impacts was used in each case.

Likelihood Key

Score	Numerical Probability	Qualitative Assessment
1	Below 1%	Low
2	1-10%	Moderate
3	10-20%	High
4	Above 20%	Very High

Severity Key

Score	Value
Destruction of assets/economic damage	
1	US$ 10-50 billion
2	US$ 50-250 billion
3	US$ 250 billion - 1 trillion
4	over US$ 1 trillion
Lost human lives	
1	under 100
2	100–10.000
3	10.000-1 million
4	over 1 million
Growth impact (% of global GDP)	
1	less than 0.2
2	0.2-0.7
3	0.7-1.5
4	over 1.5

Summary descriptors

A more extensive description of the scenarios for each risk can be found at www.weforum.org

Economic Risks

		Likelihood	Severity
Coming Fiscal Crises			
Short-term Base	Fiscal deficits decline modestly	3	1
Short-term Worst	Fiscal positions become unsustainable, risks of default	1	1
Long-term Base	Fiscal positions under pressure due to demographic pressure	2	2
Long-term Worst	Fiscal deficits seriously challenged by demographic pressure	3	3
China			
Short-term Base	Careful management of integration into global economy	3	1
Short-term Worst	Re-emergent protectionism in the rest of the world, hitting China's exports	2	2
Long-term Base	Successful modernization and integration	2	2
Long-term Worst	Social and economic dislocation	2	3
US Current Account Deficit			
Short-term Base	Current account deficit causes 20% depreciation of US$	2	3
Short-term Worst	Current account deficit causes 40% depreciation of US$	1	4
Long-term Base	Gradual balancing of accounts	3	3
Long-term Worst	Unsustainable deficits impact growth	2	4
Hedge Funds			
Short-term Base	Fraction of start-up hedge funds fail	4	Falls below threshold
Short-term Worst	Individual large hedge funds fail	2	1
Long-term Base	Fraction of start-up hedge funds fail	3	1
Long-term Worst	Market crash hits several funds	1	2
Oil Price Shock			
Short-term Base	12-month spike to US$ 80/bl	4	3
Short-term Worst	12-month spike to US$ 100/bl	1	4
Long-term Base	Supply constraint leads to gradual price increase	1	2
Long-term Worst	Steeper sustained price increases	2	3
Critical Information Infrastructure (CII)			
Short-term Base	European power outage	3	2
Short-term Worst	Transatlantic data blackout	1	3
Long-term Base	Attack on IT infrastructure	3	1
Long-term Worst	Coordinated extensive attacks on wireless infrastructure using electromagnetic pulses	1	3

Environmental Risks

		Likelihood	Severity
Tropical Cyclones: Typhoon East Asia			
Short-term Base	Category 3 typhoon	2	1
Short-term Worst	Category 5 typhoon hits major city	1	2
Long-term Base	Severity and frequency of storms stays at 2005 level	2	1
Long-term Worst	Category 5 typhoon hits major city	2	2
Tropical Cyclones: North Atlantic Hurricane			
Short-term Base	Category 3 hurricane hits modestly populated area	3	1
Short-term Worst	Category 5 hurricane hits Miami	1	3
Long-term Base	Severity and frequency of storms stays at 2005 level	3	1
Long-term Worst	Severity and frequency of storms increases	2	3
Earthquake: Japan			
Short-term Base	Earthquake in densely populated area causes hundreds or thousands of deaths	2	3
Short-term Worst	Major earthquake hits Tokyo	1	4
Long-term Base	Earthquake in densely populated area causes hundreds or thousands of deaths	2	3
Long-term Worst	Major earthquake hits Tokyo	1	4
Earthquake: California			
Short-term Base	Earthquake in densely populated area causes hundreds of deaths	2	2
Short-term Worst	Major earthquake hits San Francisco or Los Angeles	1	2
Long-term Base	Earthquake in densely populated area causes hundreds of deaths	2	2
Long-term Worst	Major earthquake hits San Francisco or Los Angeles	1	2
Environmental Degradation			
Short-term Base	Continued loss of watershed areas	4	2
Short-term Worst	Loss of watershed areas and severe weather events	3	3
Long-term Base	Limited mitigation of loss of watershed areas	4	2
Long-term Worst	Extensive coastal degradation due to loss of ecosystem regulating services	3	3
Climate Change: Severe Economic Damage			
Short-term Base	No assets damaged in 12-month period	N/A	N/A
Short-term Worst	Increased severe weather events	1	2
Long-term Base	Climate change causes irregular weather events	2	2
Long-term Worst	Climate change causes extreme weather events	2	3

Summary descriptors

Societal Risks

Pandemics

		Likelihood	Severity
Short-term Base	Pathogenic avian virus H5N1 spreads, low human mortality	2	4
Short-term Worst	Pathogenic avian virus H5N1 spreads, high human mortality	2	4
Long-term Base	Pathogenic avian virus H5N1 spreads, radical advances in vaccine development	2	2
Long-term Worst	Pathogenic avian virus H5N1 spreads, several recombinations appear	1	4

Developing World Disease: Spread of HIV/AIDS and TB Epidemics

		Likelihood	Severity
Short-term Base	New infections of 5m in 2006	4	4
Short-term Worst	Rapid growth in incidence outside sub-Saharan Africa	2	4
Long-term Base	Incidence flattens, deaths remain high	3	4
Long-term Worst	Incidence flattens in sub-Saharan Africa but expands rapidly elsewhere	3	4

Chronic Diseases in Industrialized Countries

		Likelihood	Severity
Short-term Base	Lifestyles and diet increase risk of obesity, cardiovascular disease, diabetes and cancers; antibiotic resistant bacteria cause new fatalities	4	1
Short-term Worst	Antibiotic-resistant bacterial infections increase and lead to hospital avoidance and class actions	2	2
Long-term Base	Lifestyle changes reduce fatalities from obesity; pharmaceutical R&D produces new effective antibiotic	1	2
Long-term Worst	Obesity becomes widespread; health-care costs rise sharply; new multi-resultant bacterial strain emerges with 30% lethality	1	3

Intellectual Property Rights

		Likelihood	Severity
Short-term Base	Gradual rise in piracy	4	1
Short-term Worst	Legal enforcement of rights fails, public support for corporate IP rights weakens	2	1
Long-term Base	Gradual decline of IP	4	1
Long-term Worst	Steep decline of IP	2	2

Liability Regimes

		Likelihood	Severity
Short-term Base	10% capacity loss for insurers; US insurance costs triple	3	1
Short-term Worst	25% capacity loss; suspension of US high-risk insurance	2	2
Long-term Base	Decline of insurance; rise of deep-pocket liability in Europe and US	2	2
Long-term Worst	Collapse of property and casualty insurance industry	1	3

Regulation

		Likelihood	Severity
Short-term Base	Little change in regulation, expectations, or economic activity	4	Falls below threshold
Short-term Worst	Regulatory pressures; rapid decrease in corporate activity	3	2
Long-term Base	Centrist future supports commercial freedom	4	Falls below threshold
Long-term Worst	Populist realignment undermines corporate activity	2	2

Corporate Governance

		Likelihood	Severity
Short-term Base	Only small-scale governance failures	4	Falls below threshold
Short-term Worst	Major governance failure undermines confidence	2	2
Long-term Base	Only small-scale governance failures	3	Falls below threshold
Long-term Worst	Major corporate governance failures	3	2

Organized Crime: Counterfeiting

		Likelihood	Severity
Short-term Base	Costs and benefits largely matched	4	1
Short-term Worst	Sharpening US/China dispute on rules of trade	2	2
Long-term Base	Rising deaths from counterfeit medicines and undermining of public trust	3	3
Long-term Worst	Increased vulnerability of IT networks and aggregate GWP reduction	1	4

Summary descriptors

Technological Risks

Electromagnetic Fields (EMF)

		Likelihood	Severity
Short-term Base	No new evidence of adverse health effects caused by EMF	3	Falls below threshold
Short-term Worst	Causal relationship between EMF and human health revealed	1	1
Long-term Base	Conflicting viewpoints about impact of EMF on human health	2	Falls below threshold
Long-term Worst	Causal relationship between EMF and human health revealed	1	3

Nanotechnology

		Likelihood	Severity
Short-term Base	No new evidence of adverse health effects caused by nanoparticles	3	Falls below threshold
Short-term Worst	Causal relationship between nano-particles and human health revealed	1	1
Long-term Base	Risks managed, widespread consumer acceptance	2	Falls below threshold
Long-term Worst	Widespread adoption followed by proven health impacts	1	3

Pervasive Computing

		Likelihood	Severity
Short-term Base	No adverse public reactions to radio frequency identification device (RFID) tagged items	2	Falls below threshold
Short-term Worst	RFID-tagged products trigger massive public protests	1	1
Long-term Base	Risks managed, widespread consumer acceptance	2	Falls below threshold
Long-term Worst	Pervasive computing applications promote perceived "Big Brother" environment	1	3

Converging Technologies

		Likelihood	Severity
Short-term Base	No emergent effects[1]		
Short-term Worst	No emergent effects		
Long-term Base	Managed implementation of converging technologies	3	Falls below threshold
Long-term Worst	Elimination of privacy reduces social cohesion and weakens ability to share risks	1	3

[1]Converging technologies is, for the moment, an "over the horizon" issue, not suited to the one-year short-term time frame used in this paper.

Geopolitical Risks

Middle East Stability

		Likelihood	Severity
Short-term Base	Precarious stability	3	1
Short-term Worst	Escalating violence	2	3
Long-term Base	Precarious stability, structural weakness remains	3	1
Long-term Worst	Widespread violent conflict	2	3

Hotspot: Iran

Short-term Base	Continuation of conflict over nuclear programme	3	1
Short-term Worst	Open nuclear defiance	1	3
Long-term Base	Nuclear compromise	3	1
Long-term Worst	Aggressive nuclear posture	2	3

Hotspot: Iraq

Short-term Base	Tenuous stability and partial economic recovery	3	2
Short-term Worst	Civil war	1	3
Long-term Base	Tenuous stability and partial reconstruction of infrastructure	2	2
Long-term Worst	Disintegration	2	3

Hotspot: Saudi Arabia

Short-term Base	Oil revenues preserve status quo	3	1
Short-term Worst	Increased pressure on the Kingdom's governance structure	1	2
Long-term Base	Successful balancing of external and domestic challenges	2	1
Long-term Worst	Stability of the Kingdom severely undermined	1	3

European Dislocation

Short-term Base	Stagnation and reform resistance	3	2
Short-term Worst	Economic crisis in large member state	2	2
Long-term Base	Gradual decline of economic competitiveness	2	2
Long-term Worst	Radical economic and political upheaval in Europe	3	2

Hotspot: Korea

Short-term Base	Fragile status quo preserved	2	1
Short-term Worst	North Korea tests nuclear weapon	1	3
Long-term Base	North Korea's nuclear programme contained	2	1
Long-term Worst	North Korea's nuclear test triggers arms race, internal disintegration	2	3

International Terrorism

Short-term Base	Attacks continue at 2004-5 frequency and intensity	4	1
Short-term Worst	Simultaneous conventional attacks worldwide	1	4
Long-term Base	Terrorism continues to be a threat, yet is largely contained	3	1
Long-term Worst	Non-conventional attack in major city	2	4

Contributors

This report was prepared by the Global Risk Team at the World Economic Forum, in partnership with MMC (Marsh & McLennan Companies, Inc.), Merrill Lynch and Swiss Re and in association with the Risk Management and Decision Processes Center at the Wharton School of the University of Pennsylvania

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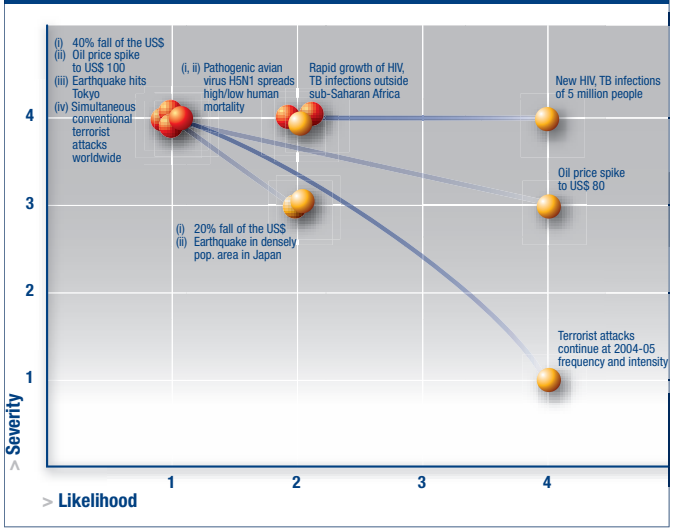
Global Risks: How likely, how severe?

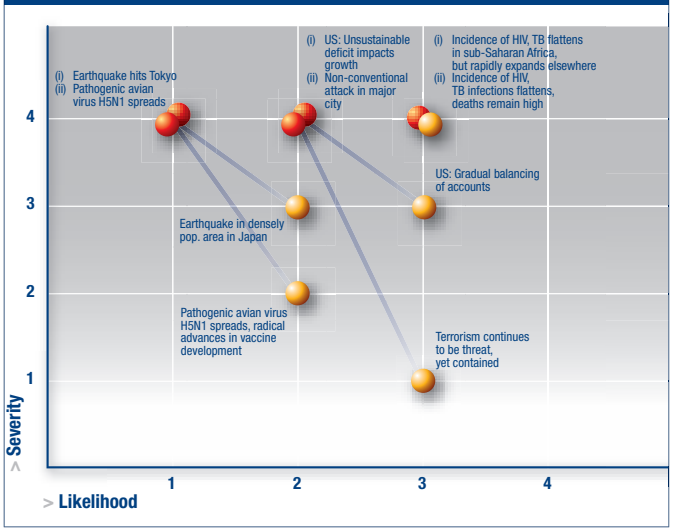
The following graphics provide an overview of the economic, environmental, technological, geopolitical, and societal risks that the Global Risk Programme has identified over a short- and long-term time horizon.

Severity and likelihood assessments for individual base- and worst-case scenarios are based on indicators described in the Appendix of this publication.

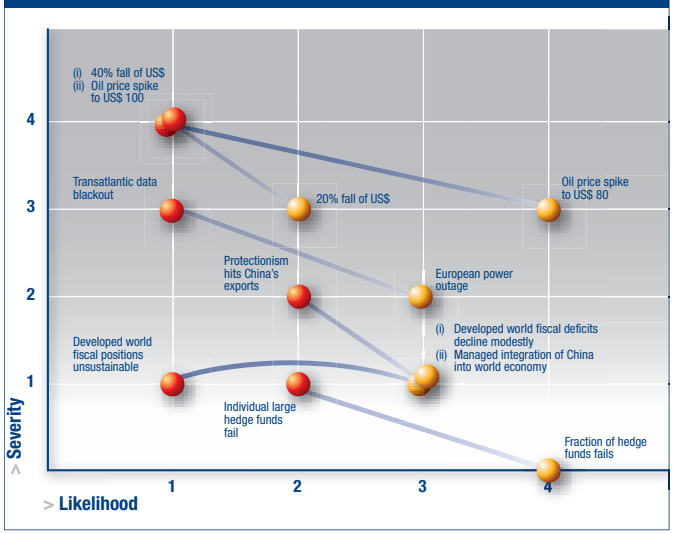
The Top Short–term Risks With the Highest Severity Ranking



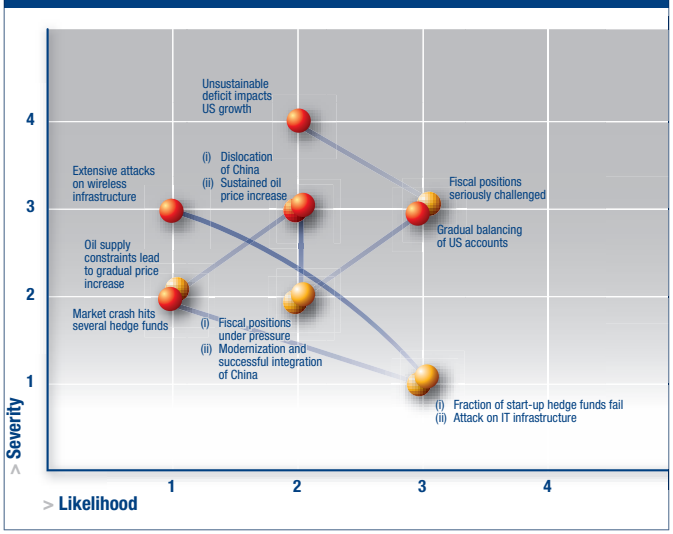
The Top Long–term Risks With the Highest Severity Ranking



Economic Short–term Risks



Economic Long–term Risks



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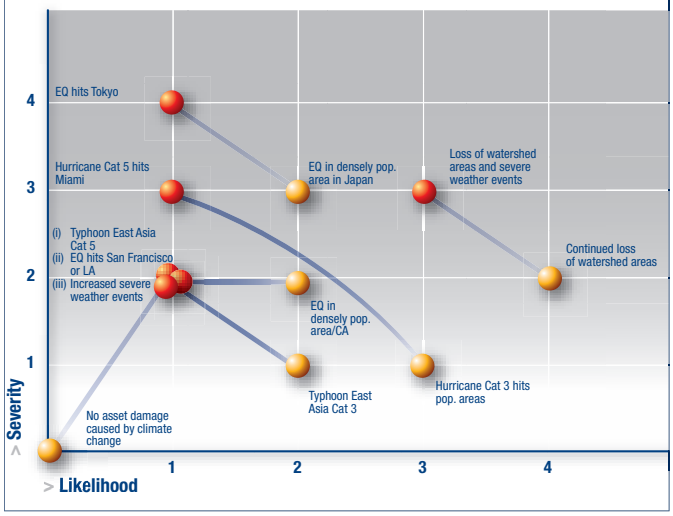
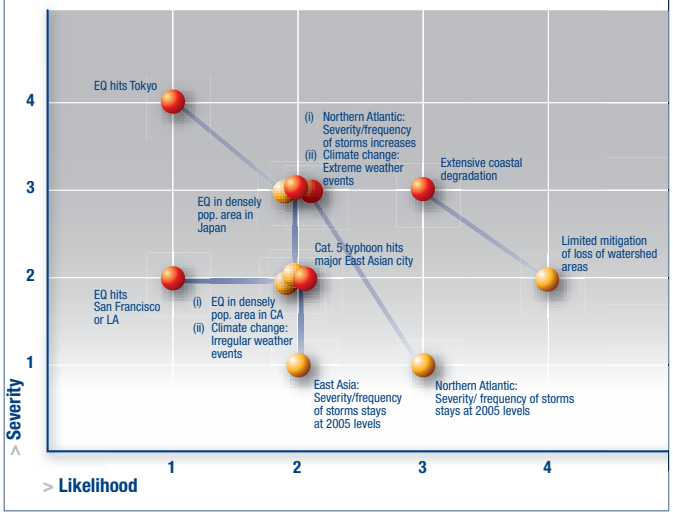
Environmental Short–term Risks



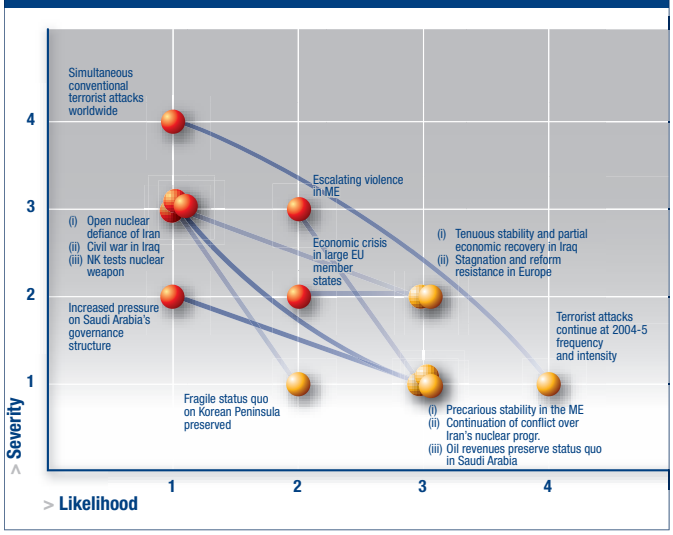
EQ = Earthquake

Environmental Long–term Risks



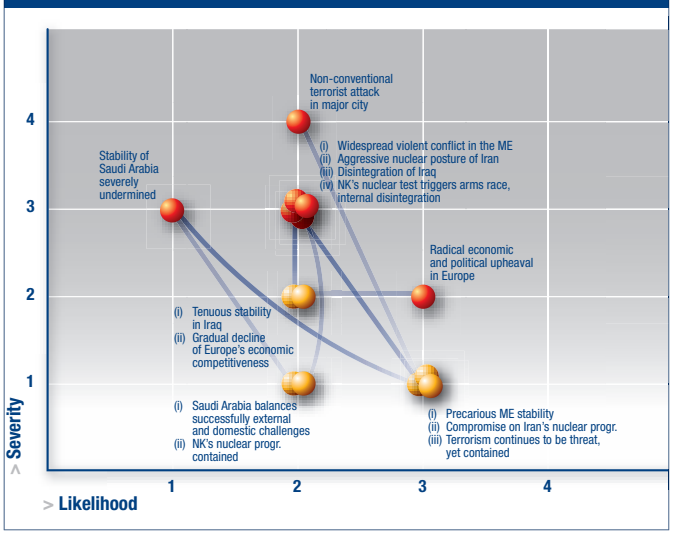
EQ = Earthquake

Geopolitical Short–term Risks



ME = Middle East
NK = Democratic People's Republic of Korea (North)

Geopolitical Long–term Risks



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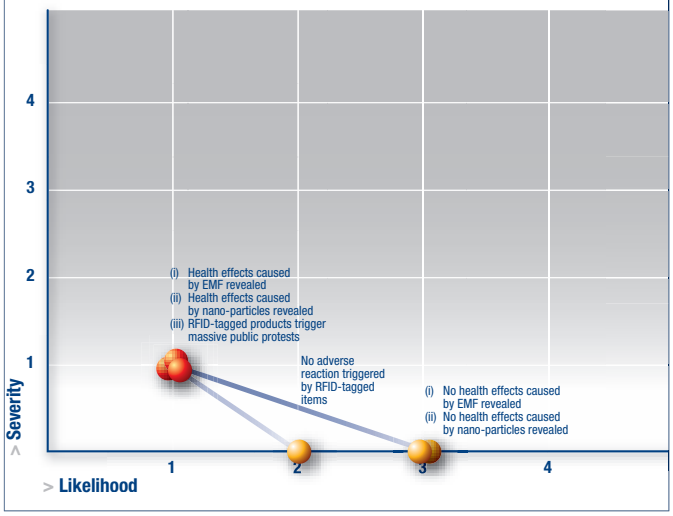
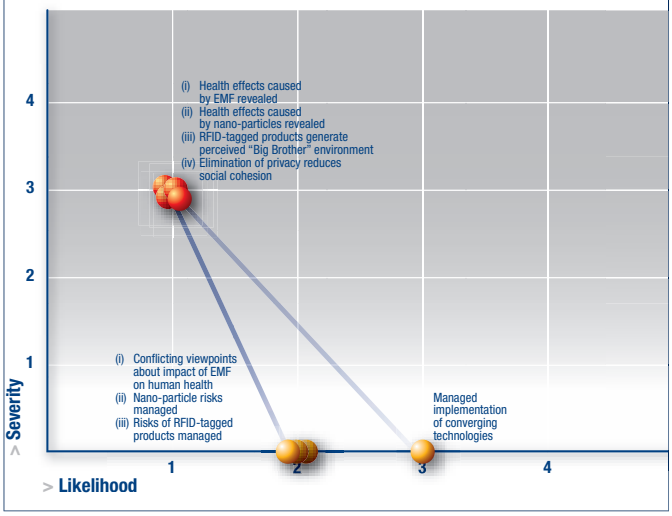
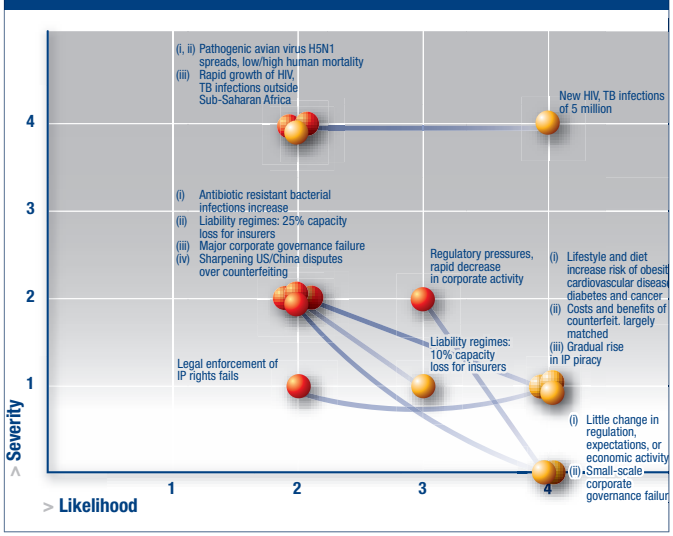
Technological Short–term Risks



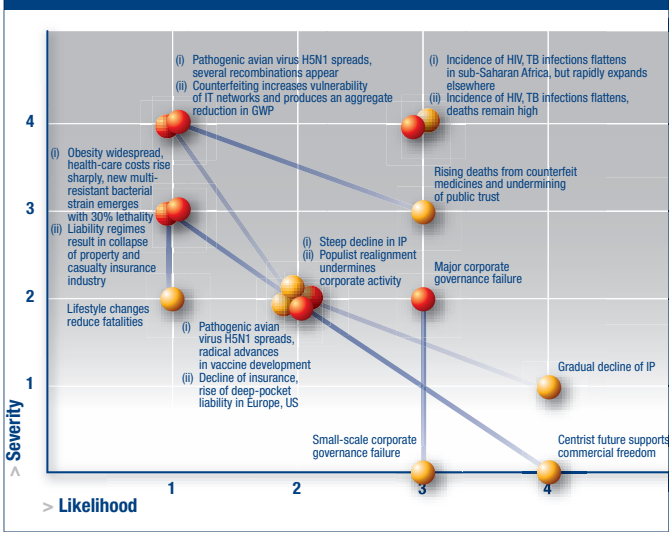
Technological Long–term Risks



Societal Short–term Risks



Societal Long–term Risks



CG = Corporate Governance

CG = Corporate Governance

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Global Risks: Likelihood and Severity

Larger versions of these graphics are available online at:
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