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Editorial

EDITORIAL

Looking 25 Years Forwards at Risks and Opportunities

By Walter R. Stahel[+]

In the editorial of the Risk Management newsletter of May 2013, I was looking back at 25 years of Risk Management Research of The Geneva Association. Today, this editorial and newsletter will look at some specific risks of the next 25 years.

The first feature article looks at the potential implications of solar storms for the insurance market and specifically at how a high impact solar storm could manifest in claims. The second article examines perceptions of nanotechnology and nanomaterials risks—adding the dimension of risk perception to technological risks. Our final article, entitled "Disaster Risk Reduction—How and what can Private Insurance Contribute" focuses on how risk—the known-known risk—can be mitigated by understanding the lessons from the past.

Learning the lessons of past events was also at the heart of The Geneva Association's 5th CR+I Seminar, organised at the end of October 2013 jointly with the Tokio Marine & Nichido Fire Company in Sendai. The city was at the centre of the north-eastern Japanese earthquake and tsunami on 11 March 2011.

If we first look back 25 years, to 1988, the PC had just been invented, Internet was still an internal network at the site of its invention the CERN in Geneva, cars were driven by people and mobile phones weighed five kilos and cost $5000, to give but a few technical examples. Dying forests, air pollution and retreating glaciers were the main environmental topics in the news, unemployment and sovereign debt were high on the agenda of politicians—some topics change, others remain.

Looking forward to 2039, the impacts of climate change will have amplified: invasive species—both plants such as ambrosia and animals such as the tiger mosquito—will have advanced further northward in Europe, while intensive agriculture in Scotland and Scandinavia will have become the norm—the European Union (EU) expects a 75 per cent increase in agricultural yields in these regions.

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Other topics, such as bacteria which are resistant to antibiotics, represent a formidable challenge both as an opportunity for science and a risk to society. The European Commission estimates that today, 25,000 people die annually as a result of an infection with multi-drug-resistant bacteria.

The ageing population is another major opportunity and risk in the hands of policymakers, a topic which The Geneva Association started analysing more than 25 years ago. Yet the multiple benefits of continued activity by the elderly—such as lower health costs—are only starting to be recognised by politicians. And most companies, organisations and administrations are still extremely hesitant to keep able employees beyond the legal age of retirement.

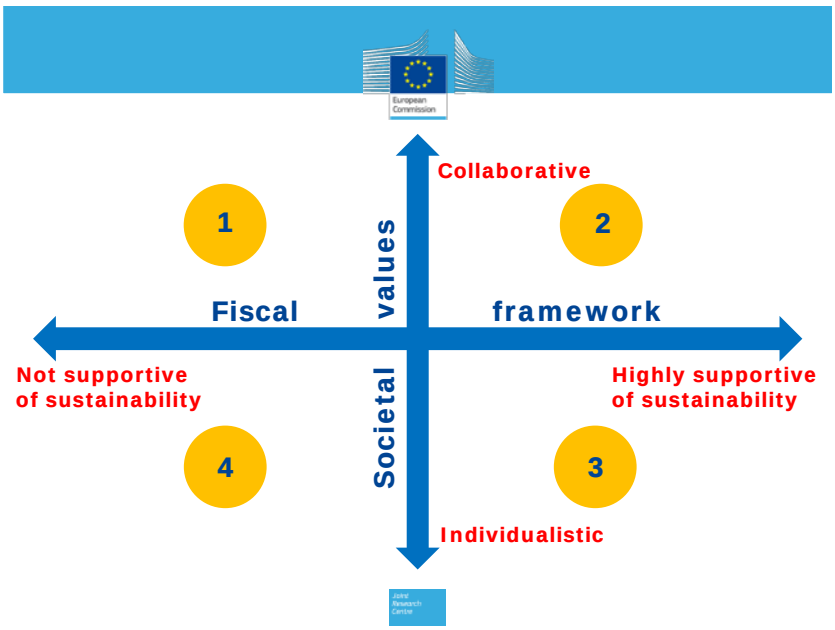
No easy predictions can be made on the outcome of societal changes. Trends such as a shift from science-based policymaking to policy-based science, from evidence-based advocacy to advocacy-based evidence and from fault-based liability to need-based compensation could lead society onto down the wrong path, which may be irreversible.

By 2038, globalisation will have lost its lustre, not least because of growing resistance from emerging economies to extend the trade of goods (ruled by the World Trade Organization-WTO) to trading services, knowledge and intellectual property. Industrialised countries have moved to a post-industrial economy based on the knowledge society, but developing countries refuse to pay for ideas and knowledge. The U.S., initially champion of the globalisation, have been changing their strategy to bilateral and regional free trade agreements since 2010.

Scenarios are a smart approach to glance into the future. In early 2013, the EU's Directorate General of Joint Research Centres launched a project to determine "The potential of eco-innovation for jobs, economic growth and sustainable development in the EU eco-industries 2035". Yours truly was part of a group of 20 experts invited to develop, in five, two-day workshops, a number of scenarios.

The study takes a systemic approach to eco-industries by looking at those that set greater sustainability and resource efficiency as their business objectives—the enablers—that "can optimise service delivery per unit of input and design for resource efficiency". By identifying key drivers of change, trends and opportunities, and developing possible scenarios linked to eco-industries, the study will make recommendations for EU policies and research to bring about the vision policymakers will choose for eco-industries in 2035.

The report, to be published in mid-2014, uses the following scenario logic to define four possible alternative futures:



The vertical extremes—collaborative and individualistic—can also be translated as global governance or top–down, versus decentralised or bottom–up. As both dynamic changes (start-up companies) and building resilience (decentralised production) are bottom–up, but global governance by the UN, IAIS and other non-elected bodies is top–down, the scenarios open dynamic, contradictory approaches.

The horizontal extremes of fiscal framework—highly supportive of sustainability or not—can be translated as taxing non-renewable resources instead of renewable ones including labour (highly supportive of sustainability) versus today's fiscal framework conditions of subsidising fossil fuels[1] and heavily taxing income from work, again opening dynamic opposites.

Looking into the future, the role of governments as an obstacle to societal progress may be one of the most overlooked factors. The risk analysis of the impacts of solar storms on terrestrial infrastructure has shown the vulnerability of national electricity grids as a centralised structure: the economy of scale completely dominates the related dis-economy of risk. In North America and Europe, the alternative of decentralised power production, enabling electricity autonomy of buildings and even municipalities, has emerged as an option for building societal resilience. However, when I recently suggested this idea in a sustainability discussion at the Assemblée Nationale in Paris, I was immediately stopped—Electricité de France (EdF) a French majority state-owned enterprise has a monopoly on electricity production in France. Similar rules exist in some U.S. states.[2]

Germany has no such regulation; Spain changed the legislation in October 2013 from a free market to a monopoly. Small companies which invested in photo-voltaic systems to become independent from future cost increases of electricity from the grid now have to pay a fee to the grid for not consuming its electricity. Yet the European Union explicitly grants to right to choose one's power provider.

What is the role of insurance?

In the risk management discussion, the focus has shifted from mitigating specific risks to building resilient communities. This opens a huge opportunity for insurers to show approaches through which insurance can contribute to achieve this new objective and to increase the quality of life for people.[3] But as the power monopoly issue above shows, this could turn increasingly into insurers participating in political dialogues.

Governments have a role and duty to mitigate risks and reduce their impact. The events of March 2011 in Japan—a geo-risk event—showed that authorities had acted successfully with regard to building codes to reduce earthquake impacts. In the case of global climate risks, such as warming oceans and sea level rise, which are aggravated by subsidence caused by locally pumping gas and water from underground natural reservoirs in coastal zones, governments have failed. COP19 in Warsaw has shown yet again that a reduction of GHG emissions is not a priority of governments. Michael Butt, Co-Chair of the Extreme Events and Climate Risk (EE+CR) project of The Geneva Association (previously named Climate Risk and Insurance), has stated repeatedly that insurers should put more pressure on governments to reduce climate change risk by mitigation. Is the insurance industry willing to pick up this challenge?

This issue of the Risk Management newsletter mentions some of the topics that we propose to study more closely in the future—the future of risk management will be lively and interesting.

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1 Subsidies for the production and consumption of fossil fuels in the EU amount to €56 billion per annum, and US$ 540 trillion worldwide, according to the latest OECD and IEA figures.

2 Private conversation with Lindene Patton, ZIG USA

3 The Geneva Report no 7 May 2013 *'Insurers' contribution to disaster reduction—a series of case studies'*, edited by Meghan Orie and Walter R. Stahel, was a first step in this direction by The Geneva Association, in collaboration with UNISDR.

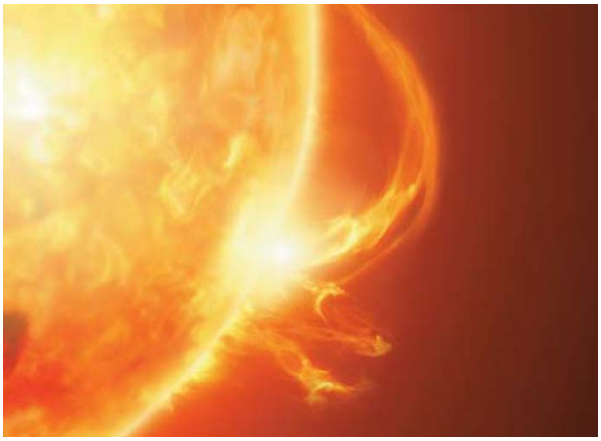
Solar Storms and Their Impacts on Power Grids: What Consequences for (Re)insurers?[4]

By Romain Launay[+]

Solar storms and their impacts on power grids

Solar storms are events which result from explosions on the surface of the Sun. They may cause disruptions to a wide range of activities and devices, including radio communications, GPS, radar systems, satellites, electronics, railway signalling systems and pipelines.

Figure 1. Solar eruption with coronal mass ejection



Source: NASA

The most severe solar storms can generate coronal mass ejections (CMEs). CMEs are vast clouds of seething gas, charged plasma of low to medium energy particles with imbedded magnetic field, which are ejected from the Sun. They are correlated with the 11-year solar cycle for sunspots. However, large CMEs can occur anytime during the cycle. When a CME reaches the vicinity of the Earth, its magnetic fields interact with Earth's magnetic field (the magnetosphere) and distorts it. This creates the beautiful aurora borealis.

Figure 2. Picture of an aurora borealis observed from space

Source: NASA

According to Faraday's law of induction, these time-varying magnetic fields also create differences of electric potential in the ground that can reach several volts per km. When a solar storm hits the Earth, electricity transmission lines whose extremities are grounded to the earth provide a shortcut between points with very different electric potentials. This drives currents called geomagnetically induced currents (GIC).

GICs may damage grid transformers in the bulk power system (BPS), because these transformers are designed to deal with AC currents, not DC currents. DC currents may cause overheating of transformers and the production of gases in the insulating oil, damaging them up to the point of failure. Moreover, even before GICs damage any transformer, they may increase their reactive power consumption and cause a voltage collapse. Furthermore,

[4] This article summarises a SCOR paper published by the author in February 2014. Texts appearing in SCOR papers (as well as this article) are the responsibility of their authors alone. In publishing such articles, SCOR takes no position on the opinions expressed by the authors in their texts and disclaims all responsibility for any opinions, incorrect information or legal errors found therein. Available at http://www.scor.com/images/stories/pdf/scorpapers/sp28.pdf.

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harmonic currents may cause the tripping of protective systems on the grid. This can also cascade into the collapse of parts of or even the whole grid.

Such disruptions have already been observed in relatively recent years, notably in March 1989 when a solar storm collapsed the Hydro-Québec power grid in less than two minutes, resulting in the loss of electric power to more than six million people for nine hours. However, no major solar storms such as the spectacular "Carrington storm" have been experienced in contemporary times. In 1859, when that storm hit the Earth, auroras could be seen in Cuba, and telegraph systems became unusable across Europe and North America,

While there are reasons to believe that a one-in-200-year solar storm would not be that different from the 1859 event, studies diverge as to what would be the impact on modern power grids.

Some of them foresee only rather limited disruptions. Thus, modelling done for the U.K. National Grid suggests that a Carrington-like solar storm […] would only result in "temporary localised power interruptions" (National Grid, December 2012).

But other studies anticipate a major power blackout affecting millions of people for several weeks or more, with consequences reaching trillions of dollars. Among them, a study conducted in 2013 by AER concludes that a Carrington-level storm would deprive between 20 and 40 million people of electricity in the U.S., with durations of 16 days to one to two years, with economic costs estimated at US$0.6–2.6tn (LLoyd's & AER, 2013). The reason why power blackouts caused by solar storms, if triggered by the destruction of transformers (as opposed to being triggered by the tripping of protective equipment), may last for an extended period of time is that damaged transformers could neither easily be repaired *in situ* or replaced by new ones. Indeed, it takes several months to build a transformer (Office of Energy Delivery and Electric Reliability, 2012), manufacturing capacities are limited to around 70 units per year (Aon Benfield, 2013) and spare inventories are low.

In light of such doomsday scenarios, solar storms are increasingly on the radar of public authorities. In the U.S., on 16 May 2013, the Federal Energy Regulatory Commission (FERC) issued a rule related to solar storms. This rule mandates the development of reliability standards requiring owners and operators of the BPS to take two actions. First, they should implement operational procedures to mitigate the effects of solar storms when alerts are sent by agencies such as the Space Weather Prediction Center (SWPC), which broadcasts solar storm forecasts. Second, they should conduct assessments with a view to developing and implementing action plans as needed (FERC, 2013).

What consequences for (re)insurers?

In spite of the economic costs anticipated by some studies, and in spite of the damage caused by recent events such as the 1989 storm, very few insurance policies currently mention solar storms[5].

Consequently:

- Solar storms would arguably be covered by "all risks" policies, given the absence of any exclusion clause.
- Solar storms would arguably not be covered by "named perils" policies, given the absence of any inclusion clause, unless they indirectly provoke one of the perils named in the contract (fire, explosions, etc.).

Given this, the remainder of this article attempts to review potential impacts from solar storms on various types of insurance policies.

- **Property insurance**

Property insurance policies may be triggered by a major solar storm. In that case they may cover:

- physical damage incurred by the insured,
- business interruption caused by such damage,
- business interruption caused by physical damage incurred by a supplier/service provider/client.

[5] The author has only found one recent insurance policy for a Telecom operator in the Middle East, containing the following exclusion: "Excluding loss/damage due to solar disturbances viz, solar tsunami".

In all cases, someone needs to incur physical damage for the policies to be activated. In this respect, it is interesting to keep in mind that a major blackout could happen without being caused by property damage to the grid: the loss of reactive power or the tripping of protective equipment may result in a partial or full collapse before transformers suffer from overheating.

Physical damage incurred by the insured

Generating companies/transmission system operators

A major solar storm could damage transformers up to the point of failure, if the grid does not collapse before. The destruction of a transformer would be indemnified by the property cover of the owner: the generating company or transmission system operators (TSOs). The typical cost of a transformer is US$10m. The overall cost would depend upon the number of transformers affected: around 13 for the U.K. in National Grid's simulations of a Carrington scenario (Royal Academy of Engineering, 2013), and hundreds of them in more pessimistic studies.

Large corporate clients

A power outage, especially if prolonged, may cause physical damage to large corporate clients. This is the case for manufacturers using certain types of processes. For instance, aluminium melting furnaces will already sustain irreversible physical damage after 4–5 hours without electricity (Bruch *et al.*, 2011, p. 12). Property insurance policies would typically cover such damage.

Retail consumers

Due to a power blackout, retail electricity consumers may suffer from various kinds of physical damage: loss of food in freezers, frozen water pipes, etc. Traditional property covers may cover some of this damage.

Business interruption

If the insured suffered both physical damage and a loss of revenue due to this physical damage, this loss of revenue would fall under the "business interruption" (BI) extension of its property cover, such an extension being widespread, not to say systematic, for large corporate insureds in developed countries.

Generating companies

If a generating unit resulted being cut off from the grid for a period longer than the waiting period stipulated by its insurance policy, the amount of the claim would correspond to the net loss of revenue of the generating company. This amount would partially depend on the spot price of electricity during the period when the power plant would not be able to operate. This spot price might behave unexpectedly given the circumstances, adding uncertainty to the amount of the claim.

TSOs

Similarly, TSOs not being able to transport power to end customers (large corporate or retail) because of physical damage to their own property could claim loss of revenue. Contrary to generating companies, they would typically be paid a fixed sum for each MWh they transport.

Large corporate clients

Physical damage directly suffered by large corporate electricity consumers (such as aluminium producers) may halt production for a certain period of time. If this period is longer than the waiting period stipulated by the insurance policy, BI covers could be triggered.

Service interruption/Contingent business interruption

In a severe solar storm-induced blackout scenario, many companies relying upon electricity for their operations would suffer from disruptions and loss of revenues, even if they do not incur physical damage themselves. In most cases these losses of revenues would be eligible for coverage under "service interruption" extensions of property covers, which are also widespread, not to say systematic, for large corporate insureds in developed countries. As a matter of fact, the purpose of these extensions is precisely to cover insureds against loss of revenues caused by the interruption of services such as power, gas or water supply.

Service interruption extensions generally include the same provisions as BI extensions in terms of waiting period, minimum combined deductible and indemnity period. However, the limit is typically 10 per cent to 15 per cent as high as the limit applicable to property and BI losses.

In such a situation, insurers may face an "accumulation" problem, with a large number of policies (virtually all policies including a service interruption extension in the area affected by the blackout) being triggered at the same time.

Insurance policy wording

Since the awareness about solar storms remains limited among risk managers, brokers, insurers and reinsurers, policy wording does not take this risk into account. This is a real source of uncertainty as to the triggering or not of insurance policies, all the more so since court decisions may bring their lot of surprises.

Notion of physical damage

As stated above, the triggering of property covers, including BI/service interruption/CBI extensions, requires physical damage to be incurred (as far as service interruption and CBI extensions are concerned, this damage would not be incurred by the insured itself).

But an imprecise wording may cause the insurer to pay claims even if there is no such "physical damage". Suriano & Haas (2012) mention a series of cases judged by U.S. courts which illustrate this.

Notion of electricity supplier

The simultaneous triggering of the service interruption extensions of commercial/industrial clients dependent upon electricity in a region affected by a prolonged blackout is one of the highest risks for insurers.

Hence the importance of the wording of these extensions. In particular, wordings may raise the question of whether generating companies and TSOs would all be considered by a court as "suppliers" of electricity. This is of particular importance for TSOs, which are likely to be the ones incurring physical damage on the grid.

- **Liability insurance**

A major solar storm could result in the impossibility for certain parties to perform their contractual obligations towards other parties, or even in damage caused by certain parties to other parties. For instance, a TSO may not be able to fulfil its contractual obligation to transport electricity. By doing so, it may also inflict damage to a third party, such as the aluminium producer mentioned earlier sustaining irreversible damage.

This raises the question of whether such parties would be held liable and their liability covers would be triggered.

At first glance, one could argue that a major solar storm would fall under the exception of *force majeure*. However, it does not seem possible to sweep aside any liability risk altogether.

Plaintiffs may try to show that the risks posed by solar storms to power grids were well known and that mitigation measures were available, with a cost–benefit ratio that would, in retrospect, look compelling.

They may challenge the idea that solar storms are unpredictable by pointing at existing space weather forecasts, which make it possible to identify CMEs one to four days in advance, even though the danger cannot fully be assessed more than 15 to 30 minutes before a solar storm hits the Earth. They may point at deficiencies in operational procedures meant to react to such events. In the absence of any such procedure, they may use the fact that some TSOs such as the U.K. National Grid have put in place comprehensive procedures as a proof that they could/should have done the same.

Until recently, it seems that no binding standard or regulation applicable to power grid operators specifically addressed the risks from solar storms. But the new FERC rule changes this situation: when the reliability standards are defined, failure by U.S. operators to comply will most certainly lead to liability in case of the occurrence of a

superstorm with heavy consequences. It is not clear whether such liability would extend to operators from outside the U.S. Although they would not be legally bound by these standards, they may be considered negligent for not having implemented them.

If generating companies or TSOs were held liable for a blackout, their liability covers could be triggered. However losses for (re)insurers would be limited by two factors. First, contrary to electricity consumers, the number of generating companies and TSOs in a given area is relatively small. Even if they were all held liable, losses shouldered by their (re)insurers would be capped by the limit per cover times the (small) number of insurance policies concerned. Second, liability insurance policies for generating companies and TSOs usually only cover liability arising from bodily injury, personal injury and property damage. Consequently, these policies would not cover business interruption losses suffered by industrial electricity consumers merely due to their inability to operate without electricity. They would only be triggered if the industrial electricity consumers suffered physical damage (as can be the case for aluminium producers for instance).

- **Wider impacts in the event of a prolonged blackout scenario**

If a solar storm were to cause a prolonged blackout, indirect impacts would cause severe losses on top of direct losses. For instance, disruptions suffered by firefighting units (lack of fuel, lack of water) may reduce their capabilities, which may result in more destructive fires. After days or weeks of power outage, distressed populations may resort to looting.

For insurers, losses on the P&C liability side may be compounded by losses on the asset side. For instance, a prolonged blackout affecting the north-eastern part of the United States would certainly affect stock markets. The insurance industry, which holds investments worth trillions of dollars, would be affected.

These wider impacts show that solar storms should not be the concern only of (re)insurers' underwriting power, BI or CBI/service interruption policies. If one gives faith to the prolonged blackout scenario supported by some studies, all (re)insurance companies would be heavily affected by a major solar storm. Consequently, the industry as a whole should engage with governments, power grid regulators, power generating companies and TSOs in order to raise awareness and promote concrete answers[6].

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[6] The report on which this article is based outlines 16 recommendations for (re)insurers, touching upon risk management, underwriting and engagement with governments.

Insurance Market Perception of Nanotechnology and Nanomaterials Risks

By Lijana Baublyte, Martin Mullins, Finbarr Murphy and Syed A.M. Tofail[+]

ABSTRACT

Insurance market perception of nanotechnology can influence the sustainability of technological advances. A combination of survey and interview methods was adopted to analyse insurers' perception of risks associated with nanotechnology and nanomaterials. We find that insurers worry less about some nanotechnology risks than scientists.

Introduction

The insurance industry is one of the main stakeholders capable of contributing to the safer and more sustainable development of nanotechnologies and nanomaterials. This, however, also means that the industry is one of the bearers of potential losses that can arise from nanomaterials production and use. Despite its role in sustaining technology development in modern society, insurers' perception on nanomaterials has been largely overlooked by researchers and regulators alike. This paper seeks to address this gap by providing some insight into the insurers' awareness and perception on nanotechnology and nanomaterials risks.

Nanotechnology and insurance

Nanotechnology and nanomaterials production is still in its research and development stage. Nevertheless it is rapidly making its way into the consumer market. The Project on Emerging Nanotechnologies (2010) reports that the number of products containing nano-applications already available to consumers has grown by nearly 521 per cent from 212 products in 2006 to 1317 in 2010. The use of nanomaterials is not specific to any particular industry and the new products can be found across different sectors such as health and fitness, automotive, food, clothing, cosmetics and electronics.

There are a number of uncertainties regarding the production and use of nanomaterials. The real impact of nanoparticles and nanomaterials on human health and the environment is still largely unknown. However, recent research shows that nanoparticles less than 100nm in diameter can enter cells, those with diameters below 40nm can enter the cell nucleus and those that are smaller than 35nm can pass through the blood–brain barrier and enter the brain (Dawson, Salvati and Lynch, 2009). Scientists are calling for a holistic and comprehensive nanotechnology life cycle assessment (LCA) in order to better manage these uncertainties (Klöpffer *et al.*, 2007).

Insurance losses can arise at any stage of nanomaterial production and use. Figure 1 shows how different insurance policies relate to the life cycle of products containing nanomaterials. Workers can become exposed to nanoparticles and nanomaterials during different stages of the product life cycle such as research and development, raw material production, consumer product manufacturing as well as at the end of the product's life (Mullins et al., 2013). The employer's liability insurance policies can be triggered if some nanomaterials happen to be hazardous to the workers' health. Consumers and the public can come into contact with nanomaterials once the product has reached retailers' shelves. The probability of exposure increases if the consumer does not follow the instructions and/or directions for product use and handling, or if the product is damaged. All sellers or providers of services and repair (e.g. manufacturers, wholesalers or retailers of products containing nano-applications) may incur liability to their customers and others for injury, illness, loss or damage arising from the supply of goods. Liability may arise under common law, under contract or under statute. In addition to employer liability and product liability losses, there can be losses arising out of environmental liability. There are numerous scenarios in which the environment can become contaminated at any stage of the nanotechnology life cycle. These include industrial accidents at the

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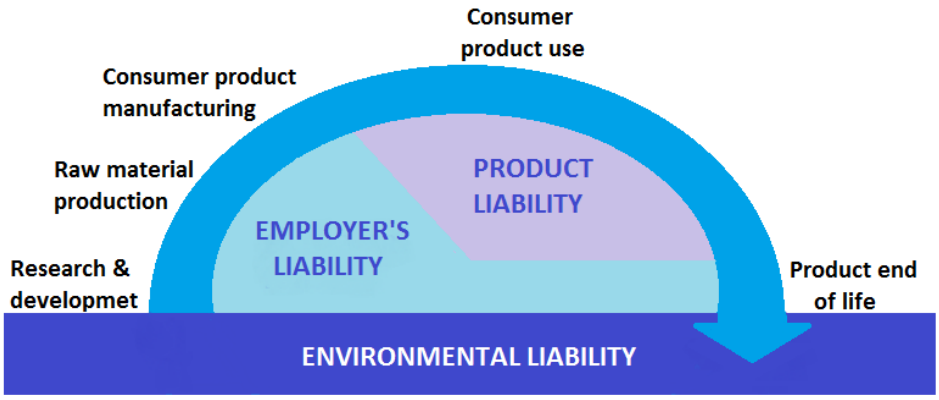
production and manufacturing stage, spillages, leakages and toxic waste accumulation in landfills. Products containing nanomaterials are becoming increasingly more available in areas like medicine, automotive, food, electronics and appliances. This means that professionals such as medical doctors and corporate directors and officers can become subject to some nanotechnology risks (e.g. professional liability can arise from wrong dosages or drug prescription).

Figure 1. The life cycle of products containing nanomaterials and the type of insurance products that can be impacted



Research design

A mixed methods approach was adopted in order to assess the perceptions of the insurance market on the development and use of nanotechnology and nanomaterials. In doing so, the perceptions of nanotechnology experts and laypeople were also explored. The rationale behind including laypeople and experts was to control for the level of knowledge, which then allowed us to identify the level of awareness within the insurance market with regard to nanotechnology. Two primary data collection methods were employed. The first phase of research involved interviewing experts in the insurance and nanoscience fields. In total, seven in-depth research interviews were conducted. Three interviewees were from the nanoscience field and the remaining four came from within the insurance market. The second phase of research involved designing a questionnaire regarding the perceived benefits and risks of nanotechnology. The data collected during the first phase of research and literature review helped in the development of the questionnaire which was then distributed to insurers, experts and laypeople. Study participants were asked to express their judgements on the perceived risks of different nanomaterials applications, as well as whether they believed nanomaterials posed potential hazards for workers, consumers, public and animal health and environmental pollution. These areas of interest were purposely selected as they represent the main perils insured under general commercial liability insurance (e.g. employer's liability and public and product liability). A total of 173 usable research instruments were generated, of which 39 were nanotechnology experts, 31 insurers and 103 laypeople.

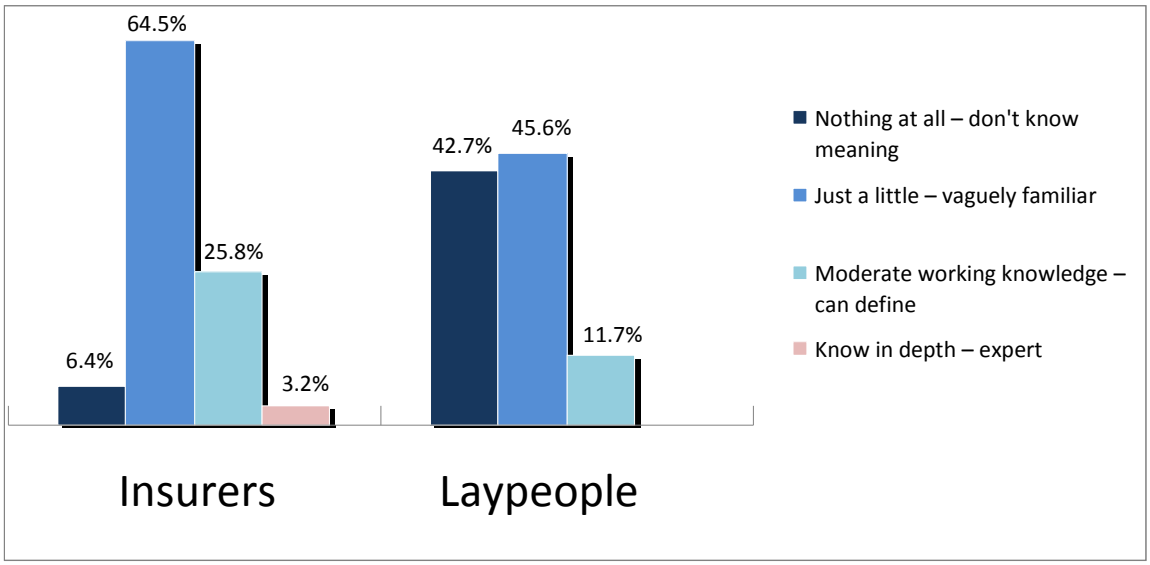
Results

Nanotechnology awareness

Qualitative and quantitative data analysis results show that insurers are relatively aware of nanotechnology and nanomaterials. Over 64 per cent of surveyed insurers said they were *vaguely familiar* with nanotechnology and nanomaterial terms, and over 25 per cent said they had a moderate working knowledge and were able to define the terms. The interview data, however, suggests that this knowledge is at a basic level and there is a need for more information in order to allow this group to differentiate between distinct nanomaterial risks. Only one participant from within the insurers' group stated that he/she had an in-depth understanding of the field. However, the insurers' group was still significantly more aware of nanotechnology and nanomaterials terms compared to the

laypeople group, at a $p \leq 0.001$ level of significance according to the Mann–Whitney U test results[7] (see Figure 2). Over 40 per cent of surveyed laypeople heard nothing at all about nanotechnologies and nanomaterials, 47.5 per cent said they were vaguely familiar with the technology and the remaining 11.7 per cent of respondents reported having moderate working knowledge. This finding is in line with the observations from previous nanotechnology perception studies (see Priest, 2006; Seigrist, *et al*., 2007; Bostrom and Löfstedt, 2010). A meta-analysis conducted by Satterfield *et al.* (2009) estimated that 51 per cent of respondents had heard nothing about nanotechnology between 2002 and 2007.

Figure 2. Insurers (N=31) and laypeople (N=103) awareness of nanotechnology and nanomaterials risks

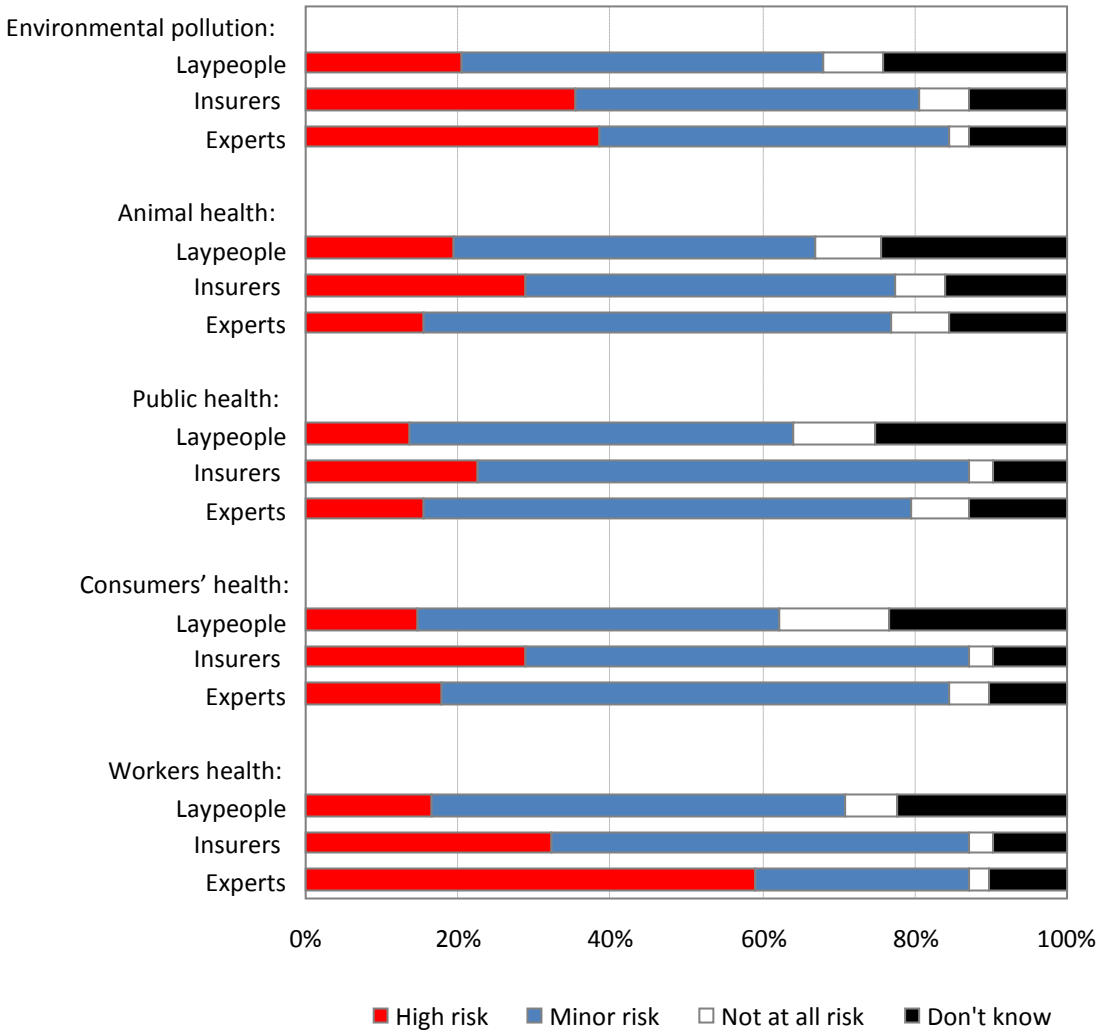


Perceived nanomaterial risks

The survey results reveal that insurers are mostly worried about the environmental pollution in the five areas covered by the survey (see Figure 3). Over 35 per cent of insurance professionals indicated that they believed nanomaterials to pose a high risk to the environment and 45.2 per cent believed that it was a minor risk. Only 6.5 per cent of insurers said they thought that the production and use of nanomaterials would not contribute to environmental pollution. In comparison, the experts group was marginally more concerned about the risk to the environment, with nearly 39 per cent of the scientists believing that nanomaterials could pose a high risk to the environment and only 2.6 per cent said that they considered this technology to be risk free. The experts group was also significantly more worried about workers' health than the insurers group was, at a $p \leq 0.10$ level of significance, according to the Mann–Whitney U test results. Nearly 60 per cent of the surveyed nanoscientists said that they believed nanomaterials posed a high risk to workers' health, whereas only 32.3 per cent of the insurers surveyed thought them to be high risk. Overall, insurers were relatively more worried about consumers and public and animal health as compared to the experts group's perceptions, which mainly considered the exposure to nanomaterials in these areas to pose minor risks. The laypeople group was significantly less concerned about the exposure to nanomaterials in relation to the environment, workers, consumers and public health in comparison to the surveyed insurers group.

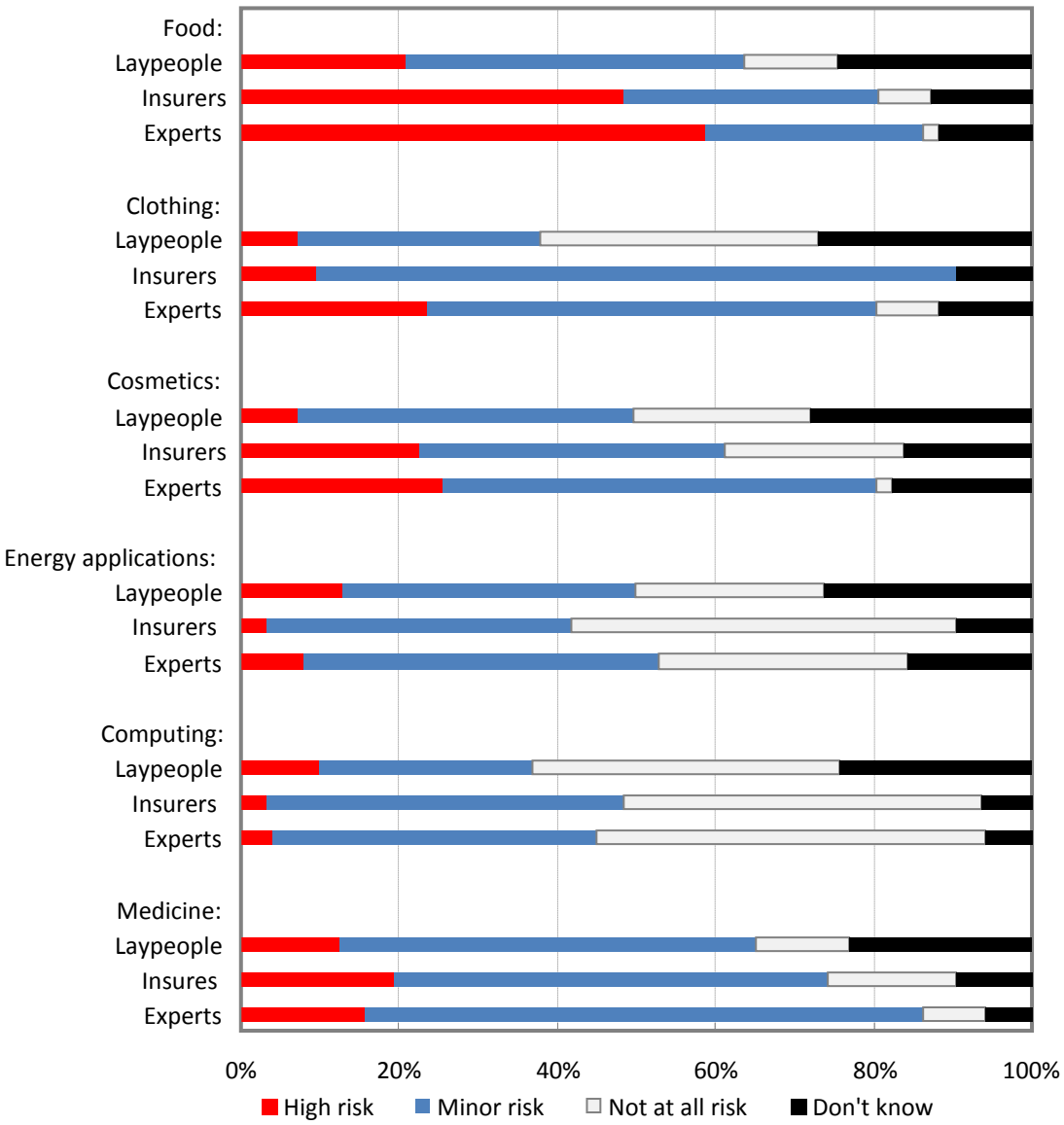
[7] The Mann-Whitney U test was used to look for the differences between the three groups surveyed. The test was chosen in this case for three main underlying reasons. Firstly, it is a standard non-parametric test which deals with categorical data that is not normally distributed. Secondly, it is suitable for both small and large samples (Bajpai, 2011). Finally, it is used for samples that are independent and possibly of different sizes.

Figure 3. Insurers, experts and laypeople's perceptions about the risk posed by nanomaterials to society over the next 15 years in the following areas: workers health, consumers health, public health, animal health and environmental pollution



We also asked study participants to state whether or not they considered nanotechnology applications in the areas of medicine, computing, energy application, cosmetics, clothing and food to pose potential risks to society over the next 15 years (see Figure 4). Nearly 60 per cent of surveyed experts and about 50 per cent of the insurers indicated that they considered nanotechnology applications in the food sector to pose a high risk to society. The second area of concern according to the survey results was the use of nanomaterials in the cosmetics industry. Over 20 per cent of the surveyed experts and insures said it to be a high risk and more than 40 per cent indicated it to be a minor risk to society. In comparison to the experts group, the insurers group was relatively more worried about the use of nanomaterials in medicine, whereas the experts group was more concerned with the use of nanomaterials in the clothing sector than was the insurance professionals group. However, these differences between the two groups are not statistically significant. Both groups of experts and insurers surveyed agreed that the use of nanomaterials in the computing and energy application sectors pose only minor risks to society. The laypeople group was significantly more optimistic about the use of nanomaterials in the food, clothing, cosmetics and medicine sectors in comparison to the insurers group. This finding is in line with a general pattern as demonstrated in the existing literature, with nanotechnology's benefits seen as exceeding risks (see e.g. Gaskell *et al*., 2005; Priest, 2006; Fujita, Yokoyame and Abe, 2006; Kahan, *et al*., 2007). Satterfield *et al*. (2009) argue that the widely reported "benefit centrism" may be overestimated and that publics' judgements could move in either direction in response to any risk information that may yet emerge.

Figure 4. Insurers, experts and laypeople's perceptions about the risk posed by nanomaterials to society over the next 15 years in the following areas: medicine, computing, energy applications, cosmetics, clothing, and food sectors



Discussion and conclusion

Nanotechnology has been hailed as "the next technological revolution", which comes with appealing benefits. Insurers' perceptions of nanotechnology and nanomaterials should be taken into account in order to assure the sustainable development of the technology. Insurance does not only compensate for losses, but it can also incentivise nanotech companies to engage in more responsible practices in the production and use of nanomaterials.

The qualitative and quantitative data presented in this paper indicate that insurers are familiar with the nanotechnology and nanomaterials terms. Moreover, although, insurers are more aware of the technology than the laypeople, this familiarity is still at a basic level. Given the fact that the insurance industry is one of the main bearers of the potential nanotechnology and nanomaterials risks, this suggests a need for more information transfer and exchange between the different stakeholders such as nanoscientists, regulators, nanotech companies

and insurers themselves. This in turn could inspire the insurance market to move beyond the "wait and see" approach and encourage the adoption of different strategies to manage potential risks arising from nanomaterials production and use. For example, Mullins *et al.* (2013) propose a control banding (CB) approach that can be used by underwriters to assess the relative level of nanomaterials production risk. It can also form the basis for an underwriting decision-making process. Better risk communication and collaboration between the insurance market, nanoscientists, regulators as well as nanotech companies could also lead to the introduction of new insurance products. This, in turn, would directly contribute to the sustainability of nanotechnology and nanomaterials development and use.

The vast majority of the insurers surveyed said that they considered the benefits of nanotechnology to outweigh the risks. However, this optimistic view is in part due to the fact that there have been no reported major adverse events involving nanotechnology and/or nanomaterials to date. The insurance industry has a tendency to base their underwriting decisions on past experiences (i.e. claims history) rather than hypothetical future scenarios. The perceptions of insurers could shift towards a much more cautious approach in response to new information or due to a loss of a larger scale caused by nanomaterials production and/or use. This was the case with the terrorism risk which was generally included under open peril property insurance policies. However, after 9/11, most insurers excluded terrorism risk from their insurance policies, as it was perceived to be too large and unpredictable, which in turn made the risk temporarily uninsurable in the U.S. market. To avoid a situation where nanotechnology risks become uninsurable, the insurance market has to actively engage in risk communication with other main stakeholders in the field, as well as to adopt a number of precautionary risk management strategies. This is needed in order to manage the impact of possible adverse events that could threaten the ability of the nanotechnology sector to procure insurance, which ultimately could threaten the sustainability of nanotechnology development and use.

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Disaster Risk Reduction—How and What Can Private Insurance Contribute

By Hans Peter Würmli[+]

A great offshore earthquake hit Portugal and north-western Africa on All Saints' Day 1755. The earthquake and subsequent fires and tsunami almost totally destroyed Lisbon and took a large toll of lives. The king's prime minister, Sebastião de Melo, the later Marquês de Pombal, immediately embarked on rebuilding the city, apparently having said, "What now? We bury the dead and heal the living." He adhered to Enlightenment ideals, pushing reforms on commerce, taxes and education. In the same way, new building codes and zoning laws for the reconstruction of Lisbon were issued, based on scientific experiments to make buildings more earthquake resistant and on the local experience of the Great Earthquake. His major insight that, not the earthquake or any other natural peril is the catastrophe, but how and where people build their houses, still drives our thinking on how the impact of disasters can be reduced.

Modern insurance is characterised ideally by three traits: 1) an enlightened, rational approach to risk; 2) corporations offering defined services in regulated free markets; 3) true, fair and realistic accounting.

The enlightened, rational approach to risk comprises, first of all, the awareness that only the exposure to the vagaries of nature or human activity can be managed. Zoning laws and building codes can dramatically change exposure to flood, storm, earthquake or fire. "Electric light is the most efficient policeman" [Louis D. Brandeis]. Precaution has a cost, but there might be a huge saving compared with the avoided cost of human suffering and damage to property. Insurance works in no other way than by internalising otherwise external costs. By guiding human behaviour and enforcing precaution, insurance can mitigate the impact of feared events. This can be called the" invisible hand" of insurance.[8]

Corporations as insurers were first founded after the Great Fire of London. These companies made possible the development of special skills, knowledge and expertise. Three decisive strengths of the insurance community should be highlighted: the ability and independence to assess risk, including judgements as to the limits of insurability; the capacity to create insurance products to internalise external costs, e.g. of dreaded events; and, most importantly of all, having the right incentive to impose provisions and measures to manage risk exposures that can render dreaded events more unlikely.

The insurers' business model has proven to be sustainable, largely because insurers know how to quantify risk and to set up appropriate technical provisions.

This is no different than knowing how to account for risk. In the same way that modern double-entry accounting in late-medieval Italy drove the development of trade and vice versa, adequate, sometimes termed "true, fair and realistic" accounting, is key to insurance.

Insurance risk management has learned to deal with two pertinent issues: the agency dilemma and the importance of right incentives, these not being insurance issues per se. Both emerge when human cooperation to accomplish tasks takes place in a division-of-labour-based society. The agency dilemma, or principal–agent problem as it is also called, arises when others than those that set the goals carry out the activities to reach them. It arises at the macro as well as the micro level. How can the principal trust the agent to carry out the tasks appropriately? Solutions often have been found by setting incentives and installing controlling institutions, somehow balancing inclusion and coercion. The principal–agent–controller set-up can be identified in many places: in constitutional democracies, it is the split between the legislative, executive and judiciary powers; in governments, the principle might be applied via laws regulating a special activity which is supervised by a state agency; within a company, it might be the board level issuing policies, and the executive level running the operations which are controlled by internal audit, compliance and risk controlling.

[+] Chairman of the CRO Networks, The Geneva Association.

[8] Würmli, H.P. (2011). Guest editorial: the invisible hand of Insurance. *Geneva Association Information Newsletter on Risk Management No. 49.*

The successor of the current Hyogo Framework for Action, informally called HFA2, can build on strong principles and standards already set. They are close or identical to what is summarised above. Strengthening the role of public–private partnerships clearly could play an important part. If this is done properly, governments could gain better access to the broad risk management knowledge and experience of the insurance industry: risk assessment and pricing, design and management of insurance schemes, design and definition of constraining clauses and necessary precautionary measures, as well as management of claims when disaster strikes. This all requires strong institutional frameworks that regulate the rights and duties of insurers and insureds. The importance of legal certainty cannot be underestimated. But all good intentions will be vain if the right incentives are missing or disincentives are set. Each party involved needs the right incentives: the government, the insurers and insured citizens and enterprises.

The Geneva Association's report entitled *Insurers' Contributions to Disaster Reduction—a Series of Case Studies*[9] gives a valuable analysis of cases, some of which worked well, others not. It turned out that well-meant measures and incentives had an effect opposite to what was intended, which is sometimes easily discernible, sometimes not at all. Learning from real-life examples and improving on the design of public–private partnerships will be a worthwhile and gratifying task the insurance industry is ready and eager to undertake.

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11th Geneva Association Health and Ageing Conference

on

Emerging Health Risks and Insurance

6–7 November 2014
Madrid

Hosted by MAPFRE Foundation

The Geneva Association has the pleasure to inform you that the 11th Health and Ageing Conference, generously hosted by MAPFRE Foundation, will take place in Madrid on 6–7 November 2014.

The conference will focus on new and emerging health risks, how they impact health and health financing mechanisms, and how insurance covers and manages these risks.

Topics will include:

- Typology and assessment of emerging health risks
- New health technology (including big data and smart analytics) and insurance
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- Lifestyle, risky behaviours (obesity, smoking) and prevention of non-communicable diseases
- Antimicrobial resistance, pandemics, and climate change
- New health risks for an ageing population
- New insurance products and markets for emerging health risks

We encourage you to submit contributions related to the topics of the conference. Suggestions for other topics will be considered.

Should you be interested in contributing to this conference, please contact christophe_courbage@genevaassociation.org

Participants will come from insurance and reinsurance companies, universities and related institutions. There is no conference fee. The conference will have a limited number of participants to guarantee an active exchange of opinions and animated discussions.

For further information, please contact our Conference and Programmes Manager, Ms Barbara Botterill at: barbara_botterill@genevaassociation.org

[9] Orie, M. and Stahel, W.R. (eds). (2013) *Insurers' contributions to disaster reduction—a series of case studies*, The Geneva Reports No. 7. Geneva: The Geneva Association.

THE RESEARCH PROGRAMME ON RISK MANAGEMENT

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- to be a facilitator for the chief risk officers (CROs) of The Geneva Association and CROs in general;
- to foster the use of risk assessment tools and risk management in new fields of application, such as policymaking;
- to promote the concept of the insurability of risks as the "natural" borderline between State legislation and the market economy;
- to identify new opportunities for insurers in the emerging sustainability concept in order to enlarge the field of insurable and insured risks; and
- to research and illustrate the new risks in the emerging service economy, based on an extended performance responsibility of economic actors.

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The Geneva Association Risk Management Newsletter, N° 54, June 2014

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5–6	Paris	**12th Annual Round Table of Chief Risk Officers**, organised jointly by The Geneva Association and SCOR, sponsored by SCOR
22–25	London	**The Geneva Association/IIS Research Award Partnership**

September

15–17	St. Gallen	**41st Seminar of the European Group of Risk and Insurance Economists (EGRIE)**, sponsored by The Geneva Association
22	Munich	**International Colloquium on Global Capital Standards (BCR, HLA, ICS)**, hosted by Munich Re

October

23–24	New York	**6th CR+I Seminar on "Extreme climate and weather events in the USA and globally"**, organised in collaboration with XL Group

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4	London	**10th International Insurance and Finance Seminar of The Geneva Association**, hosted by Prudential plc
6–7	Madrid	**11th Health and Ageing Conference on "Emerging health risks and insurance"**, hosted by MAPFRE Foundation
18–19	Munich	**10th CRO Assembly**, hosted by Munich Re

2015

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