FOCUS

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PUSHING THE EDGES OF RISK AWARENESS AND INSURANCE

The role of the (re)insurance industry to cover risks affecting societies and governments

SCOR
The Art & Science of Risk

CONTENTS

FOREWORD

VICTOR PEIGNET
CEO, SCOR Global P&C

Victor Peignet has been the Chief Executive Officer of SCOR Global P&C since 2005. He joined SCOR's insurance business, now called SCOR Business Solutions, in 1984 from the offshore oil & gas contracting industry. He was trained as a Marine & Offshore Engineer and graduated from France's Ecole Nationale Supérieure des Techniques Avancées (ENSTA).

10 YEARS OF LESSONS LEARNED

For the last 10 years, the SCOR Annual Conference has reflected the major issues and challenges of the (re)insurance industry. Below is a list of past topics, – nearly every one of which was critical at the time and remains important today. The conference of September 2017 brought together all of the topics discussed over the past decade within a holistic framework.

2008	Climate change Management: how to transform threat into opportunities for the (re)insurance industry
2009	Enterprise Risk Management: a driving force for the insurance industry
2010	Enterprise Risk Management: a risk-based approach to manage a company
2011	The risks and challenges of renewable energy in a fast changing environment
2012	Property Cat: key strategic issues and trends ahead
2013	Supply chain and CBI: a perspective on property and casualty
2014	Gaining a strategic edge through capital management: key issues faced by the P&C insurance industry
2015	Managing the consequences of macroeconomic and (geo)political risks: what roles for (re)insurers?
2016	Cyber Risk on the rise: from intangible threat to tangible (re)insurance solutions

FIGURE 1: 10 YEARS OF SCOR ANNUAL CONFERENCES AND PUBLICATIONS

THE INSURANCE INDUSTRY'S ABILITY TO LEARN AND ADAPT

Many of the issues highlighted by SCOR over the years are now reappearing in new and different forms, requiring us to learn from the past and adapt for the future.

As an example, we discussed Capital Management in 2014. Today, insurers are still dealing with the requirement to optimize capital and to comply with increasing capital requirements, at a time when reinsurance margins are reducing and (at least in Europe) both regulations and accounting standards are changing dramatically. Will capital management be a game-changer? The market certainly cannot be expected to continue to function as it has in the past. In 2017, the global market responded to the consequences of three major hurricanes and an earthquake in Mexico. Following these catastrophes, the market has sustained significant losses, representing more than one full year of reinsurance premiums for the entire US market, which is worth roughly USD 60 - 65 billion. The US reinsurance market accounts itself for more than 40% of worldwide premiums. How will capital providers react to these losses?

In 2016, cyber risk was our key topic and it remains one of the main challenges for the industry, not only in terms of providing cover and understanding the risk but more importantly in terms of managing the "silent cover" that exists in all businesses.

The reinsurance industry's issues tend to resurface regularly on a 5 to 10 – year cycle. These cycles illustrate the difficulty of our industry in terms of durably implementing solutions that would definitively solve an issue. It is more than ever necessary to form a consensus regarding certain principles for resolving matters as an industry.

PUSHING THE EDGES OF RISK AWARENESS AND INSURANCE

Like the conference in 2017, the main theme of this publication is "Pushing the edges of risk awareness and insurance: the role of the (re)insurance industry to cover risks affecting societies and governments".

This theme is derived from the identification of a challenge in terms of sustainable development, and from our belief that, as a good corporate citizen, SCOR, along with its partners and the entire industry, should develop risk transfer solutions to the world's major problems.

Sustainable development rests on four elements – water, food, health and longevity, infrastructure. Water is indispensable and is necessary to grow food – but populations are expanding, their wealth is increasing, and all the while their expectations are rising in terms of quality of life, quantity of resources, and guarantees of safety. Energy (oil) is no longer the world's only critical natural resource constraint: the world is now facing a water challenge. A water challenge also means a food challenge. These two issues have a direct impact on health and longevity, and are accompanied by a context of increasing global pollution, the development of new diseases, and a higher risk of global spread of these diseases as climates become more suitable for disease-carrying pests.

Water, food, health and longevity are intrinsically linked – not least by climate change. Moreover, a society that is growing and increasing its wealth also experiences higher demand for infrastructure and power. With this demand, it is necessary to address the issue of producing environmentally compliant and resilient infrastructure. Wealthy societies and even some emerging economies also face the problem of decommissioning or upgrading infrastructure that does not meet growing expectations in terms of quality and safety.

In closing, we would like to thank all the speakers, panelists and, of course, our delegates who made last year's SCOR Annual Conference such a success. We are delighted to be able to produce this report of the conference.

WATER: THE BIG PICTURE

RICHARD CONNOR
Senior Water Resources Expert,
United Nations World Water
Assessment Programme

Since 1995, Richard Connor has worked on international projects in the fields of integrated water resources management and climate change adaptation for the North American Commission for Environmental Cooperation, the World Water Council, the Co-operative Programme on Water and Climate and the Government of Japan. Rick previously served as Governor on the Board of the World Water Council and as the Facilitator for the World Water Assessment Programme's Expert Group on Indicators, Monitoring and Databases.

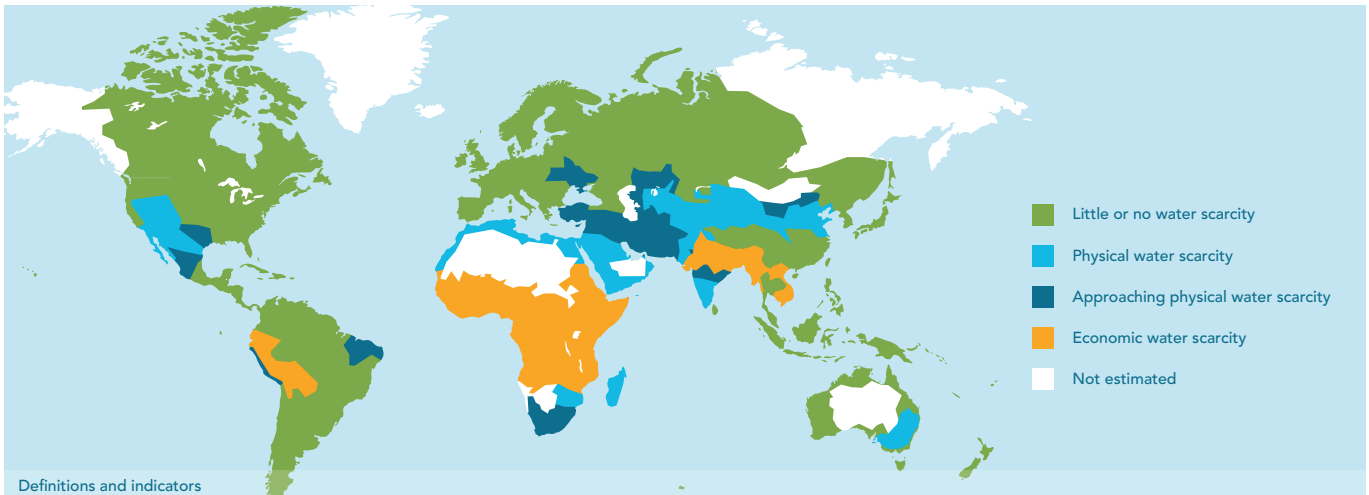
He is currently Editor-in-Chief of the United Nations World Water Development Report, the UN's annual flagship report on water, and remains actively involved in the international water movement.

IS THERE A "GLOBAL WATER CRISIS"?

The notion of a global water crisis is an important question and its existence depends on perspective. There are certainly many local and regional crises that are either related to an excess of water, a shortage of water or the presence of impure water. These crises can be chronic, recurring, seasonal, multi-annual, etc.

WATER SECURITY

The concept of water security is not just a question of water scarcity, but rather of insuring access to adequate quality water, though not necessarily in a physical manner. In fact, most crises are related to the mismanagement of water and the lack of human, institutional and financial capacity to sustainably manage water resources and provide access to safe water supply and sanitation services.



Definitions and indicators
• Little or no water scarcity. Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.
• Physical water scarcity (water resources development is approaching or has exceeded sustainable limits). More than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.
• Approaching physical water scarcity. More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.
• Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.
Source: Comprehensive Assessment of Water Management in Agriculture (2007, map 2.1, p. 63, © IWMI, http://www.iwmi.cgiar.org/).

FIGURE 1: GLOBAL PHYSICAL AND ECONOMIC WATER SCARCITY

Source: Comprehensive Assessment of Water Management in Agriculture (2007, map 2.1, p. 63, © IWMI, http://www.iwmi.cgiar.org/).

The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

UN-Water, 2013

This notion is called economic water scarcity (see Figure 1) and it affects zones where water is available but there is no infrastructure or capacity to bring that resource to the users, whether its use is for irrigation in fields, manufacturers, etc. It is the overall lack of investment in water management that creates this type of water insecurity.

GLOBAL WATER DEMAND

As shown in Figure 2, global water demand is rising. Between now and 2050, the overall global demand for water is expected to increase between 40 and 50%. This increase in demand is due in part to population growth, but more importantly to economic development, industrialisation, improved standards of living and a change in consumption patterns. People are increasingly introducing meat into their diet, and meat has a very high-water footprint.

The sectors set to experience the highest growth rates in water demands, and therefore drive the global increase in demand, are:

- manufacturing, whose demand is expected to grow by 400% between now and 2050;
- thermal electricity (over 90% of all power generation is water-intensive);
- domestic use, as people increasingly gain access to water and sanitation through urbanization.

Geographically, the rise of water demand is uneven. In OECD countries, water demand is not growing and might even diminish in the future. However, it will occur in the rest of the world and particularly the emerging BRICS (Brazil, Russia, India, China & South Africa) economies as their manufacturing and electricity activities are driving the global demand increase. This leads to the concept of virtual water, a term to explain trade for exports and imports of water that has been transformed. For example, the soy production in Brazil is mostly exported to China. However, this export is not only one of soy but also of the water used to grow that soy, because once that water has been used it is no longer available for other uses. This is a way to envision water being extracted from one area and moved to another. The demand for water and water usage in China will increase by 20 to 50% over the next twenty-five years, but China's global impact on water use and demand will, in fact, be larger because of the water-intensive products that they import from other regions of the world.

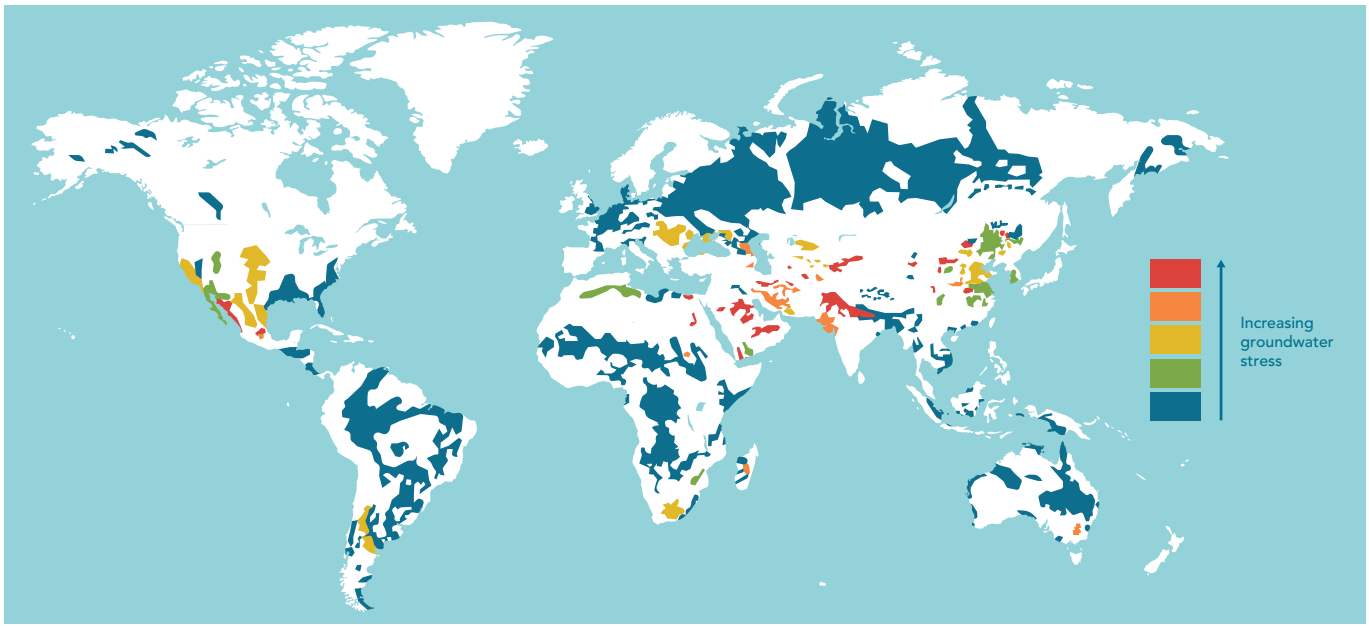


FIGURE 2: WATER STRESS OF AQUIFERS IMPORTANT FOR FARMING

Source: Gleeson, T., Wada, Y., Bierkens, M. F. P. & van Beek, L. P. H. Nature 488, 197–200 (2012).

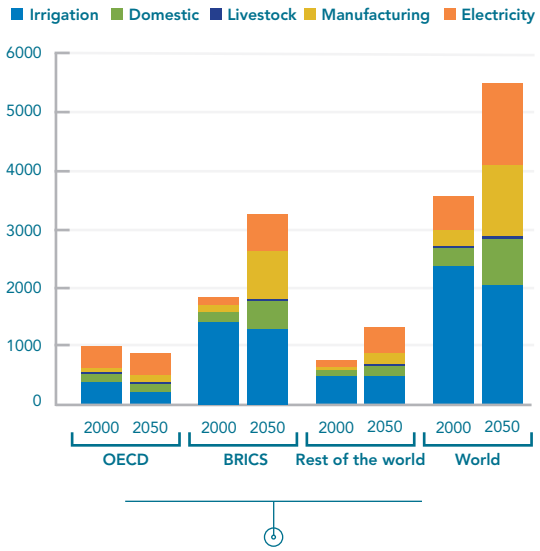


FIGURE 3: GLOBAL WATER DEMAND (FRESHWATER WITHDRAWALS): BASELINE SCENARIO, 2000 AND 2050

Source: OECD 2012: OECD Environmental Outlook to 2050

GLOBAL WARMING & WATER

Dry areas are becoming dryer, wetter regions are getting wetter and the frequency and intensity of extreme weather events is growing as well. However, in terms of actual data, the accuracy of results is lessened as the scale decreases. For instance, with global warming, the extreme events are felt but the gradual increase in temperature every three years is barely noticeable. The same can be said for water: patterns are distinguishable on a global scale, however they are not necessarily apparent at a basin level.

There is a reason why climate scientists look mainly at temperature, as opposed to water: the water system is too complex. Isolating man-made fluctuations from natural ones in temperature may be difficult, it is however utterly impossible to evaluate for water.

WATER RISKS TRANSLATE DIRECTLY TO SOCIAL, ENVIRONMENTAL AND ECONOMIC RISKS

Water is so intrinsically linked to many aspects of life and global economy that its fluctuations and disruptions have social, economic, environmental and socio-economic impacts.

SOCIAL RISKS

In terms of health, currently:

- 2.1 billion people lack access to safely managed drinking water services, or water that is safe and delivered to their homes;
- 4.5 billion people lack safely manageable sanitation services, that is, access to a toilet or means of safe treatment and disposal of excrements;
- nearly 900 million people still practice open defecation;
- over 5 million people die each year from water related diseases, the majority of which are children under 5 years old.

Among these global numbers, there are obviously regional and local hotspots, and without access to water supplies and sanitation services there is an increased vulnerability of populations, rendering them more vulnerable to pandemics. For example, after the 2010 earthquake in Haiti, over 230 thousand people were killed. However, the cholera pandemic that followed, which was directly related to the lack of proper sanitation and water treatment systems that had been completely destroyed and never replaced, killed more people than the actual earthquake.

Equally, current water treatment facilities are generally unable to treat elements such as micro-plastics, pharmaceuticals and other emerging pollutants. For instance, endocrine disruptors and several other compounds found in pharmaceuticals have recently become an issue of concern, because water treatment plants cannot remove them for water and when they appear in reused water, they can have both serious environmental and health impacts.

SOCIO-ECONOMIC RISKS

The United Nations World Water Assessment Program estimated in 2016 that 78% of all jobs are either directly or indirectly water dependent. Those that are directly water-dependent are obvious, for instance if farmers lose access to water, they can no longer grow crops and thus lose their source of income. However, there is a trickle-down effect that makes certain employment opportunities equally vulnerable to water crises. For example, if a local economy is based on agriculture and that sector collapses because of water crises, then the employees of the banking industry in that area are subsequently at risk.

Another important aspect of water in relation to employment is the notion of providing workers with access to safe water supply and sanitation. This access and provision make good business sense, as it leads to a healthier and more productive workforce. A concrete example of this is a case study that the United Nations World Water Assessment Program examined in Bangladesh of a medium sized textile factory, where the majority of employees were women. These women would use cloth cuttings as feminine hygiene products; as a result, these women would contract illness and infections which would prevent them from working. The owners of the factory simply invested in providing each and every one of their female employees with feminine hygiene products. The investment had an initial financial cost but as a result absenteeism dropped and overall productivity increased.

Economic losses due to water related hazards had greatly risen over the past decades: since 1992, floods, droughts and storms have affected 4.2 billion people, or half of the world population, for a total of USD 1.3 trillion in damage. More generally, droughts lead to food insecurity and inflated food prices, which in turn can lead to civil unrest, conflict and mass migrations. Two examples of this:

- In 2009, a major drought occurred in Russia and forest fires crossed large parts of the country. The wheat production collapsed and in order to maintain national food security, grain was not exported that year. This led to inflated food prices in all the areas that typically import Russian wheat, including parts of the Middle East. As a result, in 2010, the price of wheat and the price of bread in Egypt doubled. The initial drought in Russia caused an incredible inflation of Egyptian food prices, which in turn, led, to a non-negligible extent, to civil unrest and the Arab Spring of 2010.
- From 2004 to 2009, Syria suffered from a drought that caused roughly one million people from the rural population to move to the cities. Groundwater was not allocated on the basis of social need, but was the object of political maneuvering. In the midst of other socio-political elements, this situation triggered the current crisis in Syria.

ENVIRONMENTAL RISKS

In the past, ecosystems were viewed as water users; however they are now being recognised as valuable parts of overall water cycle. Beyond simple evaporation, healthy ecosystems maintain soils and healthy soils allow for substantial water retention, which can help maintain agricultural activities during dry periods, and play a critical role in maintaining the hydrological cycle.

For all these reasons, environmental degradation directly affects water quality and availability and polluting water leads to environmental degradation – it is a negative feedback loop.

ECONOMIC RISKS

In addition to the majority of employment, all major economic sectors are water dependent, at least to a certain extent – for example: agriculture accounts for 70% of all water withdrawals on the planet, mainly through irrigation. But, global demand for food is expected to increase by about 60% between now and 2050. Maintaining food security for increasing populations means that increasing amounts of water will become necessary to grow more food or that new ways of producing food with the same amount of water must be developed. Moreover, the over-dependence of agriculture on groundwater has become unsustainable, not only in developing countries. For instance, in the US Midwest and Southwest, the Ogallala aquifer has been substantially depleted. The overexploitation of groundwater is not economically sound: the deeper drilling and pumping occurs, the more energy is necessary to extract water, and that water becomes increasingly expensive.

Energy production accounts for roughly 15% of the global water use – though it is less important than agriculture's demand for water, it remains highly significant. In comparison, manufacturing only accounts for 5% and domestic use accounts for 10% of global water use.

ENERGY, A WATER INTENSIVE PRODUCT & THE NEED FOR SUSTAINABLE DEVELOPMENT

Most forms of energy production, including electricity, are highly water intensive. Between now and 2050, energy demands are expected to increase by 50%.

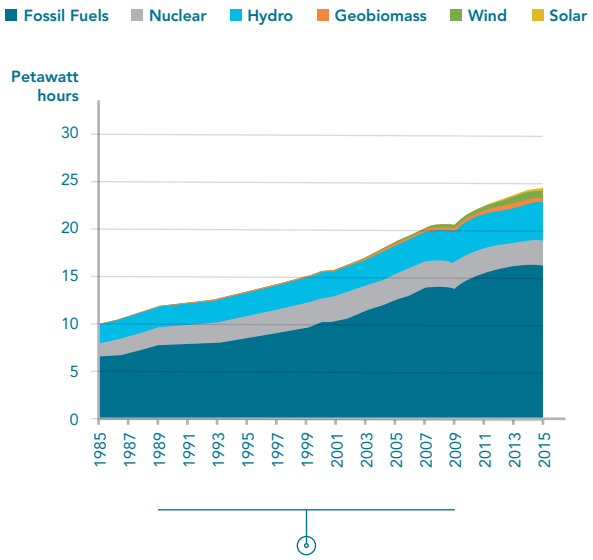


FIGURE 4: WORLD ELECTRICITY GENERATION

Source: World energy consumption based on data from BP 2016 Statistical Review of World Energy.

Some observers believe that the growth in the demand for primary energy will stabilise by 2030 and that the projected growth in energy demand will be met through increased electrification.

As of now, the global power generation mix is still highly concentrated on thermal electric power, whether it is derived from coal, peat, gas, oil or nuclear. These sources account for three quarters of the worldwide energy production and require large amounts of water for cooling.

Currently, 1.3 billion people worldwide lack access to electricity, with 700 million of this population living in Africa. These are often the same populations lacking sanitation and access to clean water. In order to meet the Sustainable Development Goal of access to energy for all, a limited number of options are available and the attractiveness of coal power is still an issue.

For instance, in China, coal plants are still being built, but this is accompanied by an important investment in solar and wind energy solutions. In terms of the Sustainable Development Goal, the first initiative was to double the amount of renewable energy solutions. However, in terms of water this objective is not sufficient – wind and solar energy solutions (which are not water-intensive), account simply for too little a proportion of the global energy mix. Renewable energy will have to be significantly increased (much more that double) if there is to be a noticeable impact on the water footprint for electricity generation.

RECOGNISING WATER AS A DRIVER OF DEVELOPMENT AND GROWTH

Industry's demand for water is expected to grow by 400% by 2030. As industries, cities, power generation and agriculture's demand for water increases, it forces the question of whether or not it is possible to meet that demand and avoid a global water crisis. One manner of achieving this goal is to recognise that water is not a simple resource but a driver of development and growth, and that investing in water resources management, water supplies and sanitation makes good business sense. Water sustains economic productivity and growth, creates employment and improves livelihoods in general. The need for institutional backing has become paramount – governments and businesses have to consider the importance of water in their decision-making processes.

The term "wastewater" is technically an oxymoron, since it is not waste. In other languages this resource is often translated to "used water", which is a more appropriate term for it.

WASTEWATER & THE FOUR Rs

At least 85% of all wastewater produced in the world is released to the environment without any treatment; in many developing countries that number reaches 100%. To solve this global crisis, and transform wastewater from the current burden that it is to a valuable resource, four actions can be implemented - the 4Rs:

- **Reducing:** the global amount of wastewater can be lessened by reducing the amount of water used, by being more efficient with its use or through less polluting practices.
- **Removing & Reusing:** there are different levels of treatment for water and different types of treatment. The goal is to find the best technique to treat wastewater, in the most affordable way. In western countries, there are many large central water treatment systems that are efficient but expensive and space-consuming. However, with only 1% of the water used in home is actually consumed and the rest being used for washing or upkeep, it is not necessary that all water be treated to drinking water quality standard. The term "fit for purpose" needs to be considered, where wastewater would be treated to a level of safety that corresponds to its intended reuse.

FIGURE 5: THE FOUR Rs OF WASTEWATER MANAGEMENT

- **Recovering:** there can be several added values to improving wastewater management. The first is that wastewater can contain nutrients, phosphorus and nitrogen, which can easily be extracted, transformed into pellets and sold or used as fertilizer. The second is sludge, which is rich in organic matter and can easily be converted to biogas, such as methane. Both the nutrients and biogases can be extracted, sold on the market and create a revenue stream back that will help finance the wastewater treatment that will become necessary in the future.

Recovering is not a "pipe dream": the city of Stockholm uses methane extracted by its water treatment plants as fuel for its buses and taxis.

NATURE-BASED SOLUTIONS

Nature-based solutions can be implemented to help achieve the three main water management objectives:

Improving water availability & supply through:

- infiltration (precipitation, surface water) for groundwater recharge,
- soil moisture retention which is key for vegetation,
- moisture recycling.

Improving water quality by:

- preventing water sources from being contaminated in the first place,
- using nature-based solutions to treat/remove contaminants.

Disaster risk reduction by:

- mitigating the impacts of floods and droughts.

Wetlands, and many other ecosystems that are recognised as natural water treatment plants, are capable of cleaning water and could be used to improve water management. However, this is not currently being implemented for a number of reasons. The first is that engineers have not yet determined how these nature-based solutions work and do not trust that it will work in the long term because of a certain lack of data. But the fact remains that adopting nature-based solutions show a huge potential to enhance the performance of human-built infrastructure in a cost-effective manner, thus reducing operational risks to water management systems.

PUBLIC POLICY SOLUTIONS

In terms of improved water management, several public policy solutions could be implemented. One of these is the decentralisation of water management – for the same reason that it is difficult to look at climate change's signature on water, water management needs to be lowered to a community level as much as possible, with national oversight. In essence, encouraging increased public participation and overall acceptance from the local decision-makers of the link between water and socio-economic development. Several concrete examples of this decentralised approach, and of government policy creating an enabling environment for public participation, exist:

- In New York City, a stipend for environmental service has been put in place, where the city and the utility service that provides drinkable water for NY citizens pay land owners in upper basin zones to use sustainable agriculture. This includes maintaining riparian buffers, so that when the water enters the stream it is protected and nitrogen free. By increasing these buffer strips, agricultural land owners are not using the maximum of their arable land, however the utility service compensates them for this loss of income. This also generates a concrete and steady stream of income as opposed to agriculture revenue which is subject to annual fluctuations.
- In South America, farmers located in different upstream locations of a basin work together as part of a basin community organization. They are given a voice in regards to basin related issues, and are also ideally placed to alert authorities of their water utility system in the event of a problem. Peru implemented national legislation with a series of standards and policies to be met in order to facilitate the creation of payment for environmental service schemes.

CONCLUSION

Socio-economic growth is currently limited by water and local water crises. Some relationships between waters and sectors are obvious (agriculture, cities), whereas other are less so (energy, business). However, the underlying point is that perception of water resources management needs to be changed, which can be accomplished through a better understanding of why water must be managed. The co-benefits of improved water management and the notion that there are tradeoffs – that a limited amount of water is available – must be acknowledged.

Summary of the panel discussion on WATER SECURITY AND WATER SUPPLY, IMPACT OF CLIMATE CHANGE AND FUTURE TRENDS, CHALLENGES FOR BOTH CORPORATE AND (RE)INSURANCE COMPANIES

Panel discussion:

FRÉDÉRIC DHERS
SBS Chief Underwriting Officer, Americas, SCOR Global P&C
moderated the panel discussion on "Water security and water supply"

JOHANN CLERE
Strategic Partnerships Director at Veolia, Group expert on water risks & shared value opportunities

PHILIPPE JOUBERT
Founder and CEO, Earth on Board. Former CEO of Alstom Power, expert at the World Energy Council (WEC) based in London, Faculty at Cambridge Institute for Sustainability Leadership (CISL), Senior Advisor Energy and Climate at the World Business Council for Sustainable Development (WBCSD) based in Geneva

INTRODUCTION

In Frédéric Dhers opinion, it is important to remember the words Albert Einstein once said: *"We shall require a substantially new manner of thinking if mankind is to survive."* Though this statement was made in regard to a different period, with its own particular threats, this admonition is more relevant than ever in terms of water. Water is a raw material of high importance, more so than oil, because of its irreplaceable nature – there are no alternatives to water.

The industrial sector is responsible for 15% of global freshwater withdrawals, which is why a water issue impacts directly and significantly global industry. More specifically, a new dynamic and dependency subsists between the energy sector and water.

ASSESSMENT OF ENVIRONMENTAL & WATER TRENDS

THE LIMITS OF THE PROVIDENTIAL SYSTEM

Philippe Joubert states that an incalculable amount of services are provided by nature, annually and free of charge. However, the limit of this providential system has been fast approaching since the 1970s, as mankind has breached the 100% of renewed resources on Earth, as shown in Figure 1.

FIGURE 1: THE BIOCAPACITY CONSUMED

Source: Global Footprint Network - Earth overshoot day

Last year, that number reached 170% - transposed to the business world, it seems as senseless as a company that spends 170% of the revenue it can generate every year. Yet this is what has been done to Earth - certain consequences are currently emerging and have serious financial repercussions:

- the gradual and global increase of temperature creates casualties (fires, droughts, etc.), which in turn causes losses for insurance companies,
- the lack or overabundance of water,
- decrease of biodiversity,
- the progressive redefinition of land as glaciers melt and sea levels rise.

Overall, the consequences of climate change are complex but tangible (as shown in Figure 2) and this phenomenon is considered as number one risk to world peace. "Climate wars" and occurrences of mass exodus are multiplying: natural occurrences such as floods or droughts pave the way for extremism, from which people flee, as they cannot live in their own country, and migrate.

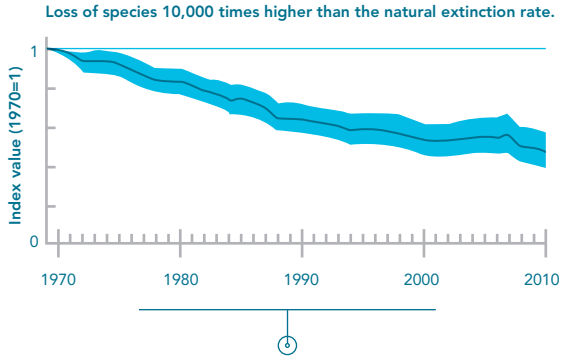


FIGURE 2: LOSS OF SPECIES 10,000 TIMES HIGHER THAN THE NATURAL EXTINCTION RATE

Source: WWF, 2016. Living Planet Report 2016. Risk and resilience in a new era. WWF International, Gland, Switzerland

THE RELATIONSHIP BETWEEN WATER AND ENERGY

According to Philippe Joubert, the subject of an existing relationship between water and energy is relatively new - up until five years ago, this notion was hardly being examined. Water and Energy are a couple that cannot afford to divorce as shown by two following facts:

- 66% of water used for agriculture is obtained through energy-intensive pumping,
- the energy sector withdraws 15% of global water resources each year.

In a nutshell, the two are mutually dependent: without water, there is no power and without power, there is no water.

Another important, though often forgotten notion in Philippe Joubert's opinion, is that mankind has perturbed the hydraulic cycle: 20% of energy originates from water and all energy produced requires water. Bhutan is an emblematic example of this perturbation: the country depends heavily on hydropower built by India. The problem is that the Himalaya is rapidly melting: in order to maintain the safety and the security of the country, construction workers must climb up to 6000 meters and build artificial drains into the natural dams that have taken from, in order to evacuate the excess of water from melted snow. Bhutan is not the only nation concerned by hydraulic perturbation, so are Switzerland and France with the Alps, and some countries of South America with Andes.

EMERGING CORPORATE RISKS IN WATER

WATER RISKS IN THE ENERGY SECTOR

Philippe Joubert states that water risks are already emerging in the energy sector and according to the Global Electricity Initiative, 2014 Report, the CEOs of the main electricity companies in the world are increasingly concerned by two issues:

- **access to land:** the sector is being pushed towards modern technologies that are not all equal in terms of kwh/m² footprint. Additionally, overhead lines are necessary to bring this energy to consumptions centers. Overall, 77% of CEOs indicate that land use will increasingly be a challenge.
- **used water:** as water systems are deteriorating, 63% of CEOs indicate that water requirements will increasingly be a problem.

It is common knowledge in the energy sector that water is necessary to cool down thermal plans, which is why all of them are located near a water source, usually the sea. General opinion describes Fukushima as a nuclear problem, when the disaster was in reality water-related: the backup diesel generators located in the basement were flooded and unable to maintain a proper cooling level, whereas ones on the roof might have prevented that. This is not the only instance of a water-related nuclear incident: in France, during the heatwave of 2003, the rejected water's temperature after cooling down the reactors was exceeding the norms acceptable. This has resulted in a scale back of production of the equivalent of four nuclear plants. This year, in India, a thermal plant was closed not because of lack of coal, but due to lack of water. The protection of coastal power is increasingly becoming a significant challenge, as shown in Figure 3.

FINANCIAL AND LEGAL RISKS

In Philippe Joubert's opinion, the world today is that of an organized society: with every problem comes a new rule. The global stock of climate change legislation has been multiplied by over a factor of 20 in 20 years, as shown in Figure 4. Large corporations with the means to pay for expensive legal council will attempt to go around the rules but it is becoming increasingly difficult to do so. Class actions now cost companies billions of dollars.

However, the risk of infringing upon the rules is no longer solely about money, but reputation - as Warren Buffet said: *"it takes twenty years to build a reputation and five minutes to ruin it"*. In the digital age, that amount of time has been reduced to a single click, which can destroy a company's reputation and value. Therefore, the risk of reputation endangerment is not one that should be taken lightly.

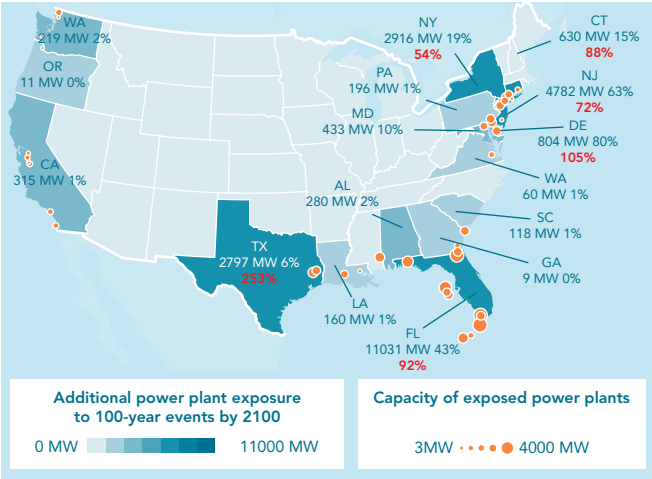


FIGURE 3: SEA LEVEL RISE & POWER PLANTS

Source: "US Power plant sites at risk of future sea-level rise", Bierkandt et al., 2015

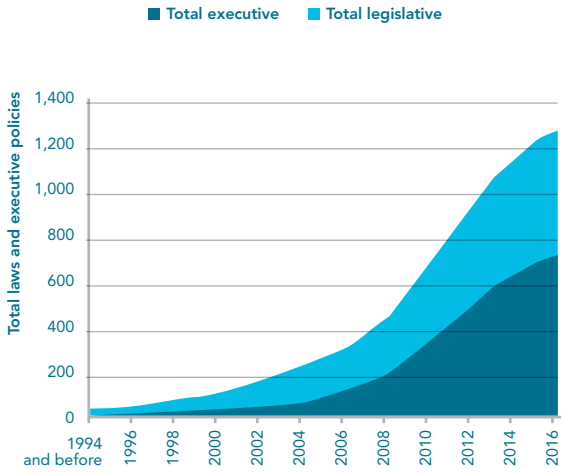


FIGURE 4: TOTAL NUMBER OF CLIMATE CHANGE LEGISLATION

Source: Global trends in climate change legislation and litigation, 2017 update. Grantham Research Institute on Climate Change and the Environment, May 2017.

THE TRANSITION RISK OF STRANDED ASSETS

Moreover, Philippe Joubert observes that on top of those risks exist ones called "transition risks". Some claim that they do not believe in climate change, that they have always done business that way, using water, emitting CO_2 in this manner, and for generations business has done this way - why should they have to change now?

Frédéric Dhers explains that this is how a numerous amount of stranded assets is emerging, and are those that have suffered from unanticipated or premature write-downs, devaluations or conversion in liabilities. In 2012, the IPCC (Intergovernmental Panel on Climate Change), the International Energy Association or the Carbon Tracker Initiation did some research and concluded that 60 to 80% of all stranded assets are companies that have natural resources of fossil fuels (coal, oil and gas). The notion of "unburning the energies that become unburnable" would have massive financial consequences, probably destroying USD 4 trillion of market capitalization and USD 1.3 trillion of corporate debt.

Johann Clere advances the case of Samarco, Brazil as a concrete example of how strong exposure to water risks or poor water management have already materialized in stranded assets. The copper mine of Samarco is a joint venture between VALE and BHP Billiton – the extraction of copper generates copious amounts of waste water, which in this case was stored in a low-cost system which consisted of a pond protected by a single dam. Because of climate change, heavy rains and Samarco's low cost water management practices, the mine's dam collapsed.

This caused numerous deaths in the villages nearby the plant and had a strong impact on the local biodiversity.

The economic repercussions were significant for the company: local fines and sanctions were imposed, the share price rapidly decreased (as shown in figure 5) and finally Moody's downgraded the asset of Samarco in Brazil after the collapse of the dam.

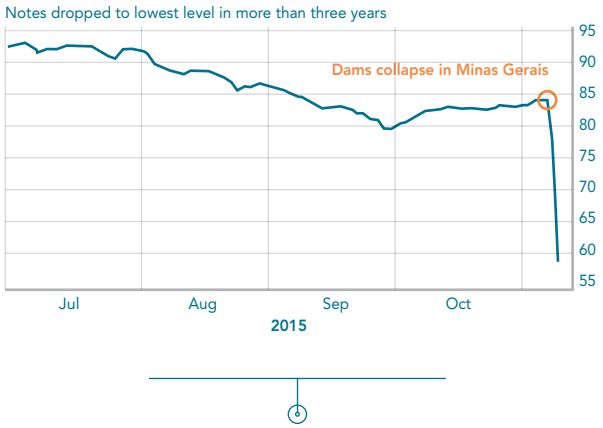


FIGURE 5: SAMARCO BONDS SLUMP AFTER DISASTER

Source: Bloomberg

COMPANIES DRIVEN TO INCREASE RESILIENCE & ROBUSTNESS

According to Johann Clere, the three major credit rating agencies - Fitch, Standard and Poor's, and Moody's - have all begun to incorporate water into their assessment and ratings. It should be noted that carbon emissions was the former focus in terms of new environmental considerations. With these agencies taking the lead, this should drive companies to become more resilient, more robust, in an attempt to increase their competitive advantage and master their cost of capital.

THE GENERAL ACCEPTANCE OF THE NEED FOR CHANGE

CHANGE IS DETERMINED BY DEMAND

Philippe Joubert observes that 2015 was a turning point, with the Paris Agreement successful in creating the conditions to limit the increase of temperatures and its consequences on climate. The 196 parties present agreed to limit global warming to 2°C and to attain a neutral carbon footprint between 2050 and 2100. Net-zero emission is not an empty promise, it will be done, and it is currently being carried out in certain economic sectors, changing the way business is done.

Businesses are taking the lead - not because of an altruistic desire but because it is the only way to do business nowadays. The RE 100, a congregation of several multi-national companies such as Google, Microsoft, Coca-Cola or Procter & Gamble, decided that they wanted to achieve 100% renewable electricity. This movement was initially met with a certain level of disbelief and resistance from the energy sector, which is still dependent on coal and gas. As a result, some companies opted to self-produce their electricity.

THE IMPACT ON BUSINESS MODELS IN VALUATION

According to Philippe Joubert, a new business model is emerging. Companies must now understand that in terms of risk, of opportunity, of allocation of resources, nature is no longer free and unlimited. This is not only true in the case of water, it can equally be applied to ecosystems, biodiversity, CO_2 emissions into the atmosphere, Sulphur, etc.

The companies who do not accept these changes and fail to incorporate them into their business model would have difficulties to survive the next twenty years.

Boards have the duty to take the lead in this regard. In the past, the financial market has been able to alter the definition of a board of director and deviate their responsibility solely towards the interest of shareholders. However, boards were never constituted for this purpose, instead they have the responsibility of acting in the interest of the company. Currently, the interest of companies is to comply with this new business model, to analyze the real risks and opportunities, and only then to generate profit.

Following the Paris Agreements of 2015, the G20 issued several norms for ratings agencies and regulators in general. However, the major change brought on by the agreements concerns the due diligence and the reasonable care which now concerns the board of directors. 2015 signed the end of "I did not know" claims. It has become impossible to be a board member and admit that you are not taking into consideration climate risk or ecosystems risk – any board member that does so could be liable for negligence.

TECHNOLOGY AND INITIATIVES FOR CHANGE

Johann Clere explains that since water does not disappear, but it is displaced or polluted, it is in fact very challenging to mitigate water risks.

The potential solution is to increase resilience or robustness. There are many different risks, however technologies exist to tackle the most pressing challenges:

- Jerry Linenger, a NASA astronaut, spent five months in the MIR space station, during which he drank "repurposed" water.
- In the face of water scarcity & license to operate issues Nestlé developed a water neutral plant in Mexico, which produces baby powder and reinjects the water extracted from the milk back into the plant.
- After Hurricane Irma, desalination units were sent to the casualty zones. These units are a small process and consist of a container which produces drinking water from sea water.

The technologies exist, the challenge is that people do not yet fully comprehend water externalities, and focus on the probability of a risk occurring rather than producing resilience and robustness solutions. It is important for decision makers, insurance companies, industrial companies and cities to understand the true cost of water as a whole, beyond the simple cost of fresh water or of water infrastructure.

There is a tremendous opportunity to unleash innovative insurance shared value models leveraging water resilience.

CONCLUSION

Philippe Joubert states that "Business as usual" is dead, nature is no longer free or unlimited and society must take that into consideration. From an insurance point of view, there are two things that could change and that should be considered. First, extreme weather events are becoming more frequent and foreseeable and therefore no longer "acts of god", and that the human responsibility at their roots might make them "acts of man", which could have grave consequences in contractual relationship that exists in insurance. Second, that the past is no longer an adequate source of information for the future. Mankind has disrupted the system and it is fundamental that businesses consider the new behaviors and consciousness that have emerged from rapid changes and a fragile system.

AGRICULTURE/FOOD (RE)INSURANCE SOLUTIONS USING APPLIED SCIENCE AND NEW TECHNOLOGY

RENE KUNZ
Chief Underwriting Officer
Agriculture, SCOR Global P&C

Rene Kunz has a professional background in banking, finance and reinsurance. Before joining SCOR in 2006, Mr. Kunz worked as Deputy Head of Agriculture for GE Insurance Solutions where he was responsible for Strategy, Planning and Finance of the Agriculture Underwriting Unit. Prior to that, he held various underwriting positions at Winterthur Re with special focus on Credit and Surety, Securitization, Mortgage Insurance, Financial Guarantee and SRT.
He joined the Reinsurance Industry in 1991, coming from the banking industry, where he held various positions in Commercial Banking, Project Finance and Rural Finance.

Agriculture is currently using up to 70% of the global fresh water – as a result, the sector has contributed to the development and implementation of various technologies that optimize the use of water in agriculture. However, the challenge of population growth remains serious, as agricultural output should grow by 50 to 70% once the planet has reached a gross population of 9 to 10 billion people. Overall, it is inevitable that the absolute amounts of water consumption should continue to grow in agriculture whilst access to sufficient and clean water becomes more and more challenging.

The next decades will bring forth significant structural changes, water will have its cost and it will require substantial investments on the agriculture production industry's part to overcome future challenges. One foreseeable consequence being higher costs for agricultural goods.

AGRICULTURE PRODUCTION CHALLENGES

Generally speaking, water is not a farmer's only daily concern: there are major production risks due to weather events and climate change. Agriculture is an open-roof industry and a large part of the production remains rain-fed. Irrigation systems will help to optimize the usage of water, however, they will have its costs. In addition, the Farmers are confronted with mortality risks on the livestock side and market/price risks:

- **Weather risks:** the first line of defense is the farmer or the producer. If he is applying proper farm risk management practices and remains up to date with the latest developments and technology, a substantial amount of risks can be managed on site. There are standard farm production practices to mitigate risk: analyzing the weather, field rotations, seeds, fertilizers, controlling input, sprinklers for frost, protecting against hail with nets, maintaining high sanitary standards and closed production cycles in the livestock production, etc.
- **Mortality risks:** mortality incidents are easy to cover; however, disease is a trickier issue as it requires the farmer or producer to meet specific sanitary demands such as quarantine protocols or decontamination stations. Epidemics can quickly become a major issue – for example, the avian influenza caused many European poultry producers to go out of business or to be confronted with grave risks. In addition, consumer perception and regulation frame of given countries will influence risk characteristics.
- **Market risks:** globalization opened new markets for farm products but it is equally having an impact on price volatility and fluctuation. This is probably the most imminent challenge for farmers. In addition, potential renegotiation of trade agreements represents a risk for farmers, as political decisions can create uncertainty regarding future investments.

GROWTH POTENTIAL AND SUBSEQUENT EMERGING RISKS IN AGRICULTURE

Overall, agriculture's future seems to look bright. There is only potential for growth, due to the following factors:

- the anticipated growth of world population;
- the globalization of markets in combination with improved income in emerging markets;
- the development of sophisticated farm practices;
- the increase of government investment due to the acknowledgement of agriculture's strategic importance.

However, this potential growth is accompanied by several problems:

- **Access to water:** will there be enough water of sufficient quality to manage this growth?
- **Desertification/urbanization** and the loss of arable land becoming even more serious with the potential rise of sea levels.
- **Availability of fertilizer and use of pesticides:** use of fertilizer and pesticides is necessary to increase output and protect the crop during the growth phase. Phosphate is mainly used in the production of fertilizer. As there are no known significant substitutes or alternatives to the application of phosphate, production costs are a very sensitive factor driving fertilizer prices and demand for fertilizer at affordable costs may exceed supply one day.Pesticides go into the ground and into the product, which in various cases already showed a serious impact on health and the environment, resistances and mutations not being sufficiently understood so far. The challenge in this case is to continue to boost production, while meeting qualitative and health expectations of consumers, the market and decision-makers at affordable costs.
- **Cyber-risk:** modern technology contributes more precise applications and hence to the increase of output – farmers are using satellites and drones. In the case of a French farmer with close to 100 hectares of production, through the use of drones and analytical tools obtained through one of his machinery providers, the quantity of fertilizer and pesticides used could be reduced by 15 to 20%. Technology can improve efficiency, however with computers and especially big data, there is always the challenge of cyber-risk.
- **Political stability:** this will most likely be a constant issue, as governments have varying priorities.

THE ROLE OF INSURANCE & REINSURANCE IN AGRICULTURE

Many risks cannot be controlled, such as severe hail, drought, flood: this is the purpose of insurance companies, covering risks outside of the farmer's control. We differentiate by non-systemic and systemic risks. Non-systemic risks are local, often frequent and non-severe events. Systemic risks on the other hand, for example a nation-wide drought such as the one that occurred in 2012 in the US, cannot solely be financed by the insurance industry at reasonable prices - they require the support of governments, whether this support is in the form of CAT-relief payments or a stop-loss coverage to the insurance programs or premium subsidies.

Along with the farmer, insurers and reinsurers are the ultimate risk-takers. In the event of a problem, the insurer issues the check, which hopefully will enable the farmer to surpass the hardship encountered and be ready for the next season's production.

This requires insurers and reinsurers to master the developments of technology, the development of farm practices and to fully comprehend the farmer's needs. Ultimately, the (re)insurers offer products that will protect the farmer's income and facilitate the repayment of his bank debt or investment into future production.

FOCUS ON CROP SHORT FALL RISK

As shown in Figure 1, several populations are exposed to crop shortfall risk. When observing the production chain, traditionally farmers and livestock producers are the ones who are insured.

However, if the entire process and production chain are considered, it is visible that every company involved is exposed to crop shortfall risk

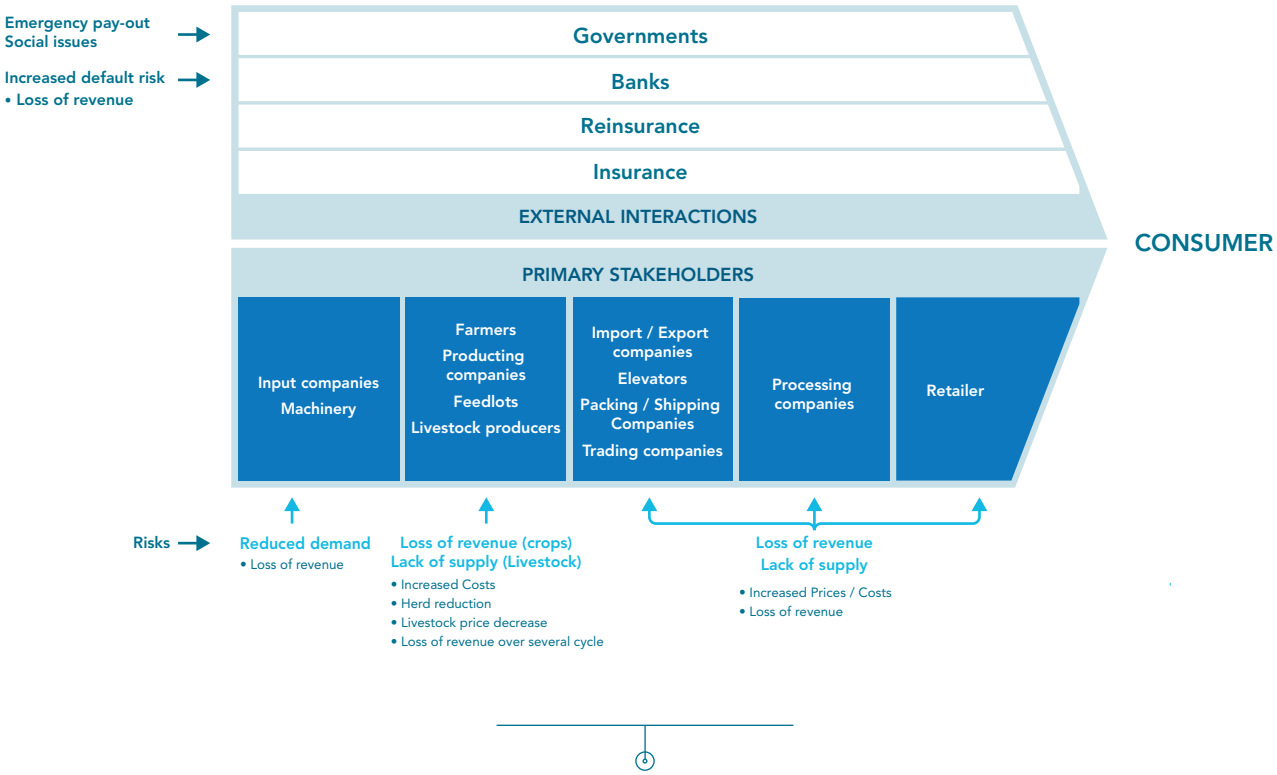


FIGURE 1: WHO IS EXPOSED TO SHORTFALL RISK?

Source: SCOR

REQUIREMENTS FOR NEW SOLUTIONS

To develop solutions for farmers, food processors or risk aggregators, insurers need to be able to underwrite and manage risks in a fast, accurate and cost-efficient way. The key challenges to develop appropriate solutions are often:

- **lack of access to historical data:** the data is not available or was not collected in a consistent manner, the data can be subject to confidentiality or data protection laws. In the past, the main problem was big data volume – 24h of global weather data represents 10Gb of data. Today, the computing power necessary to model this data is available and affordable,
- **lack of infrastructure** (underwriting, sales, risk management, loss adjustment),
- **costs and time** to set up an underwriting and loss adjustment infrastructure.

By making use of today's available technology (illustrated in Figure 2), the industry is in the process of collecting, analyzing and modelling the potential impact of in season events (rain, heat, freeze, etc.) on a actual or past crop production.

The output can then be used to build a tailor-made index or model for structuring new insurance solutions / products.

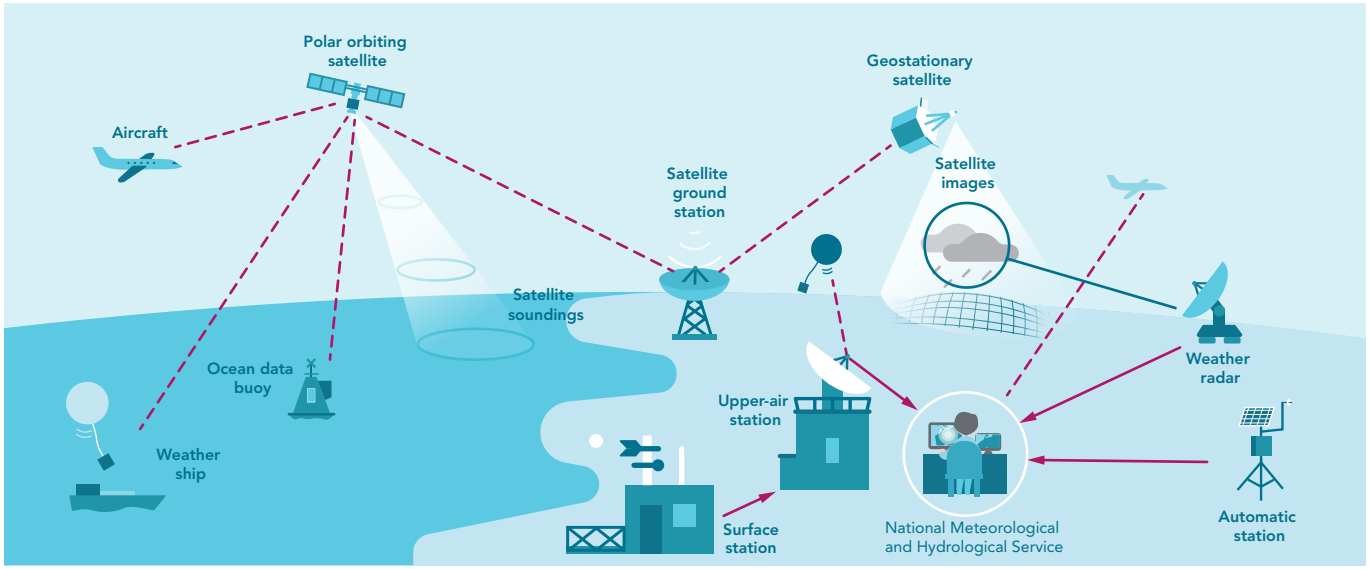


FIGURE 2: A GLOBAL OBSERVING SYSTEM

Source: "A global observing system". Inness and Dorling, 2013

WEATHER BASED INDEX

This index, illustrated in Figure 3, is used in cases where one single peril during a defined time period is the clear loss driver. Though it has been mainly replaced by Area Yield based indexes, the weather based index may still be ideal for countries which suffer from lack of infrastructure and physical loss adjustment and yield statistics.

The largest producer of hazelnuts, which is currently Turkey, produces roughly 70-75% of the global hazelnut supply. A significant shortfall caused by poor weather will force processing companies to seek out different producers.

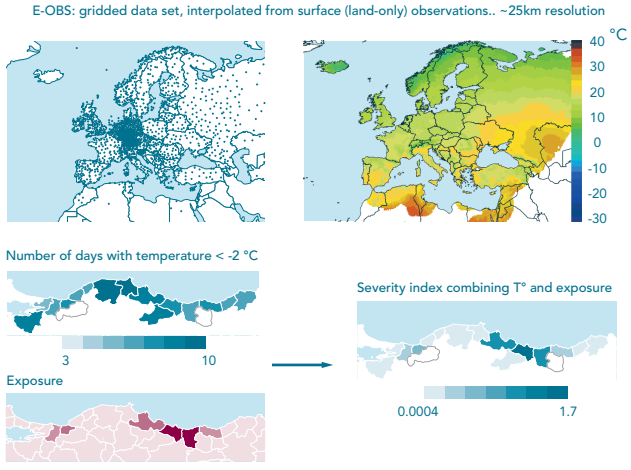


FIGURE 3: WEATHER BASED INDEX - FROST ON HAZELNUTS

Upon realizing that Turkey's supply would be feeble, the remaining markets consequently would raise their prices. A weather-based index could protect the insured from the financial impact of increased prices due to a production shortfall. To build this index, first, weather data of the area where the hazelnuts are produced is collected, then it is modelled and analyzed.

The analysis in this case demonstrated that there is a critical point in time, a phase in April, where if the temperature is below -2°C for a consecutive number of days, then there is an important loss of hazelnut production. Secondly, the exposure of area must be defined; the behavior of weather and its impact on hazelnut production must be modelled. In this case, the origin of the data used was weather stations and radar. Based on historical data, the model was successful in obtaining an 85-90% correlation rate between actual production shortfall and weather data. The advantage of the use an index in this particular case is principally the straightforward and timely pay-out: if during the critical phase there is a frost, the client receives a pay-out to cover increased costs.

ADVANTAGES	CHALLENGES
Straightforward	Does not work in cases of multiple loss drivers
Timely Pay-out	Cover only a pre-define time exposure, some event might not be covered by the Index (season delayed…)
Data availability to build the index	Basis risk: the client believes he deserves a payout, does not receive it, and will choose to not buy insurance again

AREA YIELD BASED INDEX

This particular index is based on historical yields data for large areas, such as is shown in Figure 4.

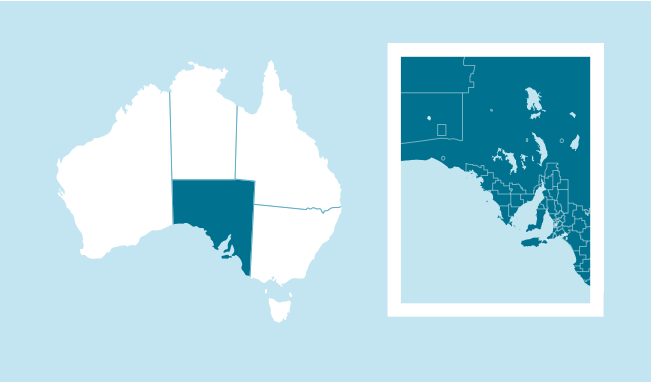


FIGURE 4: AREA YIELD BASED INDEX

By comparing the yield of the current year to historical data, pay-outs are made should the former be inferior to the latter. The area yield based index can only be used for extensive areas, as in smaller areas the moral hazard and farm management risk come into play.

ADVANTAGES	CHALLENGES
Cover the whole season	Data availability & reliability
Cover all perils	Delayed pay-out
Straight forward	Data trend (technology trend, farm practices...)

CROP MODEL BASED INDEX

The crop model based index relies on a model that simulates the actual growth of a plant in order to produce a yield estimation for a specific crop type, as illustrated in Figure 5. Based on the modelled yield data, a yield trigger is defined. In case the yield of a current year is below the trigger, a pay-out is then made.

ADVANTAGES	CHALLENGES
Cover the whole season	Technicality and acceptance
Multi-peril approach	Quality of the weather data input
On time pay-out	
Independent source	
Applicable when yield data are missing	
Yield estimation based on today's technology	

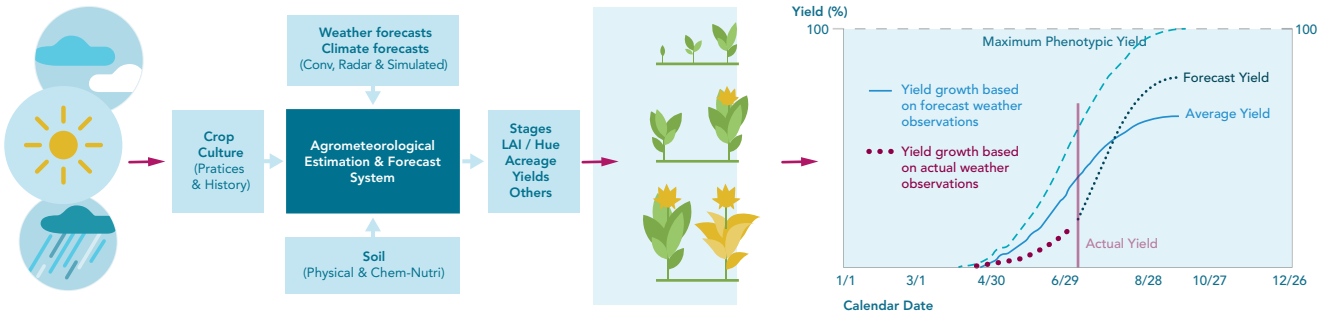


FIGURE 5: CROP MODEL BASED INDEX

Source: Zedx Inc

COMBINED YIELD AND CROP MODEL BASED INDEX

This index combines the two previous indexes with a cover based on the yield index and an advance pay-out based on crop model estimations, both illustrated in figure 6A-6B.

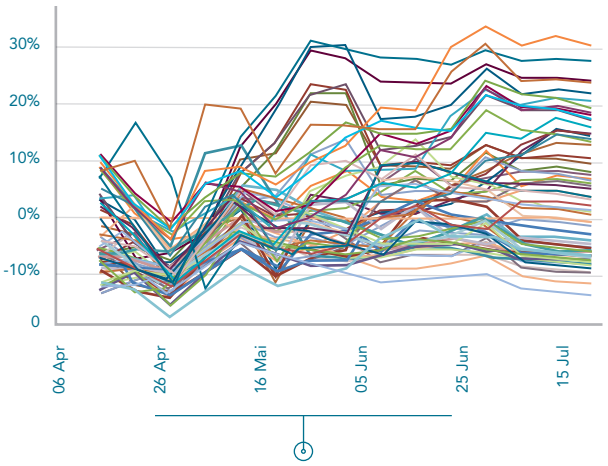


FIGURE 6A: ESTIMATED YIELD DEVELOPMENT FROM APRIL TO AUGUST 2016 COMPARED TO THE MEAN

Source: SCOR

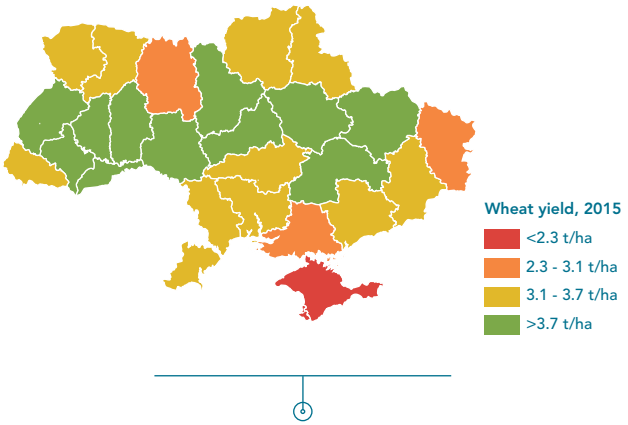


FIGURE 6B: FINAL YIELD NATIONAL STATISTICS COMPARED TO THE MEAN

Source: SCOR

SATELLITE BASED INDEX - PASTURE INSURANCE

Pasture insurance was developed by Airbus D&S, alongside a French insurance company which had developed a potential index for the measurement of grass mass or quality by satellite: the company was capable of capturing the annual profile of vegetation growth for one grid cell using Biophysical Parameters Technology, illustrated in Figure 7.

ADVANTAGES	CHALLENGES
Cover the whole season	Quality of the weather data input
Multi-peril approach	Quality of national statistics
On time preliminary pay-out	
Independent source	

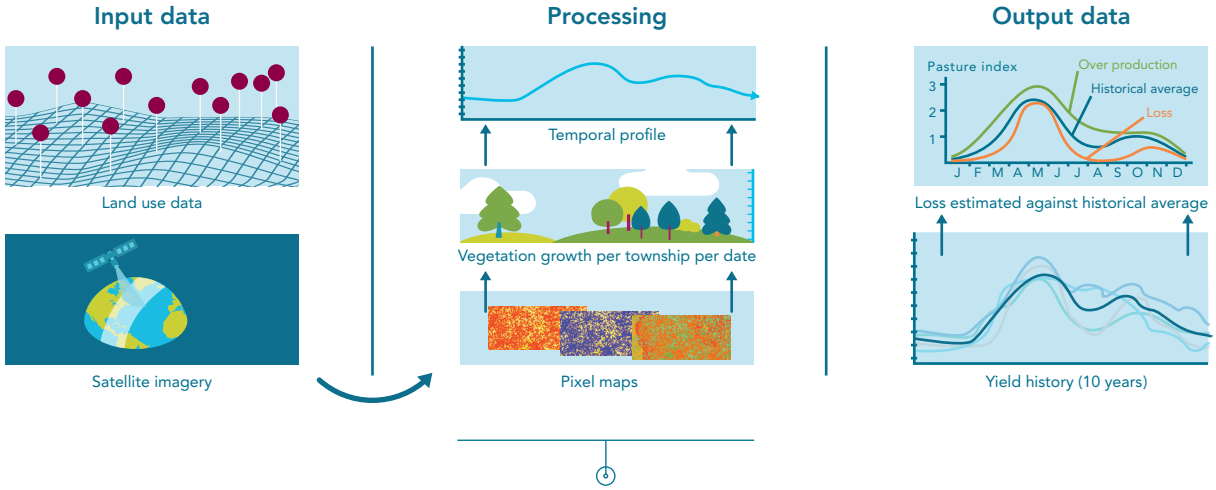


FIGURE 7: ANNUAL PROFILE VEGETATION GROWTH THROUGH BIOPHYSICAL PARAMETERS TECHNOLOGY

Source: Airbus

Grass land is relatively easy to measure, once elements such as clouds, rainfall and atmospheric disturbances have been filtered out of the picture. The technology developed by Airbus consists of satellite pictures taken every two days, which they overlay and filter out any disrupters until a single, full picture is produced. From this picture, the index is modelled and the final pasture indicator corresponds to the relative value of an annual production compared to the historical production. In case the yield of the current year is below the trigger, a pay-out is made.

ADVANTAGES	CHALLENGES
Traditional solutions are not suitable for Pasture	Technicality and acceptance
Multi-peril approach	
Adaptable to customer needs	
On time pay-out	
15 years of historical data	

CONCLUSION - SCOR'S MOTIVATION

It is SCOR's ambition to be a competent partner for our clients, especially when it comes to the application of innovative technology and products. This requires an understanding of the potential use of modern technology, its limitations and the ability to select the most appropriate tool for a specific transaction (i.e. tailor-made solutions).

To achieve this target, SCOR has:

- implemented a dedicated modelling team to support the underwriting and risk analysis,
- entered co-operations with crop modelling companies, weather stations and satellite imaging providers,
- established relations with universities and research entities, as well as with production associations and governments.

In addition to providing services to the market, the access to - and ability to make use - of weather-related information will further improve SCOR's view of various risks, including the qualitative estimation of hazard, the estimation of return period of extreme events, the PML estimates and the monitoring of current conditions.

LONGEVITY: RECENT TRENDS AND THE ROLE FOR (RE)INSURERS TO MEET THE CHALLENGES

DARIA OSSIPOVA
Head of Health and Longevity R&D
SCOR Global Life

Daria Ossipova is Head of Health and Longevity R&D at SCOR and leads five centers of excellence situated around the globe: Longevity (Paris), Health (Cologne), Critical Illness (Singapore), Long Term Care (Paris) and Disability, Unemployment and Special Risks (Paris). She joined SCOR in 2002 and since then has built a strong multi-cultural and cross-functional team of specialists: demographers, mathematicians, epidemiologists and statisticians, who provide their expertise and modelling capacities to the insurance industry to optimize profitability, expand insurance coverage and provide new solutions adapted to protection and prevention needs.

Daria's teams conduct research projects, assist local entities with product development, establish scientific partnerships with academics and contribute to the risk management policy as well as capital modelling. She holds a Master's degree in Mathematics with honors from St Petersburg State University and a PhD (with distinction) in Mathematics from Hull University in UK and subsequently completed a post-doctorate fellowship at the French National Scientific Research Centre (CNRS). Daria then chose to go into applied research, gradually taking the lead role at SCOR in the successful combination of research and its practical applications.

INCREASING LIFE EXPECTANCY

AN AGEING POPULATION

One of the challenges our society faces today that clearly demonstrates another evidence of technological development and human progress is the ageing population.

This phenomenon can be accurately illustrated by the age pyramids, featured in Figure 1. The pyramids are read as follows: each pyramid represents an area.

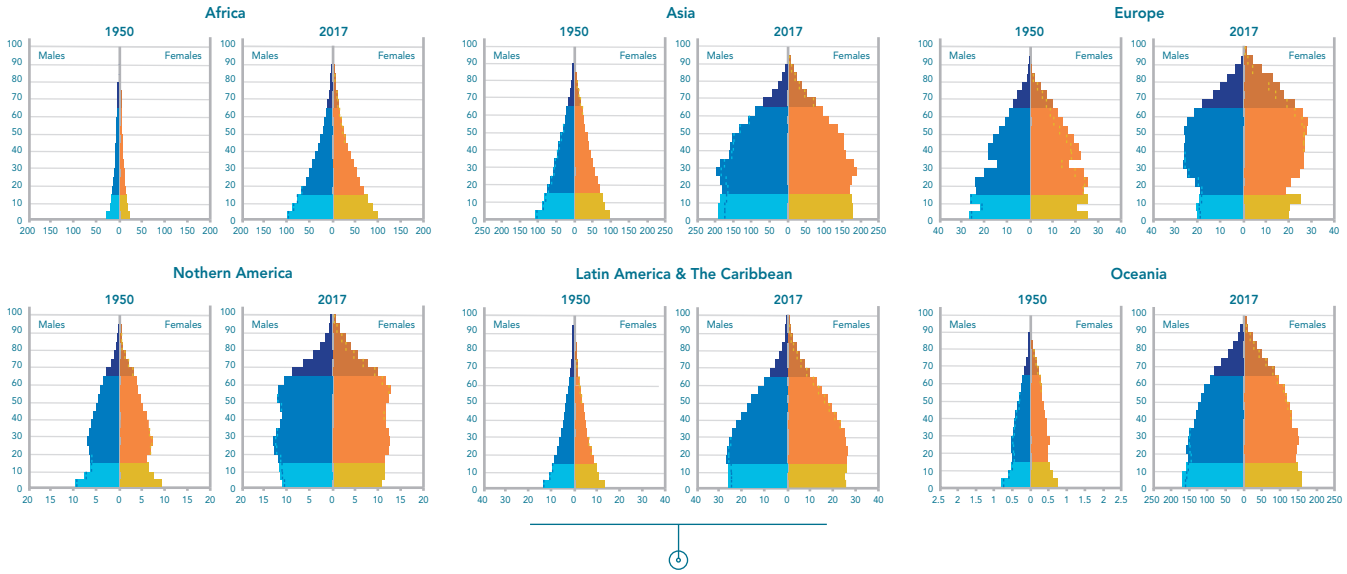


FIGURE 1: WORLD POPULATION PROSPECTS 1950-2017

Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision.

The base of the pyramid corresponds to the number of births in a specific year, and each layer of the pyramid represents the number of people of a given age living on the continent, with the top of the pyramid representing the number of the oldest living members of society. Males are represented on the left of the pyramid, and females on the right.

Over the years, these pyramids, with the exception of the African one, have undergone significant changes: they have become narrower and taller due to decreased child mortality, lower birth rate and increasing life durations. The world population is ageing – and to support the pensions of the older generations, there are less and less young people of the working age.

To ensure pension payments to all populations reaching retirement age, pension providers must have an accurate estimation of the average life duration. However, this is not an easy task as illustrated in the graph featured in Figure 2. It depicts the world highest life expectancy observed each year; the record was held by different countries through time.

Historically, numerous experts assumed there was a limit to the human life expectancy (represented by horizontal lines); for example, Louis Dublin, an American demographer, assumed in 1930 that life expectancy could not be greater than 65 years. He did not know that at the moment he published his article, life expectancy in New Zealand had already reached 67 years! Over the past 150 years, life expectancy has increased by one trimester every year on average. Over the years, the methods used to forecast life expectancy have become more and more sophisticated, and the short-term prediction errors have become smaller, but a real uncertainty on the future trends still exists: is there a biological limit to our life durations? Will lifespans shorten due to emerging risks such as pollution or lack of water?

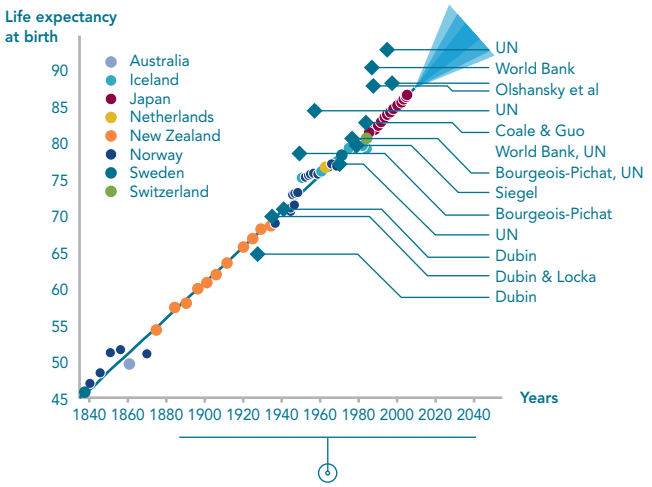


FIGURE 2: LIFE EXPECTANCY AT BIRTH KEEPS GROWING

Source: OEPPEN.J and W.VAUPEL.J. Broken limits to life expectancy. www.sciencemag.org, 296, May 2002

ACCURATELY EVALUATING LONGEVITY RISK

As mentioned earlier, longevity forecasting methods have evolved. It is necessary to combine both quantitative and qualitative analysis to evaluate longevity risk. On one side, quantitative analysis using advanced statistical tools and sophisticated modelling techniques allow us to detect signals in the data, and to estimate the numerical impact of our assumptions. And, on the other side, deep qualitative analysis helps us to understand and interpret these signals; this requires a close collaboration with medical doctors, demographers, epidemiologists, a constant follow up of medical developments, behavioral and lifestyle changes. Both parts of this investigation are iterative and complementary.

CHALLENGES FOR THE (RE)INSURANCE INDUSTRY

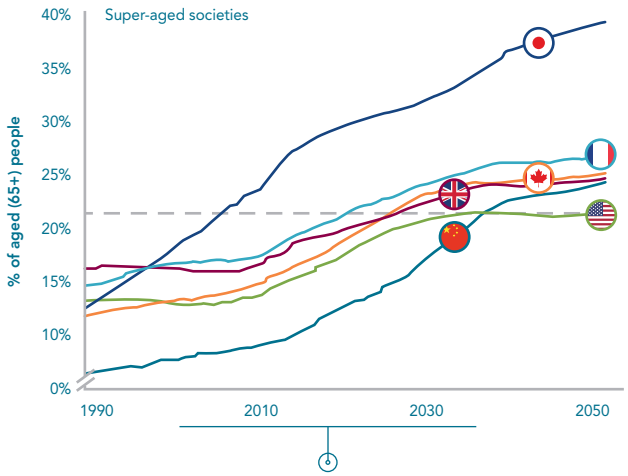


FIGURE 3: AGEING POPULATION IN OECD

Source: OECD data 2016

REDEFINING RETIREMENT?

Life expectancy is undeniably increasing. As shown in Figure 3, the segment of age 65+ people people has grown significantly. The health of this population has never been better; however, the conventional retirement age has barely changed in the last century. For instance, Otto von Bismarck introduced the first official pension in the 1880s and it was fixed at age 70, though later reduced to age 65. At that time, however, the average life expectancy was only 47 years.

As of today, nearly 90% of people survive to the age of 65 in pretty good health and the widespread belief of three stage life circles (shown in Figure 4) is changing.

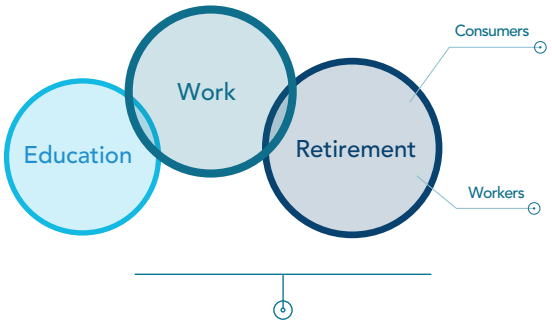


FIGURE 4: STAGE LIFE CIRCLES

Source: SCOR

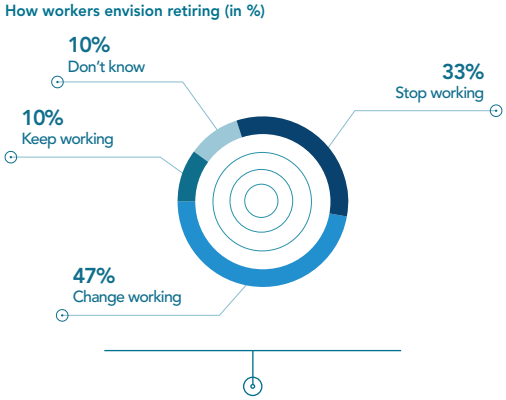


FIGURE 5: HOW WORKERS ENVISION RETIRING (IN %)

Source: The Aegon Retirement Readiness Survey 2017

Studies, as illustrated by Figures 5 & 6, show that a majority of the retirement-aged population do not intend to stop working. They continue to work part-time or even full-time, and some create new businesses.

FIGURE 6: "OLDERPRENEURS" ON THE RISE

Source: Global Entrepreneurship Monitor

THE BALANCE BETWEEN PUBLIC AND PRIVATE WELFARE

Increasing longevity for age 65+ people is a relatively recent phenomenon as past life expectancy had been increasing due to the mortality decrease of younger people. It was only after the 1970s that the cardiovascular revolution and the significant mortality decrease of the age 65+ population was observed. Longevity had been generally underestimated by governments and private pension schemes, which tended to make generous promises in terms of benefits and pension guarantees, but are now struggling to meet these promises. This creates an inter-generational burden, with younger generations that have to pay the pensions of current pensioners, the wealthiest of any prior or future generations.

Public pensions are still the main source of income for the age 65+ populations of OECD countries, as shown in Figure 7; however, the proportion of this source of income varies between countries.

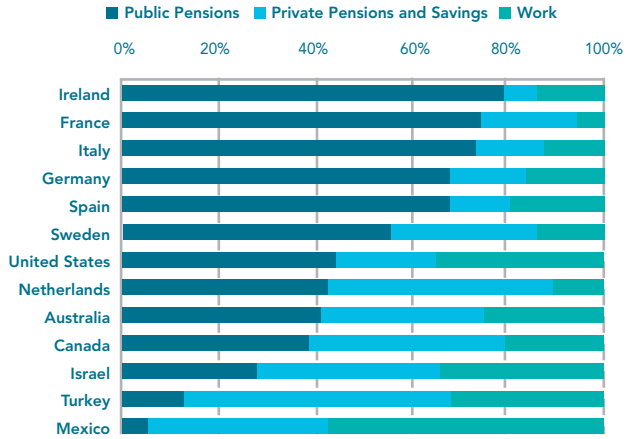


FIGURE 7: SOURCES OF INCOME FOR OVER-65s

Source: OECD

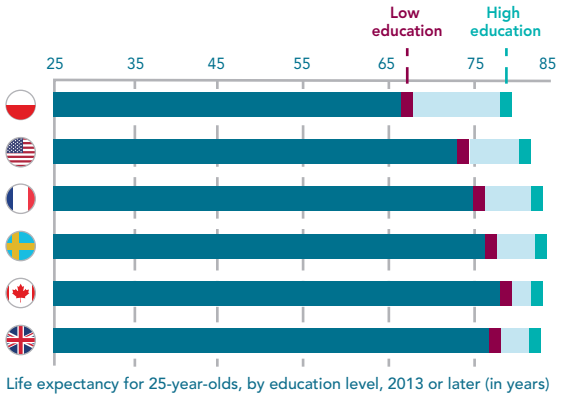


FIGURE 8: LIFE EXPECTANCY FOR 25-YEAR-OLDS, BY EDUCATION LEVEL

Source: OECD

ADDRESSING THE LONGEVITY CHALLENGE

There are many measures that governments can implement to address the challenge:

Encouraging flexible retirement age:

- 1998, Spain: Ford introduced the possibility to progressively reduce working hours for blue-collar workers before early retirement at 58.
- 2001, Sweden: official retirement age is 65, but one can continue after to work to increase its pension. There are still countries, however, where one cannot work after the legal retirement age.
- 2011, Cambridgeshire County Council (UK): eligible employees can request a permanent reduction in working hours or a transition to a role with downgraded duties and responsibilities.

Promoting professional re-qualification or re-orientation:

- Technology will continue to help reduce the manual intensity of some jobs, allowing employees to work till they are older.
- Some companies value a generational mix as they consider it to be a good balance for productivity, through the speed provided by younger workers, and experience provided by older generations.

Providing universal health care and low-cost high-quality education for all:

- these measures address the issue of inequalities in lifespan. As demonstrated in Figure 8, there are significant differences between the life expectancy for people with lower level education and that of higher level education. In countries that value this universal access to healthcare, such as Australia, New Zealand or Canada, this difference is very much reduced.

THE (RE)INSURANCE INDUSTRY: EXTENDING EXISTING PRODUCTS & PROVIDING NEW SERVICES TO HIGHER AGE POPULATIONS

This change in profile of age 65+ population will require the (re)insurance industry to rethink its product offering, so that it can accompany this generation in their extended active lives. Potential measures include extending to higher age groups:

- critical Illness insurance
- mortgages
- disability insurance
- Long Term Care insurance

Technology will equally help reshape (re)insurance products. Insurance contracts could provide additional services that would change the life of the insured and assist in preventing health risks:

- Critical illness prevention (heart rate problems, sugar levels, etc.)
- Old age dependency prevention through the means of sensors that would track feeding or bathing and devices that would encourage keeping contacts with family and friends.

CHALLENGES SEEN AS OPPORTUNITIES

While challenges will continue to affect both public and private sectors as the ageing populations grow, these always accompany the rise of opportunities. With long-term care provisions and/or a generous public pension system being subject to changing government policy, it is essential for the (re)insurance industry to help citizens well understand their protection needs and the many benefits that insurance products offer. Ongoing public awareness campaigns, online educational tools, greater consumer engagement at key touchpoints and other measures can help the prevailing understanding and protection gap diminish over time, leading to positive changes in today's society.

RISK AND RESILIENCE OF INFRASTRUCTURES: HOW THE SMART TECHNOLOGIES CAN IMPROVE THE RISK MANAGEMENT

DR JENNIFER SCHOOLING
Director, Centre for Smart Infrastructure and Construction, University of Cambridge

Dr Jennifer Schooling is Director of the Centre for Smart Infrastructure and Construction (CSIC), at the University of Cambridge. CSIC brings together world-class engineering research, academic excellence and commercial industry to support the UK in becoming a world leader in the fields of sensing technology, asset management and smart city development.

Jennifer and her team work with more than 40 partners from across the infrastructure industry, including asset owners, consultants and contractors, and the technology supply chain, to develop commercial technologies, tools for data analysis and asset management, best practice guidance codes and specifications for scale-up and standardization. CSIC also works with industry bodies including the Construction Leadership Council (CLC) and the Institution of Civil Engineers (ICE) to unite the industry in smart innovation.

Before joining CSIC, Jennifer worked in consulting engineering and in product development. Jennifer has a PhD in Materials Science from the University of Cambridge.

OLIVIER HAUTEFEUILLE
Chief Underwriting Officer, Industrial and Commercial Risk, SCOR Global P&C

A civil engineer, Olivier Hautefeuille started his career as Contract Engineer on several construction projects in France and Middle East with French Major Contractors.

He joined SCOR in 1991 as a construction Underwriter and has been involved in all the major (re)insurance leads that SCOR has secured (Storebaelt, Hong Kong airport projects, Taiwanese High speed train, Heathrow Terminal T5, the EPR projects, etc...).

He has occupied various functions in our company and worked in Paris, Hong Kong and London with a focus on the Corporate segment.

Until recently he was the CEO of SCOR UK company Ltd and the CUO for Construction and Specialities for SCOR Global P&C. Today, he oversees the EMEA operations for SCOR Business solutions and is based in Paris.

He was also the co-writer of the Tunneling Code of Practice for Risk Management and he is part of the Executive committee of the IMIA (International Association of Engineering Underwriters).

INFRASTRUCTURE – SETTING THE SCENE

VARYING DEFINITIONS AND DIFFERENT CLASSIFICATIONS BUT AN OBVIOUS LINK

In regard to infrastructure, different definitions subsist - the following was defined in 1980: "the basic physical and organizational structures and facilities needed for the operation of a society or enterprise." Since then, as infrastructure has evolved, and was defined by the US government in 1994 as "the transport links, communications networks, sewage systems, energy plants and other facilities essential for the efficient functioning of a country and its economy" or in corporate terms, the essential physical assets necessary to run a business. This change of definition marks the beginning of concerns for critical infrastructure and the terrorism threat.

Infrastructure covers various economic sectors of activity, such as transportation, energy and power, water, waste. However, social infrastructure, for which the definition of resilience is different, will extend to education, health, defence and security, jails and administration generally. This panel will focalize on addressing economic infrastructure issues, rather than those concerning social infrastructure.

The link between country development, growth and infrastructure is quite apparent and is generally qualified as the backbone of any country. Many modern governments have been implementing policies that aim to develop or simply catch up with current expectations.

INFRASTRUCTURE & RESILIENCE

Surprisingly, the concept of resilience is fairly recent and is an emerging field of research. In essence, resilience characterizes a system's ability to react and recover from unanticipated disturbances and events.

Two properties are associated to resilience:

- robustness, the capacity of a system to remain unchanged when exposed to perturbations, such as natural catastrophes;
- rapidity, the speed at which a system recovers from an undesired event.

These definitions proposed by Jorn Vatn, Per Hokstad and Ingrid Bouver Utne ("Risk and Interdependencies in Critical Infrastructure") are quite interesting as we are not just speaking of preserving the assets but also their functions.

CRITICALITY & RESILIENCE

These works show the benefit to consider resilience in a system. However, it is uncertain whether decision-makers are considering resilience as part of their decision process. For instance, there is little mention of resilience, or even criticality in the OECD reports on infrastructure; on occasions where it is mentioned, the term is mainly linked to the world economy, though not to systems. The same can be said about infrastructure rankings that observe how countries build and how they equip themselves with infrastructure: resilience is not really considered.

As the rankings of the UK and the US were considered, disparities became noticeable. The new World Economy global index (see Figure 1) considered that they were part of the top 10 countries in terms of Infrastructure Construction. However, the World Economic Forum (WEF) (see Figure 2), which ranks the Overall Quality of Infrastructure, placed both countries respectively 24th and 25th. It would seem that the WEF index illustrates the reality of infrastructure in a more accurate way that the WE index, because the latter does not consider the quality and state of infrastructure are part of the review.

	Total	Transport	ICT	Energy	Finance
Top 10	Hong Kong Singapore Germany US Switzerland Canada Norway Luxembourg Japan UK	Hong Kong Singapore US Germany Luxembourg India Austria Switzerland UK Japan	Germany Hong Kong Luxembourg Switzerland Korea France Denmark UK Singapore Sweden	Norway Kuwait Canada Finland Qatar Sweden US Luxembourg UAE Australia	Hong Kong Singapore Jordan Spain China Israel Malaysia UK Australia US
Bottom 10	Cameroon Gabon Iraq Nepal Botswana Haiti Kyrgyz Rep. Namibia Bolivia Congo, Rep.	Senegal Myanmar Mauritania Chile Bangladesh Brazil Peru Cameroon Paraguay Bolivia	Ethiopia Mozambique Burkina F. Papua N.G. Guinea Madagascar Congo, DR Myanmar Zimbabwe Kyrgyz Rep	Yemen Nicaragua Nambia Cambodia Dom. Rep. Iraq Nepal Botswana Haiti Congo, Rep.	Ecuador Kazakhstan Namibia Bolivia Venezuela El Salvador Papua N.G. Georgia Ghana Argentina

FIGURE 1: THE WORLD ECONOMY GLOBAL INDEX

Rank	Country/Economy	Value
1	Switzerland	6.6
2	Singapore	6.5
3	Finland	6.5
4	Hong Kong SAR	6.5
5	France	6.4
6	United Arab Emirates	6.4
7	Iceland	6.3
8	Austria	6.3
9	Germany	6.2
10	Netherlands	6.2
11	Portugal	6.2
12	Luxembourg	6.2
13	Denmark	6.0
14	Bahrain	6.0
15	Canada	6.0
24	United Kingdom	5.6
25	United States	5.6

FIGURE 2: WORLD ECONOMIC FORUM RANKING OVERALL QUALITY OF INFRASTRUCTURE

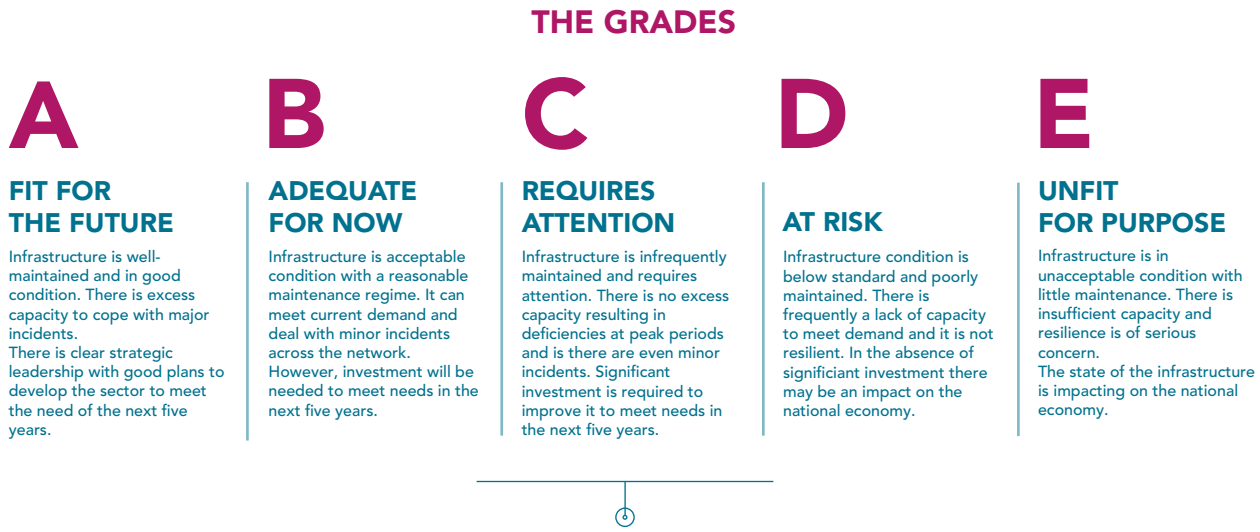


FIGURE 3: ICE RANKING GRADE QUALIFICATIONS

Source: University of Cambridge

After being ranked 24th in the WEF infrastructure ranking , the UK infrastructures were rated by the ICE (Institution of Civil Engineers), with standings going from B to D, as shown in figure 3. This ranking was issued despite the UK being on the front end for project finance and the development of concessions in the country.

Similarly, the US Infrastructure was rated in 2017 by the American Society of Civil Engineers, with a D+. This grade signifies that the infrastructure is poor, or even at risk (see Figure 4). This is a concern that no one can ignore, especially the policy makers.

FIGURE 4: D GRADE QUALIFICATION FOR THE ASCE

Source: University of Cambridge

The US certainly has the capabilities to change this situation and perform better, as over the last three years, SCOR Global P&C has seen infrastructure projects - such as subways, airports, bridges – increase in the US but the journey to resilience will be a long one.

Though Chinese infrastructure has been ranked 69 in the WEF ranking, but there has been an active government policy to get the best infrastructure. For instance, SCOR Global P&C has reinsured over 100 metro lines in China these last 10 years. The general assessment of infrastructure in China is that its quality and risk management has significantly improved. Canada and New Zealand are both excellent examples of advanced infrastructure policy:

- Canada has implemented an active risk management policy for their critical infrastructure – this means that the government has defined what critical infrastructure is and their expectations in terms of risk management, as illustrated in the foreword of their Risk Management Guide for critical infrastructure sectors, featured in Figure 5.
- In the aftermath of two earthquakes, in 2010 and 2011, the public authority of New Zealand, alongside the government, began to review the existing infrastructure and carried out a comprehensive analysis of the initiatives necessary to achieve the desired resilience.

THE "CRITICALITY & RESILIENCE" LESSONS LEARNED

Infrastructure can be exposed to various risks, classified into four categories:

- **Breakdown & domino effect on cross-infrastructure inter-connectivity:** these risks englobe power black outs, of which there have been numerous occurrences (New York, Kuala Lumpur, Italy, etc..), as well as cyber risks that befall ports, grids, telecoms and Scada systems.

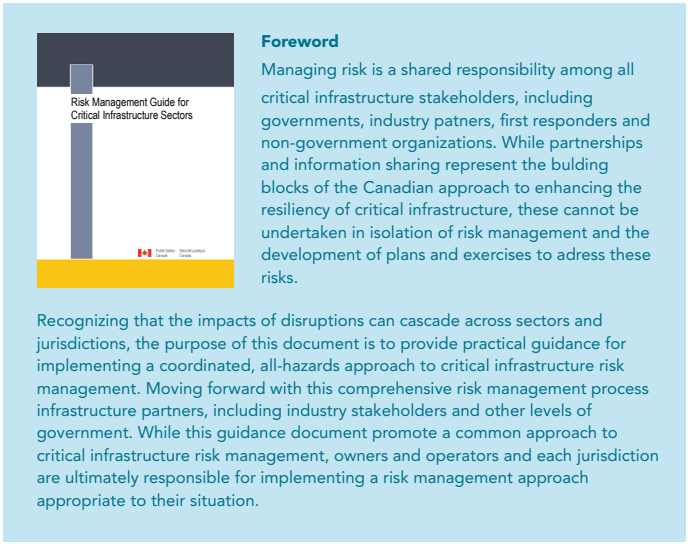


FIGURE 5: FOREWORD OF THE RISK MANAGEMENT GUIDE FOR CRITICAL INFRASTRUCTURE SECTORS

- **Terrorism:** this exposure may have generated the concept of criticality and resilience. In fact, the US defined vertical infrastructure in the Patriot Act (1994), and stated resilience as a concern to the government. The entirety of infrastructure is concerned by this exposure.
- **Natural Catastrophes** (all infrastructures): windstorms, earthquakes, floods, etc. The entirety of infrastructure is concerned by exposure to these risks. For example, Hurricane Harvey proved that the city of Houston was not resilient to this classification of risk. The sewage was not built to withstand the average of 1m/m² of rainfall - with peaks at 1.32m/m² - that occurred. In addition, the return period that underwriters had been using for their modelling were exceeded. It was well in excess of 500 years of return period.
- **Ageing risks:** these risks affect mainly transportation infrastructure and are linked to the quality of the infrastructure. On the 1st of August 2007, the Minneapolis bridge, an eight-lane bridge, collapsed into the Mississippi river during rush hour. The bridge was old, had not been properly maintained or correctly sculpted, and when one of the twenty-four gusset plates[1] failed, which were about half the thickness they should have been, this resulted in the collapse that killed thirteen people and injured 145 people. This incident is a clear example of the impact of ageing infrastructure, and how stake-holders must be held accountable - in this case, the municipality or the highway agency. According to the ASCE, In the US alone, 11% of bridges are structurally deficient.

Considering the scale of the subject, how can we improve the resilience and recognise the criticality of the infrastructures which need to be? This is where the technologies can be a game changer as they can adapt to any situation more or less.

THE ROLE OF TECHNOLOGIES IN BUILDING RESILIENCE FOR NEW & EXISTING INFRASTRUCTURE

Dr Jennifer Schooling, Director, CSIC, University of Cambridge

SMART INFRASTRUCTURE

Smart Infrastructure is the result of combining physical infrastructure with digital infrastructure, providing improved information to enable better decision making, faster and cheaper throughout the life-cycle of an infrastructure asset[2].

Better understanding of the performance of our infrastructure will allow new infrastructure to be designed and delivered more efficiently, and to provide better whole-life value.

1. Sheets of steel used to connect bridges and columns
2. Smart Infrastructure: Getting more from strategic assets; https://www-smartinfrastructure.eng.cam.ac.uk/files/the-smart-infrastructure-paper

Application of smart infrastructure solutions to existing assets will allow owners and operators to get more out of what they already have – increasing capacity, efficiency, reliability and resilience. Getting more from existing assets will enable owners and operators to enhance service provision despite constrained finance, growing resource scarcity and, in mature economies, short supply of green field space. Crucially, the better understanding of our assets and infrastructure systems that smart infrastructure solutions provide will enable reduction of risk throughout the life of an asset, improving performance, increasing resilience and reducing uncertainty.

Figure 1 illustrates how wide application of sensors to infrastructure assets – buildings, bridges, roads, tunnels, pipelines, etc – will enable them to communicate their condition continuously, live-streaming data, with assets connected together in a system.

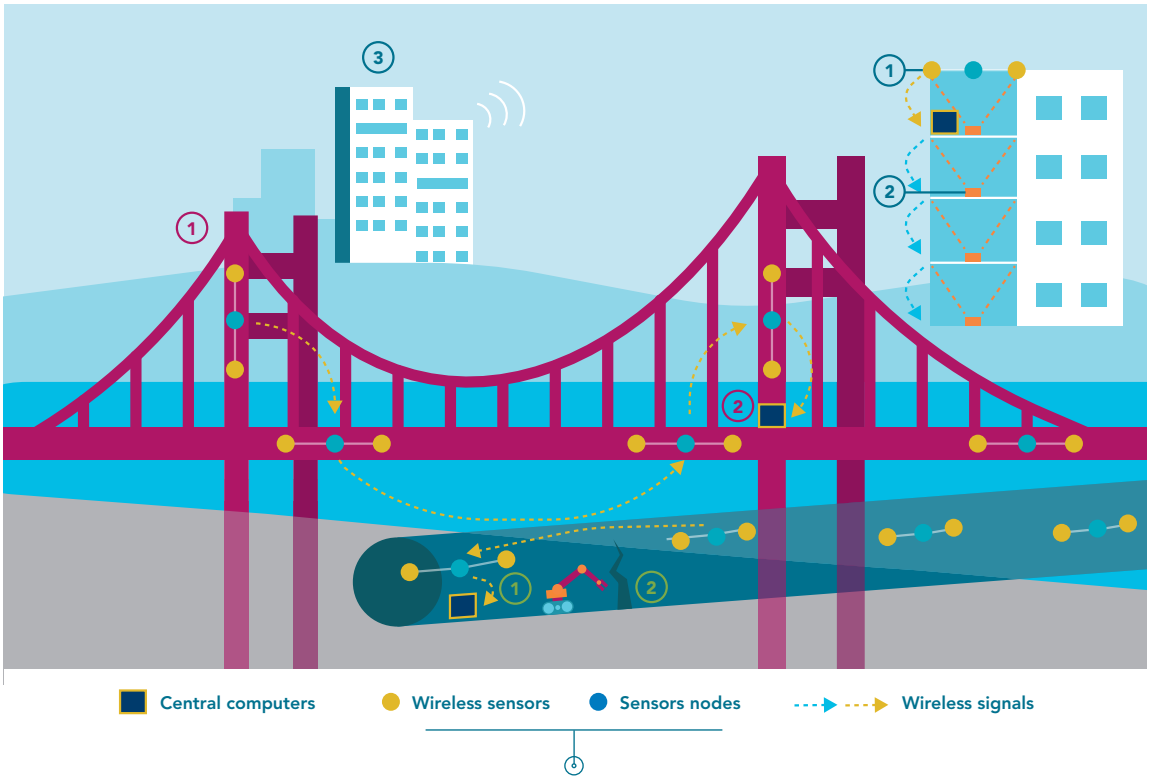


FIGURE 1: TALK OF THE TOWN

Source: The Economist vol 397, iss 8712, Dec 2010

TECHNOLOGY SOLUTIONS AND THEIR APPLICATION

A wide range of technologies and data sources are available to apply to monitoring of infrastructure, as shown in Figure 2. The Cambridge Centre for Smart Infrastructure and Construction (CSIC) carries out research in all of these areas, combining data from a wide range of sources to generate insights into the performance and condition of assets.

This can include:

- movement data from satellite imagery,
- laser scans and photogrammetry which produce 3-D representations and can track movements,
- embedded sensors monitoring strain, temperature, tilt,
- and social media data which can provide insights into infrastructure demand and user satisfaction.

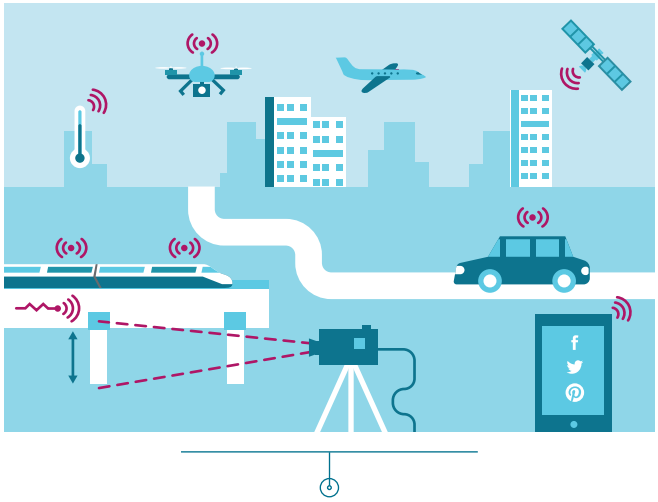


FIGURE 2: AN ILLUSTRATION OF THE RANGE OF TECHNOLOGIES WHICH CAN BE APPLIED TO MONITORING INFRASTRUCTURE, FROM SATELLITES AND DRONES TO EMBEDDED SENSING, SENSORS ON VEHICLES AND SOCIAL MEDIA DATA.

Source: Cambridge Centre for Smart Infrastructure and Construction, reproduced with permission

The information that this data provides is used to improve understanding of performance throughout life, as illustrated by the diagram in Figure 3, which shows CSIC's strategic research themes. In each area there is a range of opportunities to create new insights, and reduce risk:

- Performance based design
  - validating design models and improving design codes,
  - demonstrating cost savings and value,
  - designing for whole-life value.
- Transforming construction
  - providing digital models of the 'as-built' structure, for use in asset management,
  - quality assurance – capturing actual construction and comparing to design,
  - construction progress monitoring, reducing schedule delays,
  - monitoring of 'third party' assets, to mitigate potential for damage or disturbance.
- Managing and operating infrastructure
  - condition monitoring and predictive maintenance,
  - whole-life, value based asset management,
  - risk-based approaches to asset management,
  - future-proofing of infrastructure assets.
- Smart city systems
  - understanding infrastructure usage and demand in real time,
  - demand forecasting for future infrastructure needs,
  - optimised network management,
  - future investment planning.

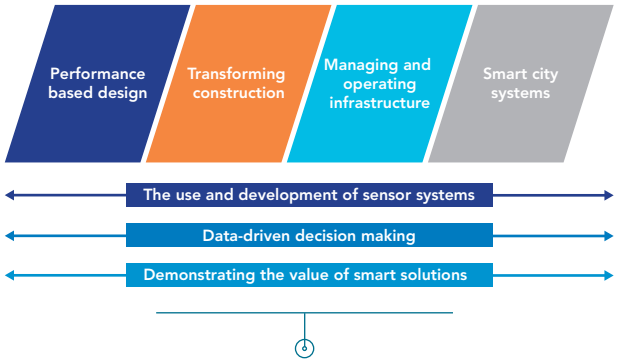


FIGURE 3: CSIC'S STRATEGIC RESEARCH THEMES

Source: Cambridge Centre for Smart Infrastructure and Construction,CSIC

CASE STUDY EXAMPLES

1. Performance based design

Sensor systems applied to new infrastructure can be used to validate and calibrate Finite Element Analysis (FEA) models, giving designers greater confidence in their designs and identifying areas where current design practice is over-conservative and hence savings in materials, cost and construction programme might be made.

One such example is the work carried out by CSIC during the construction of Crossrail Liverpool Street Station by de Battista et al[3]. The Crossrail project in London is one of the largest construction projects in Europe, including six new railway stations under central London and 42 km of new tunnels. Underground stations consist of a passenger concourse tunnel running between two platform tunnels, linked by a number of cross-passages. These station tunnels are constructed using sprayed concrete lining (SCL) techniques. De Battista and colleagues embedded Distributed Fibre Optic sensors (DFOS) into the SCL of the concourse tunnel during construction (Figure 4), and used them to monitor strain changes in the tunnel lining during the excavation of the cross-passages.

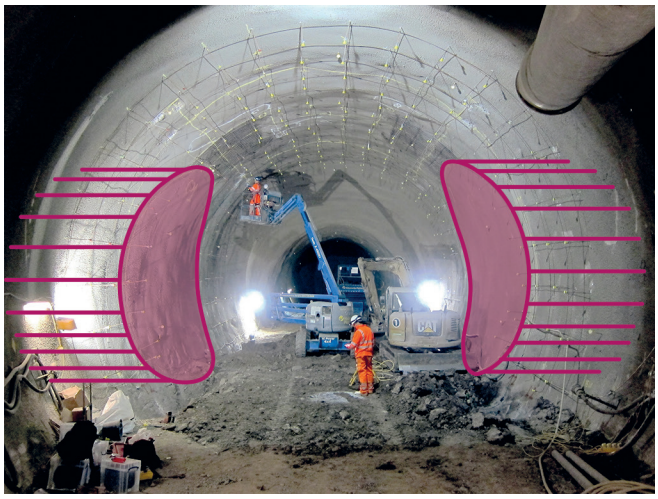


FIGURE 4: INSTRUMENTATION OF CROSSRAIL LIVERPOOL STREET STATION CONCOURSE TUNNEL, SHOWING FIBRE OPTIC SENSORS BEING INSTALLED IN THE THICKENED LINING, WITH THE LOCATION OF THE FUTURE CROSS-PASSAGE EXCAVATIONS SUPERIMPOSED

3. Strain monitoring using embedded distributed fibre optic sensors in a sprayed concrete tunnel lining during the excavation of cross-passages; de Battista et al, 7th International Conference on Structural Health Monitoring of Intelligent Infrastructure, 2015 https://www.repository.cam.ac.uk/handle/1810/255405

For the first time ever this provided data that could be used for calibrating the design models, which previously had been purely analytical. The data revealed that the area of thickening around the cross-passage openings is likely to have been conservatively designed and that the area of the tunnel lining affected by the cross passage excavation was considerably smaller than the extent of the thickening of the tunnel lining.

The implications of this for similar future tunnel designs are significant:

- extent of thickening could potentially be reduced,
- cost savings can be made,
- time savings can be made,
- resource use and associated carbon emissions can be reduced,
- reduced need for the SCL process reduces operator exposure to an inherently difficult and potentially dangerous process.

Implementing similar instrumentation in future designs will enable confirmation of these results, and increase confidence in design tools, enabling them to be better calibrated in future projects.

2. Operation and management – ageing infrastructure

Instrumenting existing ageing infrastructure can significantly improve our understanding of its condition and help us to model degradation rates, informing maintenance strategies and giving an indication of remaining load-bearing capacity and asset life.

This is particularly relevant to operators of major transport infrastructure. For example, the UK's Network Rail operates an asset base over half of which was constructed before 1914. In all, Network Rail is responsible for 28000 bridges; 22000 retaining walls; 21000 culverts and 600 tunnels. Many of these assets have limited condition and maintenance information available prior to the last 20-30 years, and hence the asset managers are dealing with assets of uncertain history and uncertain condition. In addition, many of the assets were originally designed for lighter loading conditions than those they experience today, as train loads are now three times heavier than they were in the 1860s[4].

Many of these structures are deemed to be in potentially poor condition. One such structure is a 150 year old Network Rail masonry viaduct which CSIC have monitored in order to provide insights into the damage and behaviour of the structure, and which is now being monitored long term to assess the rate of degradation of the structure[5-6-7].

The arch has extensive visible cracking, and signs of water damage where water has been leaking through cracks in the masonry structure (Figure 5). Previous maintenance interventions had not completely arrested the progressive damage, with cracks continuing to propagate.

FIGURE 5: 150 YEAR OLD MASONRY VIADUCT SHOWING SIGNS OF DAMAGE

CSIC employed a range of monitoring techniques to fully comprehend the bridge's behaviour, including laser scanning (to determine the distorted shape of the bridge), digital image correlation (to monitor 3-D movements with video cameras) and fibre optic sensing (to monitor strains). This revealed a complex structural behaviour, with adjacent spans of the viaduct opening and closing as trains crossed it, and cracks causing differential movements in the arches and at the top of the piers, as shown in Figure 6.

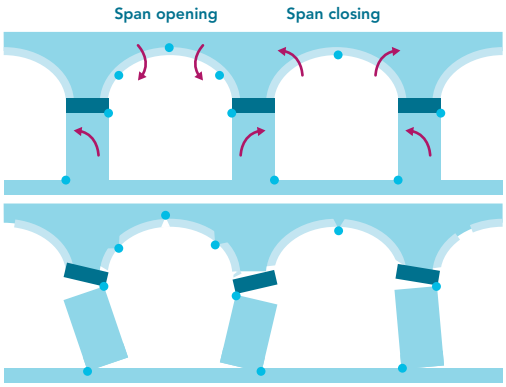


FIGURE 6: ILLUSTRATING THE MOVEMENT OF THE MASONRY VIADUCT DURING PASSAGE OF TRAINS

4. Alan Alan Hayward, IABSE Henderson Colloq. 2016
5. Acikgoz S, Kechavarzi C, Soga K and DeJong MJ (2017). Dynamic response of a damaged masonry rail viaduct: Measurement and interpretation. Engineering Structures. Under review.
6. Acikgoz S, DeJong MJ and Soga K (2017). Sensing dynamic displacements in masonry rail bridges using 2D digital image correlation. Structural Control and Health Monitoring. In press.
7. Ye C, Acikgoz S, Riley E, Pendrigh S and DeJong MJ (2017). Mapping 3D deformation and inferring past support movements of masonry arch bridges using point cloud data. Engineering Structures. In press.

These insights will enable improved decisions making for maintenance interventions, and ongoing monitoring will reveal the degradation rates of the main cracks, enhancing decisions regarding scheduling and criticality of interventions, and hence improving the value of maintenance investments.

FUTURE-PROOFING INFRASTRUCTURE

Infrastructure assets are persistent – we expect them to last for 100 years or more. Hence, ensuring long-term performance from key infrastructure is essential.

Future-proofing infrastructure involves two key components:

- resilience to unexpected or uncontrollable events (e.g. extreme weather events),
- adaptability to changes in use or loading requirements in the future.

It is becoming increasingly important to consider future challenges as part of the life cycle of major assets, and to incorporate this into planning, design, operation and management processes.

CSIC has developed a framework for addressing this[8], enabling asset owners to identify key future-proofing criteria, assess how future-proof an asset needs to be against each criterion, and assess its current design or condition.

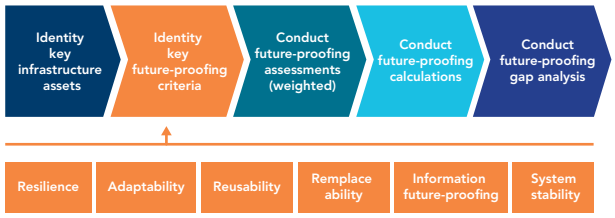


FIGURE 7: A METHODOLOGY FOR ASSESSING HOW FUTURE-PROOF AN ASSET OR GROUP OF ASSETS ARE AGAINST FUTURE CHALLENGES (EXAMPLE FROM LIVERPOOL WASTE WATER TREATMENT PLANT[9])

This results in a series of radar plots (Figure 7) which identify the most significant gaps in potential future-proofing, and can be used as part of the design assessment or asset management practice to identify necessary interventions and investments to either improve future-proofing or to develop mitigation strategies against inherent risks.

Figure 8 shows a number of radar plots for a case study at Liverpool waste Water Treatment Works. This shows that criteria can differ in importance for different assets, and demonstrates the ability to identify significant gaps in future-proofing to target and prioritise investment and mitigation measures.

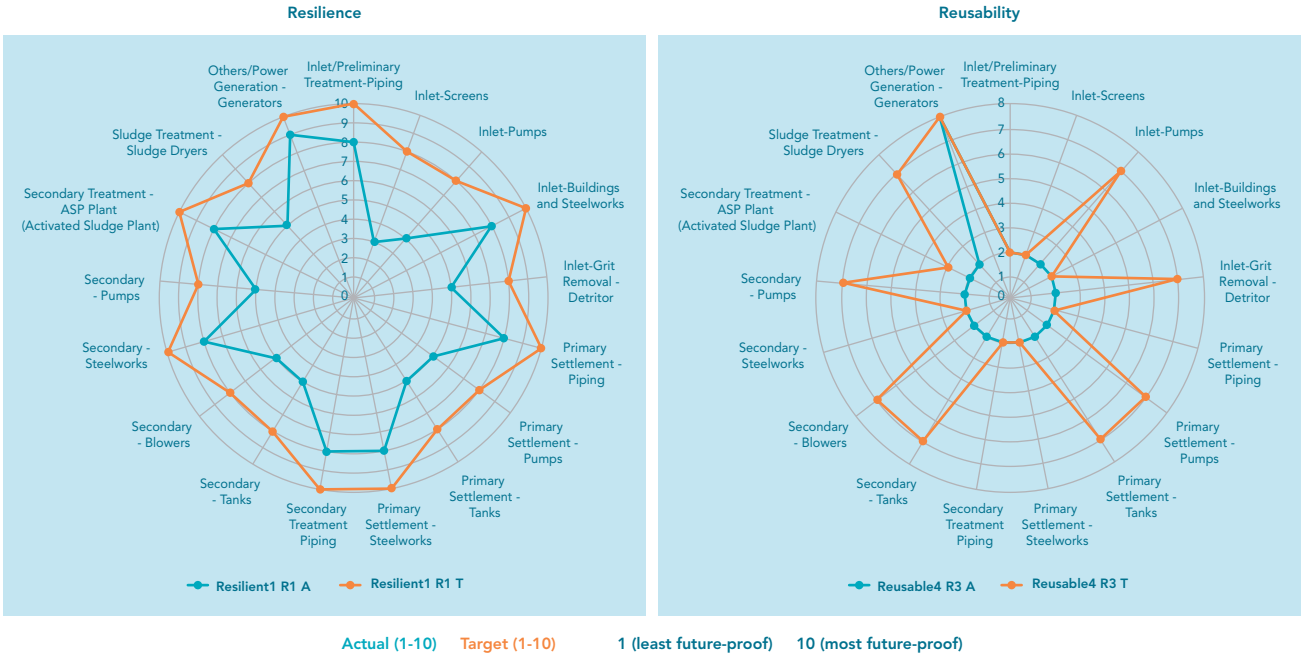


FIGURE 8: EXAMPLE RADAR PLOTS DEMONSTRATING A FUTURE-PROOFING ASSESSMENT AGAINST TWO SPECIFIC CRITERIA (AS APPLIED TO LIVERPOOL WASTE WATER TREATMENT WORKS[9])

8. Masood et al 2016. Towards the future-proofing of UK infrastructure. Infrastructure Asset Management https://www.icevirtuallibrary.com/doi/10.1680/jinam.15.00006
9. Masood et al 2016. Future-proofing assessment of infrastructure assets. Proceedings of the International Conference on Smart Infrastructure and Construction, 2016. https://www.icevirtuallibrary.com/doi/full/10.1680/tfitsi.61279.621

CHALLENGES OF DATA

Today, massive amounts of data can easily be generated about a single infrastructure asset over short periods of time. If this data is to be used to make live-decisions, it will have to be processed just as quickly, and the reliability and quality of the data needs to be considered. Figure 9 shows how data can be curated and processed to generate increasing value in terms of sense making and insight in order to inform decisions[10]. The higher up the pyramid, the more valuable the information is.

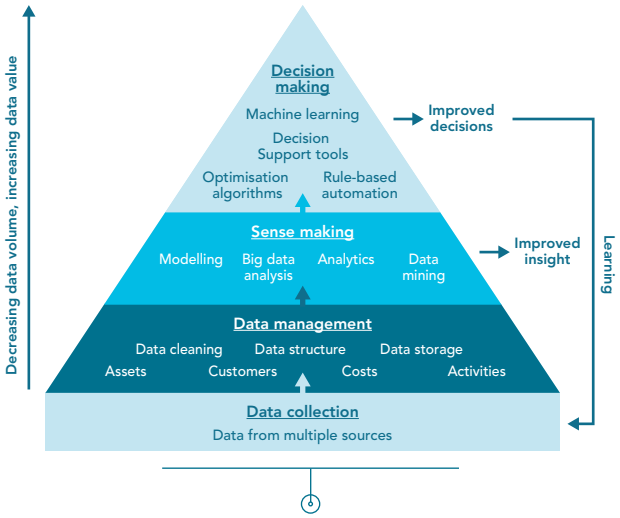


FIGURE 9: A MODEL OF THE ROLE OF DATA IN AIDING DECISION-MAKING

Source: CSIC

However, processing large quantities of data presents a number of challenges. These have particular characteristics for infrastructure, due to the varied nature of the data and the need to assess it over extended periods of time.

The 'five Vs' of Big Data as applied to infrastructure are:

ADVANTAGES	CHALLENGES
Volume: the increasing size of data sets	**Challenges in infrastructure:** typically challenging, but not as much as for other sectors (e.g. astronomy research)
Variety: the increasing variety of sources from which data originates and its storage	**Challenges in infrastructure:** a wide variety of sensors may be used, giving different kinds of information about the same asset (e.g. temperature, humidity, acceleration, strain)
Velocity: the speed at which the data is created, changes and needs to be processed	**Challenges in infrastructure:** the variety of velocities (sub second, minute, week, month, year, etc..) at which different types of data are generated, and how to bring these various datasets together
Veracity: the quality and reliability of the data	**Challenges in infrastructure:** as assets are persistent through time, understanding and trusting the quality of ageing datasets is paramount
Value: the value that the data provides for an organization	**Challenges in infrastructure:** the same data may have utility for several different purposes at different time, from reactive (immediate) decisions, e.g. on safety, to reflective purposes such as planning asset maintenance or renewal. The data needs to be curated so that it can be accessed and utilized for these different purposes.

This leads to the concept of 'information future-proofing'. Many existing assets are challenging to assess and manage because the data regarding their design, construction and maintenance is incomplete, often due to poor management of information, or complete loss of information, over the lifetime of the asset.

CSIC has developed a structured approach for managing asset information[11], which sets out an approach for ensuring that required infrastructure asset information is retrievable and reusable throughout the whole lifecycle of the asset, when needed.

Future-proofed information is defined by the fact that it is:

1. **Available** - the information is stored somewhere,
2. **Accessible** - the information is stored in a place that can be opened,
3. **Retrievable** - the information is searchable,
4. **Reusable** - once the information is created, it can be used multiple times,
5. **Flexible** - the information can be used for different purposes, beyond its creation purpose.

10. Smart Infrastructure: Getting more from strategic assets; https://www-smartinfrastructure.eng.cam.ac.uk/files/the-smart-infrastructure-paper

11. Masood et al 2016. Information future-proofing assessments for infrastructure assets. Proceedings of the International Conference on Smart Infrastructure and Construction, 2016. https://www.icevirtuallibrary.com/doi/full/10.1680/tfitsi.61279.557

A structured approach to information future-proofing is laid out in[11], based on a consideration of information retention requirements for the long term, the hazards which may result in loss of information, and the risks to the asset of loss of information in the long term.

The hazards which may lead to loss of information include hardware (e.g. storage media deterioration, obsolete storage methods), software (e.g. file format compatibility between versions, loss of information in format conversion) and organisational (e.g. data custody, loss of data in handover from one organisation to another, poor practices in data structuring and management).

Lack of relevant data may increase risks and costs in asset management and operation, by resulting in incomplete or inaccurate datasets being used to take decisions. Therefore a structured approach is recommended to planning for information future-proofing and creating policies and practices to manage data appropriately throughout the life of an asset.

FURTHER INFORMATION

Further information about all of these projects and approaches is available from the Cambridge Centre for Smart Infrastructure:
www-smartinfrastructure.eng.cam.ac.uk

KEY TAKE-AWAYS

There is an alignment between the infrastructure and insurance sectors to further develop the concept of resilience, with the development of resilience studies being carried for new projects, alongside their environmental counterparts.

Technology is the way forward to contribute to the development of resilience and to the management of these assets as:

- it can be adapted to existing asset,
- it can provide effective risk management tools, which lead to a substantial reduction of residual risks, either during construction or operation,
- it can optimize the insurance transfer (for example, deductibles and pricing), while still allowing underwriters to take new risks and insure what was ultimately not insurable.

Technology could also assist in the improvement of:

- risk's robustness to natural catastrophes,
- assessment and management of a situation post catastrophe,
- the way underwriters are designing their exposure models in Nat Cat areas.

However, the incorporation of technology and data into infrastructure will be accompanied by several challenges for the insurance sector:

- the need for regulations or guidelines,
- data complexity: how can algorithms be created in order to collect data, process it and deliver it in a form that will be usable to various stakeholders?
- data acquisition and access to data,
- data ownership: should the data be the property of the operators or simply associated to the infrastructure, with a duty for the operator to ensure adequate maintenance?

11. Masood et al 2016. Information future-proofing assessments for infrastructure assets. Proceedings of the International Conference on Smart Infrastructure and Construction, 2016. https://www.icevirtuallibrary.com/doi/full/10.1680/tfitsi.61279.557

POLITICAL RISKS, LAST OPTION: THE RISE OF FRAGILE STATES, IRREGULAR CONFLICT AND NON-STATE ACTORS

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Kade Spears joined the Channel Syndicate in October 2013 to head up the Political and Credit Risks team and has worked in this field since graduating with a Bachelor of Science from Washington & Lee University.

Kade was previously the head of a team in the London market and has worked in Bermuda, Houston and Singapore during his career.

FRAGILE STATES & CORE SERVICES

A state defined as "fragile" will have three specific characteristics:

- Firstly, the state is unable to perform core services for their population (e.g. the state is unable to provide drinkable water to a wide range of its population).
- Secondly, the state is unable to control all, or part, of his sovereign territory.
- Thirdly, the state is unable to maintain the monopoly over the use of force within their borders.

Certain questions need to be asked to ascertain whether or not a country can perform these core services for its population. Is there equal access to public services? Is there access to drinkable water? Is there an adequate sanitation system implemented in the country? Is there an adequate supply of fuel, and which fuel is it? Is there adequate housing on the market? Are the roads adequate and safe? Are people protected from violence? But equally: are these core services only provided to the elite of the society?

THE FRAGILE STATES INDEX

Since 2005, Fund for Peace, a United States think tank, and the Council on Foreign Relations have published the Fragile States Index, in an attempt to identify pressures in countries throughout the world, where states can no longer address issues such as income inequality or demographic shifts.

The following countries were featured in the latest edition of the Fragile State index, as the ten worst countries for the provision of core services:

- Central African Republic
- South Sudan
- Afghanistan
- Republic of Chad
- Haiti
- Mozambique
- Yemen
- Democratic Republic of Congo
- Republic of Congo
- Guinea

WHAT CREATES A SUCCESSFUL STATE?

Beyond the simple provision of core services to their population, the creation of successful states rests on two concepts:

- **Vertical legitimacy:** the state is granted moral authority by the population. Citizens of the country believe in the state and the institutions within their territory.
- **Horizontal legitimacy:** all aspects of society are represented within the government.

Low vertical legitimacy will cause large parts of the population to not grant their loyalty to the state.

The creation of personalized states or a state with low horizontal legitimacy, where there is not a single inclusive political community, will also tend to create weak, failing or failed countries.

POPULATION RESPONSE TO A FAILING STATE

A failing state will prompt a population to react in one of the following ways:

- **Endurance:** humans are generally willing to endure a substantial amount of repression and suffering.
- **Discussion:** the population can collectively discuss concerns and issues, such as the lack of core services, and create a common voice.
- **Exit:** exodus is a current issue, with for example millions of refugees from Syria fleeing a brutal war and seeking refuge in Turkey, Lebanon and Europe. The same situation is occurring in Libya, which has created a refugee crisis in both Malta and Italy.
- **Rebellion:** when society chooses this option, events can escalate quite quickly, as seen during the Arab Springs.

Roughly half of the countries in the world have been classified as weak, failing or failed by the Fragile States Index. This alarming number should create concern, as it creates a fertile environment for the establishment of armed groups. With no provision of core services by the state, the government has no legitimacy, which the population will endure as best as they can until either reaching the stage of exodus or rebellion. Simultaneously, the creation of non-state actors will occur and this will lead to irregular conflict, where the state and the non-state actors are both vying for legitimacy and trying to control the population. When these conditions arise, it takes a very long time for conditions to change.

For instance, in Columbia, the conflict between the FARC and the government lasted for fifty years before they could agree to terms of peace. During those fifty years, critical resources were diverted towards financing defence and away from societal investment.

THE INSURANCE OF POLITICAL RISK

Political risk insurance is a name peril policy, which can cover a wide range of perils (see illustration below). To name only a few:

- Physical damage and resulting business interruption, due to acts of terrorism, strikes, riots, civil commotion, civil war and war itself.
- Economic losses due to elements such as forced abandonment, confiscation, nationalization, license confiscation, forced divestiture of selective discrimination.
- Arbitration award default, currency inconvertibility and exchange transfer, business interruption threat, contact frustration and trade credit.

FIGURE 1: POLITICAL RISK PERILS

PREVENTING RATHER THAN FIXING

Political risk exists - the issues listed above can occur not only in developing market, but in developed markets as well. It is important that customers understand the need that subsists to protect themselves. However, the greatest challenge in the political risk business rests in the fact that potential clients discover their need for coverage when the damage has already been done.

THE GLOBAL POLITICAL RISK MARKET

Evaluating the size of the market is difficult, as insurers typically include the business derived from standalone terrorism contracts or might even include trade credit or contract frustration business. In terms of pure political risk, the market is evaluated at roughly USD 250 million gross written premiums, however if bundled elements are equally included, that number can reach up to USD 1.5 billion in gross written premiums.

The market has expanded dramatically from a relatively small market to one that can cover an extensive range of political risks. For instance, a company that would have had maximum capacity of USD 5 million ten years ago, can today put out well over USD 100 million in capacity on any given risk. However, in comparison with other lines of insurance, the business is relatively selective – today, sixty different players evolve within the political risk sphere, with varying interests and approaches to business.

The Channel Syndicate is one of the few actors on the market that possesses a claims team capable of leading highly complex claims for political risk and trade losses. Alongside SCOR, the Channel Syndicate holds top quartile capacity and can allocate close to USD 90 million to any risk.

CYBER RISKS, WHERE WE ARE TODAY

SÉBASTIEN HÉON
Deputy Chief Underwriting Officer,
SCOR Global P&C

Sébastien began his career as mathematics professor and crypto expert for the French Ministry of Defence. After 10 years in various positions in the MoD, he was appointed as Director of International Relations at the French Network and Information Security Agency (ANSSI). Sebastien joined Airbus in 2009 as a senior adviser for Intelligence & Cyberdefence, and headed the cybersecurity consulting & training division. In this position, he advised decision makers on cyber threats and mitigation of cyber risks.

Since 2005, he has been an associated professor at Paris 7 University, teaching cryptology and protocol security to postgraduate students.

Sébastien joined SCOR in July 2015 as cyber expert to support the development of the newly created Cyber Solutions unit.

The objective of this chapter is to offer a retrospective of cyber risk's evolution since last year and establish the accuracy the statements made during last year's conference. The first area analyzed is that of cyber risk itself and whether the risk has changed.

The second matter examined is the market of cyber risk and whether it has reacted to the various incidents that have occurred over the past year. The third topic analyzed will be the understanding of cyber risk and the underlying drivers of its development.

EVOLUTION OF CYBER RISKS

WHAT WE SAID IN 2016

The following statements were made during the SCOR P&C conference of 2016:

Denis Kessler, quoting the WEF (World Economic Forum) Global Risk Report: "Cyber risks have both a high impact and likelihood, above that of terrorist attacks and large scale, involuntary migration!"

Victor Peignet:

- **"Risks are increasingly connected and ubiquitous:** technology is everywhere."
- **"Risks are increasingly systemic:** the same technology standards are used globally."
- **"Blurred time and space boundaries** change risk accumulation and aggregation patterns (it is easy to cross borders online)."

Didier Parsoire & Sébastien Héon: "The Cyber Threat landscape is undergoing tremendous changes in nature, frequency and the size of risks."

CYBER-ATTACKS & DATA BREACHES

An interesting evolution of cyber-attacks has been observed over the last year, with the occurrence of disruptive cyber-attacks increasing significantly, as seen in Figure 1.

The first incident involved Dyn, an internet operator, which was victim of a DDoS attack with cascading impacts on their clients. This incident was followed by several famous disruptive cyber-attacks, which include:

- WannaCry, which impacted different companies worldwide from various sectors (NHS, Renault, Telefonica, FedEx, etc.)
- Petya, which allegedly originated from a Ukrainian software which impacted several firms (Reckitt Benckiser, FedEx, Mondelez, etc.)

In both cases, the targeted companies illustrated that cyber today is widespread and that cyber risks impact all business sectors, companies of all sizes, whether public or private, and globally.

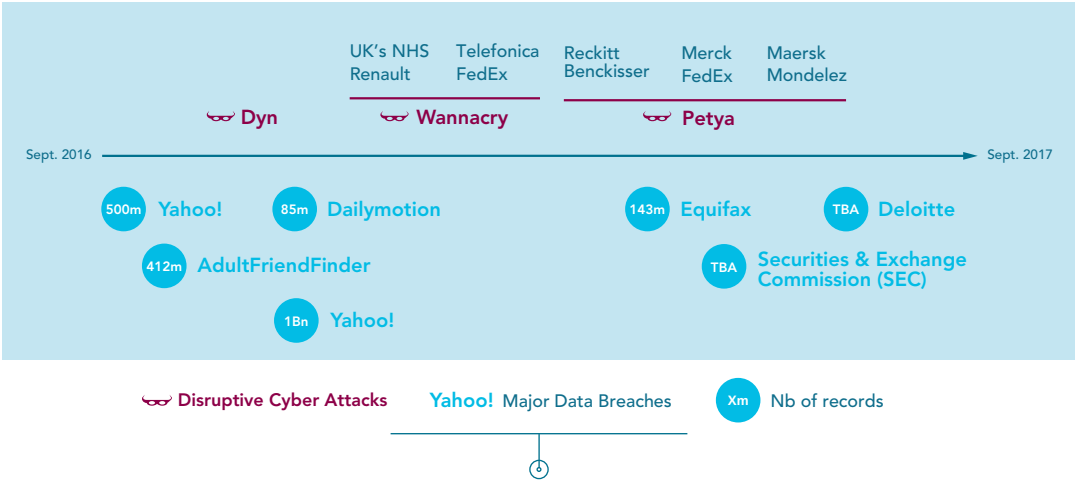

FIGURE 1: DISRUPTIVE CYBER ATTACKS OF 2017

Source: SCOR

Cyber attacks are no longer mere data breaches with loss of personal data and privacy liability, as the affected companies were not ones that process copious quantities of personal data, but large manufacturing, industrial companies.

Similarly, geopolitical tensions appear to be a risk driver, as Petya allegedly originated from Ukraine, which could be connected to the ongoing tensions between the latter and Russia. These events equally demonstrated potential for accumulation, as a single virus is capable of impacting simultaneously a variety of companies.

The severity of these incidents has been significant; certain companies impacted by Petya, such as Mondelez International, have issued profit warnings, as shown in Figure 2. On the basis of the company's net revenue in its first yearly quarter, the estimated loss will be in the range of USD 200 million.

In addition, the traditional data breaches and leak of personal information have not been quelled.

Featured in Figure 1 is the time line of recent and major data breeches. For instance, Equifax, a US credit bureau, lost 143 million personal records. Once again, other companies besides the standard banks and large data processing firms have also been targeted: the Security & Exchange Commission in the US, Deloitte, etc.

Cyber is continuously growing and confirming certain of the main statements made last year.

Mondelez International, maker of Oreo cookies and Cadbury chocolates, estimated the attack would shave three percentage points from second-quarter sales growth because of disruptions to shipping and invoices. The US company's net revenues were USD 6.4bn in the first quarter.

FIGURE 2: MONDELEZ INTERNATIONAL STATEMENT

Source: Financial times - July 7, 2017

EVOLUTION OF THE CYBER (RE)INSURANCE MARKET

WHAT WE SAID IN 2016

The main statements made about the evolution of the cyber (re)insurance market were that:

- Cedants remain cautious about holding cyber risk on their balance sheets and many are concerned by silent cyber aggregates.
- Reinsurers, like cedants, remain cautious on writing cyber and are unwilling to take large lines.

In 2016, uncertainty subsided on how to process, model and deal with cyber risks.

Additionally, the market is characterized by a great diversity of cyber cover purchase, such as:

- Cyber Exclusion write-back or Cyber Endorsement
- Cyber Standalone Policy
- Cyber + E&O Bundled Policy
- Comprehensive Cyber Packages

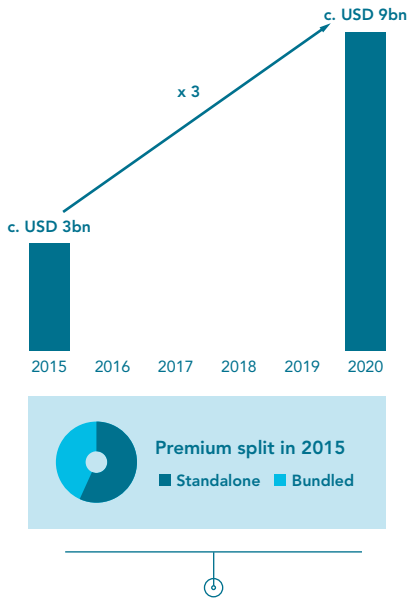

FIGURE 3: MARKET GROWTH ESTIMATION

Source: Aon Inpoint for SCOR

Cyber was scattered into a variety of programs and the market could therefore respond with diverse answers. The market was also predicted to grow significantly, from USD 3 billion in 2015 up to USD 9 billion in 2020, as shown in Figure 3. Finally, the capacity on the cyber insurance market was evaluated at approximately USD 500 million.

WHAT WE WILL SEE NEXT YEAR

A certain stability of the insurance capacity and of the reinsurance structure is expected. The market growth corresponds to expectations: some large programmes have been placed at a capacity of roughly USD 600 million.

Furthermore, in the aftermath of the Wannacry and Petya cyberattacks, a take-up rate in the manufacturing, utilities and industrial accounts has been observed.

However, an unanticipated trend has emerged: the SME (Small & Medium Entreprises) market remains challenging despite numerous attempts to develop a portfolio of dedicated cyber products. The level of awareness necessary to create an impulse to buy cyber coverage has not been reached with SMEs.

In regard to the premium, the challenge lies in how it is accounted for - the figures depend on how the premium is calculated, whether only cyber or cyber bundled with tech is taken into account, or whether a share of the premium from property programs that include cyber coverage is also incorporated in the calculations. For instance, Fitch Ratings and A.M. Best have evaluated a growth of 35% over the last year, but had accounted only USD 1.35 billion last year. Another stable element is that the vast majority of reinsurance treaties remain proportional deals.

Unfortunately, the structure of cyber products is equally stable. One observation is that risk managers buy a large range of responses to cyber exposure, such as exclusion write-back, cyber extensions to standard policies, cyber standalone, comprehensive cyber products, etc. It is probably still unclear for risk managers what their exact coverage needs are, what is available on the market, and how much capacity they should buy. This will require the market to raise awareness and knowledge with the risk management community. Similarly, companies tend to buy several cyber solutions, which creates an overlap in coverage - this will most likely create a new challenge when claims arise.

Wording is another issue - in certain cyber or tech wordings, data recognition exclusion may still be mentioned, which refers to the Y2K bug. A lack of maturity prevails in the wording of cyber risk contracts, with an absence of alignment in definitions. It has become imperative for insurers to create new and accurate wording to deal with cyber.

Finally, all of these issues are passed down to reinsurers who, faced with a diversity of cyber coverage, struggle to compute and control accumulation and to identify exposures in reinsurance treaties. Without these abilities, it will remain difficult for the sector to progress and offer innovative reinsurance solutions.

The improvement in cyber coverage should therefore be considered from the risk management level down to the reinsurance sector.

UNDERSTANDING CYBER RISKS

WHAT WE SAID IN 2016

The salient point made about understanding cyber risks during last year's conference, was that the will to structure cyber insurance products and develop innovative tools was a challenge that required cyber knowledge and out-of-the-box innovation, etc.

Cyber is not simply a question of IT, but also concerns intangible assets. The market has to consider how to collectively protect those intangible assets - the value of which "is now a greater proportion than is the value of tangible assets for rich nations"[1] -, how to create new products to protect the value of intellectual property, share price, innovation, R&D, etc.

The 2016 conference also brought forth the conclusion that a cultural change was necessary, among which can be found:

- multidimensional cross class approach to address issues such as property, casualty, intangible assets, human capital, etc.
- attracting talents, including from outside the industry;
- modelling improvements, required by interconnectedness and complexity, as historically models addressed physical events with defined geographies;
- predictive analysis, not experience, which require access to data but create confidentiality issues.

CYRIUS - THE RISK ASSESSMENT TOOL

SCOR has been working on the development of a new risk assessment tool, that processes the information collected through client questionnaires that are often carried out in cyber insurance (about organization, technology, processes, strategy, digital, etc.). To assess the quality of a company in terms of cyber, this tool then models and correlates the combination of qualitative and quantitative data through a Bayesian network which produces two figures: the score of the client (see Figure 4) and the score attributed to the sector(s) the company belongs to (see Figure 5).

The software is still undergoing tests; however, it is a first step towards understanding the drivers of cyber risk - profitable underwriting is not achievable without that knowledge. The best way to prepare for the reality of a potential cyber threat that could destroy a portfolio is to develop ambitious and innovative tools.

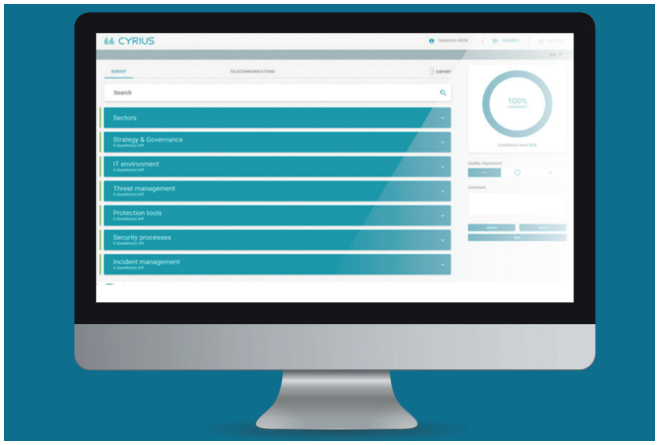

FIGURE 4: CYRIUS SCORING TOOL

Source: SCOR

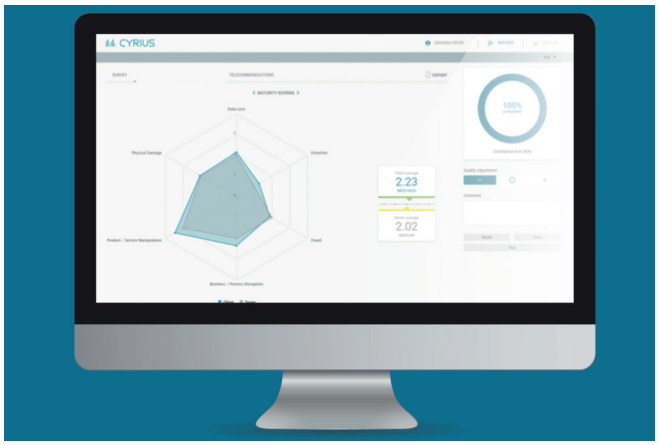

FIGURE 5: CYRIUS, COMPANY SCORE AGAINST SECTOR SCORE

Source: SCOR

1. Global Intangible Financial Tracker 2015

CONCLUSION AND KEY TAKE-AWAYS

In comparison with 2016, there has been progress made in the development of portfolios and initiatives to develop new cyber products. As a result, the market is dynamic and growing.

However, the challenges that remain must be addressed collectively, as a common endeavor to enhance the understanding of cyber and build a sustainable market.

The insureds must improve:

- exposure analysis by building scenarios in regard to the maximum possible loss,
- risk reduction and transfer strategy through increased awareness.

The insurers and brokers must improve:

- matching demand and offer in a competitive environment,
- risk selection,
- streamlining wordings,
- development/enhancement of pricing tools.

The reinsurers must improve:

- aggregation modelling & control,
- development of the cyber reinsurance offer,
- pricing.

A collective effort is necessary to progress and field off potential cyber-attacks, that are growing and will have increasingly worse impacts if the research and initiatives to develop the market aren't implemented.

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