

PARAMETRIC INSURANCE:

A fitting solution
for the weather-sensitive

**A LOOK AT NEW WEATHER RISK
MANAGEMENT SOLUTIONS
TO PROTECT PEOPLE,
COMPANIES
AND ECONOMIES**

INNOVATING IN THE FACE OF CLIMATE CHANGE

WEATHERPROOFING PEOPLE AND BUSINESS IN THE FACE OF CLIMATE CHANGE

Global temperatures are rising and the world is facing extreme weather events like never before. According to NASA and the National Oceanic and Atmospheric Administration (NOAA), Earth's average surface temperature in 2014 was the highest on record, meaning our planet was likely the warmest it has been in a millennia. Yet the weather is increasingly behaving differently from one region to the next: the winter of 2013-2014 was one of the coldest in the US Northeast, one of the warmest in France and one of the wettest in the UK. These weather anomalies hurt businesses and people alike. Companies see their bottom lines affected, economies take a hit and vulnerable populations face severe food security and health issues.

Science and technology provide promising solutions. AXA Corporate Solutions recently launched a department solely focused on a new type of insurance: parametric, or index insurance, which uses new types of information and big data processing methods to build custom-made insurance covers against unexpected weather events.

Parametric insurance is simple: the insured's losses are correlated to an index, say rainfall in millimeters, and a set amount is paid out if that index is reached. The index can be measured via weather stations or, increasingly, satellite images, making parametric insurance one of the most innovative, affordable and fitting solutions for weather-sensitive companies and populations.

Although many are insured against natural catastrophes, very few are covered against the economic and human consequences of weather anomalies. By continually coming up with innovative solutions, AXA is committed to protecting the weather-sensitive around the world.

“Climate change warrants AXA's attention because both the science and the economics are crystal clear: this is not only an environmental issue, but a broader threat to society as a whole. And as our business is about understanding risks and managing them for our clients, insurers are uniquely positioned to provide innovative solutions in partnership with public authorities but also relevant private players”

Henri de Castries,
Chairman and CEO of AXA Group

CONTENTS

1. EDITORIAL

2. FACTS AND IMPACTS

2.1	Taking on the challenge of global warming and extreme weather	4
2.2	Increasingly erratic weather patterns	5
2.3	“Trends we have already seen are likely to worsen”	6

3. AXA'S RESPONSE

3.1	What are the main weather risks by industry?	8
3.2	AXA's bet on big data to revolutionize weather insurance	10
3.3	Understanding, mitigating and insuring weather risks	11
3.4	Transferring risk through parametric insurance	12
3.5	Index insurance: a theme park's umbrella	13
3.6	Index insurance and food security	14

4. LOOKING FORWARD...

4.1	Looking forward...	15
-----	--------------------	----

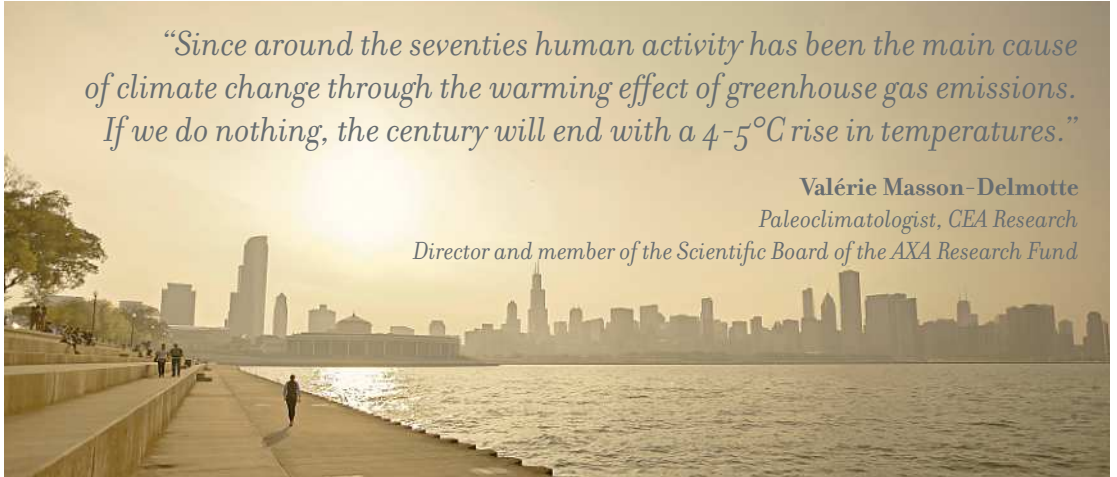
TAKING ON THE CHALLENGE OF GLOBAL WARMING AND EXTREME WEATHER

“Since around the seventies human activity has been the main cause of climate change through the warming effect of greenhouse gas emissions. If we do nothing, the century will end with a 4-5°C rise in temperatures.”

Valérie Masson-Delmotte

Paleoclimatologist, CEA Research

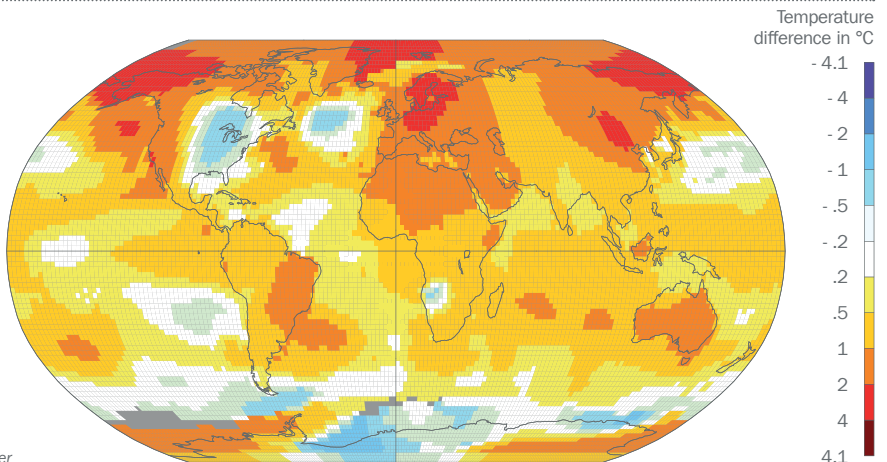
Director and member of the Scientific Board of the AXA Research Fund



Climate change and the associated likely increase in natural disasters will have a significant impact on the insurance business over the coming decades. AXA works on the modeling risk, collects scientific data and funds further research to better understand risks and how to manage them. According to NASA, since 1880,

Earth's average surface temperature has warmed by about 0.8 degree Celsius. This trend is largely driven by the increase in carbon dioxide and other human emissions into the atmosphere, and the majority of that warming has occurred in the past three decades.

Global temperature anomalies in 2014



INCREASINGLY ERRATIC WEATHER PATTERNS

Global warming does not necessarily mean warmer winters. Weather patterns develop and change over hours, days and weeks, whereas climate changes over years and decades.

Yet climate and weather are related, and global warming is resulting in an increase in extreme or erratic weather. Weather anomalies – such as warmer winters, cooler summers and rainier springs – have already risen fivefold in the past fifty years, according to the World Health Organization. Over the past few years, they have affected countries around the globe in various ways.

In Africa, notably in the Sahel region, severe droughts have destroyed crops and left millions of people hungry.

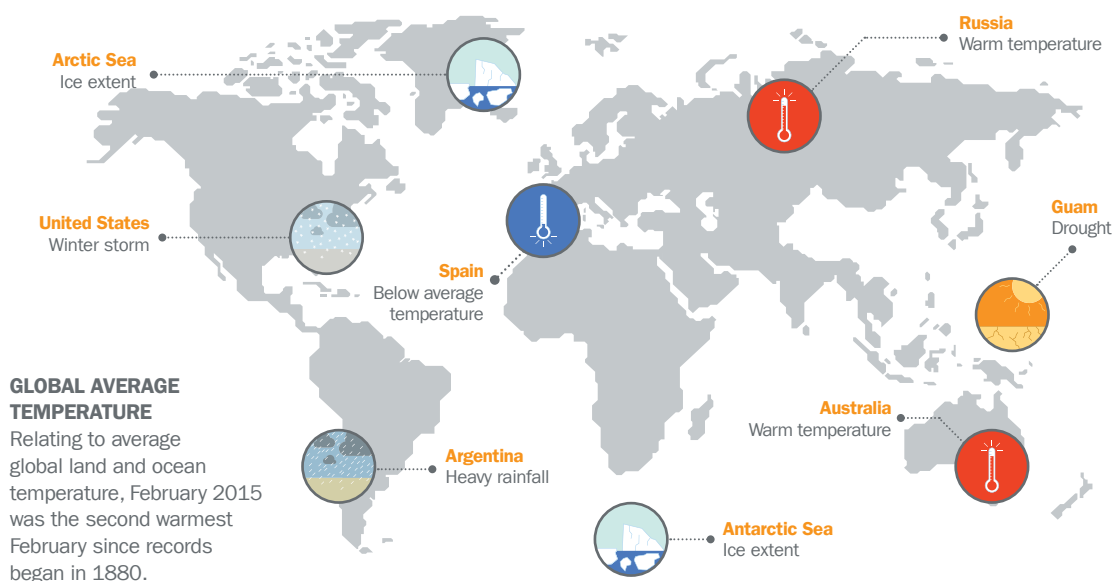
In the United States, in a large part of the Northeast, February 2015 was the most extreme winter month

in modern recordkeeping. According to the National Oceanic and Atmospheric Administration (NOAA), more than 1,000 lowest minimum temperature records were broken across the region that month, in addition to some 900 daily records for the highest snow depth.

In Europe too, abnormal weather patterns played out in the winter 2013-2014: the UK experienced the wettest winter in a century and France the second warmest winter in over a hundred and ten years.

These weather anomalies make it difficult for people and companies to find appropriate insurance coverage, and the bad news is that the Intergovernmental Panel on Climate Change (IPCC) expects their occurrence to rise fivefold in the next forty four years.

Selected significant climate anomalies and events February 2015



“TRENDS WE HAVE ALREADY SEEN ARE LIKELY TO WORSEN”

Convinced that today's research helps better prepare for tomorrow's risks, the AXA Research Fund is committing € 15 million to 44 new research projects in 19 countries in 2015. Dr. Peter Knippertz, Professor of Meteorology at the University of Leeds, is one of our experts in storm systems.



DR. PETER KNIPPERTZ,
Professor of Meteorology
at the University of Leeds

AXA: What impact does climate change have on weather patterns and weather events?

PETER KNIPPERTZ: The overarching element of climate change that most people know about is the general increase in temperature. Weather patterns and weather events are more complicated as they are more indirectly related, but one of the overarching ideas is that in the warmer world, the atmosphere can hold more water vapor, meaning more energy can potentially be released in a storm, both in the tropics and extra-tropics. This leads to a higher likelihood of heavy precipitation in the future. Additionally, many climate models show that this concentration of storm activity brings a general tendency that wetter areas – in the tropics and mid-latitudes – will become even wetter in the future, and already dry areas in the sub-tropics would become even dryer. This, of course, has many important impacts on humans, agriculture and water resources.

If you look at the global mean temperature curve, temperatures have gone up markedly already. The climate has already changed, so we are observing indications of climate change every day in that sense, but many of the trends we have already seen are likely to worsen in the future.

AXA: We observed that winter 2013-2014 was one of the coldest in the US, one of the warmest in France and one of the rainiest in the UK. How is this related to climate change?

P. K.: Typically, during wintertime in the northern hemisphere, there is a relatively strong westerly flow around the entire hemisphere, and most of the low pressure systems travel along this jet stream. In situations like we saw last winter, there was a very high-amplitude wave on this jet stream, a so-called “trough” over North America and a so-called “ridge” downstream over the Atlantic and then reaching into Britain. Associated with this are areas of strong northerly and southerly flow, respectively. Because the sea ice is shrinking in the northern hemisphere and high-latitude oceans are warming disproportionately to the rest of the world, the temperature gradient between high latitudes and low latitudes over the northern hemisphere is reduced.

There are some physical arguments that show that with this reduced North-South temperature gradient, we could expect a weaker westerly flow, so a weaker jet stream over the northern hemisphere, which is then more likely to form high-amplitude waves. Under some circumstances, these can stay in the same place, and then one area is locked under very cold weather – pos-



sibly persisting for several months – while another place could be locked under very warm and wetter-than-usual conditions. In these situations, very local seasonal extremes such as those we saw last winter are created.

AXA: How has our capacity to forecast seasonal extremes – say, predicting in September whether it's going to be a colder winter in Europe – improved?

P.K.: This is known as seasonal forecasting, and it is a research area for meteorologists and for operational weather services such as the UK's Met Office. Although still a hard nut to crack, we are making progress. We are seeing computer models with higher spatial resolution, models with a better coupling to the ocean and ice, and models that are deeper vertically, so they reach further into the stratosphere. These improvements also stem from the fact that we now have bigger

“Seasonal forecasting is still a hard nut to crack, but we are making progress.”

and bigger computers, so we are able to run more and more complicated models.

Most of the predictions that were done in the past were related to El Niño. When a strong El Niño was in place, or a strong El Niño was developing, without any model, in a purely statistical way, that made it more likely that certain parts of the world were going to be warmer or dryer, colder, wetter, etc. However, this doesn't necessarily work well for Europe. In Europe, it seems that we have to go the expensive way by running high-resolution and complicated models, and even then there remains considerable uncertainty. However, we are surely making progress.

WHAT ARE THE MAIN WEATHER RISKS BY INDUSTRY?

Natural disasters can cripple entire economies, but less spectacular weather anomalies – excess rainfall, heat or an unusually mild winter – can just as severely hit certain businesses. Agriculture, construction, energy, food and beverage, leisure, retail and transportation are the most exposed.



Construction

The main risks to the building industry are low temperatures, rainfall and snowfall, which can cause work interruptions and excess spending on specialized equipment. Concrete cannot be poured when it is too cold, so frigid temperatures can lead to a sales drop for cement makers. The unseasonably cold spring of 2013 triggered a 17% drop in revenues for the German construction sector. That year, adverse weather conditions in France caused a three-month delay on average in the sector.



Transportation

For airlines, cold temperatures and snow generate costs linked to de-icing, delays or cancellations. A single US airline lost \$200 million in the first quarter of 2014 due to the cold wave in the Northeast. On the other hand, a warmer-than-usual winter can weigh on revenues linked to de-icing for airports and their suppliers. Snow can shut down highways and hit the revenues of toll road operators. For road transporters in Europe, one day of snow can represent a €20 million loss.



Energy

Players in the energy industry – from gas and electricity distributors to producers and end users – are highly weather-sensitive. Companies and consumers can be impacted by both unusually mild winters (fall in energy consumption), and cold peaks during the season (higher production costs and energy bills for consumers). A warm winter in Switzerland in 2011 led to a 6.5% drop in energy consumption, while in France mild temperatures in January and February 2014 caused a 20% fall in the amount of gas distributed. Three in four companies are frequently impacted by the weather. They suffer dents in revenues, profitability, sometimes both.



Food and beverage

Seasonal products in the food and beverage industry, i.e. soups, soft drinks, ice cream, fresh salads, are highly weather-sensitive. Main threats include decreases in revenues or profits due to lower demand, increases in raw material costs and supply problems. For example, beer sales in France fell 15% in 2012 amid rain and low temperatures, while the cold wave in 2013 caused a 20% drop in ice cream sales in Western Europe.



Retail

Retail is particularly exposed as the business is itself seasonal and consumers' behaviors as well as logistics can be affected by the weather. Main threats for retailers include falling sales and the need to drum them up with discounts that can pinch margins. One of Europe's largest home improvement retailers posted a 20% dip in profits after the cold wave of 2013. That same year, sales dropped by 17% for spring and summer collections due to the cold weather in France



Leisure

The tourism, leisure and events industries are highly weather-sensitive: rain and cold usually mean less bookings and clients but also more costs. A French theme park saw footfall drop 20% because of cold and rainy weather in 2013. German restaurants saw revenues dip 10% during the spring 2013 cold snap. Potential losses for Italian ski resorts are estimated at €92 million in the Alto Adige in the event of a temperature increase of 1 °C above 1,800 m.



Agriculture: a particularly sensitive sector

Weather risks are a major threat to agricultural crop quality, yield and costs. Fortunately, through index insurance, we can provide area yield insurance products – for which the index is the average regional yield – as well as custom covers based on weather or vegetation indices, using high-resolution satellite data to measure soil moisture or plant development. In developing countries, AXA is building public-private partnerships and pushing for a “meso-based” index insurance solution to protect farmers against droughts or floods. We also work on custom solutions for agricultural cooperatives in developed countries, providing risk transfer solutions and special weather consulting services.

AXA'S BET ON BIG DATA TO REVOLUTIONIZE WEATHER INSURANCE

Pushing the frontiers of insurable risk thanks to big data

Parametric insurance was long unable to cater to some companies' specific weather-related risks because the meteorological data used as a trigger was imprecise. Developments in the space industry and the data revolution allow us to reduce basis risk and provide covers that reflect clients' risks much more accurately.

Today, satellite images can obtain a resolution of 250 m on average and are expected to reach up to 50 cm in a few years. We now also have the appropriate data processing methods to analyze much more granular and large amounts of data in these images (rainfall, biomass growth, wave height, air quality, ice surface, etc.).

As such, we can now offer new solutions to many vulnerable industries and improve their resilience to climate change.

AXA is already investing in the newest technologies for weather and other data, and is exploring ways to improve big data processing methods.

We created AXA's Data Innovation Lab in 2014 to:

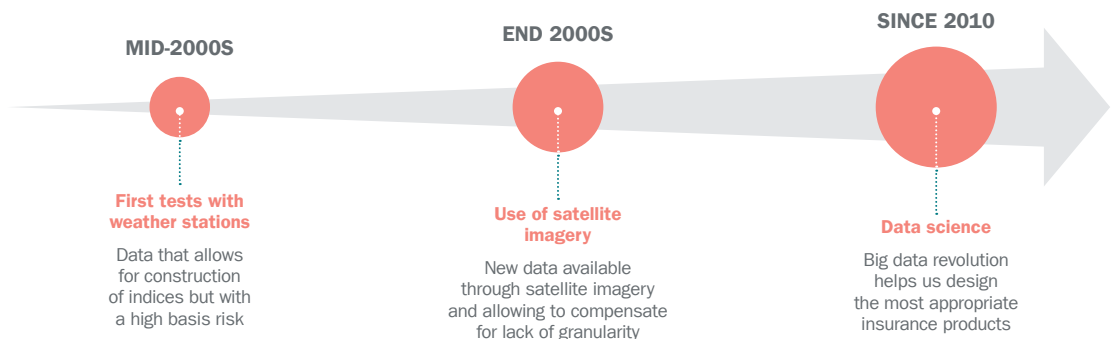
- develop big data expertise within AXA;
- accelerate entities' big data opportunities by providing data science expertise and engineering capabilities;
- be the hub for technologies and research.

“Through new technologies, we as insurers will develop innovative solutions to protect companies and the emerging world.”

Tanguy Touffut,

Head of parametric insurance at AXA Corporate Solutions

Evolution of the weather-risks solutions over the past ten years



UNDERSTANDING, MITIGATING AND INSURING WEATHER RISKS

Companies can no longer get away with blaming the weather for poor sales or performance, especially as solutions to the problem become increasingly accessible. Weather risk management will soon no longer be a luxury – it will be a necessity.

Those better able to manage their weather-related risks will benefit from stable cash flow, smoother financial results, and as a result more accurate budget management, higher earnings consistency and higher risk-adjusted returns.

Although difficult to anticipate beyond two weeks, including weather forecasts into operational management can help businesses better understand and mitigate these risks.

At AXA Corporate Solutions, we believe effective weather risk management comes in three steps:

- understanding the impact of weather on activity;
- mitigating the risk linked to weather anomalies;
- covering the remaining weather risk through parametric insurance.

AXA designed an all-inclusive and customizable weather risk management package that includes concrete solutions to understand, mitigate and insure potential financial losses caused by weather anomalies.

The myth of geographical diversification

Some international companies may argue that they are geographically diversified (e.g. operate in both the US and Europe, so good weather in one region can offset bad weather in another), but there is no direct link or symmetry between weather patterns in these regions.



In February 2015, together with Climapact-Metnext, European leader in weather consulting services, and AXA Corporate Solutions, AXA Strategic Ventures created ClimateSecure, a weather-risk management start-up that helps its clients understand, mitigate and insure financial losses caused by weather anomalies.

At AXA, we believe that innovation and technology will transform the insurance industry. AXA Strategic Ventures is a €200 million fund investing in innovative start-ups in the insurance, asset management, financial technology and healthcare service industries.

“By combining the expertise of meteorologists, data scientists, and insurance specialists, ClimateSecure adopts an innovative approach to offer its clients entirely customizable solutions.”

Minh Q Tran,
AXA Strategic Ventures



TRANSFERRING RISK THROUGH PARAMETRIC INSURANCE

Weather risks that can't be mitigated can be transferred to insurers. We believe that parametric insurance is one of the most effective, innovative and promising tools to transfer this risk.

What is parametric insurance?

Despite representing only a fraction of the total property and casualty market today, parametric insurance has rapidly gained popularity in the last decade. This relatively new approach to insurance is index-based, meaning claims are paid out based on actual meteorological conditions measured by weather stations or satellites. When the index – an objective measure (rainfall, temperature, wind speed) that is highly correlated with the variable of interest (e.g. sales, crop yield, crop quality) – exceeds a predefined value, the insurance is triggered.

An index could also be non-weather-based, say corn yield per hectare. In order to be as accurate as possible, the variable that can form an index must have the following properties:

- observable and easily measured;
- objective;
- transparent;
- independently verifiable;
- reported in a timely manner;
- consistent over time;
- experienced over a wide area.

The cover is custom-designed to compensate as accurately as possible for the losses incurred through adverse weather conditions.



“The beauty in parametric insurance is its customizability. In order to build the most appropriate cover, we bring together our client, brokers, and our team of engineers and weather experts to come up with the best-fit solution. We customize by location, dates, trigger, so each client receives a cover that accurately reflects his risk.”

Tanguy Touffut,
Head of parametric insurance at AXA Corporate Solutions

How does it work?

Putting together tailor-made risk transfer solutions is straightforward, simple and transparent. We first identify revenue and/or profitability volatility and gather historical sales data from the company in question. We then gather historical weather data at the relevant locations, either through weather stations or through satellite imagery. Next, we build a tailored weather index to match the companies' revenue sensitivity. We

then agree with the company on the deal structure and specific transaction terms and close the transaction at least fifteen days prior to the risk period.

Advantages:

- quick compensation process;
- smoothing of financial results;
- tailor-made;
- transparent;
- global coverage.

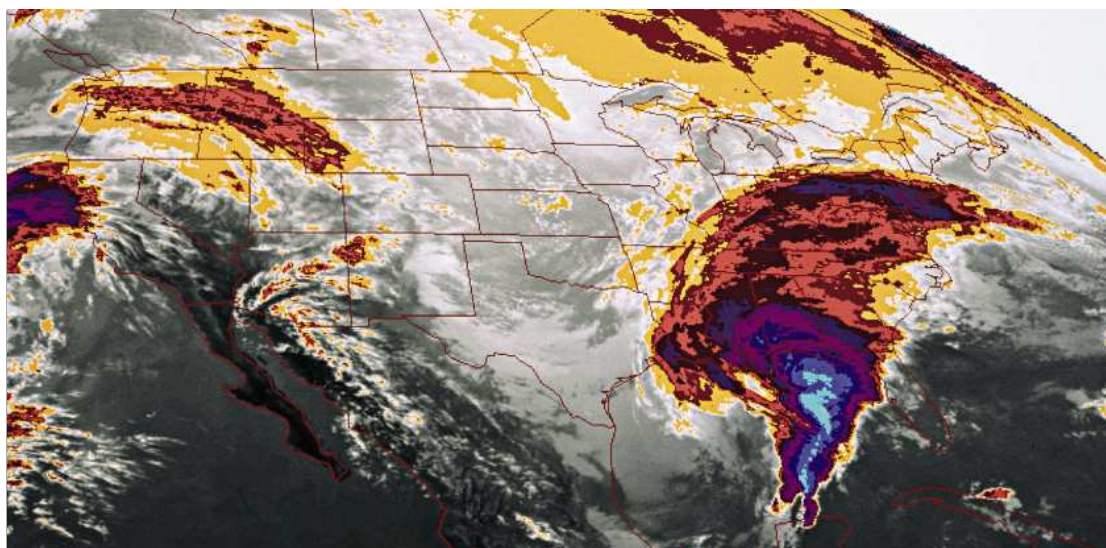
INDEX INSURANCE: A THEME PARK'S UMBRELLA

How does parametric insurance work concretely?

A theme park in the south of France was seeking a cover against rainy days during a peak season of national holidays in April-May. We identified key days for its revenue and examined historical weather data. We were able to design a custom-made cover that pro-

tested this company one critical year as it suffered six days of rain during the selected twelve-day period – more than the average drawn from historical data. Had it not been covered, the company would have posted negative results for the year.

A 3-step cover



PARAMETRIC INSURANCE AND FOOD SECURITY

Beyond business, parametric insurance can protect those populations most affected by climate change.



Climate change and weather-related risks are a huge threat for poor people in developing countries as most of them depend on farming for their livelihoods. But too few can afford agricultural insurance. Index insurance is one innovative solution to break the vicious cycle of food insecurity and help vulnerable populations become more resilient to climate change.

AXA recently entered a partnership with the World Bank Group to boost insurance coverage in emerging markets, notably in Asia, Africa and Latin America. This partnership with the World Bank's Global Index Insurance Facility (GIIF) is part of a broader global alliance recognizing the key role of the insurance sector in fostering innovation, private sector growth and overall economic development. AXA believes insurers should join forces to fully play their repair, protection and prevention roles in the emerging world.

Affordable and effective coverage for small farmers worldwide

Since parametric insurance is based on an independent and verifiable index that impacts crop development, such as temperature, rainfall or crop yield, premiums can be lowered and more farmers can afford coverage. Indeed, the cost of insurance is made up of two components: the underlying risk – which includes the frequency, severity, and extent of the impact of the loss – and administration and implementation costs. Typically in agriculture, these costs combined are very high, causing premiums to be excessive for most farmers. Index insurance can cover very large numbers of farmers without generating extra claims management costs, thus opening up affordable, effective and well-adapted solutions for the most risk-prone.

The entire agricultural supply chain could benefit from index insurance: weather risks do not only affect farmers but also the companies that supply them and the processing and logistics companies that bring their produce to market.

LOOKING FORWARD...

While companies cannot predict nor control the weather, they are increasingly expected to be able to manage its potential financial consequences. For this reason, weather risk management tools are becoming crucial means of easing shareholders' concerns over the impact that changes in weather can have on returns. For those weather risks that cannot be prevented nor alleviated, parametric weather insurance is one key means of mitigating financial risk.

Additionally, up until today, parametric insurance was unable to adequately respond to the challenge of food security for technical reasons: the meteorological data used as a trigger remained imprecise, putting risk analysis at stake and limiting the generalization of this type of solution.

Today, due to the improved resolution of satellite images and new data processing methods that allow for processing of much more granular and large amounts of data, we are confident that parametric insurance will continue to develop and improve in the future, notably in terms of:

- field of application;
- types of risks insured (parametric insurance could for instance apply to health);
- extended geography (improved satellite imagery will provide more data worldwide).



**CORPORATE
SOLUTIONS**

redefining / standards