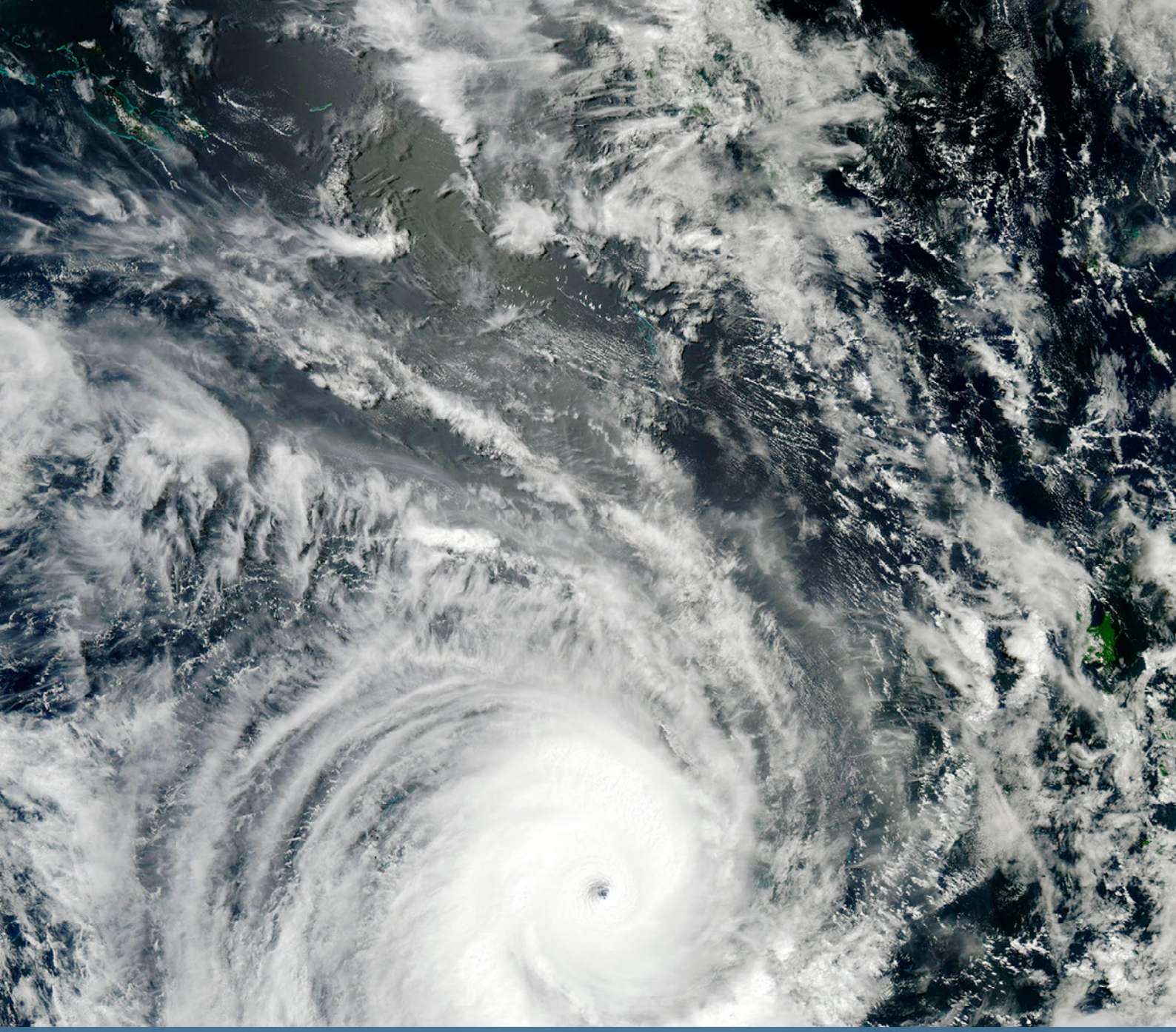


Key Findings | CROSS ASSET Investment Strategy

Measuring and Pricing Cyclone – Related Physical Risk under Changing Climate

Confidence must be earned

Amundi
ASSET MANAGEMENT

Amundi, a responsible investor

Direct effects of global warming on the planet are unequivocal: melting of glaciers, rising sea levels, unstable climate conditions, expanding deserts. This research focuses on one of the many manifestations of climate change: tropical cyclones.

Indeed, it has been demonstrated that climate change raises their intensity in a measurable way[1]. In fact, a study[2], realized over a 30-year period and since the mid-1970s, demonstrated that the intensity index of tropical cyclones has been growing already. The impact of climate change is thus undeniable and super storms are going to be the new norm.

On the economic side, the assessment of future cyclone damages requires to take into consideration multiple socioeconomic factors but also their potential dynamics in the scenario of interest.

In 2012, the annual damage from tropical cyclones was USD 26 billion according to the international disaster database (EM-DAT)[3]. In 2020, the value of the damage went up to reach USD 73 billion.

This cost is bound to increase due to rise of both population, wealth concentration in areas subject to cyclones and already unavoidable climate change.

"Acting as a responsible financial institution is a core commitment of Amundi's corporate identity. This commitment is reflected in both our responsible investment process and the solutions range that Amundi has developed to enable clients to become responsible investors. Amundi's quantitative research aims to expand knowledge to all kind of climate risks. These include not only transition risks but also physical risks such as the financial implications of extreme weather events fueled by climate change. Anticipating the costs associated with natural disasters on a global scale is essential to implement the necessary investments to help countries and companies adaptation as well as to identify and reduce the risks within investment portfolios."

1. Knutson, T. R., McBride, J. L., Chan, J., Emanuel, K., Holland, G., Landsea, C., ... & Sugi, M. (2010). Tropical cyclones and climate change. Nature geoscience, 3(3), 157-163.
2. Emanuel. (2005). Increasing destructiveness of tropical cyclones over the past 30 years. Nature, 436 (7051), 686-688.
3. Guha-Sapir, D., Below, R., & Hoyois, P. (2018). EM-DAT. The CRED/OFDA International Disaster Database. 2018.

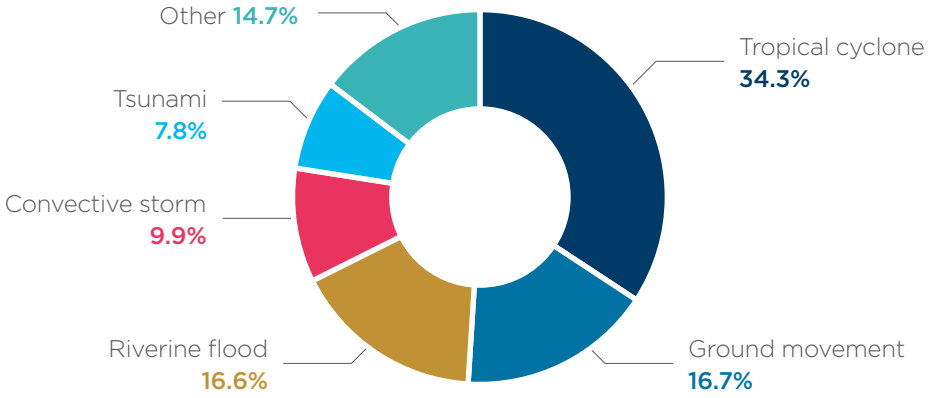
Natural disasters, major physical risk for assets

The risks associated to climate change are of high importance for long-term investors who want to safeguard their assets and ensure long-term returns. These risks are twofold: investors need to address financial risks associated to the transition towards a decarbonized economy and face direct physical risks to their assets from more extreme weather events.

While **transition risks have been under the spotlight**, the financial community tends to pay less attention to physical risks. The latter are harder to apprehend as they will materialize in the long-term and are subject to deep uncertainty. However, investors would be mistaken to overlook physical risk as climate scenario predict more intense disasters that will translate in greater losses for financial assets.

As of today, the measurement of weather damage costs is mainly addressed in the insurance market. Our study highlights that other financial actors (investors, asset managers, banks) must also take into account physical risks. This is particularly true for long-term institutional investors, who are exposed to real assets such as infrastructure, real estate, natural resources or farmlands.

Fig. 1: The EM-DAT (disaster) database ranks tropical cyclones as the costliest natural disaster (in total from 1980 until today)



Source: EM-DAT | The international disasters database.

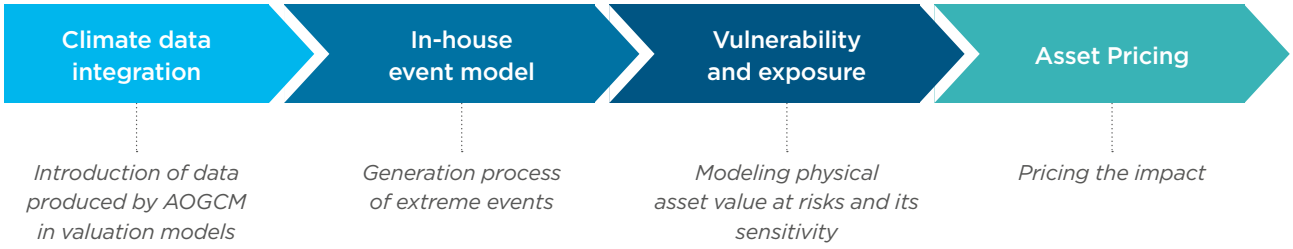
We focus on tropical cyclones because of their impact on human life all around the world and on the economy. Indeed, the global disaster database (EM-DAT) places tropical cyclones as the costliest natural disasters in terms of total reported damages. Indeed, in the past fifty years, they have significantly affected populations in Southeast Asia, Western Pacific, and Americas.

Future damages will increase due to socioeconomic factors, including population growth, urbanization, increasing coastal settlement, etc. Global warming will emphasize this growth. Indeed, the physical laws dictating the intensification of cyclones make these events particularly sensitive to climate change. In practical words, there is a significant probability that we will experience several category 5 cyclones (e.g. Katrina that caused $125bn in damage) in the same year in the future. The aim of this research is to quantify, under different climate change scenarios, cyclone related physical risks at the country level, and assess their impact on financial markets.

Amundi Quantitative Research has developed a cyclone generator to stress test the diversity of climate scenarios proposed in the IPCC assessment framework. The algorithm was trained on historical data to extrapolate the relationships between the climate conditions and the probability and intensity of the cyclones[4]. These relationships, combined with the projections of future climate in Representative Concentration Pathways (RCP)[5] allow to generate realistic synthetic future cyclones. Thereby, we can capture disasters' intensity sensitivity to climate change. The next step consists in evaluating the damage cost of simulated cyclones. Sovereign exposure is defined using the shared-socioeconomic pathways (SSP) framework[6] to represent economic development. Therefore, the framework allows estimating cyclone damage at the sovereign level based on different climate and macroeconomic scenarios. We define sovereign vulnerability from a series of regionally calibrated loss functions based on past cyclones reported damages.

4. These relationships are fitted on climate reanalysis (ERA5) and projections are drawn using 7 climate models from climate centers worldwide involved in the coupled model intercomparison project
5. From the fifth phase of the Coupled Model Intercomparison Project (CMIP5)
6. O'Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., ... & van Vuuren, D. P. (2014). A new scenario framework for climate change research: the concept of shared socioeconomic pathways. Climatic change, 122(3), 387-400.

Fig. 2: Framework assessment



The last step consists in assessing the market integration of physical risk. In the forward-looking approach, we translate the scenario-based distribution of future cyclone damage into additional debt affecting the spread of sovereign bonds.

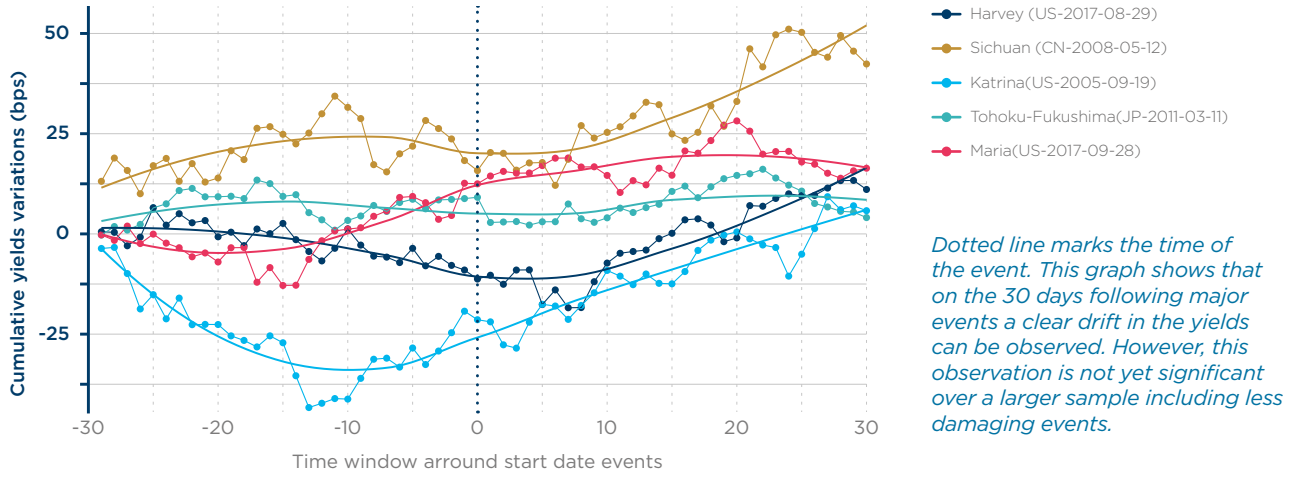
Key Findings

Our simulations suggest that future climate conditions under the highest concentration scenario (RCP8.5)[7] clearly allow for the synthesis of events whose damaging outcome would overwhelm the reconstruction capacity of the poorest countries.

Looking backward: Tropical cyclones have negative impact on sovereign bonds, local currency and stock markets.

Amundi Quantitative Research analyzed how physical risks have affected the sovereign yields and local currency valuation of developing countries in the past. Despite being hardly statistically significant, results suggest that in the past, markets reacted to natural disaster by a slight depreciation of local currency, increase of sovereign bond yields and under-performance of the bonds. However, a study of the average impact on yields of global extreme events shows that only the costliest event have a significant impact on sovereign yields. On the other hand, the impact of tropical cyclones on more liquid markets was demonstrated. For example, physical risks are already priced by the equity markets[8].

Fig. 3: Impact on 10 year sovereign yields



Dotted line marks the time of the event. This graph shows that on the 30 days following major events a clear drift in the yields can be observed. However, this observation is not yet significant over a larger sample including less damaging events.

Source: Amundi Quantitative Research from Reuters Refinitiv series.

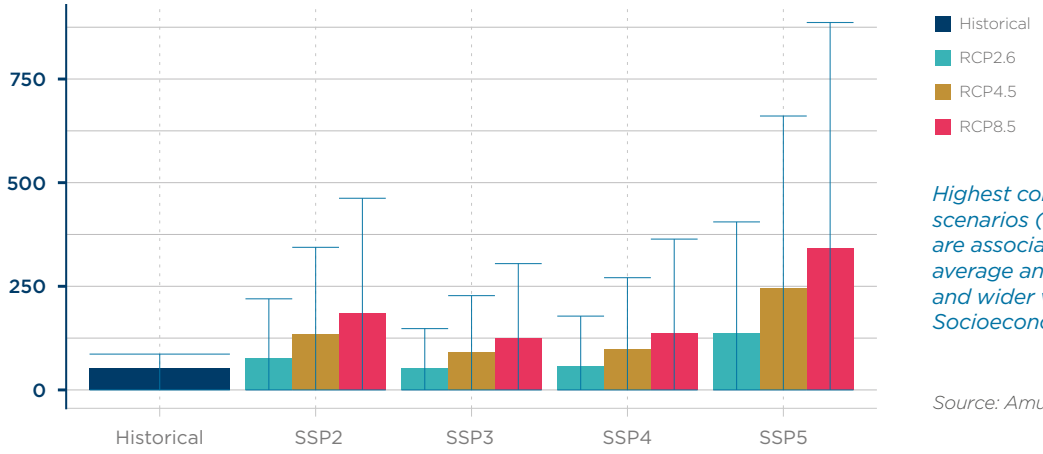
7. Representative Concentration Pathway (RCP) are labelled after a possible range of radiative forcing values in the year 2100, 8.5 W/m² is the most pessimistic scenario.
8. Lanfear, M. G., Lioui, A., & Siebert, M. G. (2019). Market anomalies and disaster risk: Evidence from extreme weather events. Journal of Financial Markets, 46, 100477.

Looking forward: Depending on global warming and socio-economic scenarios, annual financial losses can increase from 43% (best scenario) to 543% (worst scenario) by 2100.

Our simulations of synthetic damage caused by cyclones show that physical risk is particularly sensitive to the climate scenario. For example, the most optimistic scenario (the RCP 2.6 scenario, which achieves the objectives of the Paris Agreement and keeps global warming below 2°C by 2100) involves an increase in annual financial losses of 43% on average comparing to the last 40 years. In the case of RCP 4.5 (between 1.7 and 3.2°C warming by 2100) and RCP 8.5 (between 3.2 and 5.4°C warming by 2100), these increases are equal to 153% and 247%. These results were obtained under a socio-economic SSP2 scenario (the « Middle of the Road » scenario). The socio-economic scenario also is determinant to measure impact on the financial losses. In the case of the SSP5 socio-economic scenario[9] (which assumes sustained exponential economic growth), and without hypothesis on the evolution of the adaptation, the previous figures become 157%, 360% and 543% respectively. At a country level, climate change has an undeniable effect on future annualized average damage, but the real risk will most likely come from outliers (i.e. most extreme events) increasingly frequent in higher concentration scenarios.

Because of climate change, disasters intensity increase causes difficulties to some countries in paying back their debt. Although in the past, sovereign bond market reactions to catastrophic events have been moderate, climate change is increasing disasters intensity, which may compromise ability of some countries to pay back their debt. Under the assumption that the damages caused by cyclones are assimilated to additional debt, Amundi calibrated an econometric model to retrieve the exposure of the option-adjusted-spread securities sensitivity to the debt-to-GDP ratio for emerging countries in the JP Morgan Emerging Market Bond Index. This sensitivity and our damage simulations suggest that the most vulnerable countries, in particular in the Caribbean basin, are clearly exposed to spread increase (up to 200 bps) in case of extreme storm making landfall in the highest concentration scenarios.

Fig. 4: Global average annualized damage in SSPs (in billion USD)



Highest concentration climate scenarios (RCP4.5, RCP8.5) are associated with higher average annualized damage and wider variance in all Shared Socioeconomic Pathways.

Source: Amundi Quantitative Research.

Because of climate change, disasters intensity increase causes difficulties to some countries in paying back their debt.

Although in the past, sovereign bond market reactions to catastrophic events have been moderate, climate change is increasing disasters intensity, which may compromise ability of some countries to pay back their debt. Under the assumption that the damages caused by cyclones are assimilated to additional debt, Amundi calibrated an econometric model to retrieve the exposure of the option-adjusted-spread securities sensitivity to the debt-to-GDP ratio for emerging countries in the JP Morgan Emerging Market Bond Index. This sensitivity and our damage simulations suggest that the most vulnerable countries, in particular in the Caribbean basin, are clearly exposed to spread increase (up to 200 bps) in case of extreme storm making landfall in the highest concentration scenarios.

Click here to read the full article online

9. « Taking the High way » (SSP5) supposes a high adaptive capacity and sustained growth (along with intensive use of fossil fuel). This scenario naturally leads to high concentrations of greenhouse gases.

Amundi
ASSET MANAGEMENT

Date of first use September 2021.

Document issued by Amundi Asset Management, "société par actions simplifiée"- SAS with a capital of €1,086,262,605 - Portfolio manager regulated by the AMF under number GP04000036 – Head office: 90 boulevard Pasteur – 75015 Paris – France – 437 574 452 RCS Paris – www.amundi.com

Composition: Art6 - Photo credit: Getty Images — NASA/SPL.