Swiss Re Institute

CDF Engagement Initiative 2021

Promoting the Green Transformation of Economy and Society

A Three-Pillar Re/insurance Strategy to Mitigate Climate Change Risk and Support the Green Transformation

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Executive summary

Unmitigated climate change will lead to large economic losses across the globe. Understanding potential impacts from climate change and country-specific vulnerabilities to extreme weather events is a first and key step in transitioning to a net-zero world.

Our scenario analysis shows that climate change will affect emerging economies in hot regions most. For example, in our most severe scenario (assuming a 3.2°C temperature rise and most severe economic outcomes of physical climate change risks), the Association of Southeast Asian Nations (ASEAN) markets would lose most by mid-century. However, no region or country is immune. The US, Europe and China would suffer varying, but significant degrees of economic losses. The economic impacts from climate change intensify over time, which is why our mid-century results can also serve as directional guide of what's to come when temperatures continue to rise in the longer-run.

In addition to our GDP-impact scenario analysis, we also create an index that ranks countries according to their vulnerability to extreme weather events. Our index considers the GDP impact of the physical risks emanating from gradual increase in temperatures, and the vulnerability to extreme weather risks. It also factors in current capabilities to cope with the effects of climate change. Many advanced markets rank high in the index, being both less affected by climate risks and better resourced to cope. Germany, Japan, Canada and the US rank in the top quartile. Emerging markets, including China, currently have lower rankings. This is in part due to the lesser adaptation capabilities in place today compared to other major economies. However, with rising spending on green energy and in new technologies like carbon capture, China is on course to quickly close its adaptation capability shortfall.

As the financial sector, including the re/insurance industry, takes on the role to promote the transition to a net-zero emissions economy through its investing, lending and risk transfer activities, we outline the risks that the sector needs to consider and integrate into its risk management practices and business strategy. Re/insurers could provide cover for climate change-influenced risks, to maintain balance sheet strength and thereby support sustainable resilience in the following three aspects:

Pillar 1: Support climate transition by recognizing benefits of new technologies like carbon-removal techniques, as well as having limits for underwriting coal-related industry.

Pillar 2: Price climate risks by tracking and modelling latest scientific findings on climate change, and accounting for (the growing loss impacts of) secondary perils that have been inadequately modelled in the past.

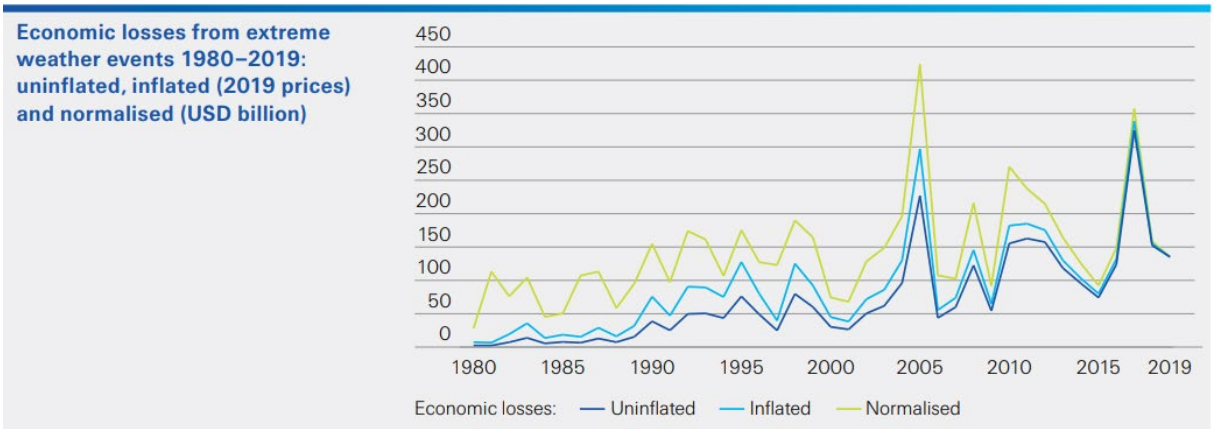
Pillar 3: Work with the public authorities by incorporating climate goals and sustainability criteria at the core. Private Public Partnerships (PPPs) should be leveraged to design, de-risk and provide financing for climate positive projects. This could have social and economic benefits, too.

Time for green transformation globally given increasing losses inflicted by weather events

Climate change manifests in the trend of rising temperature and more extreme weather events

Within this century, our world is witnessing changes and destroys affected by climate change, one of evidence is, the scale of losses inflicted by weather events have been on record globally with stronger and more deadly heatwaves, wildfires, droughts, floods, and tropical cyclones, as well as accelerated melting of polar ice, and glaciers. Based on recent sigma research, [1] normalisation adjusts to show that an event in the past, if it were to occur at the same magnitude today, would cause more damage now than in the year of occurrence due to the accumulation of value (human and physical assets) in the intervening years. All else being equal, climate change would lead to growing losses over time (Figure 1).

Figure 1 Economic losses from extreme weather events 1980-2019



Source: Swiss Re Institute

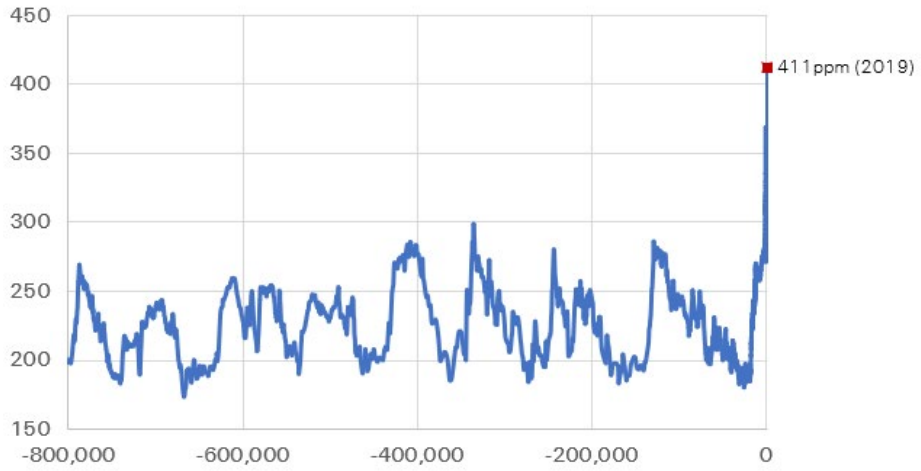
Three main components determine the impact of weather-related risks: 1) hazard or type of peril (hurricane, flood etc); 2) exposure, which refers to the populations and assets that lie in the path of weather-related hazards; and 3) vulnerability, the susceptibility of the exposed elements to the hazards. Weather-related hazard occurrence is dependent on climate conditions and natural variability. Most physical processes that define our climate and its extremes depend directly or indirectly on the temperature of the atmosphere and the oceans. Hence, any change in global temperatures and their extremes, whether from greenhouse-gas emissions or due to natural variability, will alter the risks that humans and the world are exposed to.

Climate change manifests in the trend of rising global temperature and more extreme weather events. Since the industrial revolution, human activity has continuously driven up greenhouse gas (GHG) emissions, changing the temperature of the planet and related variables such as precipitation, wind and cloud. In 2019, the concentration of carbon dioxide (CO2) in the atmosphere reached more than 410 parts per million (Figure 2). We expect warmer temperatures will lead to growing frequency of severe weather events, and that these will make an increasing

[1] Swiss Re Institute, Natural catastrophes in times of economic accumulation and climate change, sigma 2020/2.

contribution to rising losses in the coming decades. The impacts manifest most notably in more intense secondary peril events, which are smaller to mid-sized events or the secondary effects of a primary peril. For example, in 2019, the heavy rains that came with Typhoon Hagibis in Japan, the storm surge after Cyclone Idai in Mozambique, and monsoon rains in southeast Asia resulted in widespread flooding. And, while wildfires in California eased relative to 2017 and 2018, record-high temperatures in eastern Australia kept wildfires burning across millions of hectares of bushland in the longest-running wildfires the country has ever seen.

Figure 2 Atmospheric concentration of C02 over past 800 000 years (parts/million, ppm)



Source: National Oceanic and Atmospheric Administration (NOAA), Swiss Re Institute

Across the world, countries are starting to rethink their options for long-term prosperity given rising concerns for the global environment, the need to sustain and protect their domestic environment and natural capital, and the desire to promote strong and inclusive social development. As they increasingly recognize that conventional, resource-intensive economic growth can undermine their resource base and social progress, countries are increasingly moving toward green growth as their best option for long-term sustainability, social well-being, and economic prosperity.

Transition to a net-zero world is necessary and needs more actions globally

Transitioning to a net-zero world is necessary, but it comes with risks which requires a thoughtfully planned roadmap. Net-zero emissions require significant reductions in greenhouse gas emissions as well as its removal from the atmosphere and permanent storage of captured emissions. The process to significantly reduce greenhouse gas emissions entails policy and regulatory changes to remove subsidies for fossil fuels posing transition risks and to promote sectors entailing transition opportunities such as clean energy.

Furthermore, to achieve net-zero by 2050, climate science says that 10-20 billion tons of carbon emissions will need to be removed from the atmosphere each year. Carbon removal solutions come with opportunities but also significant trade-offs and negative side-effects. Nature-based processes such as reforestation which are pursued or promoted in China and Belt & Road countries come

with a particularly high storage reversal risk (i.e. the risk that the stored carbon is released again) and may entail biodiversity risks and trade-offs in land-use for other economic development activities. Technological carbon-removal solutions, on the other hand, are still at the early stage of development and subject to substantial costs. Some carbon removal solutions have also been abandoned due to their ecological side effects. [2]

As the financial sector takes on the role to promote transition to a net-zero emissions economy through its investing, lending and risk transfer activities, there are risks that the sector needs to consider and integrate into its risk management practices and business strategy. The Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) has developed a set of recommendations to ensure consistent climate-related financial risk disclosures by companies and continues to push for widespread international voluntary adoption of this standard across all financial services sectors. [3] More recently, a global group of central banks established the Network for Greening the Financial System (NGFS) which aims to redirect capital for green and low-carbon investments and integrate climate-related risks into financial stability monitoring and micro-supervision.

At national level, regulators across Europe (eg, the UK, the Netherlands, France, Germany), Asia Pacific (eg. Australia, Singapore) and in the US have conducted reviews of how financial institutions are managing the transition risks from climate change.[4] The results show that very few firms are taking a strategic approach. Considering these findings, the Prudential Regulation Authority of the UK was the first regulator globally to issue specific guidance on how firms should strategically manage climate risk. And in December 2019, the Bank of England issued the discussion paper to use its 2021 biennial exploratory scenario (BES) on the financial risks from climate change. It plans to run climate-related stress tests for the largest banks, insurers and the financial system in 2021, based on the NGFS scenario framework.[5]

Despite these initiatives, more is needed to achieve the net-zero target set by the Paris Agreement. For example, in the response to COVID-19 pandemic, governments around the world have committed more than USD 12 trillion of fiscal stimulus globally, but very few of these measures are for green, sustainable or climate objectives.[6] The EU is providing leadership by requiring member states to demonstrate that 25% of their spending should be in line with climate goals in order to access the newly created recovery fund, but actions from the US and Asian countries are largely muted.[7] In capital markets, the ESG fund universe has tripled since 2015 and manages over USD 1 trillion of assets, but still represents only 2.5% of the overall universe of 135 000 funds today.[8] Additionally, most central banks have not factored climate risks into their policy frameworks. The

[2] Swiss Re SONAR: New emerging risk insights. June 2020. https://www.swissre.com/dam/jcr:b8b148af-570f-4a7d-b51b-31462e20add4/ZRH-20-05321-P1_Sonar_Publication_2020.pdf
[3] *Recommendations of the Task Force on Climate-related Financial Disclosures*, TCFD, 2017.
[4] Including Swiss Re, which has embedded the consideration of financial risks from climate change into its governance framework. See *Swiss Re Group Sustainability Strategy*.
[5] See *The 2021 biennial exploratory scenario on the financial risks from climate change*, Bank of England PRA, 2019; *The Implications of Climate Change for Financial Stability*, Financial Stability Board, November 2020.
[6] The WEF estimates that a share of around 10% of stimulus packages – invested every year over the 2020-24 period – would be sufficient to fund the transition to achieve the goal of Paris Agreement. See *How the global coronavirus stimulus could put Paris Agreement on track*, World Economic Forum, October 2020.
[7] *Greener future post-COVID-19? Green policies & global stimulus*, Citi Research, September 2020.
[8] *ESG funds deliver,* Institute of International Finance, June 2020.

underlying reason is that climate risk analysis is inherently complex, while data gaps and methodological challenges are viewed as major barriers to assess climate financial risks. In the following section of this report, we shed light on economic risks related to climate change and introduce a climate resilience index. Then, we propose a three-pillar re/insurance strategy mitigating such exposure and supporting green transformation in the implication section accordingly.

Introducing the economics of climate change risks and climate resilience index: China is vulnerable but has much to gain from climate change adaption and mitigation strategies

Assessing the physical risks, and related uncertainties

There are many uncertainties in modelling the outcomes, economic and other, of climate change because of the complexities of biophysical science parameters and their distributions, and how these might change. We seek to further existing research to capture and assess the economic impact of this broader scale of physical risks[9] and uncertainties. We do this through a novel and complementary three-step approach:

1) Through scenario analysis to simulate the economic outcomes of the physical risks associated with ongoing and gradual climate change over time. Our scenario analysis builds on existing research by also factoring in impact variables not included in previous investigations, such as the impact of supply chain disruptions and migration. It also shows impacts for above-average warming, as well as simulating uncertainty factors.

2) We assess the exposure of countries, based on their geographical location, to the chronic physical risks of ongoing and gradual climate change, and also to severe weather events that could result from the more intense "wet" and "dry" climate conditions that global temperature rise could deliver.

3) We then build our climate index, a combination of the physical and acute risk exposure combined with a measure of countries' existing levels of adaptive capacity to cope with the effects of climate change. The index ranks countries according to the overall vulnerability of their economies to climate change risks

Scenario analysis of the GDP impacts of physical climate-change risks

Our analysis indicates that unmitigated climate change (RCP8.5) under both the 3.2°C and 2.6°C increase in global temperatures by mid-century scenarios, will lead to large economic losses globally, with a stark north-south divide in terms of impact. In the most severe scenario of an above-average 3.2°C increase in temperatures and assuming most severe economic outcomes of physical climate change (to account for uncertainty factors), by mid-century global economic output would be 18% less than in a no-climate change world. Under the same assumptions but a temperature increase of 2.6°C, there would still be a 14% loss in global GDP. Both outcomes are a stark contrast to the result that the Paris Agreement target would achieve (i.e. limiting warming to

[9] Physical risks include property damage, disruption to trade due to climate shocks (eg, severe weather events such as storms, floods and droughts), and lost productivity due to rising average temperatures.

well below 2°C and ideally 1.5°C by end of century). In this case, still assuming similarly severe economic sensitivities, global GDP would be 4.2% lower than in a no-climate change world.

In our scenario analysis, emerging economies in hot regions and oil producers would be most affected by rising temperatures over time.[10] At higher intensities of physical outcomes, the greatest negative impact shifts from oil producers to emerging Asia, on the back of the growing adverse impacts such as reductions in labour and agricultural productivity. Malaysia, Thailand and the Philippines lose more than 40% of GDP by 2048 under the most severe simulation of unmitigated climate change.

Of the world's major economies, the US, Canada and the UK would lose around 9% of GDP by mid-century in our most severe scenario analysis. Europe would suffer slightly more (11%) with economies such as Germany less exposed than southern peers (eg, Italy). China would fare worse and could see almost 24% lower GDP levels under the same assumptions.

In relative terms, a few countries would fare better. Our analysis indicates that some countries in eastern Europe and Scandinavia (eg, Denmark and Finland) are less sensitive to rising temperatures. One factor could be that higher tourism income flows to those countries offset other adverse impacts. [11] Nevertheless, even these countries would see GDP losses ranging from 1% to 6% relative to a no-climate change world.

World society must take action to mitigate climate change. Long-term tail risks need to be managed through coordinated global action, including via smart public-private investment into green infrastructure. Coordination between the top three global emitters of CO_2 (China 28%, US 15%, India 7%), which account for roughly half of all emissions, will be crucial. [12] Amongst these, India and China are more at risk from climate change than the US.

Assessment on economic vulnerability of countries

Our second analysis assesses the economic vulnerability of countries to both gradual warming as well as extreme weather events. We develop index rankings of country-specific vulnerabilities to climate change, based on their geographical locations. The rankings also factor in the current status of preparedness to cope with the fallout from adverse climate change impact according to levels of adaptive capability.

1) We use a simple ranking method to build an aggregate climate index based on an RCP 8.5 scenario and the projected temperature rise trajectory in our 49 sample countries, under that unmitigated climate change world. We assign a 70% weight in the index to the physical risk space, divided between chronic and acute risks.

[10] Higher temperatures will lead to lower energy demand for heating purposes and on aggregate drive down oil prices.
[11] Future global tourism revenues will depend on the overall economic impact from climate change and its distribution. The more severe the impact, the more tourism will likely shrink.
[12] "Largest producers of fossil fuel CO2 emissions worldwide in 2018, by share of emissions", *statista.com*, 7 September 2020.

2) Our index also includes a proxy to measure a country's current capability to cope with the negative impact from climate change: the "Climate Change Adaptive Capacity" index from Verisk Maplecroft.[13]

In relative terms, many of the large economies in advanced markets are in strongest position to withstand the negative impacts of climate change. For example, Canada, the US and Germany are all within the top 10 of the list in terms of climate resilience. They are all located at higher latitude, suggesting less stress on productivity from rising temperatures. They also have more robust mitigation infrastructure. China (see *Country cases*) and India rank relatively weak (42 and 46, respectively). This reflects the heavy GDP-impact loss projected in our scenario analysis (China, GDP -18.1% by mid-century; India, GDP -27%), and also, to date, low levels of adaptive capacity.

The index rankings show that climate change tends to have a larger negative impact on developing countries with lower per-capita income. For example, countries in Southeast Asia, Latin American, the Middle East and Africa rank low in terms of aggregate physical risk and adaptation capacity.

Country cases: Finland, US, Japan and China

Finland scored the first rank as least vulnerable country: as one of the northernmost countries in Europe, global warming will likely not inflict notable productivity losses. The country's tourism industry could even benefit from the rising temperatures. The main vulnerability is indicated by a relatively high CRS wet score, which suggests an increase in occurrence of heavy precipitation events. The economy in Finland will also benefit from the country's high existing level of adaptive capacity.

The **US** (rank 7) has experienced heavy precipitation in recent years as a result of severe weather events, particularly during the North Atlantic hurricane season. This has led to widespread flooding, also as a result of storm surges, in coastal areas of high population and economic asset density. Sea level rise could lead to more extreme flood events. Still, the US ranks high in terms of potential economic impacts and current adaptive capacity. The CRS dry climate score for the US is poor, and related heat stress could negatively impact labour productivity. Severe dry conditions have been the root cause of recent major wildfire events, most notably in California. Increased habitation in wildland-urban interface areas could compound the losses from heat (drought) and fire events in the future.

As an island nation in east Asia, **Japan** (rank 11) is particularly exposed to sea-level rise risk, coupled with frequent typhoons on the Pacific coast side of Honshū where most of the population lives. Crop yields will suffer in rising temperatures and heat stress would negatively impact human productivity during hot days in summer. On the other hand, Japan is well-equipped with robust infrastructure to counter the multiple natural perils, such as resilient buildings and clean energy. It consequently ranks relatively high in terms of adaptive capacity.

[13] This is a composite index with multiple input factors including strength of existing institutional set-up (eg. government stability, presence of a national disaster management ministry, agency or body), level of education and innovation, management of resources (eg. average dietary supply adequacy, pressure from future population growth), degree of reliance on a vulnerable economy (ie. agriculture value added as a percentage of GDP), public awareness, and scope of existing finances and burdens (mainly measured through GDP per capita).

With a wide distribution/spread of productive resources on account of the sheer size of the country, **China**'s (rank 42) economy is vulnerable to both extreme dry and heavy precipitation weather events at this stage. For example, agriculture accounts still for about 7% of national output, and production in this sector can be severely impaired by weather extremes. Meanwhile, heat stress could impact health conditions, which in turn could weigh on labour productivity. The large negative GDP impact indicated by our scenario analysis is accentuated by China, according to the Maplecroft index, as of today still having relatively low adaptive ability to manage climate change effects. However, with rising risk awareness on climate change and rapidly increasing spending on associated R&D and technology (such as carbon capture), China's overall adaptive capabilities will likely strengthen considerably in the coming years.

Climate risk is a systemic risk requiring coordinated action. Global policy action is needed to ensure equitable progress in greening economies, both for local benefit and to make the world economy more resilient in the long term.

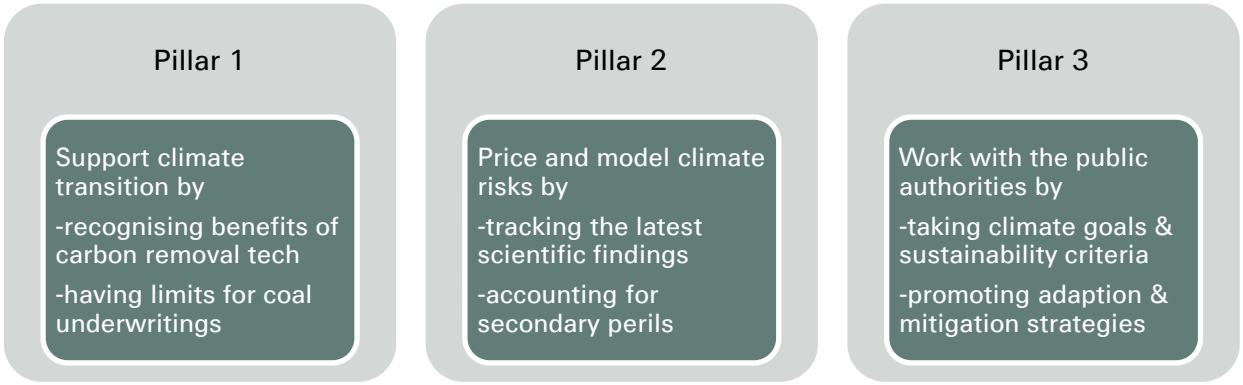
A three-pillar re/insurance strategy needed to promote green transformation

Importantly, we believe weather-related risks remains insurable, which indicates re/insurance could support green transformation through mitigate climate risks. This is due to the short-term nature of most property re/insurance business, which allows for continuous adjustment of risk views. The main effect of climate change on insurers is rising loss costs. The effects of rising temperatures are already feeding through to higher insured claims (eg, for property damage, crop shortfall, business interruption) from some secondary perils, including heat waves, wildfires, droughts and torrential rainfall. These are hazards for which confidence of a direct link with rising temperatures is medium/high. For other hazards like hurricanes (so-called "primary" perils), there is still much uncertainty around cause and effect with respect to climate change. This is in large part due to the relative infrequent occurrence of primary perils, and the complexity of their formation.

Re/insurers should use their deepening understanding of risk to help households, private companies and societies mitigate and adapt, the aim being to protect a greater share of the global assets. Insurance is a central component of building resilience at the macro- and micro levels. This is also acknowledged in the United Nations' (UN), Sustainable Development Goals (SDGs), which include insurance as a main tool to strengthen the resilience of societies. The 2030 Agenda for Sustainable Development makes explicit references to disaster risk reduction and includes numerous targets that capture various aspects of resilience.[14] There is a three-pillar re/insurance strategy to support green transformation over the course to a net-zero emissions economy (Figure 3).

Figure 3 A three-pillar re/insurance strategy to support green transformation

[14] *Transforming Our World: The 2030 Agenda for Sustainable Development,* United Nations, 2015, https://sustainabledevelopment.un.org/post2015/transformingourworld.



Source: Swiss Re Institute

Pillar 1: Support climate transition by recognising benefits of new technologies like carbon removal techniques, as well as setting limits for coal underwriting.

Innovative insurance could facilitate continued growth of the carbon removal industry. In general, insurers may increase their understanding of the new carbon removal risk pools by designing pilot offerings for property and engineering covers and investing at small scale, to gradually build up the necessary risk knowledge for profitable business in the future. At the same time, re/insurers should have limits on fossil-fuel industry to support transition of energy to renewables while also boosting energy efficiency.

Pillar 2: Price and model climate risks by tracking the latest scientific findings on climate change and accounting for (the growing loss impacts of) secondary perils that have been inadequately modelled in the past.

Insurers should better quantify the impact of frequency and severity changes of losses in the coming two to three years, and also better understand how to adjust historical loss experience to design sustainable and suitably priced products for the near future. For example, a line of business highly susceptible to climate change is agriculture: observations, physical theory and numerical modelling all converge to show increased frequencies of heatwaves and agricultural droughts in most parts of the globe.[40]

Pillar 3: Work with the public authorities by incorporating climate goals and sustainability criteria at the core. Private Public Partnerships (PPPs) should be leveraged to design, de-risk and provide financing for climate positive projects. This could have social and economic benefits, too.

The public and private sectors, including insurers as providers of risk transfer capacity and long-term investors in mitigation infrastructure, can facilitate and accelerate the transition to a low-carbon economy. An introduction of a global carbon tax, harmonised and transparent regulatory approaches, a stronger role of rating agencies, insurers' commitment to a "net zero" asset and underwriting portfolio and PPPs with sustainability criteria at their core would all support the climate transition.

Last but not least, the insurance sector also contributes to the net-zero target by providing long-term investments in renewable infrastructure that comply with ESG criteria. As institutional investors, insurers are well positioned to invest in the transition to a low-carbon economy. Moreover, assets are particularly vulnerable to stranding where the level of emissions associated with extracting and processing a resource would exceed the available carbon budget. Failure to switch to low-carbon portfolios bears elevated risk of assets experiencing pre-mature write-down or devaluation (eg, “stranded assets”). The industry can do more.