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Environmental, Social, And Governance:

Model Behavior: How Enhanced Climate Risk Analytics Can Better Serve Financial Market Participants

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(***Editor's Note:*** *Steven Bullock and Rick Lord at Trucost (part of S&P Global) also contributed to this article. This report reflects the discussion held by the S&P Global Ratings Sustainable Finance Scientific Council on June 10, 2021).)*

Key Takeaways

- In the absence of a perfect solution, enhanced analytics can provide market participants with greater clarity about an entity's exposure to physical climate risks. Climate risk data is best used to inform analytical judgement, to improve transparency, and to enrich market participants' dialogue with exposed entities.
- Appetite for such data--describing an entity's potential exposure to the future physical impacts of climate change--is growing. The availability of climate risk analytics is growing exponentially and is putting the spotlight on entities' unmitigated exposures.
- Translating the outputs of climate models into specific potential impacts is far from straightforward, more so when considering the financial materiality of climate events.
- Standardizing terminologies and data quality thresholds, as well as establishing appropriate use cases, will aid the comparison of outcomes and help avoid maladaptation and misuse. Supplementing climate model outputs with entity-specific data will help to rationalise information.
- Using multiple scenarios may help decision-makers consider a broader range of outcomes. In risks-and-opportunities assessments, this could bring greater clarity as to the types of interventions that may be required and help assess the adequacy of entities' responses to climate risks.
- The next generation of models is well placed to help rationalize the complexities of climate science. Integrated Assessment Models (IAMs), non-equilibrium models (models that assume more complex, non-linear relationships between climate variables), and/or dedicated case studies offer potential solutions as well as their own challenges.

PRIMARY CREDIT ANALYSTS

Paul Munday
London
+ 44 (20) 71760511
paul.munday@spglobal.com

Michael Wilkins
London
+ 44 20 7176 3528
mike.wilkins@spglobal.com

SECONDARY CONTACTS

Peter Kernan
London
+ 44 20 7176 3618
peter.kernan@spglobal.com

Kurt E Forsgren
Boston
+ 1 (617) 530 8308
kurt.forsgren@spglobal.com

Matthew S Mitchell, CFA
Paris
+33 (0)6 17 23 72 88
matthew.mitchell@spglobal.com

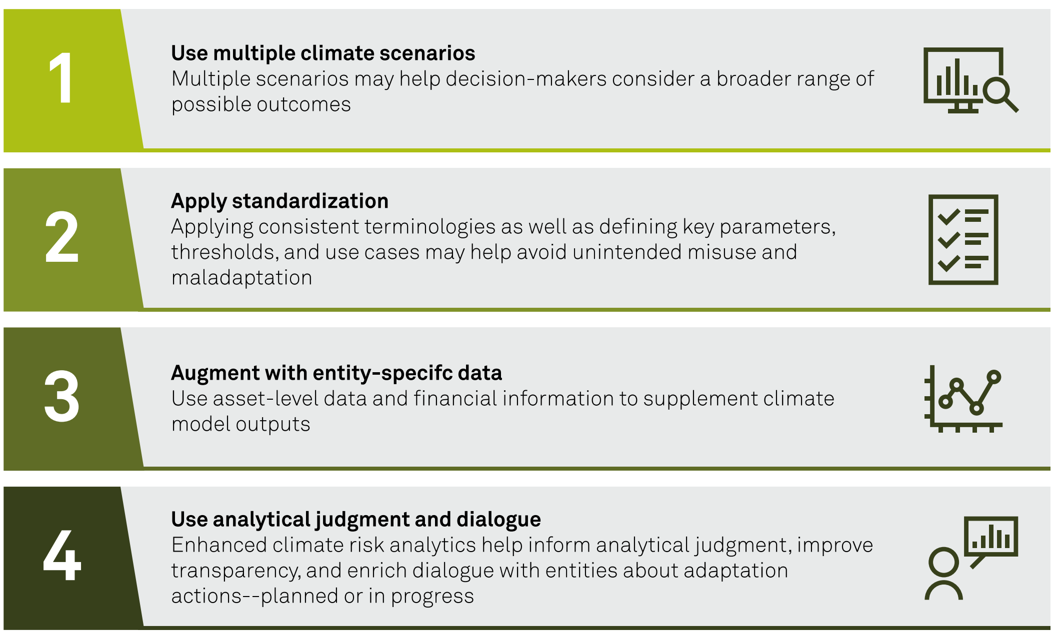
Bernard De Longevialle
Paris
+ 33 14 075 2517
bernard.delongevialle@spglobal.com

The Appetite For Better Climate Risk Analytics Is Growing

Trucost (part of S&P Global) has found that two-thirds of global companies have at least one asset that is highly exposed to the physical impacts of climate change under the most severe 2050 climate change scenario (which assumes a global average temperature rise of 3.6 degrees Celsius). Without understanding the potential physical impacts of climate change on entities, market participants (governments, financial supervisors and corporate regulators, and financial services companies, among others) will find accurately pricing in climate-related risks and opportunities an increasing challenge. Indeed, this may also prove challenging for financial institutions, as owners or capital providers, as well as savers who depend on improved returns and interest. The availability of climate risk analytics has increased exponentially, and may help entities understand their exposures. However, the lack of standardization and the complexities of climate science (as well as the precise crystallization and severity of impacts) is compounding the uncertainties.

In our view, enhanced climate risk analytics combines outputs from climate models and other dedicated models (IAMs for example), scenario planning, and other entity-derived and asset-level data, with analytical judgement based on interactions with entities, to develop better informed views about entities' potential exposure to the physical impacts of climate change.

Four Steps To Better Climate Risk Analytics



Source: S&P Global Ratings.

While uncertainty surrounding the physical impacts of climate change continues to challenge financial market participants, record-breaking years now appear more certain than ever. 2020 was no exception according to the World Meteorological Organization (WMO). Record temperatures were logged globally including in Verkhoyansk in Russia, which reached 38°C/100.4°F for the first time--the highest recorded anywhere north of the Arctic Circle. Global sea levels and greenhouse gas (GHG) concentrations also reached new highs while glaciers continued to melt rapidly and the extent of Arctic sea-ice registered new seasonal lows. Ocean heat content (which helps drive the world's weather systems) was the warmest on record. This is even more remarkable given the natural cooling effects and muted weather conditions associated with La Ninã in the east-central Pacific later in 2020. More notable still is that the La Ninã year of 2020 matched the warmth of one of the strongest El Niños on record of just a few years earlier. This arguably shows the overwhelming impact of GHG emissions on global temperatures, as reported by Carbon Brief.

The Costs Of Acute Events Have Prompted Action, And Floods Of Data

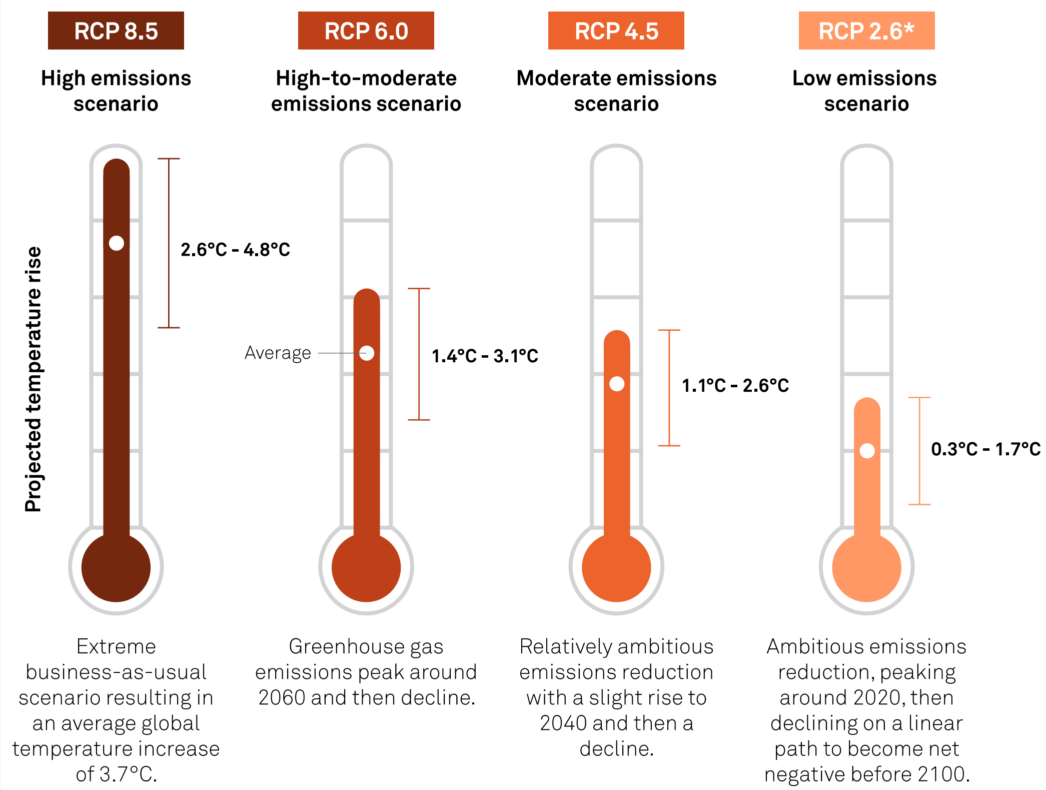
The costs of extreme weather are mounting. Five of the worst natural disasters in the U.S. have all occurred since 2005 (amounting to $523 billion in CPI-adjusted overall damages) while 22 major disasters, exceeding $1 billion, hit the U.S. last year alone (six more than the previous record) according to the National Oceanic and Atmospheric Administration (NOAA). Heavy rain and flooding in 2020 affected large parts of Africa (specifically the Sahel and Greater Horn of Africa) and Asia (the Indian subcontinent and China, Korea, and Japan). Severe droughts visited South America (Argentina, Paraguay, and the western border areas of Brazil). According to the WMO, acute weather events also triggered population migrations in Central America and the Pacific region amid the compounding effects of the pandemic.

The Financial Stability Board established the Task Force on Climate-related Financial Disclosures (TCFD) in 2015 with the aim of increasing the transparency of climate risks and opportunities in global capital markets (see TCFD, 2017a). Since then, governments (Belgium, Canada, Chile, France, Japan, Sweden, and the U.K.), corporate regulators (such as the International Organization of Securities Commissions and the Financial Conduct Authority), and central banks in Europe, Asia, and Latin America, have affirmed their support of the TCFD. These bodies are responding to the increasing momentum and widespread recognition of how the capital markets benefit from such disclosures, as well as the demands of investors and insurers.

How has the market responded? As the EU's roadmap for climate services (EC, 2015) notes, climate service providers (CSPs)--companies that compile and sell environmental data--have rallied to plug the information gap with technologies and analytics that help entities translate exposures to different climate hazards into financial risks, using multiple timepoints and scenarios (or representative concentration pathways [RCPs]). In the EU alone, there are already 371 known public and private CSPs (see Cortekar et al., 2020).

What Are Representative Concentration Pathways?

The RCPs were developed by the Intergovernmental Panel on Climate Change (IPCC) in 2014 to describe different futures based on a range of GHG concentration levels in the atmosphere, driven by economic activity, energy sources, population growth, and other socio-economic factors.



*RCP2.6 is the only scenario that aligns to the Paris Agreement target to limit the average global temperature increase to well below 2°C. Sources: IPCC, S&P Global Ratings.

Making Sense Of And Adding Value To Climate Data

Translating the outputs of climate models into specific potential impacts, as well as gauging the financial materiality of climate events, pose many challenges and are further compounded by uncertainty. The timing and geographic scales over which hazards (and impacts) play out, as well as the effectiveness of adaptation measures (either in place or planned) to mitigate exposures, are difficult to rationalize without a detailed assessment of an entity's past performance and knowledge of key risk tolerances and/or thresholds. The approach and underlying datasets used by CSPs may also yield different results (see Hain et al., 2021).

Financial market participants' information needs may also vary, both in terms of the granularity of assessment (that is, specific assets or asset classes ranging from single assets to many thousands of assets, regions, and/or sectors) and selection of appropriate timepoints. An entity might be planning for the longer term (30 years or more) or for a specific short-term window, perhaps timed for an investment cycle. Comparability is an important issue. Financial market participants' needs vary both geographically and in time, yet solutions are needed that adequately address both. And comparability inherently assumes reliable, replicable data.

The comprehensiveness of actions entities take to adapt to the physical effects of climate change also partly depends on public policy decisions, which may be influenced by electoral cycles and are subject to change. The relationship between climate change mitigation and adaptation increases uncertainty. For example, future public policy decisions about carbon pricing and emissions reduction targets will influence GHG emissions, which may affect the long-term frequency and severity of climate hazards.

Some commentators (see Fiedler et al., 2021; Hain et al., 2021; Nissan et al., 2019; Pindyck, 2017) have further cautioned against the rapid (unsupervised) uptake of climate risk analytics, highlighting the potential for unintended misuse in the context of financial decision-making and disclosures. As Fiedler explains, the potential implications of misuse are widespread. These include maladaptation (where adaptation backfires and serves to increase rather than decrease vulnerability); misplaced confidence in the assessments of climate risks and/or increased vulnerability of an entity to climate risks; material misstatements in financial reports and the potential for associated litigation; and the unintended consequences of greenwashing. Indeed, in the case of long-term capital investments in public infrastructure, which often has a multi-decade operational lifetime, maladaptation is a real risk--more so than in the popular short-term investment cycles of private-sector capital allocations to liquid or semi-liquid assets (Keenan, 2019). Furthermore, the compounding uncertainty associated with climate model outputs—including the rationalization of both the direction and magnitude of change in different climate hazards, as well as model limitations (that is, resolving highly localized, acute, events)—may lead to false precision if a limited sample of outputs is used to assess an entity's exposure. Indeed, Hain goes further to argue that financial market participants should avoid placing too much confidence in a single source.

Amid these challenges, which solutions should be prioritized? The first is relatively simple. Standardization has long been called for, but interest in it has understandably recently increased (see Bessembinder et al., 2019). Standardization is most beneficial when applied to developing a set of consistent terminologies, defining a set of appropriate use cases, and identifying key parameters and data quality thresholds that support comparability of outcomes. In our view, standardized, geographically specific, credit-risk-relevant disclosures would enhance and allow comparable assessments of climate-related risks/opportunities and their potential impacts. Standardization would support better analysis of entities' vulnerability to physical climate risks and better inform actions to mitigate and adapt to climate change, as well as reduce reliance on models and proxies. Standardization, in our view, is less useful when applied to methodologies because the approach for processing data in different global regions or localities will necessarily vary. Developing and assessing the professional competencies of data users should also be a focus area, to ensure outputs are appropriately used and interpreted, including by financial market participants.

Another solution is one that S&P Global Ratings, in collaboration with Trucost, has adopted in its applied research. We supplement the outputs of climate models with entity-specific data, such as asset-level data and revenues derived from publicly available information; licensed datasets; and our own models. If we have a clear view of an entity's assets, including their value, then we can begin to understand the possible financial effects of projected changes in climate hazards on the value of those assets over time. This analysis brings useful insights into an entity's unmitigated exposure to different, material, climate hazards. Our analysis can also facilitate and enhance dialogue with entities to understand their perspective about the risks posed by acute events (such as wildfires, floods, storms) and chronic events (related to long-term changes in precipitation and temperature patterns), and how those risks are being managed, monitored, and mitigated. This approach can be enhanced by leveraging the benefits of using multiple scenarios to help inform decision-making (see Related Research for examples of how we have applied this approach.)

Case Study

Damage Limitation: Using Enhanced Physical Climate Risk Analytics In The U.S. CMBS Sector

Using Climate Change Physical Risk data from Trucost, we undertook a scenario analysis using enhanced climate risk analytics to explore the exposure of 11,501 properties backing U.S. CMBS loans to seven climate hazards (heat wave, cold wave, sea level rise, wildfire, hurricane, water stress, and flooding), across multiple RCPs and timepoints (2030 and 2050).

For U.S. CMBS, physical climate risks may pose a threat to the creditworthiness of many issuers where locations are fixed, and the risk cannot be diversified away. Depending on the circumstances, the damage caused by such events may go well beyond repairs. The associated loss in property value may be significant, potentially reducing the value of a property to its land. In extreme cases, land values could turn negative.

Our analysis revealed patterns of exposure across the U.S, with specific metropolitan statistical areas (MSAs) showing greater exposure to wildfires and earthquakes--Los Angeles, San Francisco, Miami, and Houston. About 5% (605) of the 11,501 properties backing U.S. CMBS transactions that we rate are highly exposed to wildfire, with 99% of these assets spread across 10 states (California concentrates most of the risk). By 2050, we expect a significant 8% (664 properties or 6% of the U.S. CMBS universe that we rate) increase in the absence of adaptation measures. We specifically noted the increase in the number of properties with high exposures in Washington (from 0 to 61 in 2050 under a high stress scenario--RCP8.5).

This type of information may help improve risk awareness, enhancing the quality and depth of dialogue among all stakeholders, and refine risk analysis to ultimately support more informed decisions and holding strategies. Ultimately, if climate scenarios highlight material unmitigated exposures or point to major uncertainties and therefore risk, they can weigh on our views of current and future credit quality, if not mitigated by other credit factors such as capital and financial planning and coordination with regulators and other entities.

Using Multiple Scenarios Helps Decision-Makers Consider A Broader Range Of Possible Outcomes

Scenario analysis has long been used as a tool to help build organizational resilience and to identify risks and opportunities before they emerge. However, it is not yet in common use for assessing climate-related risks and opportunities and/or is relatively new to many market participants.

The U.S. military first used scenario planning in the 1940s to inform its strategic decisions. Over time, focus switched to the consideration of "unthinkable" events like nuclear war, and better preparedness. Companies and governments then started to adopt scenario planning to help generate foresight about potential market opportunities and to reduce investment risks, and to build organizational resilience. In the 1960s, environmental disasters increased their popularity. In the 1970s, Royal Dutch Shell leveraged its scenario planning experience to plan ahead of its competitors and quickly react to falling oil prices.

More recently, scenarios have been used to understand the depletion of the ozone layer, resulting in the Montreal Protocol in 1997 (credited as the most important example of environmental legislation to date). They have also most widely and recognizably been used by the IPCC to describe future GHG emissions and associated levels of global warming. A common theme, and resulting best practice, is the benefits to stakeholders of using multiple independent scenarios in risk and opportunity assessments. This allows decision-makers to consider (and build resilience to) a broader set of possible outcomes and/or to understand how different permutations and/or temporal developments can generate different results (see TCFD, 2017b). Indeed, climate scenarios themselves should not be considered as forecasts of the future.

We believe that enhanced climate risk analytics can increasingly play a critical role in building an entity's resilience to the physical impacts of climate change. Analytics can improve transparency and foresight about potentially material (unmitigated) exposures, as well as help a better analytical interrogation of climate hazards, including the crystallization of possible effects and management responses that may be required.

Climate risk analytics that necessitate multiple scenarios also help market participants consider potential longer term risks, generating a richer dialogue about the interventions that may be required. Better data could help investors and insurers understand the adequacy of an entity's planning for, and responses to, the increasing financial threat posed by acute and chronic climate risks. However, while the availability of better data in the form of climate risk analytics should be celebrated, the next generation of models will need to be even more sophisticated to better take account of the complexities that our climate presents.

The Next Generation Of Models Is Well Placed To Respond To Challenges

Climate hazards frequently do not happen in isolation. And, importantly, such hazards do not respect geographical or administrative boundaries, with their far-reaching effects cascading through different sectors. We know, for example, that the risk of landslides increases after wildfires, and that consecutive dry winters significantly increase drought risk.

Climate change also has the potential to create new interdependencies, as well as amplifying existing ones. As we have observed, stronger and more frequent summer heat waves can lead to buildings and infrastructure systems overheating, as well as to ill health leading to pressure on healthcare services, lower economic productivity, and reduced tax receipts. We may also see increased energy and water demand and heightened competition for natural resources. These interactions pose a challenge for existing models used by CSPs, which are, by their very nature, siloed and unable to resolve the complex interactions (including both positive and negative feedbacks) and cascading nature of climate hazards.

IAMs offer a potential solution by grouping multiple models together such that the impact chains that join our environmental, socio-economic, and climatic systems may be resolved. IAMs have been used extensively to explore cascading impacts, shared benefits, and unintended consequences. They have been used in international climate change agreements related to carbon markets to better understand the optimal balance of climate mitigation and adaptation measures, and the costs associated with different climate policy targets. A key benefit of IAMs is their ability to rationalise the effects of GHG mitigation efforts and adaptation actions on the climate system and, in turn, the efficacy of associated strategies. Notable practical applications include exploring the interaction between climate and air pollution policies; understanding the increased competition for water between agriculture and power plant cooling; the effects on water, land, and resulting land emissions of global policies that rely on large increases in biofuels; and the analysis of adaptation costs and benefits that helped to substantiate the co-benefits of adaptation and mitigation efforts (see Weyant, 2016, for a useful summary).

However, IAMs have limitations. They cannot measure economic damage and gauge reduced growth caused by, say, a severe storm, nor can they calculate the costs associated with adaptation. Further, the adaptive capacity--that is the ability to adjust to changes and take advantage of risks or opportunities-- of individual companies is also poorly understood and challenging to replicate at scale. Such models are typically calibrated to global mean temperatures or climate models. This may limit the insights they can bring to financial market participants into the extreme (or tail) risks associated with the more frequent and acute risks expected amid climate change. Furthermore, such models are inherently complex, produce large outputs, and are costly to run. The implication is that many of the challenges of the existing models, including uncertainty and the risk of users' unsupervised misinterpretations of outputs, are equally likely to apply to the next generation of models as they come online. This presents a challenge to market participants and CSPs, as well as to defining the precise role of such models in helping to resolve the known interactions of our environmental, socioeconomic, and climatic systems.

Meanwhile, some commentators argue that non-equilibrium models (models that assume more complex, nonlinear, relationships between climate variables), and/or case studies that focus on specific risks and/or transmission channels, are viable alternatives. Applying multiple scenarios as part of sensitivity testing is likely also to be beneficial (see Bolton et al., 2020).

As of now, no perfect solution yet exists to how we might resolve the material financial effects of physical climate risks, yet this shouldn't be an excuse for no action. Indeed, enhanced climate risk analytics can provide a clearer picture as to how bad (and costly) things could become for entities amid climate change. While technology will develop apace to help bring greater clarity to companies' climate risk assessments, analytical judgement is needed more than ever to rationalize outputs and to inform better decision-making. In such a fast-moving field like climate risk analytics, where the past provides only a narrow, short-term view of the future, expert judgement is therefore more important than ever.

Therefore, we are best to focus on using such data to inform our analytical judgements, to improve transparency about how we consider such risks in our analyses, and to enrich dialogues with entities about actions (planned or in-flight) they will take to build long-term resilience to climate change, whatever the future may hold.

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Related Research

S&P Global Ratings research

- Damage Limitation: Using Enhanced Physical Climate Risk Analytics In The U.S. CMBS Sector, Feb. 19, 2021

- Scenario Analysis Shines A Light On Climate Exposure: Focus On Major Airports, Nov. 5, 2020
- Better Data Can Highlight Climate Exposure: Focus On U.S. Public Finance, Aug. 24, 2020
- Through The ESG Lens 2.0: A Deeper Dive Into U.S. Public Finance Credit Factors, April 28, 2020
- U.S. Municipal Sustainable Debt And Resilience 2020 Outlook: Sprouting More Leaves, March 4, 2020
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