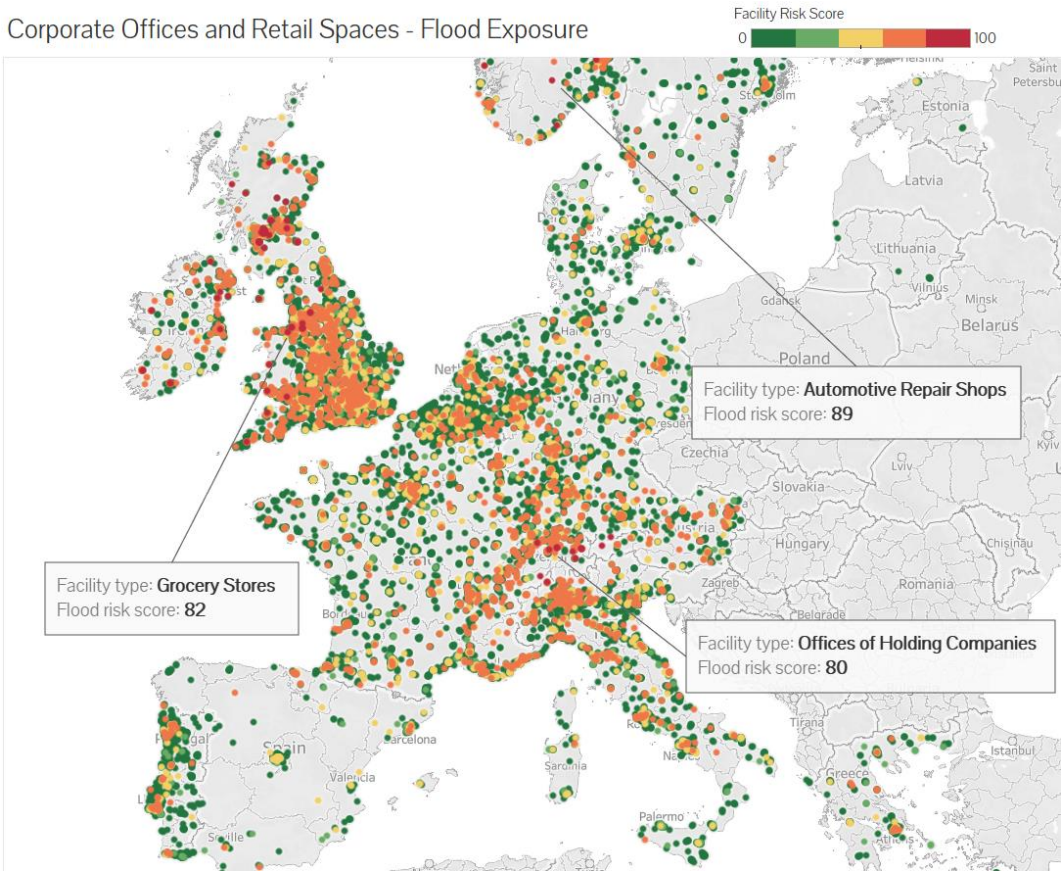
Real Estate Climate Risks
How Will Europe be Impacted?



Four Twenty Seven, September 2019

INCREASINGLY SEVERE IMPACTS

Extreme weather events driven by climate change are having severe impacts that are increasingly being seen across Europe. Between 1980 and 2017, weather and climate-related extremes caused approximately €453 billion of total economic losses. Among those losses, it is estimated that only 35% were insured. Climate change has a substantial impact on real estate markets. It can directly damage individual buildings, decrease their value or even lead to assets being rendered unusable. In Europe, floods from extreme rainfall and sea level rise represent a major threat to real estate markets. As climate change leads to more frequent and severe extreme weather events it is increasingly important for real estate investors to understand the climate risk exposure of key assets and prepare for impacts.

ASSESSING EXPOSURE TO CLIMATE CHANGE IN REAL ESTATE

To provide a view on physical climate-related risk for the real estate industry in Europe, Four Twenty Seven used a proprietary model that leverages global climate data to provide asset-level risk assessments to physical climate hazards. We analyzed the exposure of 20,816 retail spaces and 16,188 offices in Four Twenty Seven's database of one million corporate facilities. The real estate sites are owned by over 900 listed companies, out of the 2,000 companies included in our database. We used our climate risk scoring methodology to assess each facility's exposure to climate hazards, with a focus on floods, sea level rise and heat stress looking out to mid-century. Flood risk and sea level rise are assessed with a precision of 90x90m. Heat stress is evaluated at a 25x25km scale.

We found that 19% of retail spaces and 16% of offices are exposed to floods and/or sea level rise, with floods representing the highest risk for both types of asset. Heat stress also presents significant risk to these facilities.

INLAND FLOODS: A MAJOR THREAT FOR A WARMING EUROPE

Floods are one of the most prominent risks for real estate in Europe. In most European cities, climate change is increasing the frequency and the intensity of heavy precipitation events, threatening urban infrastructure and increasing flooding.

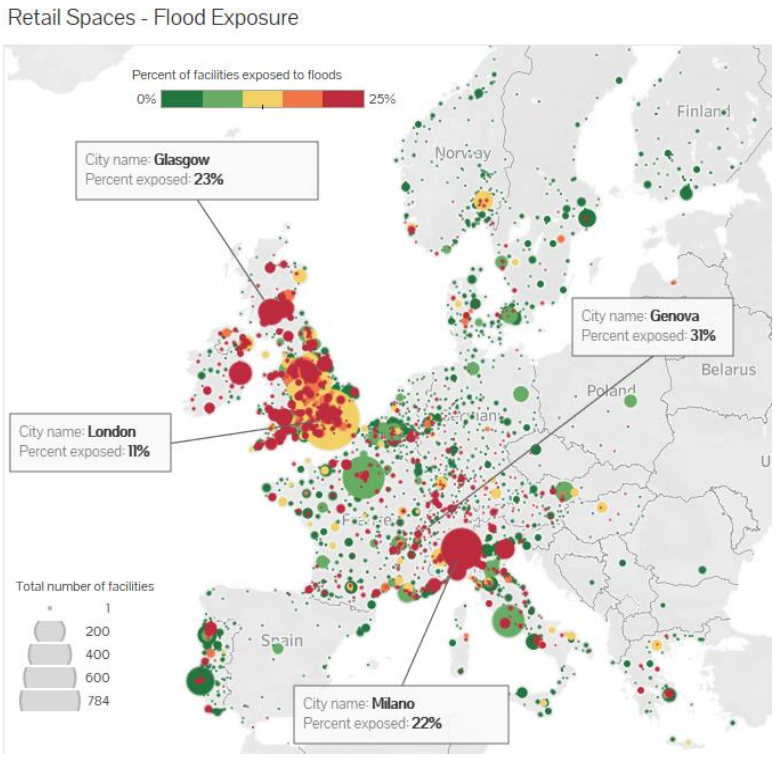


Figure 1. Retail spaces' exposure to floods. A dot represents a city and its size represents the number of retail spaces in the city. The dot's color represents the percentage of retail spaces exposed to floods, with red representing the highest percentage. Source: Four Twenty Seven

Floods can inundate facilities directly, leading to disrupted operations and equipment damage and can also have indirect impacts on operations by damaging regional transportation, power and communication infrastructure. Fluvial and pluvial floods can increase costs associated with maintenance and repair of buildings, lead to higher insurance premiums, and reduce revenue due to business disruptions.

Floods also have wider impacts on real estate markets. For example, studies looking at the residential market in Germany and Finland show that properties in flood-prone areas are sold at lower prices compared to properties without flood risk.

Retail spaces in the United Kingdom are particularly exposed to flood risks, based on our analysis (Fig. 1). Climate change is likely to contribute to more events like the winter storms of 2015-2016 which resulted in around £1.6 billion of total economic damages in the United Kingdom. Over 20% of Edinburgh, Glasgow and Sheffield's retail assets are located in flood-prone areas.

The amount of rain during heavy precipitation events in Glasgow (Fig. 2) is projected to double by 2030-2040 compared to 1975-2005. London is also exposed to surface, fluvial and tidal floods. In our analysis, London is the city with the highest number of retail spaces in flood-prone areas (Table 1). Its most exposed sites have a 20% probability of being flooded each year, and a 1% probability that the flood depth will be higher than one meter, based on Four Twenty Seven's data.

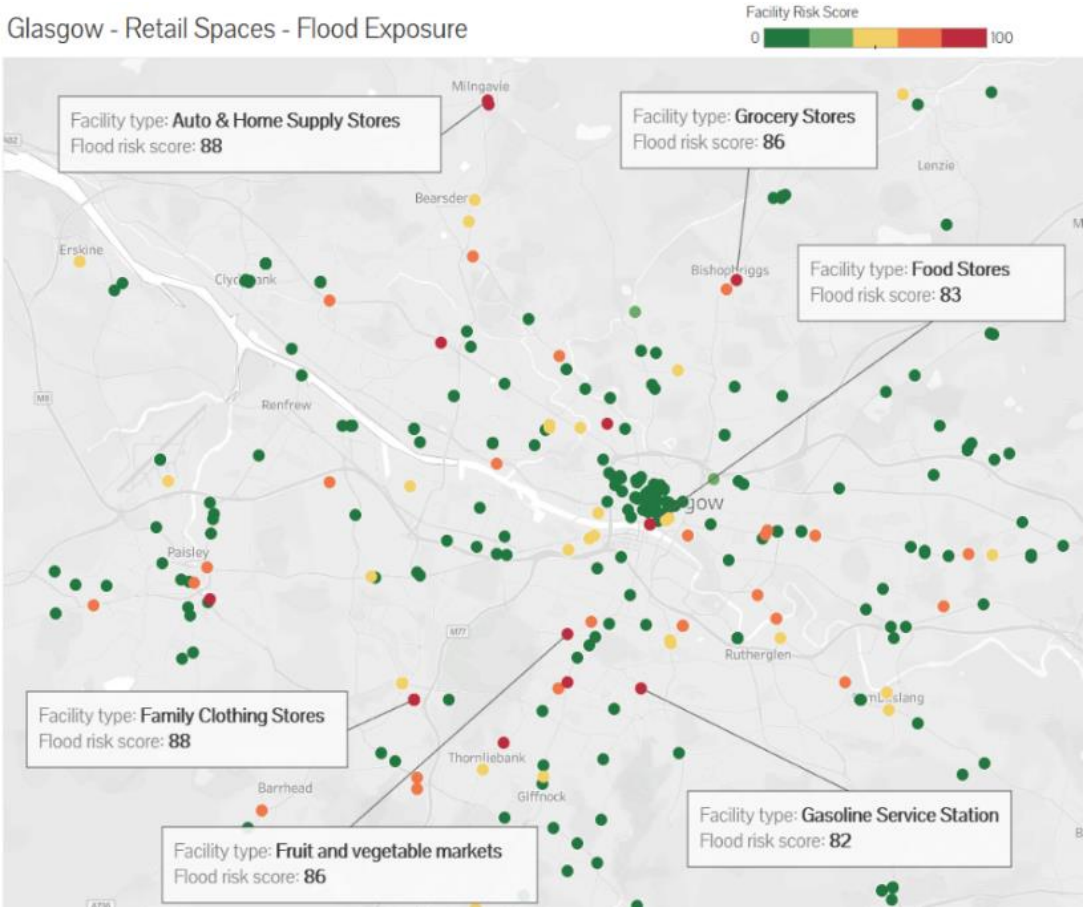


Figure 2. Retail spaces exposed to flooding in the Greater Glasgow area. A dot represents a retail space and the dot's color represents its flood risk. Source: Four Twenty Seven

Without adaptation measures at the site-level and the city-level, these assets will likely suffer from increasing property damages and potential business disruptions due to more frequent and severe rainstorms. For example, floods can reduce business at retail sites such as clothing stores when consumers may prefer to stay home or be prohibited from shopping by inundated infrastructure. Likewise, grocery stores and other retail sites may experience supply chain disruptions or damaged goods with impacts on sales and revenues.

England, Scotland, Wales and Northern Ireland all have a Climate Change Adaptation Program. The English program pledges to construct additional hard defenses and to support communities and businesses in increasing their properties' and investments' resilience.

Table 1. Cities with the highest percent of retail spaces exposed to floods, out of those cities with over 70 retail spaces. Source: Four Twenty Seven

City	Country	Percent of retail spaces exposed to floods	Total number of retail spaces assessed
Edinburgh	UK	32%	78
Genova	Switzerland	28%	81
Dublin	Ireland	26%	116
Glasgow	UK	23%	148
Venezia	Italy	22%	85
Milano	Italy	22%	378
Sheffield	UK	20%	80
Nottingham	UK	16%	77
Leeds	UK	13%	92
Torino	Italy	13%	71
London	UK	11%	784
Birmingham	UK	11%	148

SEA LEVEL RISE: WHEN BEACH FRONT NO LONGER MEANS VALUE

Several recent studies have found that there is potential for severe sea level rise if certain tipping points are reached. For example, East Antarctica is warming faster than previously expected, with immense implications for global sea levels. According to opinions gathered from experts, there is a possibility of sea levels rising to two meters by 2100 under a 5°C scenario. Without coastal adaptation investment, it is estimated that annual damages, due to storm surges and king tides, could reach up to almost €1 trillion by the end of century in Europe.

The real estate industry is at the front line of sea level rise risk. Properties can suffer from severe damages leading to maintenance and repair costs. Even if a facility itself is not permanently inundated, it may be rendered unusable if its closest rail and road infrastructure experience chronic disruptions. Sea level rise can also have far-reaching market impacts such as increasing insurance costs and higher local taxes to fund adaptation efforts. The perception of sea level rise risk can also impact an asset's value. For example, French coastal properties suffered from substantial damages after coastal flooding caused by storm Xynthia in 2012. At the Ile de Ré, a touristic French island close to La Rochelle, material losses had a longer-term effect on the real estate market. Home prices dropped in the most exposed part of the island. Fields previously sought after by developers became classified as non-constructible areas after the storm.

Our assessment found that corporate offices are highly exposed to sea level rise in Europe (Fig. 3). Increasing floods and chronic inundation from sea level rise can affect employee commutes, with implications for business continuity at offices. Assets in Ireland, France, Sweden and the United Kingdom have particularly high exposure.

Copenhagen is highly exposed to sea level rise, with 81% of its offices exposed to coastal flooding. In its Climate Adaptation Plan, the city acknowledges that it will be at high risk of flooding in 2040, stating that if no adaptation measures are undertaken, sea level rise will cause "unacceptable" damage. An asset's risk to sea level rise will be largely driven by regional adaptation efforts to prepare for flooding from higher tides and storm surge.

Copenhagen has defined a long-term adaptation strategy, including the creation of green infrastructure and flexible spaces that can be inundated during high tides, such as sports fields and parks. The city also constructed dikes and quays to protect it from up to 2 meter storm surges. However, the construction of hard protective infrastructure is leading to very high expenditure for local authorities, which can have impacts on local taxes and the strength of other government services. Adaptation policies may also affect building permit requirements and add restrictions to real estate development.

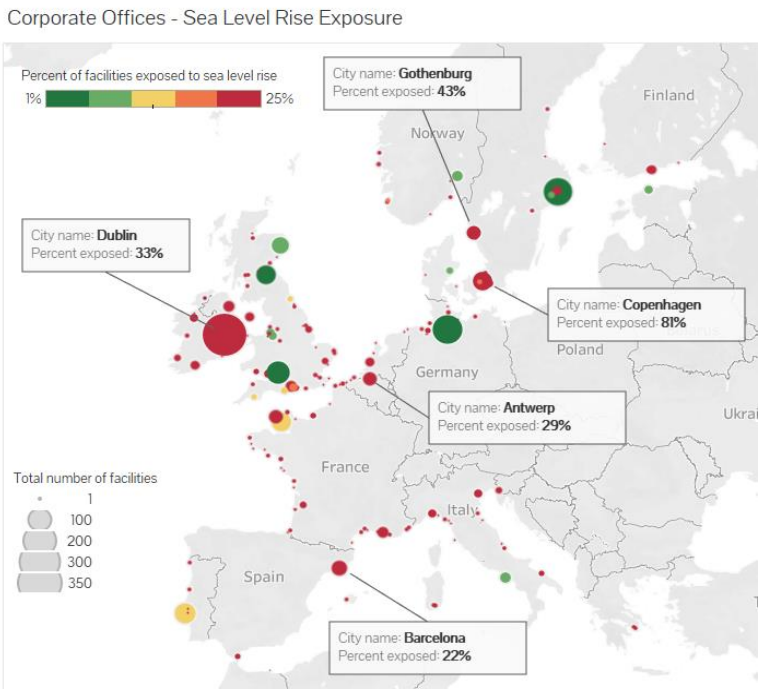


Figure 3. Corporate offices' exposure to sea level rise. A dot represents a coastal city and its size represents the number of offices in that city. The dot's color represents the percentage of offices exposed to sea level rise, with red representing the highest percentage. Source: Four Twenty Seven

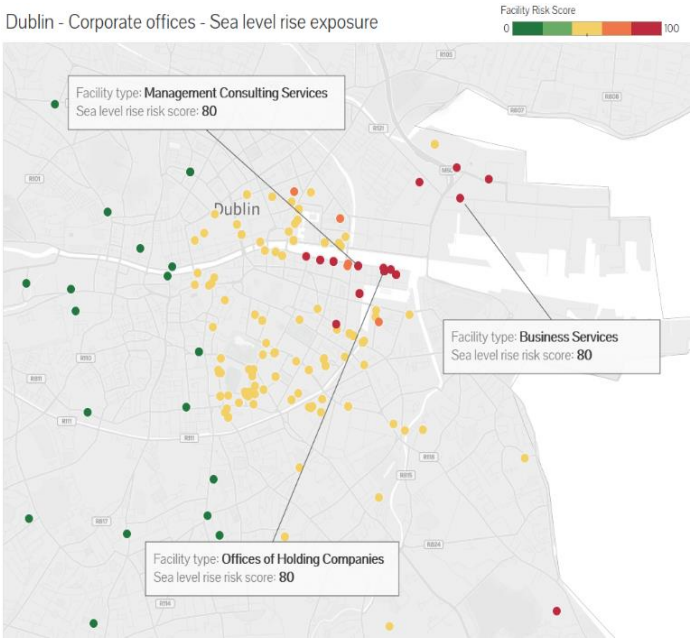


Figure 4. Corporate offices exposed to sea level rise in Dublin. A dot represents an office and the dot's color represents its sea level rise exposure. Source: Four Twenty Seven

Dublin is the city with the highest number of corporate offices from our database exposed to sea level rise (Table 2). This exposure is concentrated in Dublin's business district (Fig. 4). Floods in the business district can impact the transportation system, electric grid and telecommunications networks, which all impact local businesses.

Dublin is aware of its risk and has developed a 2019-2024 adaptation plan that budgets the construction of new flood defenses and includes a flood risk management strategy. Property managers and real estate investors can engage with the surrounding community to support these regional resilience-building efforts that will also mitigate the risk to their own assets.

Table 2. Cities with the highest percent of corporate offices exposed to sea level rise, out of those cities with more than twenty corporate offices. Source: Four Twenty Seven[1]

City	Country	Percent of offices exposed to sea level rise	Total number of offices assessed
Copenhagen	Denmark	81%	68
Belfast	UK	73%	22
Guernsey	Guernsey	53%	36
Gothenburg	Sweden	43%	37
Southampton	UK	38%	24
Dublin	Ireland	33%	350
Antwerp	Belgium	29%	35
Barcelona	Spain	22%	45
Marseille	France	21%	24
Jersey	Jersey	12%	66
Lisboa	Portugal	11%	79
Oslo	Norway	10%	21

HEAT STRESS: SHATTERED RECORDS BECOMING THE NEW NORM

Heat stress is a growing concern for Europe. The region experienced two recording-breaking heat waves within two months during summer 2019, affecting public health, hindering productivity and contributing to train delays, with implications for economies across the continent. The decade from 2009-2018 was the warmest on record, with temperatures around 1.7°C above the pre-industrial level in Europe.

Our analysis shows that offices and commercial spaces throughout Europe will experience heat waves that are 21 days longer on average compared to 1975-2005. Based on Four Twenty Seven's data, Southern Europe is expected to experience the highest increase in the duration of heat waves, with

[1] This analysis does not capture coastal flooding for areas further than five kilometers inland from the coast. This limitation may underrepresent risk in coastal-adjacent, low-lying areas that extend inland, like Amsterdam.

projections showing an additional month of temperatures above the 90th percentile every year in Madrid (Fig. 5). Heat waves will also bring higher temperatures, with an 8% average increase in maximum temperatures by mid-century, and over 10% in Paris, for example. This will manifest in cities experiencing climates typically associated with locations significantly further south. For example, a recent study noted that "Madrid's climate in 2050 will resemble Marrakech's climate today, Stockholm will resemble Budapest, London to Barcelona."

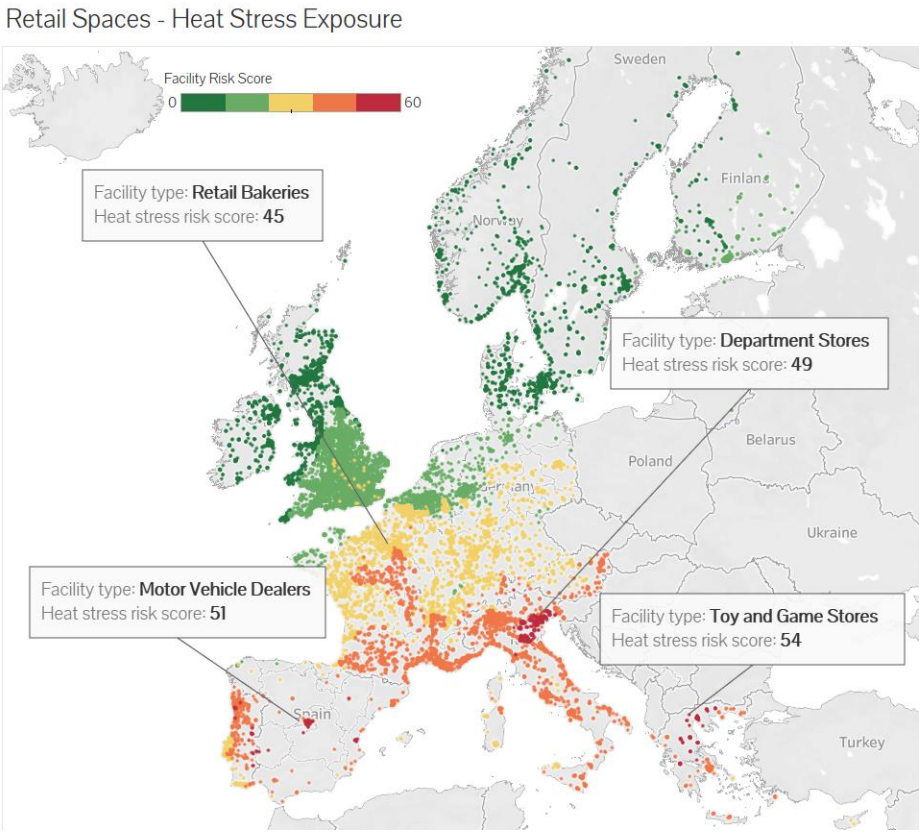


Figure 5. Retail spaces' exposure to heat stress. A dot represents a retail space and the dot's color represents its heat stress risk. Source: Four Twenty Seven

The urban heat island effect and worsening air quality will exacerbate the impacts of increasing average temperatures in many European cities, with implications for human health and economies. Heat stress can create new cooling needs for buildings and thus increase operations costs at real estate assets. This is particularly true for assets such as data centers and retirement residences, with significant cooling needs. Extreme heat can also affect consumer behavior, reducing the desire to window shop outside, for example, but increasing the visitors to air-conditioned facilities such as shopping malls. In the long run, increasing average temperatures could have indirect effects on real estate markets as consumer preferences shift.

To reduce their vulnerability, many cities are adapting to extreme heat by increasing green spaces and the use of reflective materials to reduce the albedo effect, for example. Property managers can model on-site adaptations after these examples, while also contributing to wider regional efforts that reduce the urban heat island to preserve public health and economic activity.

CONCLUSION: UNDERSTANDING RISK TO BUILD RESILIENCE

Real estate assets are already experiencing the impact of extreme heat and floods across Europe and the real estate industry will continue to be impacted by climate change in the near-term. There is an urgent need for resilience-building across assets to ensure business continuity and reduce financial losses. Understanding asset risk is an essential first step towards building resilience. Asset owners and managers can leverage asset-level risk exposure data, alongside awareness of regional adaptation efforts, to improve the resilience of their assets and engage communities around shared resilience priorities.

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You can consult the full article, with links to references, on our website (427mt.com). See QR code below:

ABOUT FOUR TWENTY SEVEN

Four Twenty Seven (427mt.com) is the leading provider and publisher of market intelligence on the impacts of climate change for financial markets. We tackle physical risk head on by identifying the locations of corporate production and retail sites around the world and their exposure to climate change hazards such as sea level rise, droughts, floods and tropical storms, which pose an immediate threat to investment portfolios.

Four Twenty Seven's ever-growing database now includes one million corporate sites and covers over 2000 publicly-traded companies. We offer subscription products and professional services to access this unique dataset. Options include data licenses, an interactive analytics platform, and company scorecards, as well as reporting services, scenario analysis, and real asset portfolio risk assessments.

Four Twenty Seven has won multiple awards for its innovative work on climate risk and resilience and our work has been featured by Bloomberg, the Financial Times and the UNFCCC. Four Twenty Seven was founded in 2012 and is headquartered in Berkeley, California with offices in Washington, DC and Paris, France.

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