TRENDS
ADAPTATION

Real estate players are re-examining their foundations to adapt to climate change

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Between calls for energy sufficiency, geopolitical pressure on the energy supply, and increasingly intense weather events, the building sector needs to adapt. Exposure to extreme climate episodes is bringing down the value of real estate. The layout, design and composition of new buildings therefore need to be revised to stand up to anticipated weather events. Both the renovation of existing buildings and the construction of future property will need to combine energy efficiency with resistance to climate impacts. To meet this challenge, the focus is on integrating adaptation into building codes, improving architecture, and updating the insurance sector.

DATA OVERVIEW

Human & financial costs and emissions are escalating due to the impact of climate change on infrastructure

The exceptionally high temperatures and torrential rain of the last few years[1] confirm the observations of the Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), which signals increasingly intense climate episodes and more frequent extreme weather. Climate events like higher precipitation, melting of the permafrost, and more frequent, intense wildfires and storms are destroying increasing numbers of infrastructures and homes, involving considerable reconstruction and renovation costs.

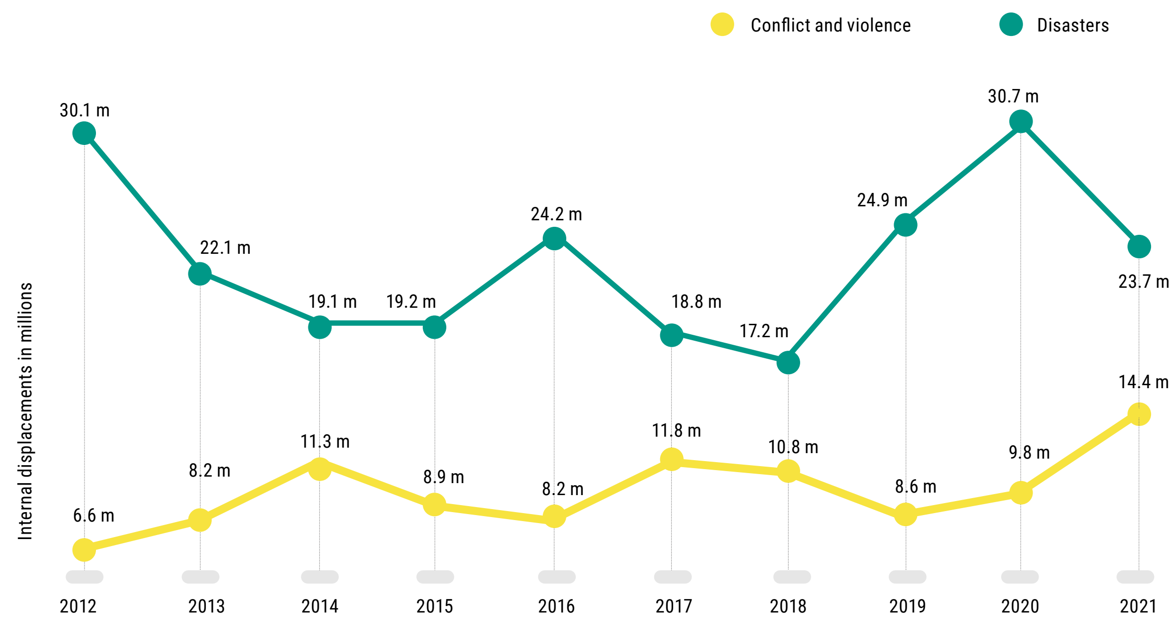
According to the IPPC scenario of a 1.5 °C temperature increase,[2] Africa and Asia are at the biggest risk of experiencing frequent, intense precipitation, followed by North America and Europe. Droughts are likely to become more prevalent on all continents compared to the period from 1850 to 1900, with the exception of Asia. From a 2 °C temperature rise, heavy rainfall and flooding will increase, in particular in the Pacific islands and some regions of North America and Europe.

These climate events impact the infrastructure of global property stock. Four Twenty Seven (427), a Californian company created in 2012 to analyze climate change risks, and the company GeoPhy, concluded in a report that 35% of the 73,500 properties owned by 321 listed Real Estate Investment Trusts, around the world, were exposed to climate hazards, of which 17% to flooding, 12% to hurricanes and typhoons, and 6% to rising sea levels and coastal floods.[3] US real estate also appears to be under particular threat. The cities of New York, San Francisco, Miami, Fort Lauderdale, and Boston face a high risk of rising water levels. On a global scale, the real estate most exposed to rising sea levels is located in Hong Kong and Singapore. The infrastructures most at risk from typhoons are in Japan, while flooding threatens cities in southeast Australia and parts of Europe (eastern France, Belgium, Germany, the Netherlands, the United Kingdom, Denmark and Sweden). The heatwave that hit the United Kingdom last summer revealed how ill-adapted British buildings

FIGURE 1

DOMESTIC DISPLACEMENTS TRIGGERED BY CONFLICT, VIOLENCE AND NATURAL CATASTROPHES FROM 2012 TO 2021

Source: IDMC, 2022



are to deal with the heat: some old hospitals in London have no air conditioning and their windows cannot be opened.[4]

Infrastructures in developing countries are particularly vulnerable to climate change, which mostly threatens countries in Asia,[5] including Bangladesh, India, Myanmar, Nepal, Pakistan, the Philippines, Thailand and Vietnam.[6] During the summer of 2022, Pakistan was subject to its wettest month in 30 years, and by early September flooding had led to the death of 1,100 people, destroyed 287,000 houses, flooded 2 million hectares of farmland, and killed 735,000 heads of livestock.[7] Asia could feature almost half of all new buildings by 2040. Yet in 2020, fewer than 50% of countries in the region had obligatory or voluntary building codes or certification programs in place.[8] Islands are also particularly vulnerable to rising water levels and are already feeling the impacts. The Alliance of Small Island States (AOSIS) is one of the most influential voices calling for funding to adapt particularly exposed and vulnerable countries to climate change.[9]

The building sector is responsible for 37% of global greenhouse gas emissions and 36% of the world's energy consumption (including construction).[10] Targets aimed at developing "net zero emission buildings" mainly focus on energy efficiency for mitigation. But in recent years, the target of "resilience" has increasingly featured in public debates, referring in this case to the capacity of buildings to withstand the impacts of climate change.

Among other things, climate change generates higher financial costs and impacts the value of real estate. In any given country, property exposed to rising sea levels has already lost 7% of its value compared to similar property not exposed to this risk.[11] The damage caused by natural disasters amounts to considerable losses. Hurricanes Harvey, Irma and Maria in 2017 caused $220 billion in damages and, in 2018, Hurricane Florence generated a loss of $10 million.[12] In the United States, the damage bill amounted to $56.92 million in 2021.[13] These figures mostly cover the cost of reconstruction, renovation and financial aid, with the risk that the new buildings might be destroyed again a few years later. In the long term, some urban areas will have to be abandoned and homes relocated.[14] For example, almost 33 million people were displaced in Pakistan during the flooding that hit the country in the monsoon of 2022;[15] in other words, almost as many people were displaced in that single country in 2022 as were displaced on the entire planet in 2021 (38 million; **FIG. 1**).[16] In terms of the carbon involved in the construction phase in a building's life cycle – about 10% of global CO_2 emissions are emitted when manufacturing building materials[17] – these reconstructions and renovations generate significant emissions.

In order to limit the sector's greenhouse gas (GHG) emissions and the financial, social, human and cultural costs of climate events, adaptation is slowly making its way into building-sector strategies. The sector is well placed for adaptation actions because it allows the topic to be approached in different ways: in addition to creating a physical rampart against climate change, buildings can make energy savings in response to the increased risk of supply shortages and the geopolitical context.

THE OBSERVATORY'S LENS

The fast-changing climate shakes the foundations of the building sector

Integration of climate data in building codes and urban planning

Building-sector strategies are based on more precise mapping of risks and local climate features, and on new construction methods to make buildings more resilient to climate phenomena. One study[18] undertaken by the National Institute of Building Sciences (NIBS) shows that the adoption of the latest building codes[a] in the United States could avoid having to build about 15,000 new homes, saving the equivalent of 1.5 million tonnes of CO_2 per year.[19] The study also indicates that if disasters were given greater consideration in building codes, thus minimizing the risk of having to rebuild, emissions would reduce accordingly.

The Global Resiliency Dialogue (GRD) was launched in 2019 and involves a working group of authorities and researchers based in Canada, the United States, Australia, and New Zealand to exchange and share experiences on integrating new climate risks into building codes. Coalition members all recognize that their building codes, traditionally based on observing historical meteorological events, are unsuitable for anticipating future climate episodes. Based on two reports published in January and November 2021, the GRD is preparing to publish its *International Resilience Guidelines*[20] in the second half of 2022. The results of the first survey show that an average ten-year wait is necessary between each new publication of historic meteorological data in building codes. For each of these countries, it is therefore vital to include climate modelling when designing their building codes to deal with the resilience of buildings **(SEE BOX 1).**

The second report[21] published by the Global Resiliency Dialogue takes the example of New York to illustrate the integration of climate forecasts in building codes and standards. The city is particularly exposed to rising sea levels – along with Calcutta, Bombay, Dhaka, Miami, Alexandria and Lagos[22] – with a projected average rise of 2.25 metres every five years.[23] To include climate forecasts in its public investment plans, the municipality has devised a set of guidelines called the *NYC Climate Resiliency Design Guidelines*.[24] The guide provides engineers, architects and urban planners with a method that integrates historical data, new data, and scientific progress. The method acts as a relay between climate data and potential action to respond to it. It tackles three climate risks that the city is exposed to: flooding; increased, more intense rainfall; and heat waves. To reduce urban heat for example, the report encourages thinking about the materials used on the external facades of buildings: materials that reflect the sun create urban heat islands and increase the use of air conditioning, which in turn feeds into the effect. Several solutions are proposed for each problem raised: for urban heat, the guide suggests covering 50% of the site's surface with a green roof project, shading and/or highly reflecting surfaces (light-coloured paving). These solutions therefore respond to a target of reducing urban heat while ensuring a stable temperature inside buildings: jointly integrating the different methods avoids putting contradictory measures in place. This is one of the messages communicated by the latest Global Resiliency Dialogue survey: "*Planning regulations should be developed in parallel with building codes, to harmonize the approach to resilience taken in both*".[25]

BOX 1 • **KEYS TO UNDERSTANDING**

CLIMATE RESILIENCE

The Center for Climate and Energy Solutions defines climate resilience as "*the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to the climate*" and in particular mentions acute events, like heat waves, heavy downpours, hurricanes and wildfires, along with long-term changes like rising sea levels, worsening air quality and population migration. Municipal resilience plans are taking shape, especially concerning buildings – such as the heat action plan in place in Phoenix, which encourages natural air-cooling methods.[26] The International Code Council (ICC), in partnership with the Alliance for National & Community Resilience (ANCR), defined how building codes contribute to the resilience capacities of communities in its 2018 report *Building Community Resilience through Modern Model Building Codes*.[27] The report lists the four aspects covered by resilience in the building sector: efficient disaster mitigation and recovery; ensuring the mental and physical health and well-being of occupants; improving building life cycles; and creating a "sustainable" community. A building that has to be demolished after an event is not considered to be "sustainable". Lastly, the resilience of the building stock is recognized by the ANCR as one of the three pillars that ensure community resilience, along with social measures and governance.[28]

Integrating different weather events into urban planning also turns out to be strategic when the risks are high. To deal with flooding, China is developing "sponge cities",[b] involving better water control thanks to soil infiltration and water evacuation management. They also include Low Impact Development (LID) plans developed in 1987 to manage storm water, which is particularly urgent in the face of intensifying storms due to climate change.[29] The LID concept has generated numerous studies on storm water management in Europe, North America, and Australia, contributing to the establishment of sponge cities in the State of Georgia and in Chicago, for example.[30] This concept also applies to some infrastructures like green

a Building codes are political instruments for national and local governments to improve the energy performance of buildings, either at their time of their construction or when renovated.

b In these cities, in addition to wetlands that readily absorb water, underground reservoirs can store water during flooding for evacuation later. The urbanization pursued to date prevents water infiltration, which worsens the impact of flooding.

roofs, permeable pavements, and infiltration trenches, whose effectiveness has been demonstrated in simulations in southern Italian cities[31] and the Polish city of Gorzow Wielkopolski.[32] Thirty cities in China have been selected as pilot sponge cities and other towns have the appropriate characteristics **(FIG. 2)**. These cities are mostly located in the south and east of China due to climate and geographic features.

Setting up this type of urban planning has numerous joint benefits: as well as increasing protection from flooding for people and buildings, it helps improve soil and water quality, fosters richer biodiversity, and contributes to the well-being of the city by creating more green spaces. Although reaching these different objectives depends on geographic and climate characteristics, the different Chinese cities in the study have so far all reported "satisfactory" impacts in terms of controlling surplus water flows.[33]

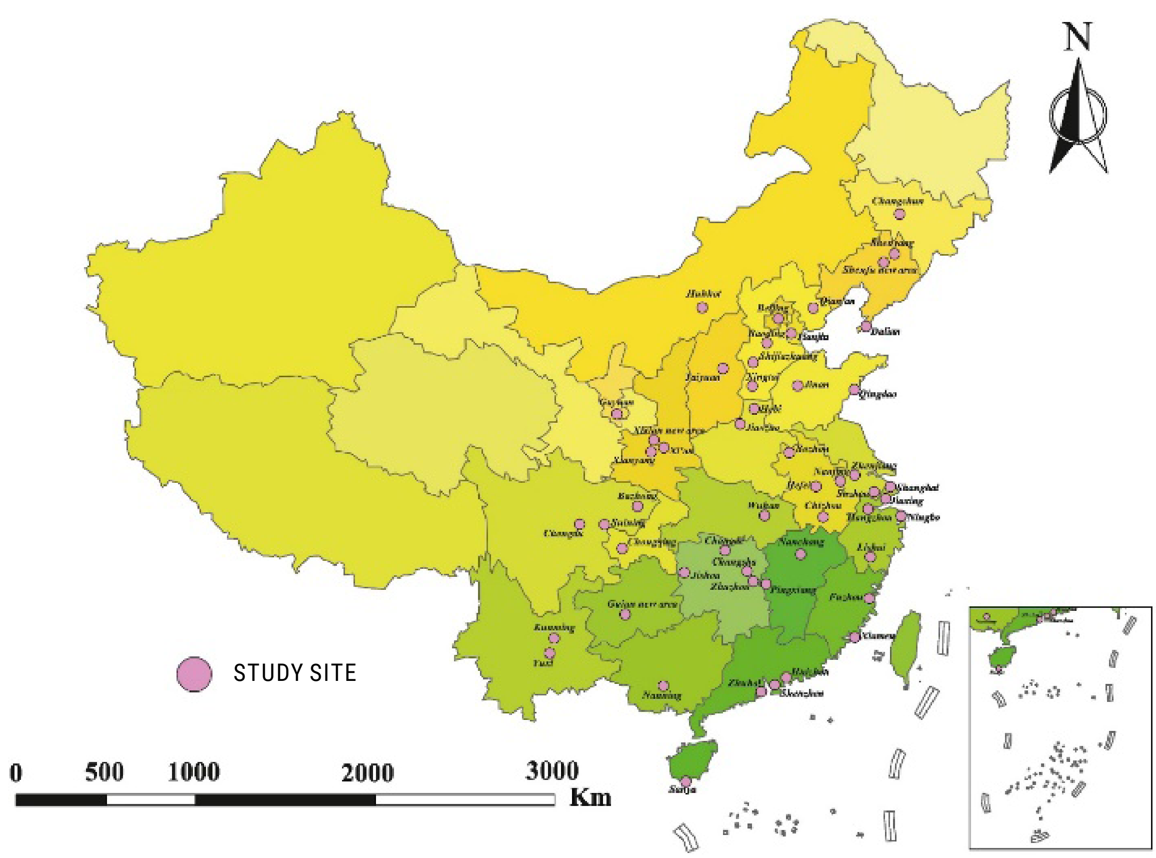
The energy performance of buildings also plays a role in their adaptation to climate hazards. Along with installing equipment that optimizes energy consumption, the energy performance of a building can be improved by insulation, ventilation and planting. In anticipation of future heat waves, the city of Basel in Switzerland initiated a green roof program with the result that today it is the city with the largest surface area of green roofs per inhabitant. The program was financed by a fund created by the city in the 1990s, thanks to a law that established that 5% of electricity bills should contribute to the Energy Saving Fund. The project developed further following an obligation in 2010 to convert all flat roofs being constructed or renovated into green roofs. The initiative has been praised for its energy-saving benefits and its adaptation qualities: green roofs can reduce indoor temperatures by up to 5 °C[34] and provide an alternative when it is impossible to create green spaces around a building. They are also an effective tool to deal with storm water runoff, which, according to a draft British study,[35] could be reduced by 17% to 20% if all suitable roofs in the United Kingdom were planted.

At European level, in a situation that calls for more autonomy and energy sufficiency,[36] optimizing energy consumption can be a strategic adaptation tool in a world subject to geopolitical tensions. It reduces the need for buying in mostly fossil-based energy **(FIG. 3)** and means that a given quantity of energy can be used for longer.

FIGURE 2

CHINESE CITIES THAT HAVE BUILT LID CONSTRUCTIONS

Source: Science of The Total Environment, 2022



During the last few months, many nations have announced that they are establishing efficiency measures to reduce energy consumption in buildings. In Italy, for example, public buildings cannot set air-conditioning below 25 °C from 1 May, 2022 to 31 March, 2023 or heating higher than 19 °C in winter,[37] and Austria has brought forward the date for prohibiting the sale of new gas boilers to 2023, initially planned for 2025.[38] Fossil-fuel-fired boilers have also been identified as generating indoor pollution, which is the subject of a petition by 25 NGOs in the US sent to the Environment Protection Agency (EPA) and calling for greater consideration of this source of pollution.[39] In Ukraine, the dilapidated state of its buildings, high energy losses in the sector, and the impact of the war led the country to announce that it will reconstruct "greener" buildings after the war,[40] based on improved energy efficiency, at a meeting between Ukrainian authorities and European partners – including the European Commission, the European Investment Bank, and the World Bank – in Lugano, Switzerland on 4 and 5 July, 2022.

The establishment of buildings codes is nevertheless one of the main obstacles to efficiency, in particular in countries where infrastructures are the most vulnerable. The GlobalABC roadmap for Asia observes that, "*Compliance with, and enforcement of, building codes is crucial yet challenging, as it is often up to subnational governments to enforce, despite variations in human and financial resources.*"[41] There is limited application of building codes in Sub-Saharan African, Central America and South America.[42] Insufficient application of building codes has been identified as one of the main factors behind the vulnerability and destruction of buildings and infrastructures due to geographic and climate hazards.[43] The capacity of countries to closely comply with building codes is linked to their level of wealth. Some studies have highlighted factors like countries' dependence on importing building materials, or the fact that major stakeholders in the national building sector do not comply with the latest building codes.[44] The level of wealth is nevertheless not the only factor at play in countries that are highly vulnerable to future changes, such as New Zealand, where one person in seven lives in an area at risk of flooding, representing $100 billion in residential value.[45,46] The National Climate Change Risk Assessment published in 2020 underlined the importance of planned implementation in New Zealand, which served as the basis of the first National Adaptation Plan, published in 2022. Chapter 7 of the Plan is devoted to the building sector and includes building codes that are "resilient" to rising water levels. The country's resilience strategy anticipates avoiding new constructions in coastal areas and reinforcing legislation concerning the transparency of banks on buildings' exposure to climate risk. In 2021, New Zealand was the first country to draft a law that will make it obligatory for financial institutions to evaluate the companies they are lending money to, in terms of their environmental impact.[47]

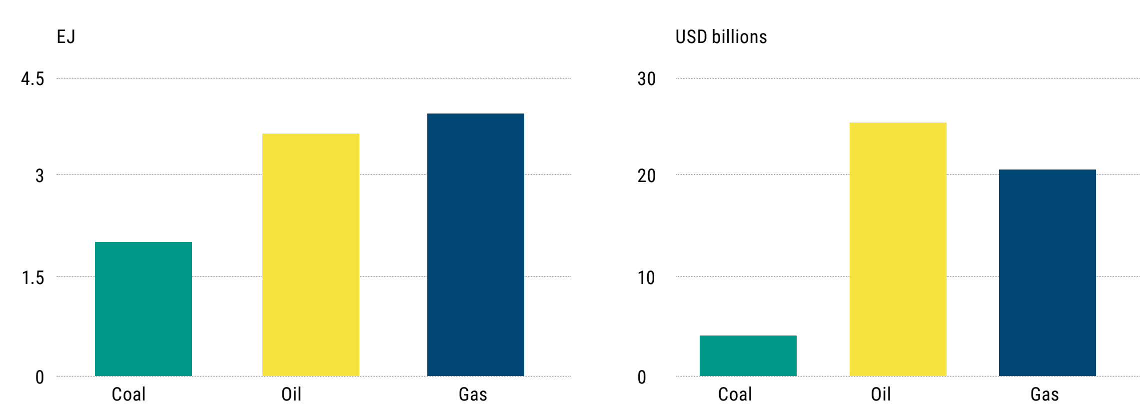
Building resilience established right from the design phase

A study by ESCAP & Asian Institute of Technology[48] demonstrates that building resilience is established at the point of architecture, while mitigation targets are dealt with during the later phases. When the construction steps are designed with climate adaption and mitigation objectives in mind, buildings are all the more resilient.

FIGURE 3

REDUCTION IN FOSSIL ENERGY IMPORTS IN IEA COUNTRIES AND OTHER MAJOR EMERGING ECONOMIES[c] FROM EFFICIENCY IMPROVEMENTS SINCE 2000 (IN DOLLARS AND FUEL)

Source: International Energy Agency, 2019

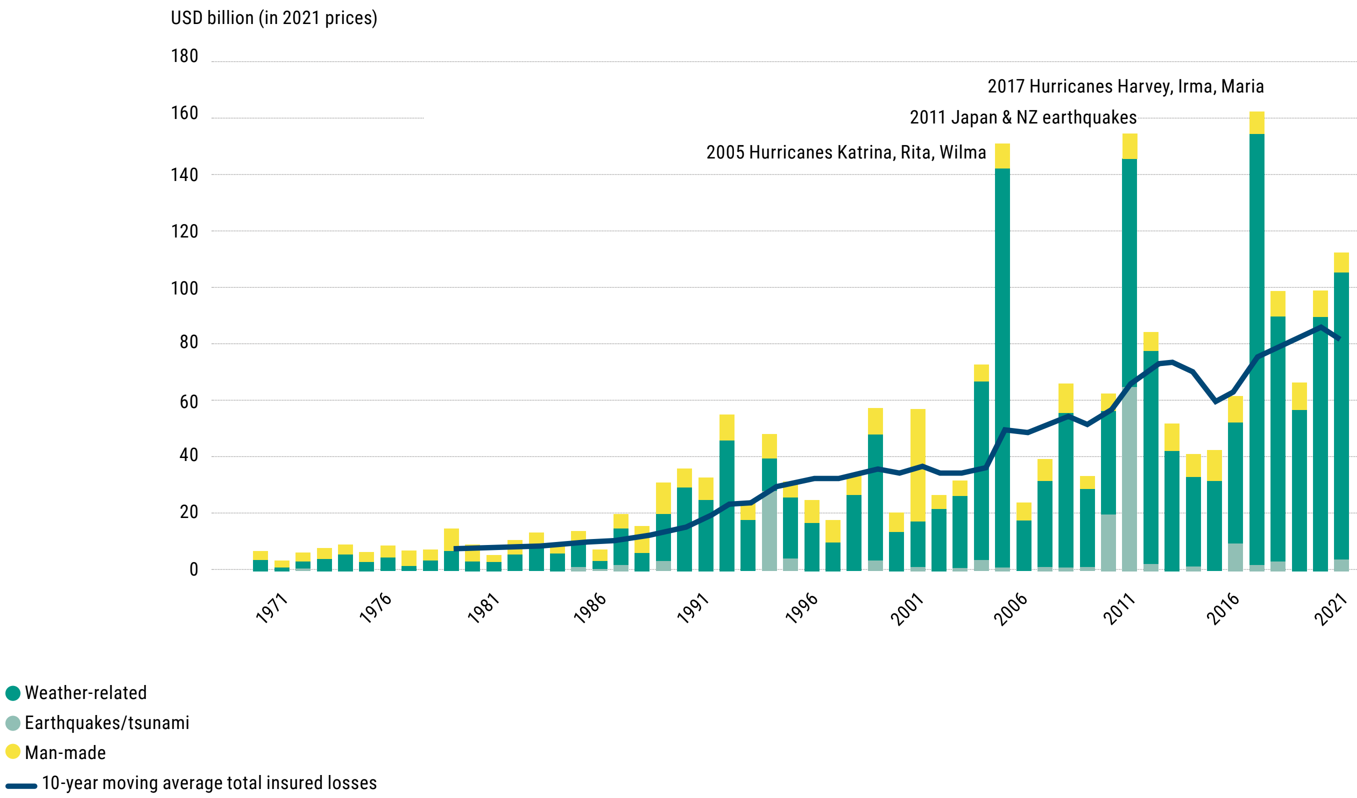


c The countries considered are the members of the International Energy Agency, and China, India, Brazil, Indonesia, the Russian Federation, South Africa and Argentina.

FIGURE 4

CAUSES OF INSURED LOSSES SINCE 1970

Source: Swiss Re Institute, 2021



Japan announced in 2022 that new buildings, both residential and non-residential, must comply with energy efficiency standards.[49] To date, only non-residential buildings over 300 m² have had to do so. Architects will have to explain the impacts of introducing renewable energy to property owners. These measures extend the contribution of the design phase in reaching mitigation targets, in addition to resilience objectives, at which Japanese architects excel. In 2018, the country was recognized by the World Bank as "*among the safest and most disaster-resilient in the world*".[50] Japanese architecture is particularly effective in standing up to the frequent earthquakes and typhoons that hit the archipelago. It was one of the leaders of the Sendai Framework for Disaster Risk Reduction, adopted by the United Nations and signed in 2015, setting out a strategy up to 2030. One of the lessons that Japan put forward was the importance of private-sector participation to share technologies and expertise.[51] Numerous initiatives have been established in Asia at different scales: further south, the city of Dapitan in the Philippines has, for example, built basalt rock houses whose dome shape makes them resistant to typhoons and wind.[52]

Architects can also improve buildings' resilience to outside temperatures at the point of design. Spain is one of the European countries most exposed to heat waves, increasingly intense droughts, and water scarcity. Located 18 km from Madrid, in Móstoles, the entire building that houses the IMDEA Materials Institute of the Madrid Institutes for Advanced Studies, constructed in 2012, was designed to resist climate hazards. The building's "bioclimatic"[d] architecture ensures resilience to very high external temperatures without using more energy for air conditioning. Insulation is provided by the building's ventilated facades and numerous other solutions have been put in place to limit direct exposure to the sun, or its radiation, and take advantage of the shade. The roof is made from a white material that reflects sunlight. The design of the building and efforts to maximize the energy efficiency of its equipment result in an A-rated energy performance certificate and a primary energy requirement of 168.90 kWhpe/m² compared to 491.70 kWhpe/m^2 for a standard building.[53] Water efficiency has also been integrated into the building's design: rainwater is collected on the roof and used to irrigate the planted areas. The carpark has a permeable surface to reduce the risk of flooding in anticipation of more intense rainfall. The toilets and sinks use 40% less water than those in a regular building.

The building surface area in Africa is set to double from 2017 to 2050, 90% of it for residential buildings.[54] The integration of climate risks in new constructions can bring numerous joint benefits, such as avoiding additional emissions thanks to energy efficiency measures, or creating access to better living conditions. ICLEI Africa, a regional network of local authori-

d Bioclimatic architecture makes use of renewable energy and natural ventilation, and optimizes the means employed in construction. In this case, it ensures low indoor temperatures when external temperatures are high and minimizes the energy needed for cooling and lighting.

ties committed to climate action, lists over 50 projects[55] for resilience in Africa that have been set up at municipal level. The two towns of Nacala (Mozambique) and Moroni (Comoros) have been recognized for their leadership and for being the first to align with the guide of the Global Covenant of Mayors. The Coastal City Adaptation Project (CCAP) ran in Mozambique from November 2013 to November 2018, and focused on adapting the country's numerous coastal cities, including Nacala, to climate change. Different groups and actors contributed to construction projects to ensure that the "*construction materials and techniques were appropriate and culturally acceptable*".[56] Twenty-two "model" houses were developed from this project, which gathered architects, local decision-makers, women's groups and local craftspeople. The models feature for example roofs that collect rainwater for use in the home and are built to resist high winds. The roofs are made from water-resistant materials and angles are no greater than 12.5 degrees to reduce their exposure to wind. The CCAP participated in drawing up the government's building codes. The project initiators justify the cost of adapting the buildings by the long-term savings, because more resilient designs avoid future expenditure on reconstruction.

African architects are also calling for the use of traditional methods to ensure buildings' resilience. GlobalABC[57] promotes the use of passive cooling when designing new buildings as an important way to limit the increased demand for artificial air-cooling systems. The winner of the 2022 Pritzker Architecture Prize, Diébédo Francis Kéré, employed this technique in a school in Gando, Burkina Faso, by combining traditional methods and local materials to adapt the building to its environment. The school is cooled entirely thanks to passive methods, employing natural ventilation and a structure that reduces heat absorption. As a result of integrating this feature in its architecture, the building consumes no energy for cooling.

Traditional methods inspire bioclimatic architecture when designed locally to stand up to particular climate events,[58] like cyclones and flooding in rural areas. Traditional construction techniques used on homes in the Salomon Islands[59] have inspired bioclimatic designs, such as for natural ventilation (for hot, humid areas). These designs employ local materials adapted to the climate, include multiple ventilation areas, and raise houses on stilts to protect them from flooding during monsoons. In addition, traditional materials[60] like wood, stone and earth, emit fewer greenhouse gases than concrete and steel and preserve architectural culture.

Faced with climate change, the insurance sector goes back to the drawing board

The insurance sector is highly exposed to the "physical risks" generated by climate change. According to an assessment by Swiss Re, natural catastrophes generated $112 billion insured losses in 2021, which is the fourth highest annual figure ever recorded **(FIG. 4)**.[61] An evaluation by the European Insurance and Occupational Pensions Authority (EIOPA), which is a European Union financial regulatory institution, reported that "*all property-related lines of business are expected to be impacted by physical climate change risk*".[62] In 2020, about 80% of commercial losses due to storms and flooding in Europe concerned damage to buildings. The increased number of "compound events"[e] calls for a change in the way that risk is managed.

Risk assessment reports in the sector integrate an increasing number of data and analyses,[63] the sharing of which constitutes a major lever of action for insurers and for adaptation, despite the fact that exposure to physical risks is particularly difficult to quantify.[64] In the United States, a new report by the NGO Natural Resources Defense Council (NRDC) shows that people who buy homes with a history of flooding can expect to pay tens of thousands more dollars[65] in flood damages over the course of their mortgage compared to the average homeowner. The transparency of historical data is therefore a crucial issue. However, 21 US states do not require the seller to share this information.[66] A house that collapsed into the ocean in North Carolina in May 2022[67] triggered strong reactions on social media, with calls to make it obligatory to disclose the risks of properties and the land they are built on. Yet the price of insurance contracts varies and is not always based on the same features. Since a recent change in the calculation methods employed by the Federal Emergency Management Agency (FEMA), the cost of insurance payments for houses located close to water sources or at risk from hurricanes, such as in Florida, is set to increase drastically. Some homeowners have already had to make additional insurance payments,[68] despite having adopted measures to make their homes less vulnerable.

The revision of the FEMA's calculation method is an example of adaptation measures in a sector faced with changes in the frequency and distribution of risks. While the insurance sector can constitute an adaptation tool to deal with extreme climate events, it must also adapt itself to the new situation to manage its own "transition risks". The insurance market in Louisiana saw a series of insurance companies go bust following the passage of Hurricane Ida last year.[69] These bankruptcies came at "the worst time of year", subject to numerous wildfires and flooding, leaving thousands of people without insurance. The vulnerability of part of Australia also points to an "insurance crisis", with one home in 25 highly likely to no longer be insurable by 2030.[70] This phenomenon could also increase inequalities because it makes houses at risk more affordable, attracting lower-income buyers. Another consequence is the increased value of assets, which makes insurance less affordable. Yet the number of contracting parties is central to the effectiveness and security – even resilience – of the economic model of insurance companies, which is based on sharing the cost of risks.

e "Compound events" are mentioned in the latest IPCC report as one of the main manifestations of climate change. They are defined by the combination of several drivers at once (e.g. heavy rainfall and heatwaves, or several climate conditions likely to trigger wildfires, such as dry, warm winds).

KEY TAKEAWAYS

To date, few building and renovation codes integrate adaptation, despite the increased impacts of climate change causing more numerous material damages and loss of human lives. Countries like Japan and the United States were early to undertake research to anticipate the natural disasters that have historically impacted them. Nevertheless, due to climate change, such episodes are likely to intensify in these countries and become more common in other countries. This calls for greater integration of mitigation and adaptation measures, which have not been considered in technologies that only focus on building resilience. Some pioneer initiatives attempt to implement projects aimed at both reducing energy consumption and making buildings more resilient in the long term. Integrating adaptation measures also involves including traditional techniques in building projects because of their highly local nature, making them harder to replicate than measures aimed at reducing GHG emissions. Insurance can be an important lever to tackle impacts that have already occurred, although with the increased number of events, the sector is faced with the need to adapt. This is because adaptation is related to the level of risks and therefore to the insurance sector's capacity to operate on a model that considers the increase in risks and then better distributes them.

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