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APPROACH TO CLIMATE RESILIENCE

Toolkit for the Built Form within an Urban Environment

As part of our Approach to Climate Resilience, Savills IM is collaborating with Dr Julie Futcher - a chartered architect with expertise in urban climates and environmental design - to create a climate resilience toolkit. Using guidance from the Better Buildings Partnership, this document showcases her research on how building and urban form impacts both the local climate and building performance; and practical urban form considerations for real estate investment managers.

Click here for our full Approach to Climate Resilience

Toolkit For The Built Form Within An Urban Environment

Savills IM believes that cross-collaboration between industry and academia can advance innovation and research to practical application. This document details the research of Dr Julie Futcher on how building and urban form impacts both the local climate and building performance, and how Savills IM is planning to put this research into practical use.[1]

Dr Julie Futcher's research is being used to develop an 'interdisciplinary planning framework' that offers a fresh perspective on achieving net-zero objectives and urban climate adaptation and mitigation. This framework emphasises the critical role of building design decisions in meeting the energy and environmental needs of neighbouring buildings and streets. It seeks to investigate how building and urban design influences urban climates and access to natural resources such as daylight, sunlight and ventilation, including the consequential effects on building energy management (heating, cooling and ventilation) and the health and well-being of urban residents and occupants.

This research falls at the intersection of building and urban climate science and draws attention to many of the built-form outcomes which are currently outside the broader discussion on sustainable urban development. This research champions the inclusion of urban climate research into built environment practice, which will demonstrate interdependent built form effects as key drivers towards creating healthy and climate resilient cities.

Here, Dr Futcher describes the background and components of the guidance toolkit.

1 'Building and Urban Form', the dimensions of buildings and their placement in relation to each other, are key drivers of urban climates [1], building energy management [2] and health and wellbeing [3]
[1] Oke et al (2017) Urban Climates. Cambridge University Press.
[2] Godoy-Shimizu et al (2021) Density and morphology: Buildings and Cities, 2(1).
[3] Barton et al (2010) Shaping neighbourhoods: Oxford: Routledge

Dr. Julie Futcher

"Research has shown that identical buildings will perform differently as a result of even small differences in the form of the streets in which they are placed"

Introduction to considering building and urban forms

Climate projections indicate that in line with climate change, urban areas – especially large metropolitan centres – will experience higher night-time temperatures, more frequent and intense heatwaves, and changes in precipitation patterns. These climate events within an urban context will have significant implications for energy demand and efficiency, thermal comfort, public health, and the health of urban vegetation.

Urban vegetation is crucial in responding to climate challenges and plays a central role in preserving ecological balance and enhancing urban biodiversity.

One key factor to consider is how cities manage heat, as urban areas tend to warm up and cool down more slowly than their surrounding non-urban areas, a phenomenon known as the Urban Heat Island effect.

The Urban Heat Island (UHI) effect refers to the temperature differences between the city and the surrounding rural (non-urban) area; where, in general, cities are found to be warmer. This phenomenon manifests in several forms, including variations in air, surface, and sub-surface temperatures, each representing a different type of UHI.

The most commonly measured UHI's are the surface and the near-surface air (or canopy) types. The surface UHI is often measured using satellite sensors, while the canopy UHI is measured using air thermometers.

The urban 'canopy' refers to the layer of air below the average building height, found between buildings. This layer encompasses various microclimates, which become particularly noticeable during the day due to shadowing effects. At night, under clear and calm weather conditions, the canopy layer slows down night-time cooling. This leads to the formation of a canopy UHI, which is most pronounced near the city centre. In these areas, buildings are typically taller and more closely spaced, offering a limited view of the sky and often having little or no vegetation.

In general, urban climates are warmer, less windy and more polluted than climates outside cities, with considerable microclimatic variation from street to street. These variations are influenced by several factors, including the street's design, such as its dimensions and orientation, the volume of pedestrian and motor traffic, and the background climate. Additionally, the time of day, the season, and the specific location within the city also play important roles in determining these microclimates.

Research has shown that identical buildings will perform differently as a result of even small differences in the form of the streets in which they are placed. The design of street canyons, along with their function, plays a crucial role in shaping urban microclimates.[2] Factors such as impermeable land cover, vegetation levels, and particularly the geometry of these canyons significantly influence this performance. To assess how built form affects urban microclimates, measurements such as sky view factor (SVF) and the ratio of building height (H) to street width (W) are used.[3]

Street canyon geometry is a critical factor in the formation of urban microclimates, significantly influencing access to sunshine and daylight, creating opportunities for street-scale ventilation, and affecting night-time radiant heat loss. These factors are vital for energy efficiency, thermal comfort, and public and vegetation health, making understanding how built forms influences the background climate as essential, particularly in terms of urban heat stress both day and night.

Working in collaboration with Savills IM, we are developing a comprehensive guidance toolkit. This toolkit is designed to assist investment teams in identifying opportunities and risks at both asset and community levels. It features a framework for identifying, considering, and mitigating the impacts of 'built form' on the background climate. This includes factors that contribute to clean and comfortable air.

The toolkit will include a set of protocols designed to inform decision-making at the building scale. It will build on existing considerations to more deeply identify local environmental risks and benefits; and help in assessing and addressing various environmental outcomes. **This includes enhancing building performance to achieve Net-Zero goals and improving climate resilience in the broader/wider environment.**

2 The term 'Built Form' is used to describe the attributes of the urban landscape. This includes its geometry (i.e., the structure of the surface such as levels of vertical or horizontal density); the characteristics of its surface (i.e., vegetated, and impervious cover), and the characteristics of its materials (i.e., manufactured and natural).

'Function' relates to how buildings and urban land are used. This includes different activities and their timings, such as residential, commercial, or service delivery (i.e., healthcare, education and leisure).

3 The height-to-width ratio in urban design measures the relative height of buildings to the width of streets, impacting shading and wind flow. The Sky View Factor (SVF) quantifies the amount of sky visible from a point at street level, affecting sunlight exposure and cooling. Essentially, while height-to-width ratio assesses the physical structure of urban spaces, SVF focuses on sky visibility and its climatic effects.

Understanding the impact of 'built form'

Cities are key in tackling climate, energy, and sustainability challenges; as a result, a holistic approach is essential to address these issues effectively. Such an approach is not one which only identifies the performance of individual buildings but one that also 'accounts' for, and 'addresses', both opportunities and risks of built form driven effects on the wider environment.

This comprehensive approach is crucial for developing resilient and sustainable urban spaces that contribute to tackling the climate and environmental emergencies while striving to achieve net-zero carbon targets.

Achieving this level of integration and effectiveness, however, goes beyond just recognising the need for a holistic perspective. It also calls for a deep understanding of the intricate connections between indoor and outdoor climates in cities, a task that necessitates collaboration among experts from various fields. It also requires a comprehensive set of tools and guidelines that bring together what we already know about cities. To date, this level of detail is missing from design guidance, and tools to access these outcomes do not yet exist.

To bridge this gap, it's vital to understand the impact of 'built form' on energy, climate, and well-being across various scales. From this perspective we set out explore four critical questions raised in the Better Buildings Partnership's **A Guide to Climate Resilience Strategies for Commercial Real Estate**.

1. **What practical measures and processes will be applied at the building level to build resilience within an urban context?**
2. **How might climate adaptation measures support or hinder climate change mitigation?**
3. **What is the role of nature-based solutions in our climate adaptation strategy?**
4. **How might climate adaptation measures impact social outcomes within the context of an urban environment?**

The concepts outlined below will be explored in greater detail in a guidance toolkit.

1. What practical measures and processes will be applied at the building level to build resilience within an urban context?

Developing urban resilience requires an awareness of the dynamic interactions between buildings, streets, public spaces, and their wider environment. Central to this is the concept of **'net-energy'**, which identifies how built forms modify natural resources i.e., temperature, wind, and sunlight, and in turn, how these resources affect building energy needs i.e., heating, cooling, and ventilation, as well as their environmental outputs i.e., heat and pollution.[4]

The **'net-energy'** perspective is a move away from buildings as 'energy islands' influenced exclusively by their wider environment. Instead, it recognises buildings, streets, and public spaces as active elements in a broader environmental and energy network. These elements continuously interact with their local surroundings, dynamically influencing and being influenced by each other. In this network, the role of building form is crucial, where their impact is defined not only by their individual performance but also by their collective influence on the wider environment.

Understanding these complex relationships are key to explaining why identical buildings perform differently as a result of even small differences such as the form of the streets in which they are placed. Consequently, location-specific strategies become vital, as an effective approach in one setting may not be suitable in another.

Exploring this concept allows us to identify site-specific characteristics that both 'accounts' for, and 'addresses', the interplay between the buildings, streets, and public spaces, and their far reaching and dynamic environmental impacts.

In brief, developing strategies that balance the individual and collective needs of buildings, streets, and public spaces with the wider environmental dynamics of the urban landscape is essential for fostering resilient and sustainable urban spaces.

2. How might climate adaptation measures support or hinder climate change mitigation?

In order to determine this question, we need to identify and address the interdependent outcomes that form between buildings in their urban setting.

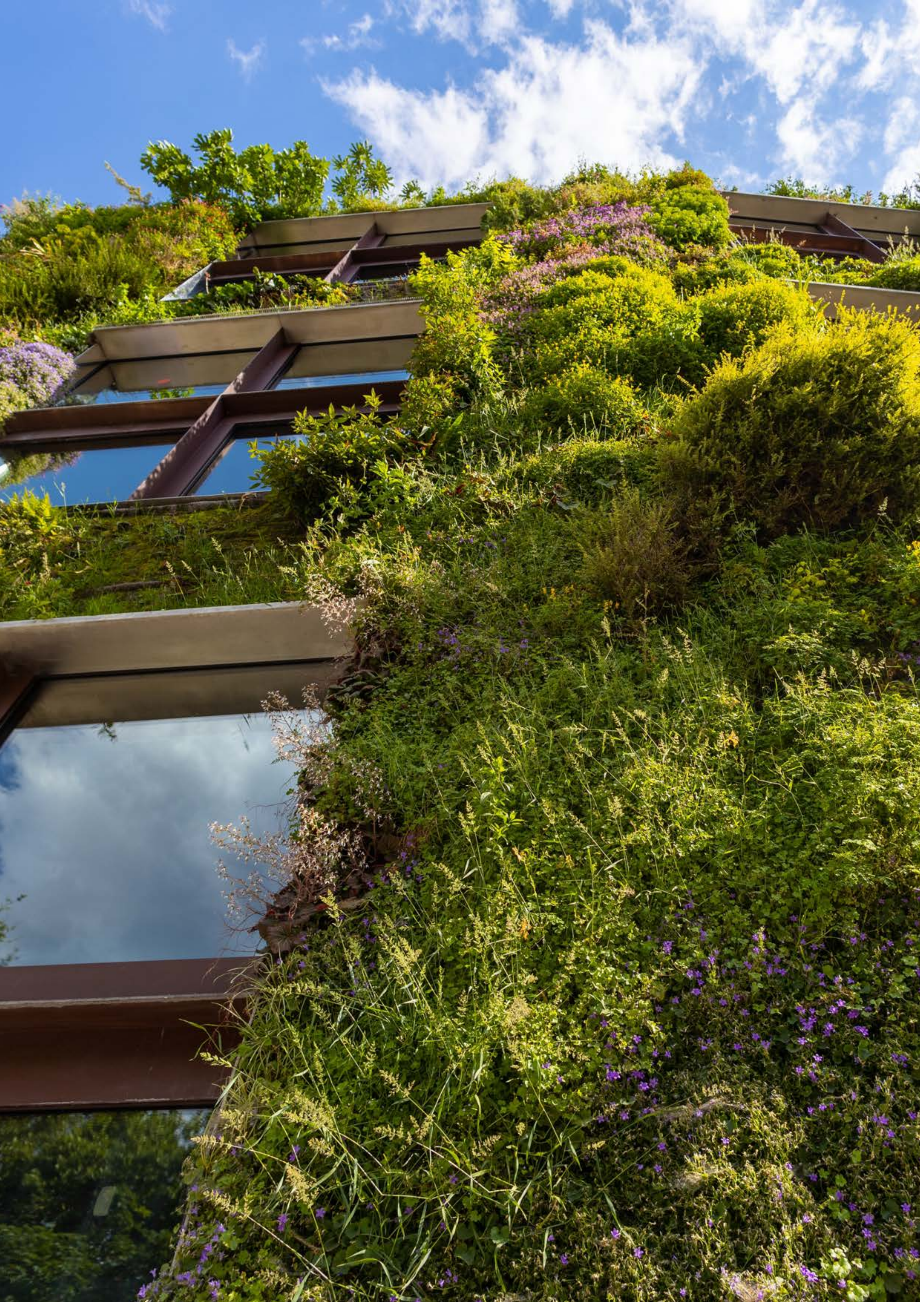
As to the previous question, in city streets, the form of the buildings and the form of the street in which the buildings are placed have a dynamic and interdependent effect on both indoor and outdoor climates. However, whilst the intensity of these relationships is dependent on a number of parameters, addressing a climate problem at one scale can present a problem elsewhere.

For example, air conditioning systems used for indoor cooling can release heat outdoors, and if trapped between surfaces (i.e., street canyons) can lead to a localised increase outdoor temperature. On the other hand, efforts to cool urban streets by increasing outdoor surface reflectivity (albedo) can reflect more solar energy into buildings, thereby raising cooling demands and exacerbating the risk of overheating.

Yet, these interdependent net-energy relationships can sometimes be beneficial, depending on the local climate. In cooler climates, the heat emitted from buildings and the solar energy trapped by street design can reduce the need for indoor heating and enhance outdoor comfort.

Understanding these complex and interconnected effects is crucial for determining how climate adaptation measures can both aid and complicate climate change mitigation efforts.

4 'Net-energy' considers the interdependent energy relationships between;
1. Energy in its natural expression (temperature, wind and sunshine);
2. Building energy needs (heating, cooling and ventilation); and
3. Anthropogenic outputs (manmade heat and pollution).



3. What is the role of nature-based solutions in our climate adaptation strategy?

Nature-based solutions (NBS) play a crucial role to address climate change impacts and enhance resilience by reducing the overheating risks associated with the UHI effect. For example, buildings, roads, and other infrastructure trap the sun's heat more than natural landscapes such as forests and bodies of water. By increasing green and open space, planting trees, and creating vegetated roofs, through shading and evapotranspiration processes, NBS can help cool urban environments, reducing energy consumption for air conditioning and creating more comfortable living conditions for residents.

Secondly, NBS can help manage stormwater runoff and reduce the risk of flooding. Natural features such as wetlands, green roofs, and permeable pavements help absorb and slow down rainwater, preventing overwhelming drainage systems. This can be particularly valuable in areas prone to heavy rainfall or coastal flooding.

Additionally, NBS provides biodiversity benefits by preserving and restoring natural habitats within urban areas. This helps maintain ecosystems, support native flora and fauna, and enhance overall ecological resilience. Biodiversity also contributes to improving the overall quality of life for residents by providing recreational spaces, improving air quality, and reducing noise pollution.

In summary, nature-based solutions in the real estate context can help mitigate the negative impacts of climate change, enhance resilience, improve quality of life, and likely increase property values.

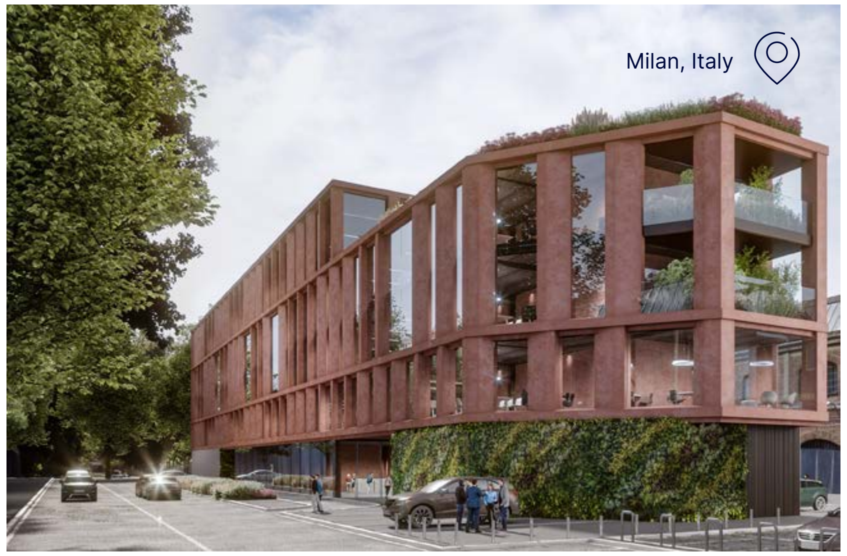
Savills IM factors in NBS wherever practicable. A comprehensive biodiversity strategy is being developed which will take into account climate mitigation and adaptation measures throughout the hold period of an asset.

CASE STUDY

Sarca Development in Milan, Italy

In October 2020, Savills IM acquired a brownfield area of ca. 2,250 sqm in the Bicocca District, north of Milan, Italy. Formerly one of the most famous industrial areas in the city, the Bicocca district has been subject to an intensive re-development and urbanisation plan for the past 10 years, transforming it into a vibrant residential and commercial district, hosting a new metro line, new office buildings, the Bicocca University, and student housing.

The location of the site has a high exposure to heat stress and the inclusion of nature-based elements such as a green roof, green walls at ground floors, and new trees on the front street are strategic to both improve biodiversity and resiliency measures of the development. For example, green roofs and green walls provide additional insulation for the building to reduce the heat transfer and maintain a more stable indoor temperature and contribute towards evapotranspiration, which is a process where water evaporates from surfaces and is transpired by plants into the atmosphere. It plays a crucial role in cooling the environment and regulating local temperatures. Planting trees at street level will provide natural shading which intercepts sunlight exposure to help cool down street surface and air temperatures.

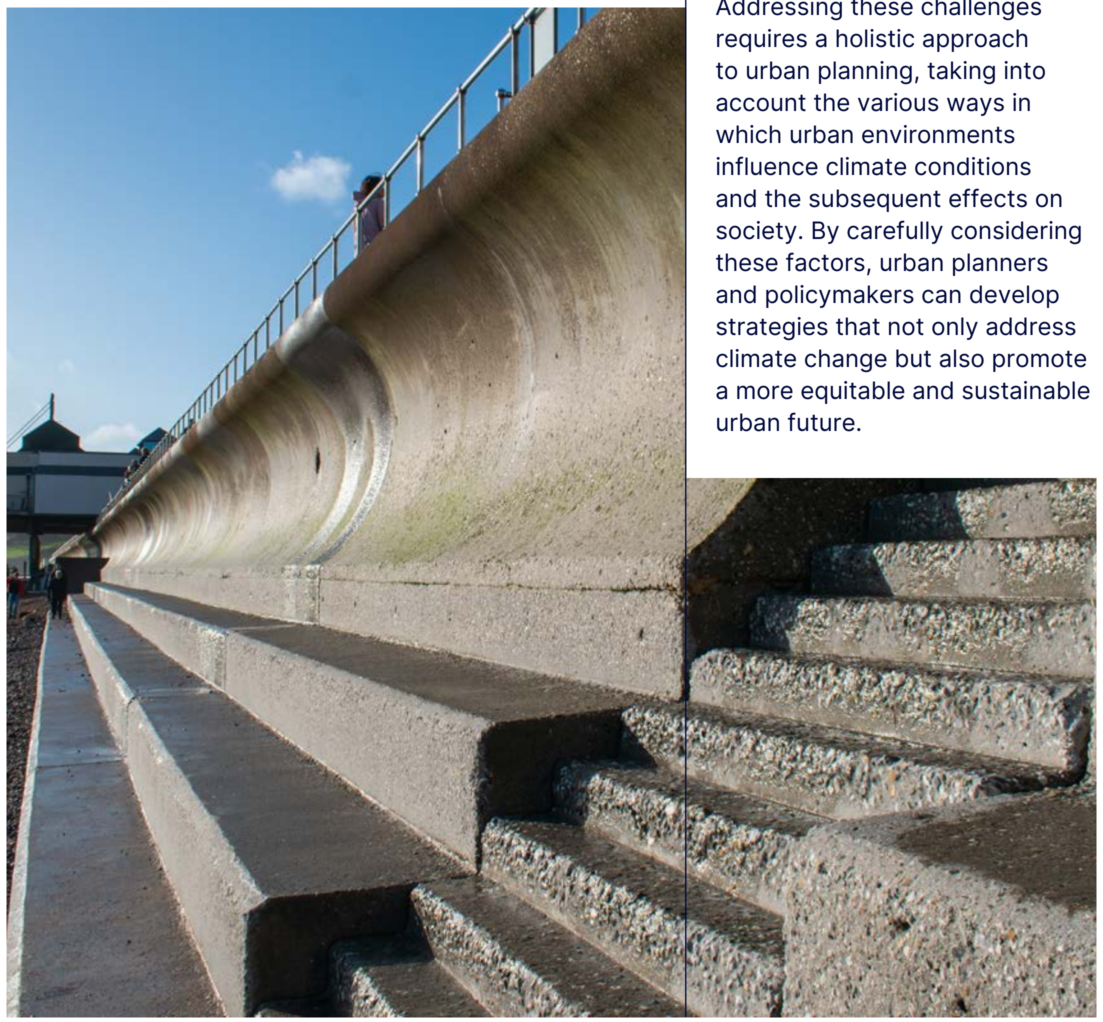


The inclusion of nature-based elements such as a green roof, green walls at ground floors, and new trees on the front street are strategic to both improve biodiversity and resiliency measures of the development.

4. How might climate adaptation measures impact social outcomes within the context of an urban environment?

Understanding the unique impact of urban environments on urban climate intensity and the timing of these effects is crucial for developing effective mitigation and adaptation strategies. Urban design decisions have broad and dynamic impacts on the environment, influencing areas like health, well-being, and social outcomes, including social equity.

One key aspect is how urban density affects local climate conditions; for instance whilst increasing urban density may be considered more efficient in terms of per capita energy consumption, daytime effects of increased urban density in residential areas is to increase levels of solar shading which in turn influence daylight availability. In temperate climates such as the United Kingdom, increased daytime winter shading can result in an increase in heating loads and diminish the value of parks and community spaces.



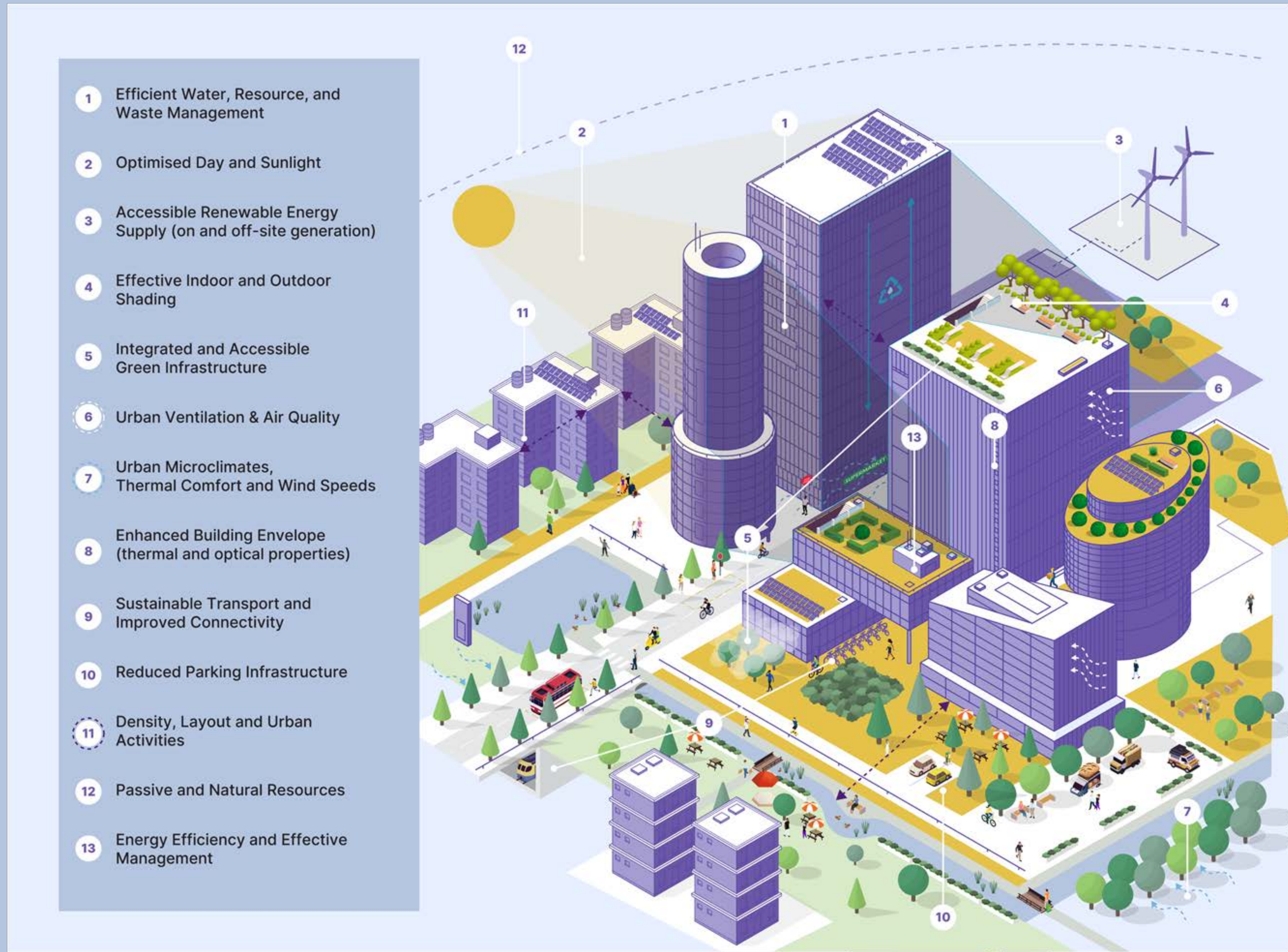
Conversely, during heatwaves, daytime shading from increased urban density can be beneficial. But at night, this same density can trap heat between surfaces, raising night-time air temperatures and intensifying the overheating risks associated with the urban heat island effect.[5]

These tensions between the benefits and risks of urban design decisions highlight the importance of balancing outcomes. It's crucial to consider both the positive and negative impacts on socioeconomic conditions. These include public health and well-being, housing and displacement issues, social equity and inclusivity, community engagement and empowerment, and economic opportunities.

Addressing these challenges requires a holistic approach to urban planning, taking into account the various ways in which urban environments influence climate conditions and the subsequent effects on society. By carefully considering these factors, urban planners and policymakers can develop strategies that not only address climate change but also promote a more equitable and sustainable urban future.

5 The term 'Density' is used here to describe the geometry of the urban landscape, both vertical and horizontal and high and low densities. Together the spatial arrangement, density, and the function of urban areas play a crucial role in the formation of the urban climate.

URBAN AND BUILDING-LEVEL CLIMATE RESILIENCY CONSIDERATIONS



Savills IM's ambition is to embed these considerations into the investment lifecycle. Through development of the guidance toolkit, these considerations will be further explored to better understand their impacts.

Urban factors (see above diagram) impact the value, appeal, and sustainability of the property, as well as its potential for long-term profitability responding to the climate crisis and improving climate resiliency. It is best practise for investment teams to take these considerations into account during the due diligence stage to make informed investment decisions and select real estate assets that align with sustainability goals and offer long-term value to both the environment and investors.

Alongside urban factors, building level considerations (see table on page 10) are crucial factors to consider when acquiring new real estate assets. These considerations not only contribute to the environmental sustainability and resilience of the building but also affect the operational costs and user experience.

URBAN AND BUILDING-LEVEL CLIMATE RESILIENCY CONSIDERATIONS

The following table is a non-exhaustive list of urban and building-level considerations for climate resilience. Some of these considerations may overlap, and this is referenced throughout. It is important to note that our approach is dynamic. We will continue to evolve this list of considerations into a comprehensive tool, and aspire to incorporate into due diligence and other assessments of climate risk.

#	Factor	Description	Scale	How climate resiliency is improved	Potential owner/ occupier benefits	Asset acquisition considerations
1	**Efficient Water, Resource, and Waste Management**	Efficient management of water, resources, and waste is crucial for reducing the ecological footprint of buildings and cities. Such strategies not only enhance climate resilience and sustainability, but also offer benefits for property owners and occupants. These benefits include improved property values, improved efficiencies, and lower risks. Implementing these practices is a key step in tackling environmental challenges and fostering sustainable urban development.	Urban	**Water Conservation:** Water recycling and greywater reuse, reduce the demand on municipal water supplies and help in drought resilience. **Reduced Negative Environmental Impact:** Effective waste management reduces landfill use and greenhouse gas emissions, contributing to environmental sustainability.	**Lower Utility Costs:** Recycling water and managing waste efficiently can lead to reduced utility costs for urban residents. **Improved Urban Environment:** These strategies contribute to a cleaner, healthier urban environment, enhancing the quality of life.	Investigate whether the property has provisions for waste management infrastructure and/or water recycling. For example, inquire about the presence of rainwater harvesting systems.
			Building	**Adaptation to Water Scarcity:** Buildings with water recycling capabilities are better equipped to handle water scarcity situations.	**Reduced Operating Costs:** Efficient resource management in buildings can significantly lower water and waste disposal costs. **Enhanced Living Environment:** Buildings with sustainable practices offer a more eco-friendly and healthier living space.	
		Integrating stormwater management systems, including blue infrastructure e.g., Sustainable Urban Drainage Systems (SUDS) and permeable surfaces, into urban planning is essential for creating sustainable and resilient cities. Additionally, blue infrastructure plays a crucial role in enhancing urban biodiversity (see #5) & climate resilience.		**Enhanced Flood Management**: These systems effectively manage excess rainwater, reducing the risk of urban flooding. **Adaptability to Climate Change**: SUDS and permeable surfaces are crucial in adapting urban areas to increased rainfall and extreme weather events due to climate change. **Urban Temperature Management**: By reducing surface water runoff and incorporating green infrastructure (see #5), these systems can help in mitigating heat stress.	**Improved Environmental Quality:** SUDS and permeable surfaces contribute to cleaner air and water by filtering pollutants and slowing rates of runoff, protecting water systems. **Enhanced Urban Aesthetics and Recreation:** SUDS which can include green infrastructure, such as rain gardens, add to the visual appeal and recreational value of urban spaces. **Health Benefits:** Reduced flood risks contribute to better overall health and well-being for urban residents.	Identify where permeable surfaces exist in proximity to the building to understand its performance, durability maintenance requirements and contribution to stormwater management and urban resilience. Examples include small parks, open gardens, street trees, canopy cover, and unpaved areas.
		Blue infrastructure also enhances the quality of life for residents, influences real estate values and investment decisions, making it a key factor in urban planning and development.		**Enhanced Stormwater Management:** SUDS and permeable surfaces facilitate better water absorption and runoff management, reducing flood risks. **Climate Change Adaptation:** These systems are adaptable to varying weather patterns, essential for cities facing increased rainfall and extreme weather due to climate change.	**Improved Urban Environment:** SUDS and permeable surfaces contribute to a cleaner, more sustainable urban environment. **Recreational Spaces and Aesthetics:** Integrating these systems with urban design can enhance the beauty and recreational value of public spaces. **Healthier Living Conditions:** Effective water management leads to better overall air and water quality, benefiting residents' health and well-being.	
2	**Optimised Day and Sunlight**	In both building and urban contexts, the strategic use of day and sunlight contributes significantly to energy efficiency, health and well-being, and property desirability, making it an important factor of building design and urban planning.	Urban	**Urban cooling and warming strategies** involve optimizing the layout and features of the urban environment in relation to the sun's path. For cooling, integrating green spaces, trees, and vegetated areas provides shade (see #4) and promotes evapotranspiration, reducing heat stress (see #5). For warming, in cooler climates or seasons, maximizing solar gain through the strategic arrangement of streets and buildings increases warmth in public spaces. Both approaches aim to harness the sun's natural heat and energy effectively for the desired thermal comfort in urban settings. **Sustainable Urban Design:** Integrating day and sunlight considerations in urban planning contributes to energy-efficient and sustainable urban development.	**Improved Public Spaces:** Urban areas designed around natural light are often inviting and comfortable, enhancing the quality of urban life. **Health Benefits:** Exposure to natural light in urban settings has positive effects on health and well-being for urban residents.	Assessing how an asset accesses day and sunlight, while considering local climate conditions, offers investment teams insight into optimising for energy efficiency, operational effectiveness, and thermal comfort in design. For example, in a region with cold winters and warm summers, a building orientated to receive maximum winter sunlight can reduce heating needs, while summer shading minimises cooling costs. These types of evaluations help inform choices in types of shading, insulation, glazing, and ventilation to boost energy efficiency and comfort year-round.
			Building	**Energy Reduction:** Effective use of natural light reduces the need for artificial lighting, conserving energy (see #14). **Thermal Comfort:** Properly managed sunlight can contribute to passive heating, reducing reliance on energy-intensive heating systems.	**Enhanced Health and Well-being:** For example, natural light is known to improve mood and productivity. **Reduced Utility Costs:** Savings on lighting and heating can significantly lower a building's operating costs.	

#	Factor	Description	Scale	How climate resiliency is improved	Potential owner/ occupier benefits	Asset acquisition considerations
3	**Accessible Renewable Energy Supply (on and off-site generation)**	The integration of renewable energy sources is a key strategy for achieving sustainability and efficiency at both the building and urban levels. Incorporating both on-site (e.g., solar panels on buildings) and off-site (e.g., community wind farms or solar arrays) renewable energy sources enhance overall sustainability and resilience. This approach offers a comprehensive strategy for energy management and underscores a commitment to environmental stewardship at multiple levels.	Urban & Building	**Energy Independence:** On-site renewable energy sources can reduce reliance on traditional power grids and fossil fuels, enhancing energy self-sufficiency. **Reduced Environmental Impact:** Off-site renewable energy sources, such as regional solar arrays or wind farms, supplement local energy needs, broadening sustainability impacts beyond immediate geographical areas.	**Cost Savings:** Long-term cost savings through reduced energy expenses. **Energy Supply Opportunities:** Increased energy supply stability and reduced carbon footprint, enhancing environmental stewardship and sustainability appeal.	Consider the availability and potential of both on-site and off-site of renewable energy sources. For example, for on-site sources, evaluate the property's suitability based on factors such as building orientation, roof size, and local climate conditions. Overshadowing risks to solar panels also need to be considered. At the urban scale, explore opportunities to utilize off-site renewable energy, such as wind farms or remote solar arrays, to complement the building's energy strategy and support broader environmental objectives.
		Both buildings and urban areas can benefit from out-of-town renewable energy sources to supplement their local energy needs. This approach expands the scope of sustainability efforts, extending beyond local geographical limits. It significantly contributes to enhancing climate resilience and fostering energy independence on a wider scale.		**Sustainable Energy Production:** Urban renewable initiatives reduce reliance on non-renewable resources and contributing to the global effort to mitigate climate change. **Resilience to Energy Fluctuations:** Cities integrating renewables are better prepared to withstand and adapt to the volatility of energy markets, ensuring a more stable and reliable energy supply even during disruptions.	**Community Energy Savings:** Urban renewable projects can lead to reduced community energy costs. **Enhanced Quality of Life:** Renewable energy contributes to creating a cleaner environment by reducing emissions, leading to improved public health and well-being and a better quality of life.	
4	**Effective Indoor and Outdoor Shading**	In both building and urban contexts, external shading plays a crucial role in managing day and sunlight (see #2), contributing to energy efficiency (see #13), occupant comfort, and the overall appeal of properties and urban spaces. In the context of increasing temperatures and heatwave frequency, external shading at both building and urban levels is crucial for mitigating heat stress, ensuring comfort, and maintaining energy efficiency (see #12).	Urban	**Urban Heat Stress Alleviation:** The provision of shade, whether through green infrastructure (see #5) or architectural structures, can significantly reduce daytime temperatures in urban public areas. This helps shield these spaces from the sun's intense heat, contributing to cooler environments. **Climate Adaptation:** Incorporating shading into urban planning is vital for enhancing the liability and resilience of cities, especially with the increasing prevalence of high temperatures and heatwaves.	**Improved Outdoor Comfort:** Shaded areas not only offer respite from the sun, making outdoor urban spaces more usable but also serve as important cool zones that can improve public health and well-being during heat events. **Health Benefits:** Providing shaded areas in urban settings are instrumental in minimizing the risks associated with heat exposure.	Investment teams are to assess the existing condition of the asset and identify potential space for shading opportunities. For example, assess existing or opportunities for green infrastructure or shading devices such as retractable awnings or canopies.
			Building	**Heat Stress Mitigation:** External shading devices, such as overhangs or blinds, actively prevent direct sunlight from entering the building, thereby enhancing the building's resilience to extreme heat conditions. **Energy Efficiency During Heat Events:** By reducing solar heat gain, external shading helps maintain energy efficiency, especially during periods of intense heat.	**Stabilizing Indoor Climate During Heat Events:** Strategic shading provides a more consistent indoor environment by moderating temperature fluctuations. This stability is crucial for occupant comfort during periods of extreme heat, making indoor spaces more liveable without excessive cooling. **Reduced Cooling Costs:** Effective shading can lower the need for air conditioning, cutting energy costs during hot weather. This efficiency translates into significant energy savings, particularly in climates where cooling constitutes a major part of energy expenses.	
5	**Integrated and Accessible Green Infrastructure**	Green infrastructure which includes features such as parks, trees, green corridors, roofs, walls, and gardens, offers a wide range of benefits. These features collectively improve climate resilience, enhance air quality, increase property values, and positively impact the health and well-being of occupants and residents at both the urban and building levels.	Urban	**Urban Heat Stress Mitigation:** Urban vegetation help alleviate urban heat stress by shading, and evapotranspiration. **Biodiversity:** Green spaces and urban vegetation that support diverse plant and animal life, aid urban ecological resilience and biodiversity enhancement.	**Air Quality Improvement:** Vegetation traps and filters pollutants, improving urban air quality. **Recreational and Health and Well-being Benefits:** Access to green spaces offers recreational opportunities, contributing to the community's health and well-being. These spaces become especially valuable during heatwaves, offering cooler environments for relaxation and physical activity, which can alleviate the stress and health risks associated with high temperatures.	Accessible and well-maintained green infrastructure and outdoor space can boost property attractiveness, and community appeal. Assess the availability and or the potential of contributing towards green infrastructure and integrating green roofs, urban vegetation. For example, when evaluating an area for green spaces and green infrastructure, the density and health of the vegetation, the diversity of plant life, and the presence of features like parks and green roofs are key indicators of the area's green infrastructure effectiveness in enhancing urban ecology and providing recreational spaces.
			Building	**Building Temperature Management:** Green roofs, green walls, nearby trees, parks and gardens provide natural cooling at the building surface, reducing heat stress and lowering the need for cooling.	**Energy Cost Savings:** Localised cooling from green infrastructure leads to reduced energy consumption, especially during periods of high heat. **Aesthetic Value and Well-being:** These green spaces enhance building aesthetics and provide a soothing environment, reducing heat stress.	
		Access to green open spaces is a crucial aspect of urban areas, significantly enhancing climate resilience. These spaces (especially when irrigated), store and release heat energy differently than built-up areas. They facilitate cooling during the day through evapotranspiration and at night promote heat loss by providing unobstructed exposure to the sky, allowing for efficient radiation of heat away from the surface. These processes contribute to a more comfortable urban environment, thereby improving the quality of life for residents.	Urban	**Mitigating Urban Heat Stress:** Green spaces provide cooling through shading and evapotranspiration, reducing overall city temperatures. **Enhancing Air Quality:** Trees and plants in green spaces act as natural filters and producing oxygen. **Stormwater Management:** Green spaces can absorb rainwater, slowing rates of runoff, mitigating the impacts of heavy rainfall events.	**Health and Well-being:** Access to green spaces is linked to improved mental and physical health, offering recreational and stress-relief benefits. **Aesthetic and Recreational Value:** Green spaces enhance the visual appeal of urban areas and provide recreational opportunities for residents. **Improved Quality of Life:** Proximity to green areas often correlate with a higher quality of life and increased happiness among urban residents.	Assess the availability, accessibility, and quality of all nearby open spaces (e.g., both green and blue). Properties near parks and green areas tend to be more desirable due to their enhanced living environment and connection to nature.
		Passive cooling through evapotranspiration involves plants absorbing and then releasing water vapor, which cools the air. This natural process, reduces ambient temperatures without mechanical systems.		**Reduced Urban Heat Stress:** Evapotranspiration from plants and trees help lower ambient temperatures, helping to mitigate overheating risks. **Increased Biodiversity:** Green spaces can support a variety of plant and animal species, contributing to ecological diversity and urban resilience. **Adaptation to Extreme Weather:** Green infrastructure significantly contributes to mitigating the impacts of extreme weather, particularly by aiding in stormwater management and providing natural cooling during heatwaves. This helps cities adapt more effectively to varied climate conditions.	**Enhanced Thermal Comfort:** The cooling effect of evapotranspiration creates more comfortable environments, reducing the need for mechanical cooling. **Health and Well-being:** Proximity to green spaces and the associated cooler, cleaner air can lead to improved health and well-being. **Recreational and Aesthetic Value:** Vegetation and landscaped areas offer recreational opportunities and enhance the visual appeal of urban areas, whilst improving health and well-being.	Assess the availability of green spaces as well as the potential to increase green space and green infrastructure. Factors such as maintenance, irrigation, and accessibility can also be considered for best practise.

#	Factor	Description	Scale	How climate resiliency is improved	Potential owner/ occupier benefits	Asset acquisition considerations
6	**Urban Ventilation & Air Quality**	Ventilation is the process of exchanging air in a space to improve air quality, involving temperature control, oxygen replenishment, and removal of humidity, odours, and pollutants. At the building scale, it includes both natural and mechanical systems for circulating air within structures. At the urban scale, it involves designing and planning spaces to facilitate air movement throughout the city, addressing factors such as building orientation, street layout, and green spaces (see #5) to ensure adequate air quality and comfort in outdoor environments.	Urban	**Natural Airflow Design:** Incorporating layouts that promote natural air flow to help relieve heat stress in urban environments and improve overall air quality. **Green Spaces for Improved Air Quality:** Utilising parks and green areas to enhance air quality and provide natural cooling.	**Healthier Living Environment:** Improved natural air circulation leads to reduced pollution levels, benefiting residents' health.	Considering the proximity to industrial sites or busy roads during due diligence is crucial to ensure compliance with environmental regulations and evaluate potential health and environmental risks that could affect property value and tenant satisfaction. **NOTE: It is important to ensure that the circulating air is of good quality to avoid the recirculating of pollutants which adversely affecting residents' health and well-being.**
			Building	**Cross Ventilation Design:** Incorporating architectural elements like strategically placed windows and vents for cross ventilation. **Building Orientation and Layout:** Designing buildings to take advantage of prevailing winds for natural cooling and air circulation.	**Indoor Air Quality:** Enhanced natural ventilation improves indoor air quality, reducing reliance on mechanical systems for air circulation and purification.	
		Improving air quality is a critical concern at both urban and building levels, with significant implications for climate resiliency, occupant health and well-being, and property value. In both urban and building contexts, improving air quality is key to fostering sustainable, healthy environments (see #7), influencing the desirability and value of properties, and contributing to the health and well-being of residents and occupants.	Urban	**Reduction of Pollution:** Measures to improve urban air quality, such as reducing vehicle emissions and increasing green spaces, reduce overall pollution levels. **Healthier Ecosystems:** Cleaner air contributes to healthier urban ecosystems, which are more resilient to climate change impacts.	**Health and Comfort:** Better air quality reduces health risks associated with pollution, leading to a more comfortable living environment. **Quality of Life:** Clean air is a key factor in overall quality of urban life, affecting both physical health and mental well-being.	Identify what measures are in place to reduce local air quality. Consider how the measures contained within reduce localised emissions.
			Building	**Building Emissions Reduction:** Implementing measures to reduce emissions from buildings, such as energy-efficient systems, contributes to overall climate resiliency. **Indoor Air Quality Management:** Effective ventilation and air filtration systems ensure a healthier indoor environment.	**Enhanced Indoor Comfort:** Good indoor air quality is essential for occupant comfort, health and well-being, reducing risks of respiratory issues and other health problems. **Increased Productivity and Well-being:** Clean air within buildings is linked to higher productivity and better mental clarity for occupants.	
7	**Urban Microclimates, Thermal Comfort and Wind Speeds**	An urban microclimate is the distinct climate of a small-scale, localised area within a city or urban setting, which can differ significantly from the climate of its surroundings. Urban microclimates are influenced by the urban layout, and design elements. For example, levels of urban density (see #11) not only determine air flow (see #6), but levels of solar radiation and nocturnal heat loss. Elements like vegetation and surface properties such as permeability and reflectivity, also influence temperature, airflow, and humidity in city environments.	Urban	**Microclimate Management and Infrastructure Protection:** The strategic placement and design of urban elements, are vital for managing microclimates, influencing airflow, solar radiation, and nocturnal heat dissipation. These elements not only play a key role in temperature regulation but also reduce wind speeds and protecting infrastructure and urban residences. Incorporating shading (see #4) and wind barriers is essential for enhancing resilience and comfort in both buildings and broader urban environments, especially in areas with high wind and or solar exposure. Shading and wind barriers, particularly those incorporating natural elements, play a crucial role in enhancing air quality and mitigating wind and noise pollution, while also significantly contributing to the sustainability, safety, and aesthetic appeal of urban spaces. This multifaceted approach contributes significantly to the quality of life and attractiveness of both buildings and urban areas.	**Improved Outdoor Comfort, Safety, Noise, and Air Quality:** Managing urban microclimates also improves air flow, reducing wind speeds, noise, and improving both temperatures and air quality, making urban spaces more comfortable and healthier.	Consider a property's interaction with local climate factors, surrounding structures, and potential for adaptive design, considering elements such as airflow, sun exposure, and sustainable features. To assess to the impact of urban layout and design elements on microclimates, focus on identifying vegetation health, surface types, shaded and sunny spots, water features, and areas of human activity, as they collectively determine airflow, solar exposure, temperature, and the overall environmental quality in urban settings.
			Building	**Structural Protection and Energy Efficiency:** Shading and wind barriers also provide structural protection to buildings against strong winds and contribute to energy efficiency by helping maintain internal temperatures and reducing heating costs.	**Comfort, Noise, and Air Quality Reduction:** Natural wind barriers, such as trees, not only prevent drafts and help alleviate heat stress, but also reduce noise pollution, and improve air quality.	
8	**Enhanced Building Envelope** (thermal and optical properties)	The thermal and optical properties of materials are important characteristics that describe how materials interact with light and heat. Adapting these properties to meet specific urban needs can greatly enhance urban resilience and contribute to the creation of cities that are healthier, more comfortable, and energy efficient. Thermal properties, such as heat conductivity and capacity, determine how well a material insulates, whereas optical properties like reflectance (albedo*) and transmission (particularly through windows) – are crucial in managing light and heat interactions. Selecting materials optimised for heat and light control can result in reduced energy consumption, improve thermal comfort, and better living conditions.	Urban	**Management of Urban Temperatures:** Surfaces with optimised optical and thermal properties contribute to managing urban temperatures, reducing heat stress and improving overall climate resilience. **Year-Round Thermal Comfort:** Strategic use of surface materials can enhance comfort in both hot and cold conditions, balancing heat absorption in winter and reflection in summer*.	**Enhanced Living Environment:** Thoughtfully designed surface properties improve outdoor comfort and overall environmental quality in urban areas. **Energy Efficiency in Public Spaces:** Reduced need for artificial heating and cooling in public buildings and spaces due to efficient surface designs.	Evaluate the potential impact on radiation exposure from the asset and surrounding buildings. Consider the impact on vegetation health, potential glare issues affecting visual comfort, adherence to regulations, long-term durability and maintenance, energy efficiency trade-offs, cost-effectiveness, mitigation of light pollution, and their sustainability and environmental footprint.
			Building	**Enhanced Building Insulation:** Effective thermal properties of surfaces contribute to maintaining stable indoor temperatures, reducing the building's environmental carbon footprint. **Reflectivity of building surfaces:** Increased reflectivity reduces heat absorption, lowering indoor temperatures and mitigating the heat stress. This feature not only improves energy efficiency but also extends material lifespan and offers aesthetic value to architectural designs. **Optimal Use of Natural Light:** Properly managed optical properties, like window transmission (glazing), can maximise natural lighting while minimising heat gain, contributing to energy efficiency.	**Year-Round Comfort and Reduced Utility Costs:** Buildings with well-designed thermal and optical material properties offer a comfortable indoor climate and lower energy costs across all seasons. **Improved Indoor Air Quality:** Efficient thermal and optical surface properties help maintain optimal indoor air quality, enhancing occupant health and productivity.	Internationally approved certifications such as LEED, contain resources and information.

*NOTE: While increasing reflectivity (albedo) of urban surfaces is crucial for reducing temperatures and energy usage, it poses potential risks such as increased reflection of radiation exposure for pedestrians and adjacent buildings. This heightened reflectivity can impact microclimates and potentially raise cooling demands in surrounding structures.

#	Factor	Description	Scale	How climate resiliency is improved	Potential owner/ occupier benefits	Asset acquisition considerations
9	**Sustainable Transport and Improved Connectivity**	An alternative transportation infrastructure at the urban level not only contributes to environmental sustainability but also enhances the quality of life for residents and has positive implications for property values and investment attractiveness.	Urban	**Reduced Carbon Emissions:** Promoting modes of transport like cycling, walking, and public transit reduces reliance on cars, thereby lowering greenhouse gas emissions. **Improved Air Quality:** Alternative transportation methods lead to lower emissions, contributing to cleaner and healthier urban air.	**Improved Health and Well-being:** Alternative transportation often involves physical activity (such as cycling or walking), which can improve physical health and reduce stress. **Enhanced Quality of Life:** Reduced traffic congestion and improved urban air quality contribute to a more pleasant and healthier urban environment.	Assess the availability and quality of transportation infrastructure in the area surrounding the property, including the availability of vehicle charging infrastructure.
10	**Reduced Parking Infrastructure**	Reducing parking infrastructure aligns with contemporary urban and building development trends, focusing on sustainability, improved quality of life, and future-proofing investments.	Urban	**Reduced Emissions:** Less parking infrastructure encourages use of public transit and non-motorised transport, reducing greenhouse gas emissions. In addition, it is important to consider the reduction in embodied carbon associated with excavation and underground parking structures.	**Enhanced Urban Environment:** Less emphasis on parking leads to more pedestrian-friendly areas, improving the overall urban living experience. **Healthier Lifestyle:** Encouraging alternative transportation modes can lead to more active lifestyles for residents.	Determine objectives and goals at urban scale, including accessibility and transportation plans, parking alternatives, traffic, and congestion. Understand how a reduction in underground parking can influence sustainability outcomes.
			Building	**Increased Green Spaces:** Space saved from parking can be converted to green infrastructure, aiding urban cooling and biodiversity. **Water Management:** Lower levels of impervious surface cover from parking lots can improve stormwater management and heat stress (see #1).	**Cost Savings:** Reduced parking infrastructure can lower construction and maintenance costs for building owners. **More Usable Space:** Space saved can be utilised for amenities, adding value to the property. **Accessibility:** Promotes transportation equity by prioritising needs of all residents, including those with disabilities and lower incomes.	
11	**Density, Layout and Urban Activities**	Urban density is the concentration of buildings and people in a specific area. It is a key consideration in creating sustainable and resilient and healthy cities. The distribution of this density, both vertically and horizontally, along with the form of the urban layout and architectural design, significantly influences climate resilience, community health and well-being, and economic stability. The ability to identify and manage these interrelated aspects, including the various types, timings, and intensities of urban activities, is essential in creating sustainable, functional, and liveable urban spaces. This holistic approach meets the evolving needs and challenges of urban development, ensuring a harmonious balance between form, function, and everyday urban life.	Urban	**Efficient Resource Utilisation:** Urban density offers benefits like efficient public transportation and reduced environmental impact, but it also comes with challenges in high-density areas. Reduced airflow limited solar radiation, and notably less nocturnal heat loss can result in the accumulation of heat and pollution. These conditions can negatively impact health and well-being and lead to increased energy consumption in such urban settings. **Heat Mitigation Strategies:** To alleviate heat stress and poor air quality in high-density areas, implementing ventilation strategies is crucial (see #6). Additionally, integrating green and blue infrastructure can effectively combat urban heat stress, improve air quality enhancing the urban microclimate (see #7). **Enhanced Natural Ventilation:** Thoughtful urban form enhances natural ventilation and airflow, facilitating urban cooling and reducing heat and pollution accumulation. **Optimal Layout and Orientation:** Strategic layout and orientation of buildings and spaces for optimal sun exposure and air flow.	**Access to Amenities:** Higher density areas often provide better access to amenities and services. **Community Vibrancy:** Dense urban environments can foster vibrant communities and social engagement. **Improved Air Quality and Cooling:** Improved air quality and natural cooling lead to a more comfortable and healthier urban environment, which in turn promote sustainable urban practice. **Community and Public Spaces:** Enhanced public spaces that foster community interaction and provide respite from heat.	Assessing the quality of local infrastructure and access to public transport, which are crucial in dense urban settings. Understand how the building contributes to or benefits from local climate resiliency efforts. Identify and assess how the asset interacts within the wider urban context. Factors such as solar exposure, local climatic conditions, overshadowing, wind patterns, impervious surfaces, and vegetation should all be carefully considered.
			Building	**Optimised Solar Access and Natural Ventilation:** In dense urban areas, building orienting, designing windows for maximum sunlight and cross-ventilation, and planning internal layouts for air flow, are critical to optimise natural light and ventilation. **Design Features for Solar Access and Natural Ventilation:** Shading devices, materials, and ventilation pathways integrated into the design can effectively manage sunlight exposure and enhance natural air circulation within the building.	**Comfortable Living Environment:** Buildings with optimised natural light and ventilation provide more comfortable living and healthy environment. **Energy Cost Savings:** Natural lit and ventilated buildings can significantly reduce energy consumption and lower utility costs.	
12	**Passive and Natural Resources**	Passive and natural resource optimisation involves using naturally occurring elements and processes, such as sunlight (solar gains), airflow, natural vegetation, and water bodies, to enhance sustainability and efficiency in urban and building environments. This approach aims to reduce negative environmental impacts and improve the quality of life by utilizing these resources for heating, cooling, ventilation, and climate resilience, thereby making environments more sustainable, healthy, resilient, and cost-effective.	Urban	**Reducing Negative Environmental Impact:** Utilizing passive resource use - for example solar gains and airflow for heating, cooling and ventilation - minimizes the environmental footprint of urban areas. **Natural Ecosystem Services:** Leveraging natural elements like green spaces and water bodies for urban cooling and stormwater management (see #1) enhances health, well-being, and urban resilience.	**Enhanced Urban Environment:** Passive resource utilisation (i.e., assess to solar gains and air flow) contributes to a more sustainable and resilient urban living environment. **Lowered Utility Costs:** Reduced dependence on artificial systems for heating, cooling, and lighting leads to cost savings.	Consideration to be given when investing in attributes for other factors such as solar access, ventilation, and shading. For example, what natural resources are presently in place and how can they be utilised to improve performance and engagement?
			Building	**Energy Efficiency through Natural Elements:** Utilising passive solar heating, natural ventilation, and daylighting to reduce energy consumption and enhance building resilience. **Sustainable Design Practices:** Incorporating features like green roofs or rainwater harvesting systems to harness natural resources effectively.	**Improved Comfort and Well-being:** Passive design elements typically create healthier and more comfortable living environments. **Reduced Operating Costs:** Buildings optimized for passive resource use often have lower energy and maintenance costs	

13	**Energy Efficiency and Effective Management**	Building management systems and smart controls are pivotal in enhancing building efficiency, occupant well-being, and market attractiveness, making them key factors in modern building design and asset management. When considered along with low energy or passive systems in building management, the focus shifts towards strategies that require minimal energy input and harness natural processes.	Building	**Energy Efficiency:** Smart systems optimise energy use, reducing the building's carbon footprint and contributing to broader climate change mitigation efforts. **Adaptive Response to Environmental Changes:** These systems can adjust heating, cooling, and lighting in response to external environmental conditions, enhancing the building's adaptability to climate variations.	**Cost Savings:** Automated control of energy and utilities leads to reduced operational costs. **Enhanced Comfort and Convenience:** Smart controls ensure optimal indoor environmental quality, enhancing comfort for occupants. **Health Benefits**: Improved air quality and temperature regulation contribute to better occupant health.	Assess whether the building has building management systems and other smart controls, such as smart meters, installed. Determine what improvement opportunities for building management systems, including emerging building technologies, are needed to be factored into the business plan of the asset.
		Incorporating low energy and building management systems is crucial for achieving energy efficiency, occupant well-being, and ensuring the building's competitiveness. Whereby combining smart building management systems with low energy/passive design strategies can create an optimally efficient and sustainable building environment. This hybrid approach leverages the best of both worlds - the intelligence and adaptability of smart systems with the inherent energy efficiency of passive.		**Natural Climate Adaptation:** Passive systems like natural ventilation and thermal mass use environmental conditions to regulate building temperature, reducing reliance on energy-intensive HVAC systems. **Sustainable Design:** Passive design elements, like sun-shading or orientation for maximum natural light, contribute to a building's overall sustainability and climate resilience.	**Reduced Energy Costs:** By maximising efficiency through passive means, these systems significantly lower energy consumption and utility costs. **Enhanced Comfort:** Passive systems often result in more consistent and natural indoor environmental conditions, improving occupant comfort. **Healthier Indoor Environment:** Using natural ventilation and lighting reduces the risk of indoor pollutants and improves overall air quality. It is important to ensure that the circulating air is of good quality to avoid recirculating pollutants and adversely affecting residents' health (see #6).	
		Energy and building efficiency are pivotal in modern building design and operation. In summary, energy and building efficiency are crucial for reducing environmental impact, enhancing occupant comfort and health and well-being. These factors are increasingly important in asset acquisition and property investment decisions and are increasingly the market value and appeal of properties.		**Reduced Carbon Footprint:** Efficient buildings use less energy, contributing to lower greenhouse gas emissions and helping mitigate climate change. **Adaptation to Energy Scarcity:** Energy-efficient buildings are better equipped to deal with situations of energy scarcity or rising energy costs.	**Cost Savings:** Improved energy efficiency leads to significant reductions in utility costs. **Enhanced Comfort:** Energy-efficient buildings often maintain more consistent temperatures and air quality, improving indoor comfort. **Healthier Indoor Environments:** Efficient ventilation and heating/cooling systems contribute to better air quality and reduced allergens.	Prioritise going lean before going green.

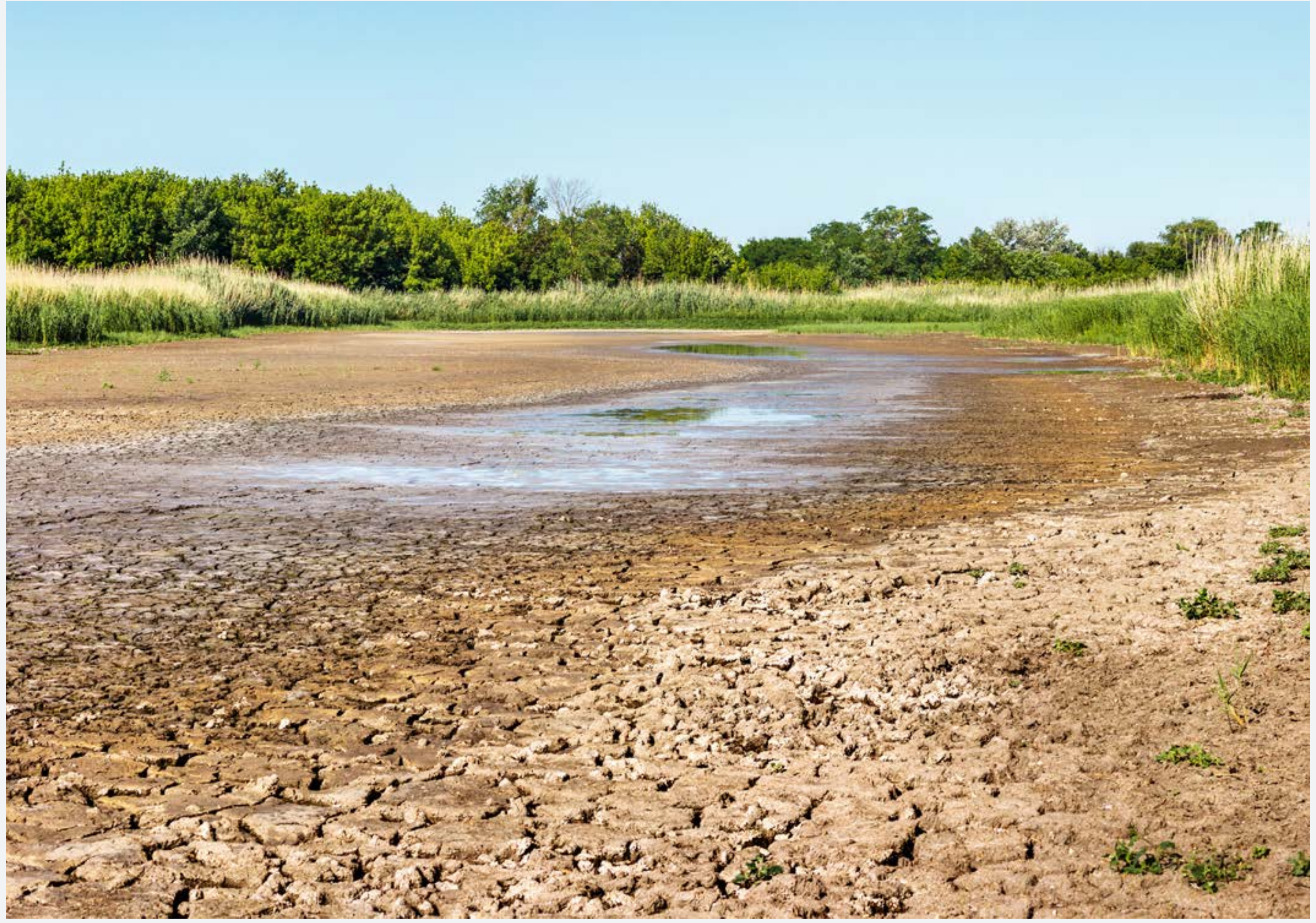
Conclusion

Urban environments are intricate systems where various elements are interwoven and dependent on one another. Alterations in one aspect can trigger significant and varied effects on other parts of the system. Presently, Savills IM's strategies for combating climate change are primarily cantered on managing energy at the individual building level, which often leads to a neglect of the larger environmental impact of these interventions.

To effectively address the challenges of climate resilience, a more comprehensive set of tools is necessary with features including:

1. Integrate Existing Urban Knowledge: Utilising the wealth of knowledge already available about urban systems can provide a foundation for developing new strategies.
2. Acknowledge Interconnected Nature of Urban Systems: Urban systems are intricate networks where changes in one part can significantly impact others. Recognising this interconnectedness is crucial for effective resilient and sustainable urban spaces.
3. Consider Wider Environmental Implications: Beyond just focusing on individual buildings, it's important to understand how the built environment effects and is affected by the broader environment.
4. Adopt a Holistic Approach: This involves looking at urban planning and development comprehensively, not only from an environmental perspective but also social and economic factors.

This overview represents first steps in integrating urban climate research into built environment practices. Such practices consider the holistic impact of built form on various aspects towards more effective urban planning and sustainable development. It is the ambition of Savills IM to explore these considerations and embed into investment due diligence when acquiring standing assets or forward funding developments.



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