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Between Buildings: An Evaluation of London's Microclimate Policy

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Declaration

This dissertation is my own original work and has not been submitted elsewhere in fulfilment of the requirements of this or any other award.

Paula Presser

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Abstract

Urban centres play a crucial role in climate change. Therefore, it is necessary to think about the role of urban planning in these changes. This thesis aims to investigate what we know about how urban factors influence the city's climate and its energy consumption, within these factors which would be the most influential in London according to the opinion of experts from the public, private and academic sectors and how these factors appear in the climate simulations that exist for London. Furthermore, how this knowledge can be added within the existing urban legislation, to this end, a mixed methodology was used between literature review, questionnaire and focus group. From the results obtained by the focus group, we saw that the main factors that we still do not know about urban climate are: urban form and modelling, about how we can tackle: regulations and modelling. In the questionnaire, we saw that the main factor that must be taken into account in London is anthropogenic heat and that the current urban policies in London are seen as unsatisfactory by most of the participants. Through the work, it can be concluded that an evaluation methodology is needed that focuses on the interrelation between urban factors, the formation of evaluation committees of the planning structure for the implementation of new climatic practices.

I dedicate this thesis to my Mother for her amazing energy that guided me here, to my husband Vinícius for his love and patience in all the moments of my journey, my friends and family who are an eternal source of inspiration. And finally, the MUrCS team for believing in science and the importance of knowledge for a better society.

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Notation and Glossary

IPCC - Intergovernmental Panel on Climate Change

CGH - Greenhouse Gases

GDP - Gross Domestic Product

UHI - Urban Heat Islands

UBL - Urban Boundary Layer

UCL - Urban Canopy Layer

CCN - Cloud Condensation Nuclei

RH - Relative Humidity

GIS - Geographic Information System

°C - Celsius Degrees

GMP - Hong Kong Greening Master Plan

BNatSchG - The Federal Nature Conservation Act

NatSchG - Baden-Württemberg Land Nature Conservation Act

NYCECC - New York Energy Conservation Code

ARCC - Adaptation and Resilience in the Context of Change network

UKCIP - UK Climate Impacts Programme

SUDS - Sustainable Drainage System

CAZ - Central Activities Zone

OTC - Outdoors Thermal Confort

1. INTRODUCTION

Studies linking urban planning to climatic factors are not new, in the German magazine Der Stadtebau (1904) there were already discussions of subjects such as humidity, temperature, air quality and ventilation. Besides another German magazine, Stadtklima, in its edition of 1956 shows the relationship between urban form and urban boundary layer (Hebbert and Jankovic, 2013). Hebbert and Jankovic (2013) explain that issues related to the pollution of motor vehicles, stormwater runoff linked to motorways, the replacement of green spaces with impermeable materials, leading to the loss of the evaporation coefficient that was previously a function of vegetation have been addressed since the seventies. However, the academic community remains disappointed with the level of response that the government takes on these issues (Hebbert and Jankovic, 2013). For the construction of public policies that deliver a quality urban space for the population and the environment, for this, we will look at the factors that influence health, urban form, thermal comfort, vegetation, ventilation, and energy consumption.

The future scenarios of the climate crisis show a severe increase in the global average temperature, according to the IPCC (Internacional Panel of Climate Change) (Ng et al., 2016). Thus do not only mitigate the impact, but it is also necessary to find ways to reduce the emission of polluting agents, been crucial looking at cities as they account for 80% of total greenhouse gas (GHG) emissions (Chakraborty and Allred, 2015). In addition, most of the world's population lives in cities, in 2014 accounted for 54% of the total population, with future projections of 70% in 2050 (United Nations, 2016). However, the role of cities is not only found in their population data for 70% of global resources are consumed in cities and 70% of global GDP is generated in cities, despite having a global coverage of only 5%(van der Heijden, 2019), concluding that cities are a big deal when it comes to climate action.

It is possible to say that urban constructions are the first forms of anthropogenic climate change, afterwards, they are ways of adapting the external environment to human requirements according to the needs of each location - cold, heat, humidity, etc. (Hebbert and Jankovic, 2013). The relationship between cities and the climate crisis is complicated, it is not possible to consider it as the villain, much less the victim of climate change. However, we need to look at cities as a solution. Since the city is an anthropogenic construction, it is possible to think that through planning focused on climate issues that adapt to human needs with the least impact it is possible to reduce the climate damage that cities have been causing to the environment (Martilli, 2014).

Today some solutions help to reduce energy consumption for buildings and assessment tools that facilitate quantifying these expenditures. However, these strategies need to relate to urban planning and take into account not only buildings in isolation but them as a group (Bourdic and Salat, 2012). Still, there is a gap between what is produced in academia and what is applied in urban policies (Lenzholzer and Brown, 2016), considering there is already scientific evidence of what needs to be done, but we still do not see these being implemented through policies. Kruger and Costa (2019) briefly enumerate some of the alternatives offered directly to thermal comfort in urban spaces, such as urban morphology, the distance between buildings, sky view, vegetation and other factors. However, the city cannot be studied as a single organism, and it is necessary to take into account the differences between each region since the morphological and land use variations have essential impacts on the microclimate (Johansson et al. 2014). Therefore the urban regulation policies they need to work at different scales in order to achieve their goals.

For this purpose, it is important to emphasize the role that urban policies play in the city climate, for this will use the definition of urban energy policy by Keirstead and Schulz (2010) "the activities are undertaken by public sector urban agents (e.g. metropolitan and neighbourhood authorities) to influence the supply and

demand of energy within their urban area". A study with more than 32 architects and design practitioners found out that building regulations are the main driver for energy changes (Heaphy 2017). As we will show in this work, urban planning has the power to take cities to an eco-friendlier level and climate responsible future, so it is in an urgent that we must study the possible strategies to be taken by cities in this aspect. This importance is emphasized in the work of Wu et al. (2018), which analyses the growth in the number of academic publications on the subject from 1997 to 2017 (Fig. 1).

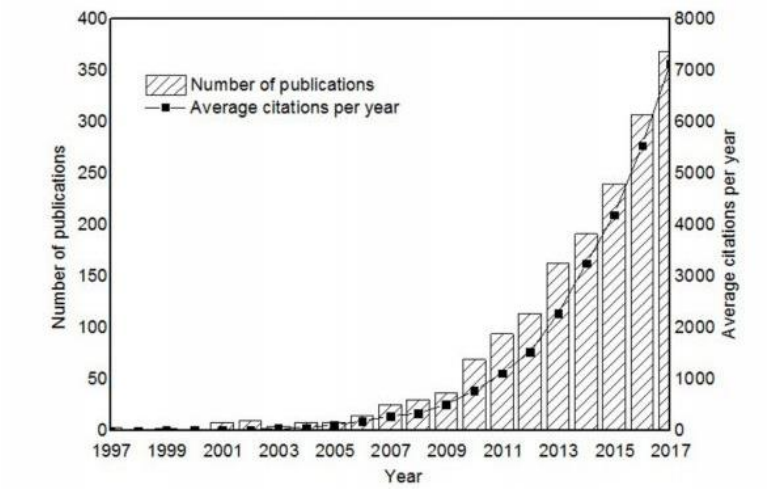


Figure 1 General trends of selected publications from 1997 to 2017 (Wu et al., 2018).

This work aims to investigate how the knowledge acquired in previous research on the influence of urban factors can effectively help in reducing the urban impact on the climate crisis and how can this be translated in Urban Governance. To this end, we will go through a literature review where we analyze the main climatic factors and how they affect urban space. What anthropogenic changes occur in the urban space and how they affect the climate in that area, so we look for some examples of how cities in different climates have been working to mitigate the effects of urban space in favour of better thermal comfort, higher energy efficiency and less impact on the population's health. These work objectives are:

- Analyse what is already known about climatic factors and what is not yet known;
- Critically explore urban climate factors through specialists (from the private sector, academics, and the public sector), and discover which factors are believed to be the main ones.
- Critically Evaluate the effectiveness of these options through existing simulations of London's microclimate on mitigating these factors.
- Propose ways in which such knowledge could be embedded in the governance structures of cities.

For this purpose, a mixed methodology will be used, with a literary and documentary review to verify what we already know about urban factors and how they present themselves in the urban regulation of some cities. The data collected by the focus group carried out in 2017 by the Adaptation and Resilience in the Context of Change network (ARCC) will also be used with London urban planning and climate experts and to know their opinion on the following questions "what we still need to know ","" what we already know but have not used yet "and" how can we tackle this problem". Finally, an online questionnaire will be conducted with urban planners and industry experts on London's urban climate policies. After this, the results of the three stages of the

investigation will be confronted and discussed and finally, the conclusions chapter with the governance indications that were finded.

2. LITERATURE REVIEW

2.1 Urban climate factors

Heat:

Episodes of extreme Heat in cities have frequently been increasing, studies show that these events have almost doubled in the United States since the 1950s, going from 10 events per year to 18 per year and that they are directly linked to hospitalizations for extreme heat-related illnesses - an example is the 70,000 deaths during the heatwave that hit Europe in 2003 (Stone et al., 2012). However, there are still risk assessment studies that do not include the phenomena of urban heat island (UHI) (Tomlinson et al., 2011), even though health and thermal comfort are directly related (Ng, 2009). There is evidence demonstrating the existence of a human thermal limit, so copping with these issues comes to be extremely important. Besides, more areas with more significant population agglomeration are also those with higher temperatures and are generally located in urban city centres, which are the most affected areas by UHI (Tomlinson et al., 2011).

The damage to human health linked to extreme warming varies from cramps to exhaustion and can even reach heat strokes. Also, it is directly linked to cardiac diseases and respiratory problems. However, when we analyze only studies of mortality due to cardiovascular illness, this data is not very clear, since there are factors such as the advancement of medicine, improvement in economic indices that also count towards improving the quality of life of the population of the great urban centres (Ng et al., 2016).

Wind:

Ventilation, air movement, perhaps one of the main factors for human thermal comfort in urban centres, it is present in cities all the time, every day regardless of the season and is directly affected by the urban shape, buildings, blocks, streets and trees (Hebbert and Jankovic, 2013). How winds behave in urban areas is very different from when movement is separated into natural areas. In cities, many factors act to alter their natural movements, such as hegemonic morphology, barriers in their movements, different temperatures, and even materiality influences their direction and speed. A region above the buildings, called the urban boundary layer (UBL) (Fig. 2), with different types of surfaces, makes it difficult to continue the wind speed in this region. When we observe an Urban Canopy Layer (UCL), this situation becomes even more complicated, where the streets act as wind canyons that follow their orientation (Ricci et al., 2017)

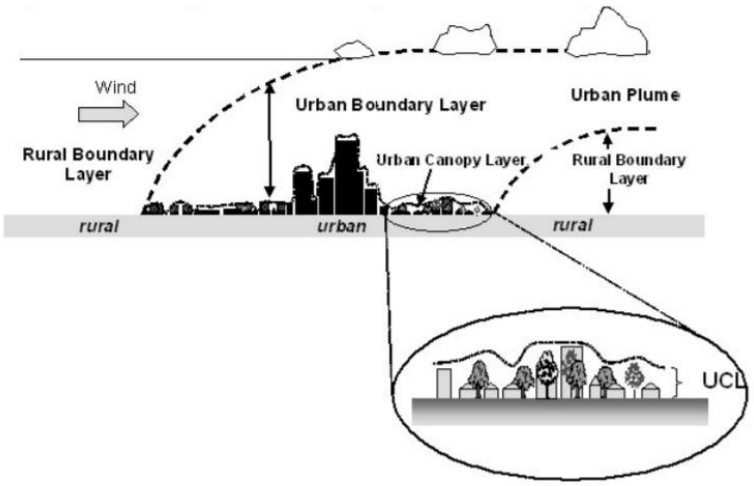


Figure 2. Schematic of the main components of the urban atmosphere (Fabrizi, Bonafoni and Biondi, 2010)

Therefore, thinking about strategies that use wind aspects to improve thermal and air quality in cities is also important. Through urban planning, it is possible to establish guidelines that lead to issues that improve thermal comfort, air quality and reduction of energy expenditure in cities, and there are already urban forms that have proven to help increase urban ventilation. Some urban forms can help improve the quality of ventilation in urban centres; one of them is the creation of permeability at the pedestrian level (Fig. 3) facilitates wind flow. It improves air circulation, in addition to removing pollutants and heat generated at the ground level. Other strategies would be, linking open spaces, squares, streets, squares; pay attention to the layout of the buildings (even more critical than their heights) so that they do not obstruct the passage of the dominant winds (Fig. 4). Furthermore, in situations where the creation of these spaces is not possible, due to the urban fabric it is still possible to work with the variation in the height of the buildings, reducing the heights towards the direction of the prevailing wind (Ng, 2009).

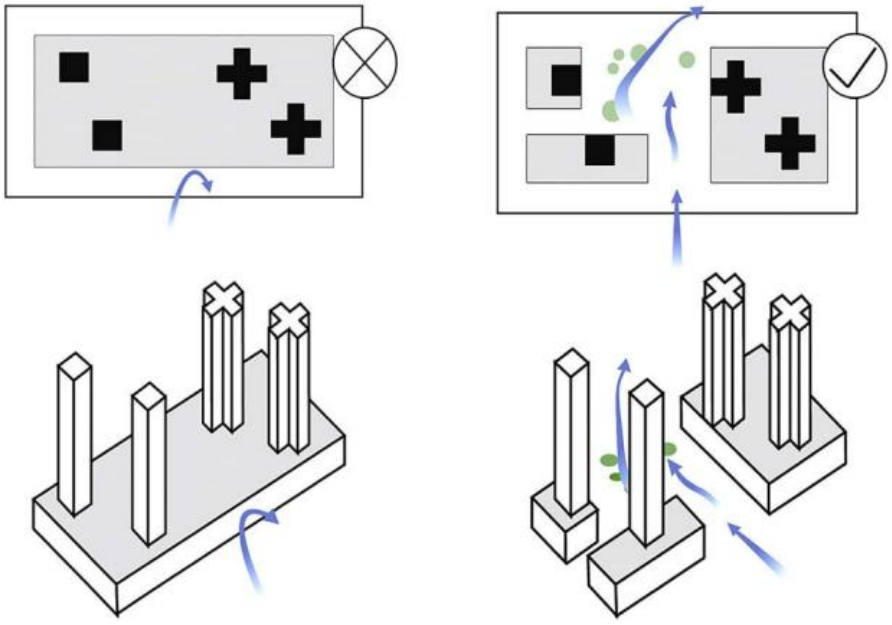


Figure 3. Non- building area. (Ng, 2009)

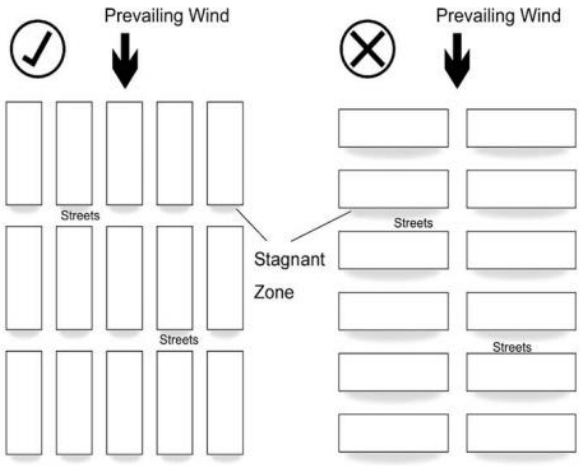


Figure 4. The orientation of street grids. (Ng, 2009)

Precipitation:

One of the natural factors influenced by the urban space is precipitation; this is because the construction of cities is based on the modification of the natural area by new surfaces, which often consist of concrete and asphalt, materials with higher thermal inertia that stores a significant amount of heat. In addition, the urban atmosphere is more polluted than its surroundings, mainly due to cars. Many studies show an increase in precipitation in urban areas, mainly due to three factors: urban heat island, surface roughness, and higher aerosol concentration (Han et al. 2014). According to Han et al. (2014), the influence of the urban heat island "induced upward motion on the downwind side is responsible for the precipitation enhancement observed downwind of urban areas". As far as the surface it changes the direction of the winds when they are passing through the urban areas; this movement also causes an increase in precipitation (Fig. 5); finally, the concentration of aerosols affects the development of clouds "acting as cloud condensation nuclei (CCN)" absorbing and scattering solar radiation (Han et al., 2014). The impact of urbanization on precipitation levels has been observed since the 1970s (METROMEX project) (Zeleňáková et al., 2020), and in general, the indication is that urbanization increases the levels of precipitation. However, there are some regions where the effect is the opposite, so a more local and in-depth study is needed to find the causes of these differences (Han et al., 2014).

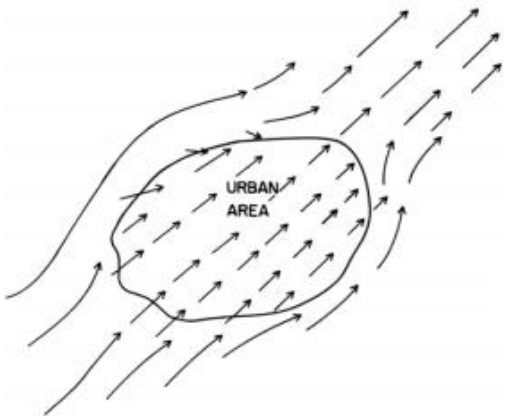


Figure 5. Schematic of low-level airflow over and around an urban area due to changes in surface roughness (Han et al., 2014)

Humidity:

Another critical factor in understanding the urban climate is the relative humidity of the air (RH) since the differences in the surface between the urban-rural areas and the vegetation cover in both are very distinct, and this difference causes disturbances in the latent heat fluxes, and so in the temperature of the cities (Zhang and Wu, 2018; Hu et al., 2014). The influence of high RH directly interferes in the formation of clouds, fog and smog, reducing the sensitivity and increasing the concentration of aerosol (Zhang and Wu, 2018). Also, high RH values can exacerbate heat stress waves (Hu et al.). During extreme heat events, both in rural and urban areas, air temperature and dewpoint increase, however, the magnitude of this increase is more significant in areas with a higher concentration of vegetation - rural, these areas generally show an increase in latent heat fluxes due to the moisture of the vegetal surface (Hu et al., 2014). Finally, it is possible to analyze the impact of HR on human health, considering the combination of grand RH with high temperatures increases heat stress (linked to cardiovascular diseases), in addition, the RH concentration directly influences the concentration of bacteria, fungi and viruses and it can increase or decrease the speed of spread of diseases. (Zhang and Wu, 2018)

2.2 Sources for Urban Climate Abnormalities

Urban Form:

According to Jabareen (2006), urban form is a composition of components that are replicated within the city land use, such as streets, blocks and transportation systems. Using a quote by Kevin Lynch (1987) "the spatial pattern of large, inert and permanent physical objects in a city", these patterns occur through agglomerations of elements that are repeated in an unlimited way. Within the distribution of these standards, something that is taken as ideally for the urban city is density, considering the density is linked to the quality of life, increasing social interactions and the proximity between facilities and services, and reducing energy consumption. Therefore, the desirable city is one that is compact enough where walking distances are predominant, so that the population does not need their car, but large enough to have a diversity of attractions (Jabareen, 2006). However, it is necessary to consider the materiality of the elements that make up this density, and how they behave with regarding thermal comfort in public spaces and how this interaction occurs in the heat exchanges between buildings.

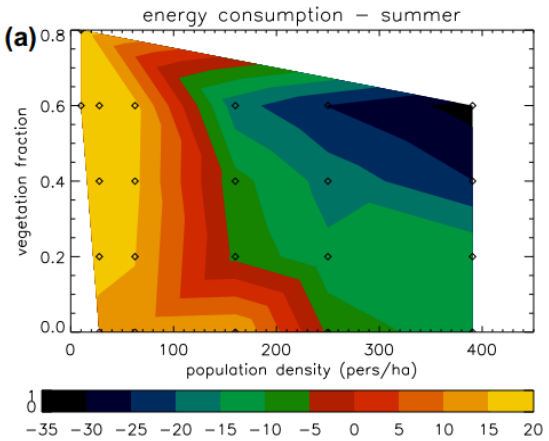
Dense cities with little vegetation are considered the heat stress most uncomfortable. This fact shows us the dichotomy existing in dense areas of cities, since when we analyze it as a whole, density is seen as something good for reducing emissions of carbon, however, when looking in smaller scales we see that the density can cause uncomfortable heating for its inhabitants (Martilli, 2014). However, recent studies show that a future scenario that helps to reduce residential energy expenditure by up to 36% would be the most compact use of space (Chakraborty and Allred, 2015). In the work of J. Futcher et al. it is illustrated how this dichotomy appears in urban centres, where a glazed tall building benefits from the shadow of the neighbouring building - saving up to 30% of energy, however, if it were designed to use solar panels it would be reducing its energy intake.

Because of this, it is necessary to explore first how features such as height, how the building is positioned on the block, skies view influence the energy demand. Futcher et al. (2017) show results that the heights of the buildings produce shade that reduces the external temperature, in addition to reducing the use of air conditioning in the neighbouring buildings. Taleghani et al. (2015) show studies of the benefits of large courtyards for cold climates, besides that for cooling effects the best orientation of rectangular courtyards is North-South - since it has a shorter time of sun exposure (in the northern hemisphere). Also, Taleghani et al. (2015) show that by controlling the skies view factor through the design of the streets, it is possible to prevent high temperatures.

However, urban forms are nothing more than the result of the planning policies of each region of the city. The urban climate is the result of the set of individual decisions of each building (Futcher et al., 2017). So choices that drive families to regions further away from their jobs and policies that do not induce mixed-used businesses to end up increasing the spread of the city, and end up promoting an increase in GHG emissions, even though there are isolated policies for increasing energy efficiency for isolate buildings, in the end, it is a question of the scale of political intervention (Chakraborty and Allred, 2015). Therefore, it is essential to develop a methodology that allows us to measure interactions between buildings together with the open space so that we have a response to the climate change policy (Mehrotra, Bardhan and Ramamritham, 2019).

Lack of Green Infrastructure:

Another vital factor for the urban climate is the green infrastructures present in cities; they are composed of natural spaces (parks, squares, preservation areas) or even in small portions such as single trees in flower beds, green roofs, etc. The use of these structures in the urban space brings several advantages, among them an improvement in air quality and reduction of air temperature by up to 4.1ºC (green roof in mesoscale) (Martelli, 2014) (Saaroni et al., 2018). Besides, the decrease of the presence of green structures can be harmful to cities, especially the denser parts, Martilli (2014) shows that when we have a compact urban space with a shortage of green areas the tendency is for it to increase its temperature, moreover with this reduction con lead to an increase in S / V radio, which escalate to more energy consumption (Fig. 6).



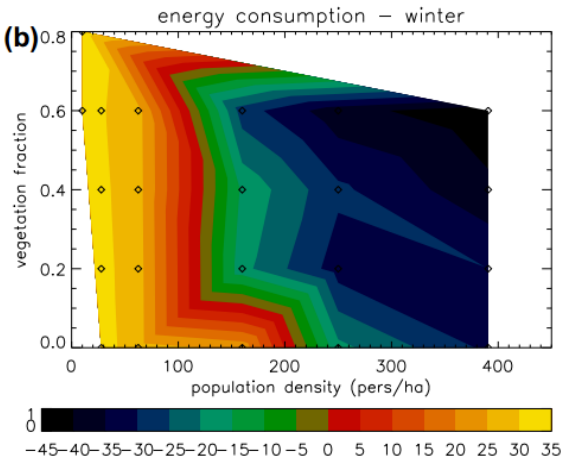


Figure 6. Relative differences (in per cent) in energy consumption for space cooling in summer (a) and for space heating in winter (b) vs population density (horizontal axis) and vegetation fraction (vertical axis). The diamonds represent the simulations (Martilli, 2014).

However, many of these green structures can have a more significant impact when in quantity, but it is difficult to find spaces for these in the densest areas of the cities - which end up being the areas that need it most, so the singles trees, trees present in the flowerbeds green roofs and vegetated yards are of paramount importance (Saaroni et al., 2018). The trees on the sidewalk are enough to reduce radiant heat load, and heat stress, trees with a higher leaf area index (LAI) can reflect shortwaves and even provide a more shaded area (Kong et al.) in addition to the leaves' transpiration. It is helping to reduce air temperature (this phenomenon depends on the structure, size density of each tree) (Saaroni et al., 2018). About the negative effect of tree shading during winter, it is only a matter of deciduous species choices (Saaroni et al., 2018). Finally, regarding the interference of trees in the speed of the winds, it is already known that this interference is minimal in dense areas. Besides, it is possible to reduce its picking of short-stemmed species, ensuring shade on narrower streets (Kong et al., 2017).

Finally, one of the main structures in urban centres is the Parks, complexes that can combine green coverage, shading in addition to blue infrastructure. Its advantages are several, such as the reduction of air temperature, some studies show that during the day the difference can be up to 0.94ºC. Also, this difference in temperature can extend up to 1.1 - 1.5 km. Another of the main advantages of parks is the improvement in the quality of public spaces. Authors show that between 25 - 50% of park users are looking for shaded areas in the city during hot periods and warn for the importance of these spaces for both their physical as well as mental health (Saaroni et al., 2018).

Materials:

About thermal balance of cities, the materiality of the buildings plays a fundamental role, since they absorb solar and infrared radiation and dissipate part of it in the atmosphere, increasing the air temperature, so it is necessary to study how we can mitigate this impact through the election of the most appropriate materials. Those with the highest reflective potential and infrared emittance are the so-called 'cool materials', as they increase urban albedo and contribute to the mitigation of the heat island phenomenon. In addition, the use of cool materials increases the energy efficiency of buildings by reducing the demand for cooling systems and improving the quality of the urban microclimate. Another critical factor for materiality is the question of colour, the lighter its albedo, the greater and the darker, the smaller it is, however, there are already studies showing the use of infrared reflective pigmentation to obtain greater efficiency (Santamouris, Synnefa and Karlessi, 2011). Radhi, Assem and Sharples (2014) show that the most considerable influence on materiality on the urban heat island is its ability to store heat, for this, it uses examples such as black granite that reaches its

surface at a temperature of 68C while white ceramic reaches 45C. So, it is necessary to think about materiality when it comes to reducing the impact of heatwaves and energy efficiency.

Anthropogenic Heat:

Although the contribution of anthropogenic activity to an increase in atmospheric temperature is considered a small fraction within the global scale, this factor influences much in the temperature of urban centres, contributing directly to phenomena such as urban heat island (Smith, Lindley and Levermore, 2009). Anthropogenic heat is a compound of emissions of fuels, electricity (industries, homes, etc.) and through the heating and cooling of buildings, with these components, it is possible to state that urban expansion has a direct impact on the discharge of anthropogenic Heat (Zhang, Balzter and Wu, 2012). Smith, Lindley and Levermore (2009) show that the impact of anthropogenic heat influences between 1 - 3C at UHI, in addition to the present an average consumption per individual of 70w sleeper and 800w in high activity, in figure 7 it is possible to see the anthropogenic consumption by morphology urban, with the most significant consumption located in residential areas of higher density. However, in order to have a more accurate notion in the anthropogenic heat, it is necessary to take into account the lifestyle of each community, and the displacements and how it is made are made (public transport or cars), so then we can plan the best way to target this type of consumption.

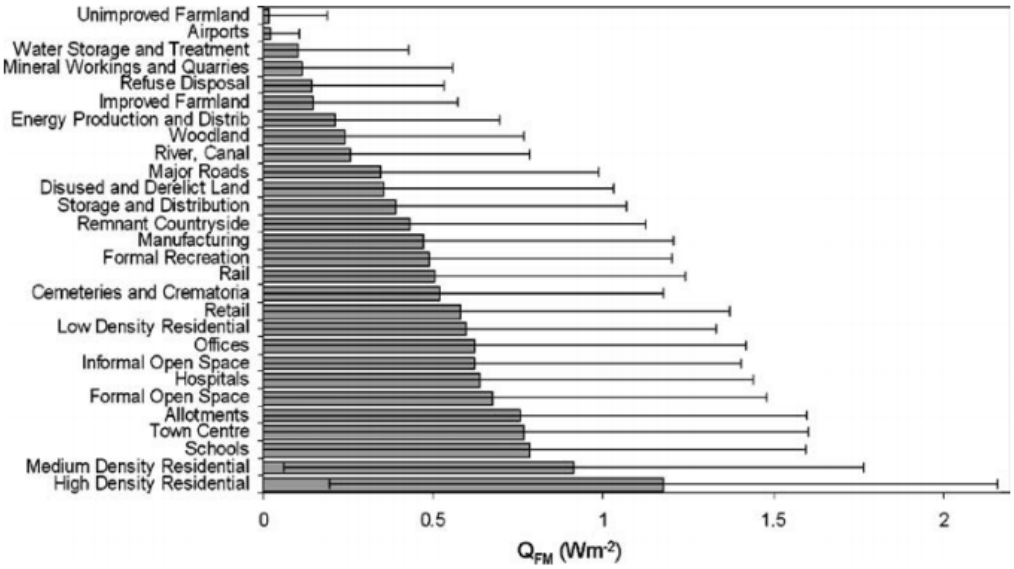


Figure 7. Mean metabolic heat flux by Urban Morphology Type (Smith, Lindley and Levermore, 2009).

Pollution:

The climate crisis, among other things, directly and indirectly, influences the formation of air pollution (Patella et al., 2018), studies show that pollution has nano and micro-sized toxins, of which the microparticles are the most dangerous since it has the potential to penetrate cell membranes and accumulate in the human body (Veremchuk et al., 2016). These particles easily reach the bronchial tree, which can cause significant inflammation, in addition to causing damage to the cardiovascular system, allergies, asthma, reknits and lung cancer. Some studies already link the increase in respiratory diseases with the increase in the global average temperature, so to reduce mortality, it is necessary to create strategies that reduce air pollution. Besides, it is necessary to take into account that in addition to air pollution, and the problems related to that already mentioned, there is another problem that is the formation of particles related to global warming and the presence of gases like ozone and other that harm the GHG balance. Therefore strategies that take into account the pollution reduction must also exist in order to revolve cities' climate issues (Patella et al., 2018).

2.3 Goals: Urban Thermal Comfort and Energy Efficiency Use

Thermal Comfort:

The urban climate is different from the climate in the open space of the countryside, and this is due to humanmade elements that compose cities, such as materiality and urban form, especially buildings, the increase and different surfaces that buildings have changed the way radiations behave in urban areas (Jabareen, 2006). So, this difference is also present in the thermal comfort that people feel in the countryside and the city, in Teleghani's research we found a definition for thermal comfort 'that condition of mind which expresses satisfaction with the thermal environment'. In order to obtain this comfort in the city, it is necessary to analyze the most appropriate urban forms and mind issues such as energy consumption, especially when it comes to the use for cooling, since in places with higher density (considered as more sustainable) spending on cooling generates an increase in the sensible heat flux (Martilli, 2014).

For this, it is necessary to think strategies to reduce the heat islands produced in large centres. Martilli (2014) shows a study that exemplifies that it is possible to reduce the heat islands in Paris with an increase in nearby forests by 30% and the use of lighter colours in buildings, a crucial strategy in a city that continually suffers from heat waves during the summer. Besides, other studies show that the combination of trees and vegetation cover, increased albedo, and a reduction in waste heat emissions can reduce temperatures in cities between 1ºC to 7ºC (Stone et al., 2012). However, we must pay attention for the functioning of each building since the strategies for the ones used during the day (usual offices) are different from those used in the evening (residential) (Futcher et al., 2017). It was also taking into account problems related to heat stress since that situation of thermal discomfort can cause health not only for the healthy urban population but mainly among elderly and chronically ill patients (Saaroni et al., 2018). Therefore, we must plan climate-responsive spaces that contribute to minimizing the damage caused by heat stress (Krüger and Costa, 2019).

Energy Use:

Finally, it is possible to say that energy consumption is one of the main factors for the emission of GHG in our atmosphere, therefore an essential factor for the mitigation of global warming. It is already known that approximately half of the effects of UHI are caused by human energy consumption and the other half by stagnant solar energy in urban space - which is directly linked to urban planning (Hebbert and Jankovic, 2013). However, although its causes and damages are already known, little is done to implement legislation that is effective for this reduction. An example is a European legislation that I use in its Energy Performance of Building Directive that relies on a single degree-day quantity for large regions, thus disregarding all other urban factors that directly influence energy expenditure (Mourshed, 2016).

2.4 Effective Legislative to Improve Urban Microclimate

Cities in Temperate Climate

Stuttgart is a city located in a valley in southwest Germany, due to its topography and its industrial function the city has been suffering from pollution problems since the beginning of the XX century, so already in 1938, it established the Agency for Environmental Protection. Besides, in 1953 begins to adopt Regulations for the Implementation of Functions in Climatology, using scientific meteorological discoveries to create urban policies. Over the years the city specialized and today it presents atmospheric models, GIS-based cartography,

mesoscale climate analyses that assist in the guidelines of urban planning, detailing of building codes, policies for tall buildings, landscape, and medium-term strategies to reduce carbon emissions. Also, detailed mapping of winds allows the city to more effectively control the effect of buildings, open spaces and even the preservation of empty terrain. Stuttgart's main contribution is the creation of a model that communicates scientific findings to urban policies using climate maps (Hebbert and Jankovic, 2013).

In the cities of Montreal and Toronto in Canada, some measures to mitigate the urban heat islands were taken, these were divided into active and passive measures, the existing ones being those related to a communication associated with 'health warning systems' which aim to influence behaviour from communities (anthropogenic heat reduction measures) warns you of the risks related to heat stress. Generally, active plans have a lower cost than passive plans, which involve changes in existing urban structures. Concerning the passive plans presented in the city of Montreal, we will have greening projects, measures that act directly on land use such as road infrastructure and urban morphology and stormwater management - which increases the permeability of urban soil helping to reduce the temperature during the heat waves. However, although vegetation has proven to be a vital strategy for reducing the urban heat island, studies show that the main action must be the combination of different measures so we can have an even more significant impact (Guindon and Nirupama, 2015).

The UHI phenomenon has had its impacts being studied in New York City for more than a century, with its nocturnal impact adding up to 4C. In 2006 it was presenting a diagnosis to define the measures that must be taken to reduce the phenomenon in the city, this study comes to some important conclusions regarding the impact that different strategies have for New York. It was found that the most effective strategy would be to plant curbside in the streets. However, the greatest temperature reduction is achieved through light surfaces, since 64% of New York surfaces envelope can benefit from it, while only 17% of the streets have space for planting trees. Another issue would be the living roofs, which have a cooling effect more significant than the light surface and are an excellent option for regions where the streets have no spaces for vegetation. The investigation of the peculiarities of New York City's regions ended up bringing the following guidelines: mitigation strategies must be appropriate to the specific conditions of each neighbourhood; planting trees on the sidewalks that make this strategy possible; measures on the scale necessary for them to be truly useful; observe the effectiveness of green structures over time so that they can be managed if necessary. (Rosenzweig et al., 2006)

In the city of Tokyo, the symptoms of global warming are also being felt, with their average temperature increasing by around 3℃, although this is directly attributed to global warming, at least 1℃ of these are caused by the phenomenon of the heat island. Because of this, some strategies are being implemented in the city that helps to alleviate the symptoms. One of these strategies is related to thermal sensation reduction that the winds bring to the cities, inspired by the strategies of the German cities, Tokyo has been studying the effects that the coastal breeze and the rearrangement of the height of the buildings can contribute to the city, thus since 2007, the Ministry of Land started using software to help calculate the effects of these measures, making the most of the prevailing winds, as well as helping to choose the location of the green belts. In line with this a study on the effects of 'cool islands', city parks can help to see what can be implemented to increase their impact. Tokyo has also been using a strategy called 'dry mist' which is a spray of little drops of water thrown at the height of two to four meters, which has a perceived temperature reduction potential of up to 3 ℃. Another significant action is the use of seawater to cool the heating released by the building's cooling systems, and the idea is to add these hot airs in ducts and instead of liberals in the atmosphere, use the water from the oceans for this. (Harrison, 2014)

Cities in Arid Climate

In 2008, the Phoenix master plan was launched, to reduce UHI intensities, consume water and energy and improving thermal comfort and air quality in public areas, this was presented through future proposals for urban form (buildings, streets, forestry, raised structures and standard developments for desert climates). The

plan took a collaborative form involving different points of view in construction sectors such as planners, scientists and municipal officials and had as its proposal the coded urban zoning to reduce thermal discomfort and also a sector called "Tree and Shade Task Force" who was responsible for the development of the plan called 'SHADE Phoenix' that designed a road map with a projection for 2030 of a total of 25% shaded area for the city. Other creative actions taken by the city were 'xeriscaping' where the city offered up to $ 500 for residences that transformed their backyard made up of mesic (grass) into xeric vegetation - reducing their water consumption. Besides, an important strategy was to introduce education focused on UHI in schools, creating greater awareness among students and teachers about the problem. (Chow, Brennan and Brazel, 2012)

Cities in Tropical Climate

São Paulo is a city with the largest population in Brazil, is located in an area that uses to be formed by Atlantic Forest, the most deforested biome in the country. Today, the city is marked by social and environmental vulnerability, the result of rapid and uneven urban growth, which does not take into account environmental factors, which means that the city today needs quick responses to mitigate the effects of the climate crisis. In 2009, it was the first city in Brazil to launch a municipal plan aimed at climate change, despite plans to protect biodiversity and actions that trigger an urban expansion, that is, they returned to the health sector. They had as their primary focus on air quality, maintaining a city tradition, which includes public policies: sectorization. Unfortunately, this type of approach reduces the scope for profound changes that threaten an institutional social order. However, escalating urban reforms are local actions with global effects, as the actions taken by the city of São Paulo were recommended in various regions of the city (Landin and Giatti, 2014).

The city of Seoul, South Korea, has been experiencing the effects of climate change in countless ways, through water-related disasters, landslides, increasing the average temperature of 1.2 C between the 1960s and 2000s. These problems are directly linked to the way the city has developed over these years, with the increase of impermeable areas, heatwaves causing the more epidemics and health problems and damage to the ecosystem caused by the development of weather patterns. As a result, in 2008 the municipal decree Tackling Climate Chance was launched, with the goal of a 25% reduction in GHG emissions by 2020 (compared to 1990), the plan categorizes disasters between health, water and ecosystem management. The drafting of the plan involved the collaboration between legal, planning, zoning, infrastructure and public services, land markets and inspection departments. Some of the actions presented in the plan are a requirement for water-saving structures in the construction of new buildings, an alarm system that warns citizens in cases of climatic events, such as heatwaves, and epidemics, in addition to monitoring urban forests and continuity in landslide reduction. However, the plan has some flaws, when it does not present solutions for all identified risks, possibly due to the lack of financial resources for its implementation, besides, the plan fails to make clear the long- and short-term risks. Other than that, the plan is an excellent example of how important it coordinate de existing urban policies and the new ones that will be implemented (Lee and Lee, 2016).

The strategy used by the city of Hong Kong - directly influenced by the SARS viral crisis (Hebbert and Jankovic, 2013) - is based on the use of maps, which help to identify the areas that need more attention in terms of ventilation, through these maps. Quantitative guidelines were created, which assist in the formulation of design criteria (Ng., 2009). Another factor that is very present in city planning is directly related to green structures. The Hong Kong Department of Engineering and Development has published the Greening Master Plan (GMP) (Fig. 8) specific plan for the city's trees. In the plan, they divide the city according to the local culture and landscape, and from this division, the short, medium- and long-term plans for vegetation were created. In a dense city like Honk Kong, the use of dense canopy vegetation is recommended to mitigate the effects of the heat island (Kong et al., 2017).

Figure 8. The recommended greenery design strategies to improve the pedestrian level comfort conditions (Kong et al., 2017).

2.5 Governance

Studies related to urban governance have a fundamental role in the analysis of the urban microclimate, because the urban form partly defines urban morphology, the metabolism of energy exchanges and even the biochemistry of cities, and this has a direct influence on the policies that define them. The need to study more profoundly is due to the importance that many of its indirect consequences have for the urban microclimate (Bai et al., 2010). Sailor et al. (2016) presents some aspects related to the complexity of this type of policy, such as lack of understanding of the real objective, leading to the implementation of actions based only on numbers, such as “planting a million trees”, or stopping only in the final consequences without thinking about the practices for that, example “reduce 1ºC”. Another issue is related to multidisciplinarity, often the strategies are focused on only one aspect (example: green roof), without thinking about the consequences of these for energy expenditure, air quality, wind direction. However, this complexity can be seen as an opportunity in a System that integrates a strategy that solves more than one problem (Bai et al., 2010).

When it comes to governance that has microclimate plans and heat mitigation, there are still few cities that have these policies in place, in the studies done by Sailor et al. (2016) among 50 cities studied, only 12 had plans for this issue. Besides, a review of more than two centuries between urban planning and climate science in Manchester argues that one of the oldest and most persistent problems for the political integration of these two fields is the lack of communication between planners and climatologists.

Finally, issues related to the growth of neo-liberalism and the reduction of the role of the State in decision-making ends up reducing its role when it comes to decision-making and control of regulations that achieve the climate goal. Nowadays, practices aimed at reducing consumption individually have become increasingly common. However, this practice is only for those who can pay for this 'green tax', so the tactic does not end up being useful. Meanwhile, less and less is required of the private sector, and therefore these end up being an increasingly decisive part of climate governance (Rice, 2014).

Today many of the policies are limited to the envelope of each building, and the political issues that have urban climate are limited to lighting and winds, being those that exist today very generic and not taking into account that when contained in the urban fabric they will interact as a whole. Also, there are still no policies that establish the right to natural resources of cities (Futcher et al., 2017) For example, the winds depend directly on the topography, shape of the buildings and landscape, solar radiation and shadows depending on the street canyon and the spacing between buildings, human thermal comfort depends on the circulation of air and humidity that is directly linked to the presence of trees on the streets, so although the

urban climate is a phenomenon at the mesoscale, it will only be felt at the micro-scale (Hebbert and Jankovic, 2013).

Thus, an issue that needs to be debated is the power that each city has over decision making regarding climate actions, today many cities have their decision making very decentralized, and urban policies are often nothing more than a miscellany of several secretaries who do not communicate with each other. In addition, for cities, as single entities, it becomes more difficult to access the necessary funds for the implementation of climate agendas, this difficulty often causes cities to fight between each other, instead of collaborating (van der Heijden, 2019). Some authors question the way postmodern urban planning is done, drastically separating departments more focused on social sciences, disregarding their connection with the physical issues of the city, and therefore end up talking about answering simple questions such as which would be the appropriate scale to reach politics sustainable urban areas (O'Sullivan et al., 2014). Van der Heijden (2019) suggests the creation of an integrated department of climate decisions where secretaries such as waste collection, transport, etc. can work together with education, employment, etc.

Urban climate management ends up being a particularity of each age, due to its macro climate, needs, financing options, competences and political autonomy. However, the cities that manage climatic issues are the ones that are ahead in the race to adapt to climate change. (Hebbert and Jankovic, 2013). However, despite the evidence, urban policies do not yet contribute effectively to energy planning (Chakraborty and Allred, 2015), so it is necessary to investigate how we can reduce the gap between possible mitigation and adaptation strategies for urban actions through policies. Cities destroy and create, they are not parasites or the final answer, cities are particular, very particular, so it is useless to search for a unique answer, it is necessary first to understand the particularity of each of them, understand their needs so that we begin to deliver the responses for implementing quality urban policies.

Finally, the problem that has been presented is that despite the existence of innumerable researches on how urban factors contribute to the worsening of the thermal scenario in cities, there are no effective policies that contribute to mitigating this problem at the urban scale, only at the building scale, not thinking about the problem jointly, in the urban form combined with the materiality, with the anthropogenic heat, etc. Therefore, an in-depth study of how these factors work together is necessary to implement effective thermal mitigation policies for cities.

Microclimate Legislations: Stuttgart:

The laws mainly govern the preservation of the natural environment in the city of Stutigart: The Federal Nature Conservation Act (BNatSchG) and the Baden-Württemberg Land Nature Conservation Act (NatSchG) (Reuter, 2016). At the same time, microclimate issues are dealt with in the Städtebauliche Klimafibel (staedtebauliche-klimafibel, 2012). In the second, guidelines such as 'avoid urban sprawl' through tools that determine the volume of the building for different climatic zones (staedtebauliche-klimafibel, 2012). Another relevant legislation is the German Building Code (1960), which underwent a review in 2004 when it inserts issues related to the preservation of green spaces, as well as issues related to water rights, pollution control and air quality (Reuter, 2016).

The main legislative element of Stuttgart is the classification of the different regions of the city based on the function of airflows, topography and green spaces. For example "valleys serve as air delivery corridors and should not be developed", or "hillsides should remain undeveloped, especially when development exists in valleys since intensive cold- and fresh-air transport occurs here". Besides, concerning green areas, today around 39% of the city's area is under protection. As a result of the greening actions, 60% of the city is covered by vegetation, having as one of its main recommendations "Vegetation should be placed to surround developments and larger, connected green spaces should be created or maintained throughout developed areas to facilitate air exchange". Also, actions that influence residents to adopt a tree and financial support for the adoption of green roofs reinforce the sentiment of preservation (Reuter, 2016). Finally, suitable areas for

agricultural use must be preserved for this purpose, and the construction of new buildings is prohibited (staedtebauliche-klimafibel, 2012).

Toronto:

The city of Toronto, Canada, presents a general plan "Toronto Official Plan" of 2015, where it is possible to find direct and indirect guidelines and policies for its urban microclimate. The indirect policies can be found in the 'Urban Parks" chapter such as "7.39 To satisfy the need for parks, the city: will guarantee land for new parks in all areas of the centre" demonstrating the importance of green infrastructure, as well as "8.25.2 which prohibits additional commercial parking on the avenue" discouraging the use of individual transport. In the Microclimate chapter, there are guidelines more directly to buildings, but we can see that the focus is on the public realm, for example, "9.18 The development will minimize shadows to preserve the usefulness of sidewalks, parks, open spaces; also "9.21 Buildings will be located, grouped and assembled. Designed to reduce and mitigate wind impacts; and "9.22.4 increasing the space between tall building elements". Access to the sun is essential for the city of Toronto, which is why the city also does not announce any plans for new ventures that have passed the sunstroke test, with simulations during the spring and autumn seasons (2017).

New York

The New York City Planning Department presents several documents with guidelines that indirectly address the issues of the microclimate. One of them is the 'Green Zones' of 2012, which demonstrates the need for retrofits for existing buildings in the city, as well as presenting financial incentives for investments in this aspect. Also, the city addresses the need to use the 'Climate Resilience Design Guideline' to approve the project with the city government (Figure 9) (NYC, 2019). Still, in terms of buildings, the updated 'New York City Plan' (2020) attests the need "to ensure the advancement of goals for the reduction of greenhouse gas emissions, buildings on qualifying sites shall either: (1) use the district steam system for the building's heating and hot water systems"(NYC, 2020), a strategy that helps to reduce heat effects for the urban microclimate. The city presents more plans as the 'New York Energy Conservation Code' (NYCECC) and '2080 Flood Map Based on Climate Predictions', both plans directly linked to climate issues, with adaptation and mitigation approach. However, none of them deals directly with the issue of urban microclimate. Finally, the city's 'climate zones' were the new legislation only confirms how the constructions are analyzed individually. Many of the planning department's guidelines value the factors that indirectly reduce the damaging effects on the city's microclimate. Nevertheless, no integrated plan takes into account the relationships within the built environment, and the result may be unexpected.

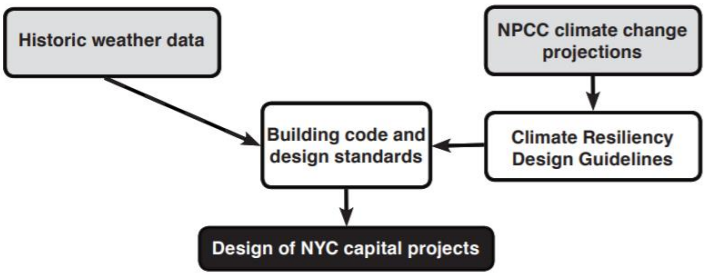


Figure 9. Both historical weather and climate change projections inform the design of capital projects in NYC (NYC, 2019).

Tokyo

The Bureau of Urban Development Tokyo metropolitan government provides some documents in English. In these documents, it was possible to find only policies that indirectly relate to microclimate issues. The city has been developing the concept of "evolving into an environmentally advanced city with charms and vitality that will serve as a model for the world," which seeks to focus more on green spaces in the city. To do so, it presents goals such as "Coexist with the global environment, which is critical to sustainable development"

and "Restore beautiful urban spaces surrounded by rich greenery and water". To this end, the city will continue the plan started in 2007 called "Kankyojiku", which is a network that connects the city's green spaces, constitute by parks, streets, rivers and adjacent communities (Figure 10). Besides, Tokyo has been working on public land to create high-performance housing with more significant energy saving to reduce carbon dioxide emissions by up to 50 per cent (Tokyo, 2010). However, the city does not present any directly related to the microclimate. The strategies intend to deal with factors such as green and blue infrastructure and the reduction of emissions that help to reduce the climatic impact. However, as they are independent practices, it is not possible to evaluate the impact that these have on the city scale.

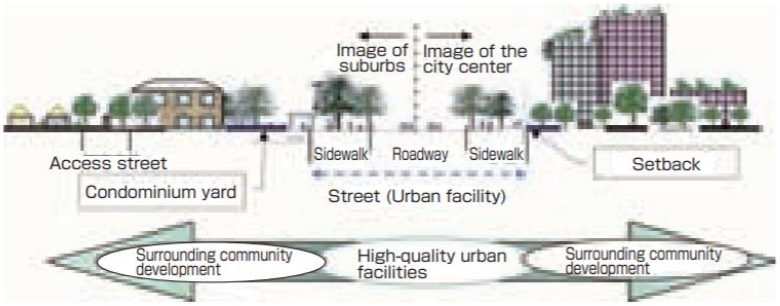


Figure 10. Image of Kankyojiku (Tokyo, 2010).

Singapore

Singapore has projections for 2100 of an increase in its average temperature between 1.4° C to 4.6 ° C and a projection of a 1m increase in sea level, in addition to all the other natural damage that this temperature increase can cause. That is why the city has been preparing for future scenarios. It is possible to see this through its Land Use Plan to maintain a high quality of life for its inhabitants, for that, some of the strategies that the city has are "Integrating greenery into the living environment", "providing greater mobility with enhanced transport connectivity" and "Ensuring room for growth and a good living environment in future" (Singapore Urban Redevelopment Authority, 2020). Concerning urban microclimate, the city has a section especially for this in its plan, having as strategies: "Using microclimatic modelling tools in the planning of new residential towns and estates to strengthen key wind corridors, optimize building layout and orientation for better natural ventilation, and identify potential hotspots for enhanced greenery placement". Besides, the city has links with the university of ETH Zurich through the "Cooling Singapore" initiative (Singapore Urban Redevelopment Authority, 2011). The group produces catalogues and guidelines specific to the city. Also, there are preparing an Outdoor Thermal Confort (OTC) tool to use for future development approvals (Figure 11). Today the group still uses existing tools such as Envi-met, OpenFOAM, PSI-BOIL, among others (Ruefenacht and Acero, 2017).

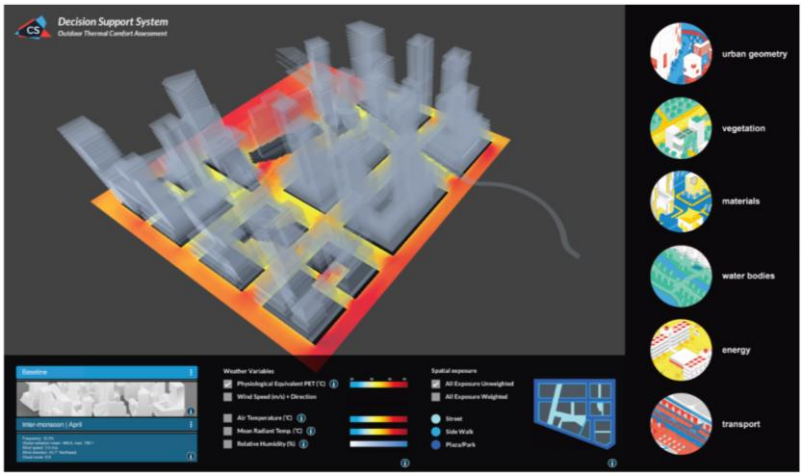


Figure 11. Singapore's Decision Support System (Cooling Singapore).

Hong Kong

In Hong Kong, the government requires new buildings to deliver an Environmental Impact Assessment (EIA) where issues such as visual impact, ventilation, noise, the potential impact on existing vegetation and implications for waste management are assessed. However, the guidance presented by the planning department is not considered rules, since it is not mandatory to satisfy all the items. The EIA is what the city of Hong Kong has that comes closest to a microclimate policy, yet the city has policies that work for qualifying the thermal comfort of the urban environment, such as: "(d) high-rise buildings and low-rise air pollution emitters are not located close to each other;" and "(g) the land use pattern will minimize the demand for road traffic and facilitate the development of railway network so that the vehicle emissions can be kept to the minimum", as well as specific recommendations regarding ventilation. The city, suffering from air pollution due to high density, ends up turning more to issues that mitigate the harmful effects of its urban form, as we can see in Figure 12, factors as air, noise, water and waster are the main ones (Planning Department - The Government of the Hong Kong Special Administrative Region of the People's Republic of China, 2010).

LAND USE/ ACTIVITY	Air				Noise		Water			Waste		Reference
	Dusty emission	Odorous emission	Gaseous emission	Sensitivity to air pollution	Noise emission	Sensitivity to noise	Effluent	Disruption to waterbodies	Sensitivity to water pollution	Waste generation	Sensitivity to waste disposal	
COMMUNITY FACILITIES												
Slaughterhouses		●	◐		●		◐	○		●		3.3.5,4.2.14, 6.4.2
Auditoria etc						◐						4.2, 4.3
Public Filling Barging Points/Public Filling Areas/Public Fill Stockpiling Areas	◐	○			◐		○	○				5.2.9-12, 6.2.4-5
Carparks			○		○							4.3.7
Cooked Food Stalls		◐	◐		◐		◐			○	○	3.3.8, 4.2.13-14, 6.4.3
Crematoria	◐	◐										3.3.9
Hospitals	◐		◐	●		●	○			●		3.4.2,4.2,4.3
Residential Care Homes for the Elderly				●		●						3.3,3.4,4.2, 4.3
Incinerators*	◐	◐	◐		○		○	○		◐		3.3.7
Landfills*	◐	●	●		●		●	●				5.2.9-12,6.5
Markets		◐			◐		◐			◐		3.3.9 4.2.13-14, 6.4.3
Open Spaces (Active)				◐					◐		○	3.4.3-5
Open Spaces (Passive)				○		○					○	3.4.3-5,4.3.8
Petrol Filling Stations		◐			○		○					3.3.8 4.2.15 5.2.13
Residential Uses				●		●	◐		◐	◐	○	2.4.1-2,3.3, 3.4.1,4.2,4.3, 5.3.7-8,6.2

Figure 12. Land Use x Impact (Hong Kong Planning Department, 2010)

Sao Paulo

In 2009, the State of Sao Paulo created the Política Estadual de Mudanças Climáticas, intending help municipalities to create guidelines for various sectors in order to adapt and mitigate the possible disturbances that climate change will bring. To this end, the Law requires cities to adapt their urban planning to issues related to irregular land occupation, usually made by the marginalized population who build their homes irregularly in the lands with native forest. The policy also talks about the urban density and how cities should plan for a tactical land occupation that uses the existing infrastructure of cities, avoiding unnecessary spread and displacement. Finally, the guideline speaks explicitly of microclimate issues in annexe VII "Incorporating changes and forms of protection of the microclimate in urban spatial planning, protecting native tree vegetation;" then "XI. Increase the vegetation cover in urban areas, promoting the planting of species suitable for the reduction of so-called heat islands;" (Secretaria de Infraestrutura e Meio Ambiente do Estado de São Paulo, 2009). However, the municipal Law responsible for planning the largest city in Brazil ends up focusing only on issues related to urban density, and how the city should be guided by the principles of a compact city, with intensive land use and avoiding displacements through better distribution of job offers (LEI No 14.933). Nevertheless, the Law instituted the formation of a Climate and Economic Change Committee whose objective is to promote actions related to energy consumption, reduction in the use of fossil fuels, waste management, green infrastructure and disaster risk assessments. However, still, it is not possible to locate the implementation of the actions devised by the committee (Secretaria Municipal do Verde e do Meio Ambiente, 2020).

3. METHODOLOGY

To achieve the objectives of the thesis, the methodology used in this work is mixed, starting by collecting focus group data, analyzing them through literature review and finally a questionnaire with London experts in urban climate governance.

In January 2017, an event was promoted by the Adaptation and Resilience in the Context of Change network (ARCC staffed and managed by UKCIP, and hosted by the Environmental Change Institute, University of Oxford), where researchers in the area of climate change and their impacts in the areas urban areas presented their research to a group made up of practitioners, academics and public sector employees (Figure 13). In total, 78 participants were gathered on one day of the meeting to deliberate about urban climate subject. The presentations were on the following topics: urban climate, urban microclimate, energy management, facility management, health and wellbeing and urban greening.

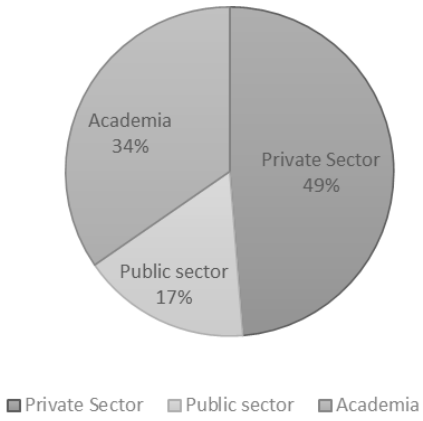


Figure 13. Distribution of participants by sector (author)

After each presentation, participants were asked to answer a questionnaire where the studies were evaluated, and ideas were collected for each of the questions related to the subject. The questionnaires have public access through the website at the event <https://www.arcc-network.org.uk/people-making-changes/urban-micro-climate/>. The answers to the questionnaires were transferred to an excel spreadsheet where only the answers corresponding to the topics were filtered: urban climate, urban microclimate and urban greening. So it was divided into three worksheets that corresponded to the answers to the question "which option does your Idea apply to?": What we already know, what we need to know and how to tackle. From this division, the responses were evaluated and divided into subcategories: thermal effects, knowledge bridge, urban form, Governance, transport, green infrastructure, costumers behaviour, social gap, healthy and modelling. So results were obtained through these categories.

After categorizing the reported factors, a literary review of the climatic factors that influence the urban space and which urban factors influence the climate began. In this phase, academic search tools provided by Glasgow Caledonian University were used with the following keywords: 'urban heat', 'urban wind', 'urban precipitation', 'urban humidity', 'urban form', 'green infrastructure', 'building materials', 'anthropogenic heat', 'urban air pollution', 'thermal comfort', 'energy use'. Besides, information was sought on 'urban climate policies', 'environment governance' and on cities that have public climate policies. The researched material was published between the years 2006 - 2019. The study has limitations due to a large number of papers available on Environmental Governance. However, the review focused more specifically on issues raised by experts at the 2017 meeting.

After that, a questionnaire was formulated in which some of the specialists of the 2017 meeting were invited to participate. The questionnaire took place online with objective questions using the Google Forms platform from 8 to 15 July. The questionnaire obtained a total of 14 respondents with representatives from the public, private and academia sectors. There are limitations concerning the number of respondents. However, it is a very restricted audience since one of the prerequisites to participate was that they: worked in London, worked on the topic of climate urbanism and understood urban legislation. Despite the limited number of participants, it was possible to reach conclusive results.

4. RESULTS

4.1 ARCC Meeting: Focus Group

During January 2017 the Adaptation and Resilience in the Context of Change network (ARCC) brought together 65 experts from the public, industry and academia sectors to discuss what are the aspects about the dense urban environment that are already known, what they still need to know and how to tackle local urban resilience in the UK context. The event promoted the opportunity for different sectors to get together and debate ideas, for this purpose, the academy presented their recent researches about the subject so the participants could answer a questionnaire about their understanding of the main topics including building form, energy, climate and health and wellbeing in the context of densified urban space (Futcher and Adams, 2017).

The event that took place on 6 January featured each presentation of around 50 minutes with content from 6 topics: 'Urban Climates', Energy Management, 'Urban Microclimate', 'Facilities Management', 'Healthy and Wellbeing' and 'Greening Cities'. The following presentations were: *Urban Climate: variations and density* by Sue Grimmnd; *Urban Heat Big Data and Critical Infrastructure Network* by Lee Chapman; *Microclimate Surface Interventions* by Maria Kolokotroni; *Urban Microclimate: Daylight / Solar* by John Mardaljevic; *Energy and Urban Building Form* by Philip Steadman; *On the simulation of energy use in buildings in their urban context* by Darren Robinson; *The Role of Facilities Management* by Jo Harris; *Intelligent Resiliente Liveable Cities* by Derek Clement-Croome; *Daylight and Sunlight in Cities* by Paul Littlefair; *Greening Cities and urban density environmental and healthy impacts* by Audrey de Nazelle and *Green Infrastructure and Air Pollution* by Rob MacKensie (Anon, 2017).

After the presentations, the 72 participants were invited to debate and answer a questionnaire (Figure 14). The questionnaire is available at the ARCC website, with responses from those who accepted the disclosure of the content. In the questionnaire, the respondent should mark which topic (urban climate, energy management, urban microclimate, facility management, health & wellbeing and greening cities) their contribution would consist. Then If that fit in 'something already known', 'something we do not know yet' or 'how can we resolve the issue'. Also, it was possible to indicate which sector would be responsible for the suggestion and whether it was a solution or a challenge. In the right corner of the questionnaire, the respondent should describe his suggestion.

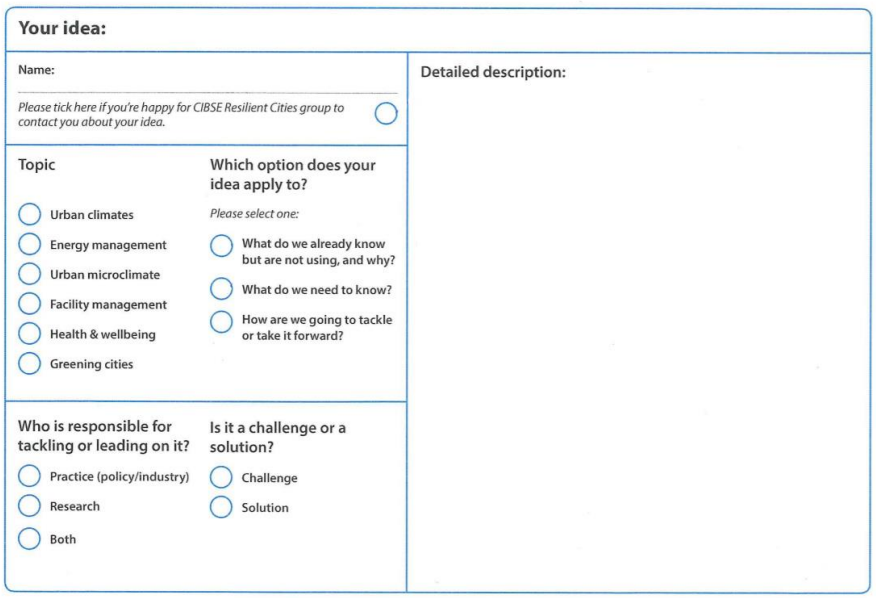


Figure 14. The questionnaire presented during "Overcoming Obstacles to high-density resilient city" (ARCC).

In other to obtain data from this research, a spreadsheet (appendices A, B, C, D, E and F) was created with the contents belonging to the following topics: urban climate, urban microclimate and greening cities. From then on, the subsequent investigation was carried out, among the suggestions brought by the experts, which were the most cited factors when it comes to "what we already know but are not using it" (Figure 15). Within the comments and ideas found (45 in total), most of the subjects that the experts claimed to be known topics were in descending order: Thermal Effects (with 9 responses); Regulations (7 replies); Green Infrastructure and Healthy (both 6); Building Form and Knowledge inside academia (with 5 each); Modeling (with 2) and Energy Consumption and Transport (with 1).

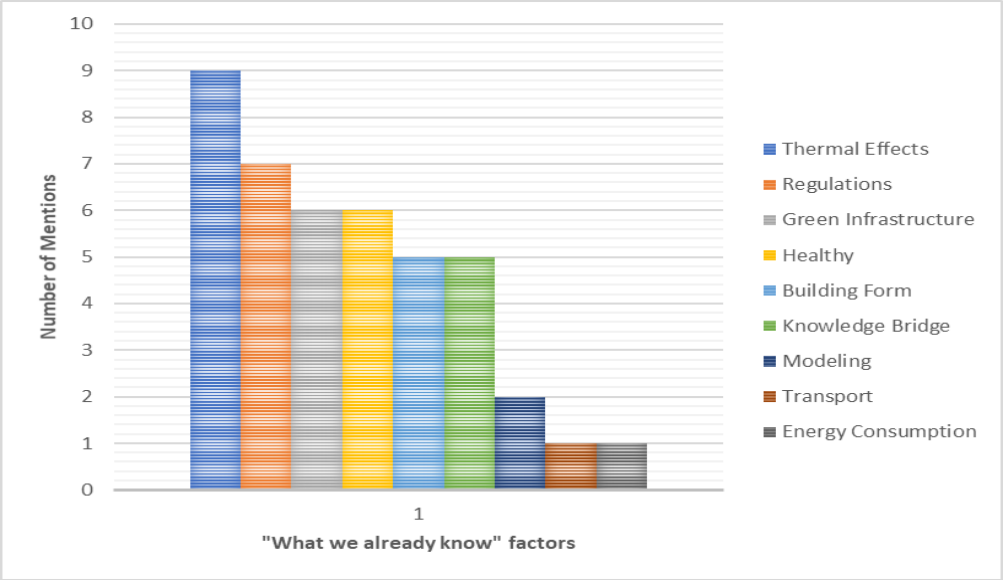


Figure 15. Graph with mentions for the question "what we already know but are not using it" (author).

Responses corresponding to "what we need to know" (Figure 16) were analyzed using the same method, taking into account issues related to the topics' urban climate, 'urban microclimate and 'greening cities'. Regarding what we still "need to know" for specialists, the most commented subjects were the following in descending order, in a total of 33 responses: Urban Form (9 citations); Data / Modeling (6 citations); Thermal Effects (5 quotes); Regulations (4 citations); Transport (3 citations); Green Infrastructure and Knowledge Bridge (2 quotes) and finally Costumers Behavior and Social Gap (1 quote).

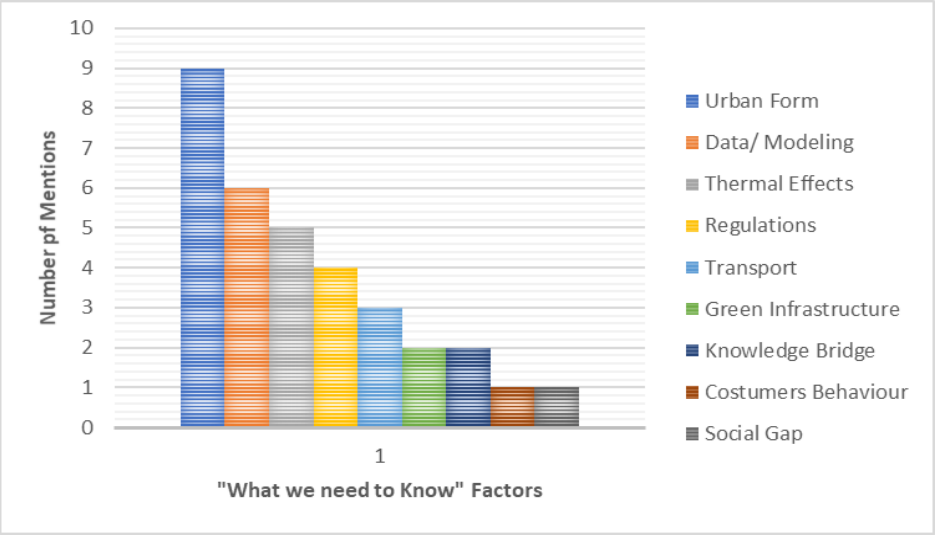


Figure 16. Graph with mentions for the question "what we need to know" (author).

Finally, using the same approach that the two previous questions, the factors related to "how are we going to tackle or taking it forward" (Figure 17) were analyzed. For this question a total of 40 answers were found, these are in decreasing order: 'Regulations' (15 citations); 'Modeling / Data' (9 citations); 'Green Infrastructure' (5 citations); 'Transport' (4 citations); 'Urban Form', 'Knowledge Bridge' and 'Healthy' (2 quotes each) and lastly 'costs' with 1 quote.

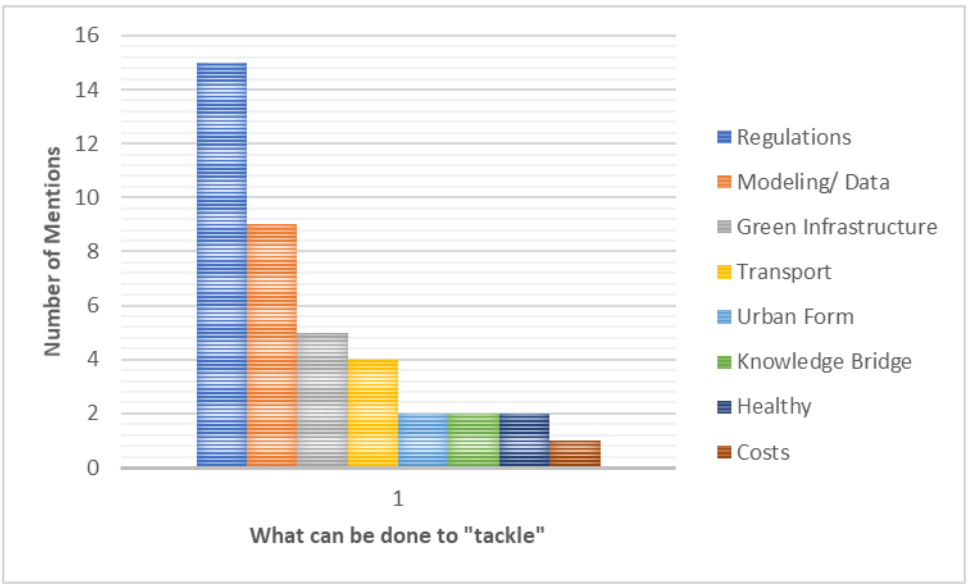


Figure 17. Graph with mentions for the question "how are we going to tackle or taking it forward" (author).

4.2 Questionnaire

This chapter describes the results we got from the questionnaire made with the experts of London's climate governance. There were a total of 14 experts that have identified themselves from the following areas: academia (3), private sector (3), public sector (4), private sector + academic sector (2) and private sector +

public sector + academic sector (2). The questionnaire was conducted using the Google Forms platform between July 8 and 17, 2020.

Question number one (Q1) asked the respondent to rank between 1 (most important) and 5 (least important) the climatic factors that they believe are the most significant influence in London microclimate. The options consisted were: 'green spaces', 'the heat generated from building and cars', 'urban morphology', 'urban density' and 'materials'. The gross results among the 14 respondents showed the following order: 1 - the heat generated from cars and buildings, 2 – 'urban density' and 'material' were tied in the second position, 3 – 'urban morphology' and 'urban density' were also tied in the third position, 4 – 'urban density' and 'green spaces', and finally 5 - Green Spaces.

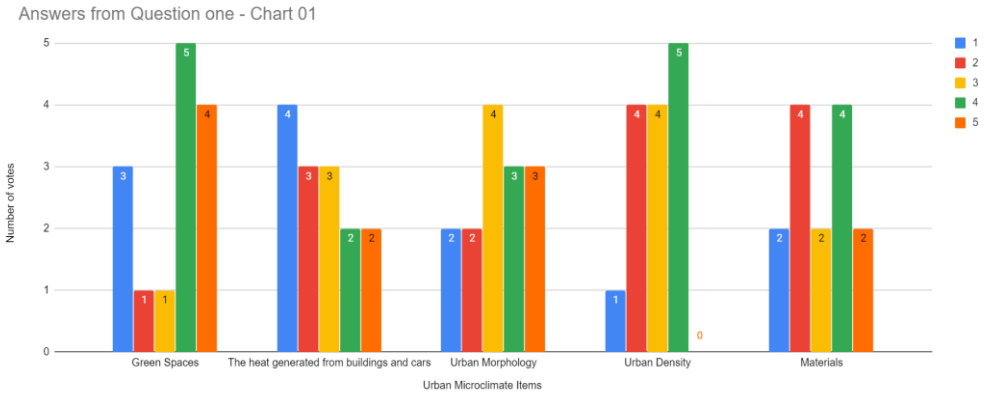


Figure 18. Chart Q1, Number of votes x Urban Microclimate Items (author).

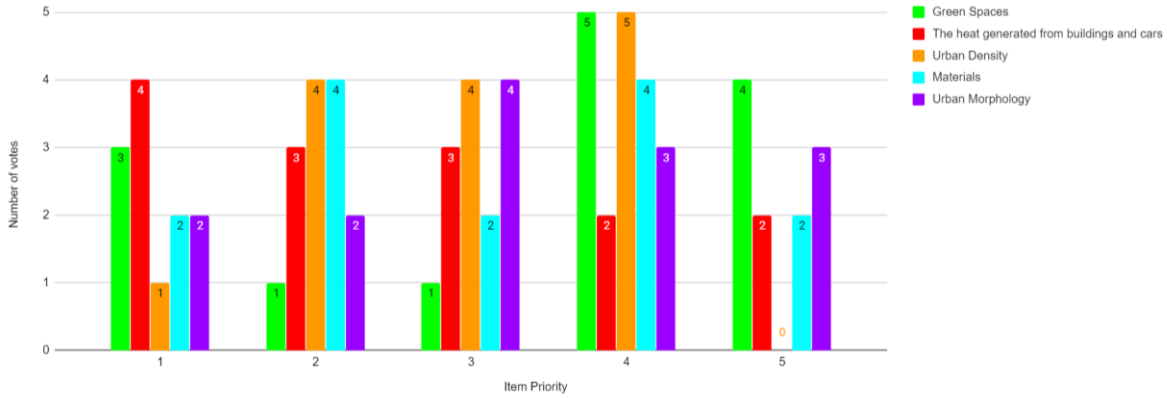


Figure 19. Chart Q1, Number of votes x Item Priority (author).

However, when we analyze the results by sector, we will see that for the ones that have identified themselves as Public Sector the order was: 1 – 'green spaces' and 'material', 2 –'urban density', 3 – 'heat Generated from cars and buildings' and 'urban morphology', 4 – 'urban density' and 5 – 'green spaces' (again). Speaking now about the Private Sector, we will see the following data: 1 – 'heat generated from cars and buildings', 2 – 'materials', 3 – 'urban density', 4 – 'green spaces' and 5 – 'materials'. Furthermore, the Academic results were: 1 - tie between 'green spaces' and 'heat generated from cars and buildings', 2 - 'heat generated from cars and buildings', 3 - again a tie between 'urban density', 'urban 'morphology and 'materials', 4 – 'urban density' and 'green spaces', 5 – 'urban morphology'.

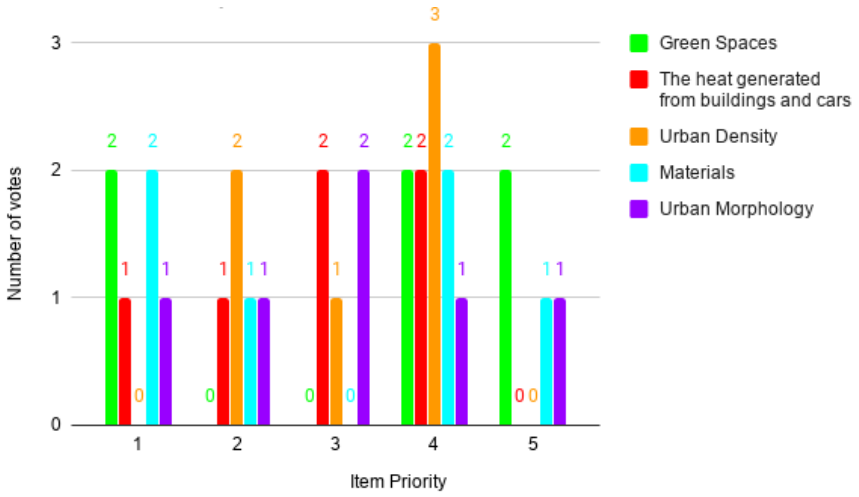


Figure 20. Chart Q1 – Public Sector, Number of votes x Item Priority (author)

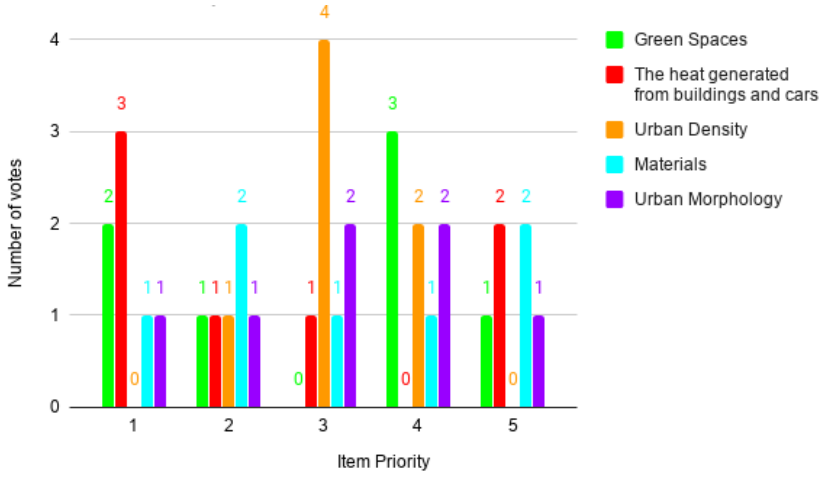


Figure 21. Chart Q1 – Private Sector, Number of votes x Item Priority (author).

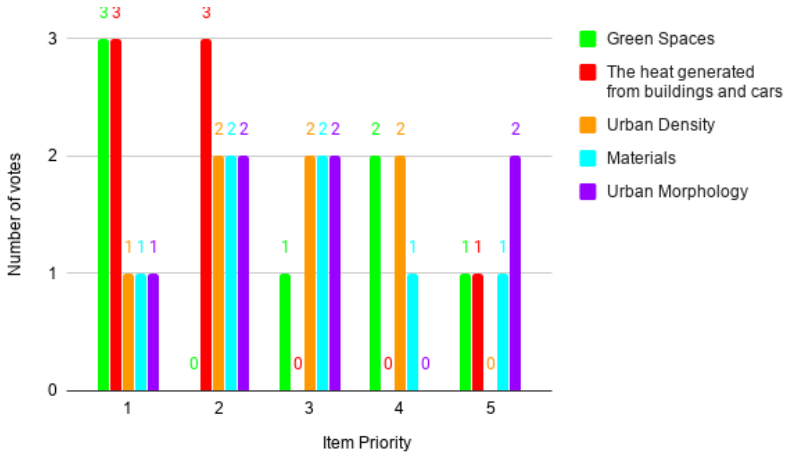


Figure 22. Chart Q1 – Academic, Number of votes x Item Priority (author).

Despite the previous results, we will see that some factors (regardless their final position) always appear concentrated in the initial or final numbers of the graph, showing a trend of the relevance of this factor to the London microclimate. For example, 'heat generated by cars and buildings' presents a decreasing graph (Figure 23), in contrast with 'urban density' which shows a crescent line as a factor of less importance (Figure 24).

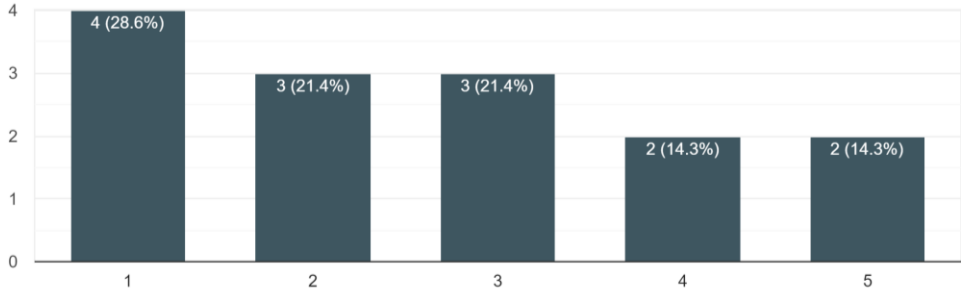


Figure 23. Heat Generated from Buildings and Cars graph - number of responses x order of importance (author).

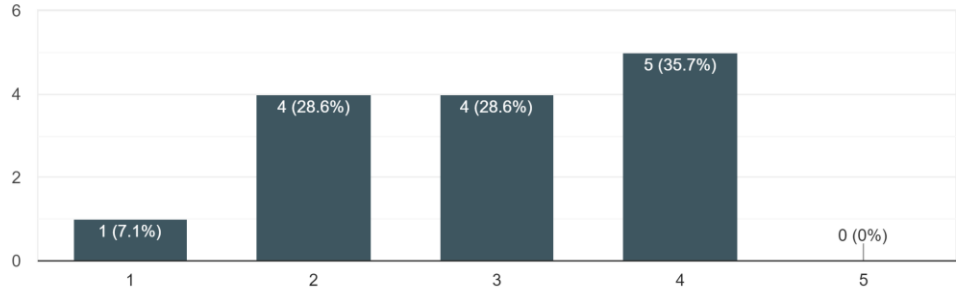


Figure 24. Urban Density - number of responses x order of importance (author).

Question 2 (Q2) shows options for the overheating issue in London and the respondent should point out whether they agree with the strategy on a scale ranging from 'strongly agree' to 'strongly disagree', the option 'do not know' was also inserted if the respondent was not familiar with the strategy. The first strategy presented was 'discourage the use of cars' where most people respond 'agree' (7) followed by 'strongly agree' (6), and only one person responds 'disagree'. The second 'increase of green areas' strategy, this option, as well as the first, had most responses with 'strongly agree' and 'agree' results (12) and only one 'neutral' and 'strongly disagree' response. 'Urban ventilation' had the vast majority of responses as 'agree' (8 in total). 'Decrease of energy consumption' got 10 responses for 'strongly agree', followed by 3 'agree'. However, ' increase of urban density' had most of its responses 'neutral' (6), followed by 'disagree' (4) and agree (3). 'Building retrofit' had its responses concentrated on 'strongly agree' (5) and 'agree' (6), following the same pattern as 'increase shading form' with 'strongly agree' (5) and 'agree' (8). 'Use of renewable energy' had its responses well distributed between 'strongly agree' (5), 'agree' (4) and 'neutral' (4). Finally, 'user behaviour' also presented its responses focused on 'strongly agree' (5) and 'agree' (8). In this question, there was no discrepancy between the responses obtained by different sectors.

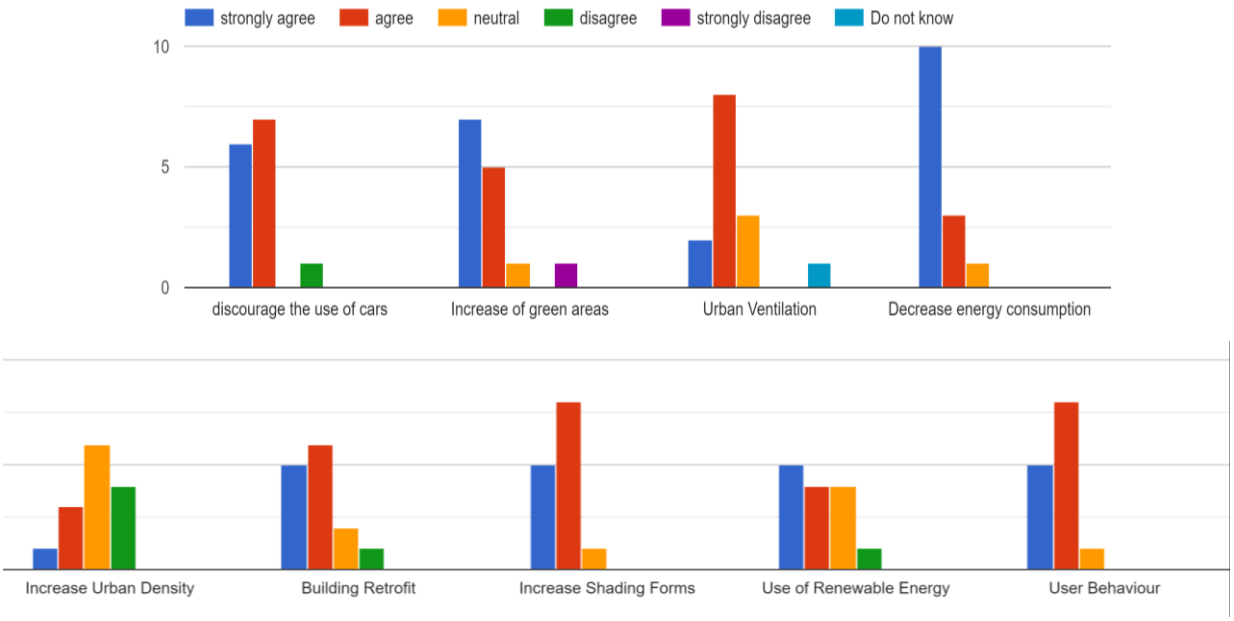


Figure 25. Answers obtained in Question number 2 (author).

In question 3 (Q3), the following sentence "The urban heat island effect helps London to save in energy consumption in heating" was presented and respondents should choose whether the answer was true or false. The sentence is correct; however, only 35.7% of respondents opted for this option, corresponding to 5/14 of the respondents (Figure 26). When we analyze the responses by sector, we see that both the academic and private sectors had an equivalent of 50% for each option. However, the public sector obtained only one 'true' answer, with the other five marking the answer 'false' as correct.

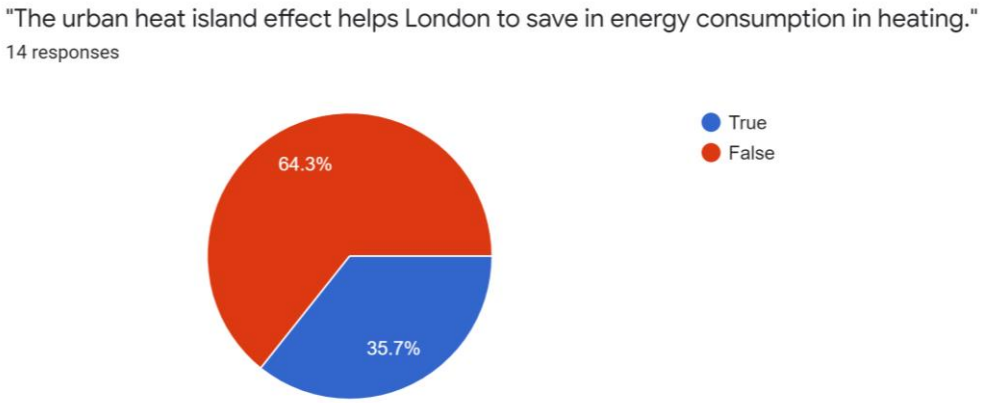


Figure 26. Answers obtained in Question number 3 (author).

Question 4 (Q4) is about the microclimate governance in London, in which statements were made and respondents should agree or disagree on a scale between 'strongly agree' and 'strongly disagree', as well as Q2 with the 'do not know' option in case the responder was not familiarised with the regulation. The first statement consisted of 'I understand that the Urban Policy that we have today in London is enough for the problems that we face today with climate change" in this question the answers were concentrated on 'strongly disagree '(6),' disagree' (4) and 'neutral' (3). The second statement "the policies that we have today are mitigation ones" in this most responses was 'agree' (8), followed by 'neutral' (2). "The policies that we have today are adaptation ones", in this the responses were concentrated between 'agree' (5) and 'neutral' (5).

Statements 4 and 5 were related to the CIBSE Guide (A), with forth statement addressing the building issues: "the guidelines found on CIBSE Guide (A) 2015 for buildings are satisfactory when it comes to delivering a climate-responsive development"; and fifth the urban spaces "the guidelines found on CIBSE Guide (A) 2015 for urban spaces are satisfactory when it comes to delivering a climate-responsive development". Despite their differences, both presented the same pattern of responses: where most interviewees chose the option 'do not know '(6),' neutral '(4), 'disagree '(2) and 'strongly disagree' (2). The last two statements are also similar, with the difference being only the words 'suggestion' and 'obligation'; however, differently from what happened with the previous statements, these had different responses. In the first statement we have 'I understand the London environmental legislation as obligations' with the highest volume of responses for 'neutral' (5), followed by 'agree' (4); in the second statement "I understand the London environmental legislation as a suggestion" most responses were also 'neutral' (5). Nevertheless, the other responses that most occurred were 'disagree' (3) and 'strongly disagree' (1).

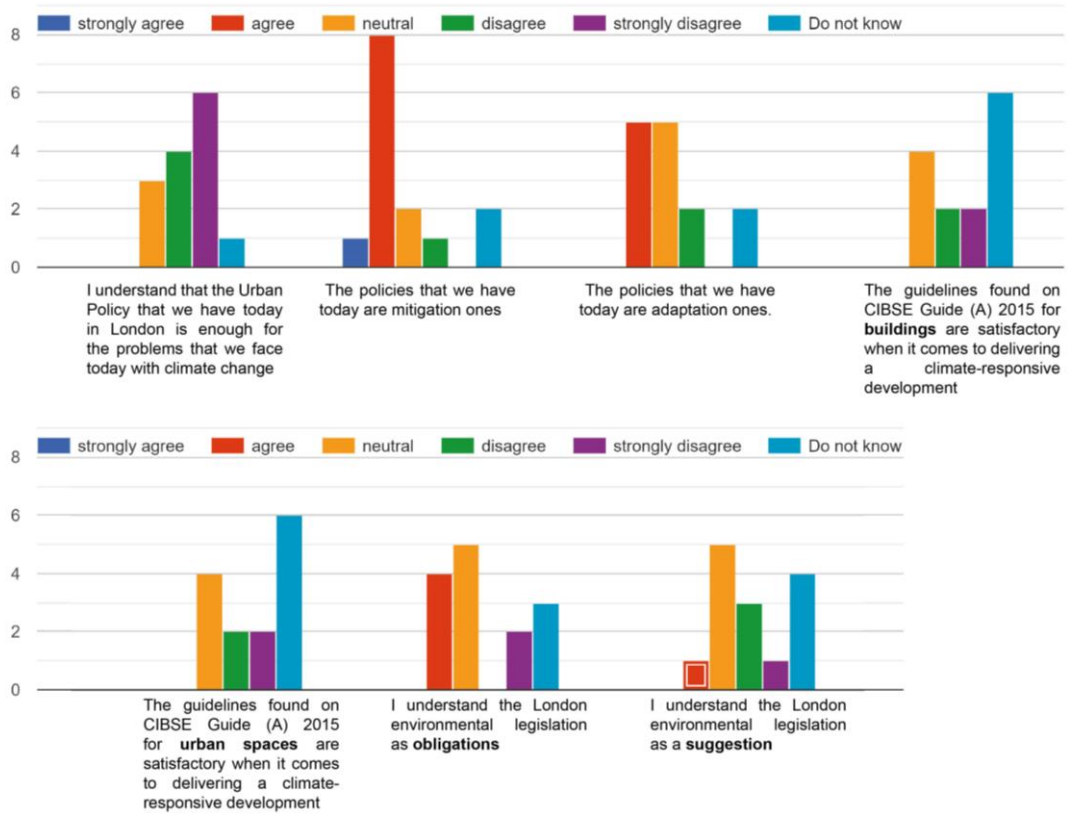


Figure 27. Answers obtained in Question number 4 (author).

Finally, question number 5 (Q5) presents the option of possible barriers that might interfere with the improvement in London's microclimate policies. As in Q1, the respondent must list the alternatives on a scale of importance (1 most important and 7 least important). When we crudely analyze the results, we will see that in 1 there was a tie between 4 categories with two votes for each 'collaboration between public, private and academia', 'private sectors lobby', 'high costs for adaptation' and 'lack of tax incentives '. Second is 'lack of tax incentives' with 4 votes, and right after 'consumers will not pay extra for sustainable developments' with 3. The third most voted reason is 'private Sectors lobby' with 4 votes. The fourth was "London population do not see this as a Government Priority" with 6 votes. Fifth "high costs for adaptation" with 4 votes. In sixth we will have a tie with 3 votes for 4 reasons' consumers will not pay extra for sustainable developments', 'high costs for adaptation', 'private Sectors lobby' and 'collaboration between public, private and academia'. Finally in the last position with 8 votes (with the unanimous answer) 'impossibility caused by Londons heritage sites'.

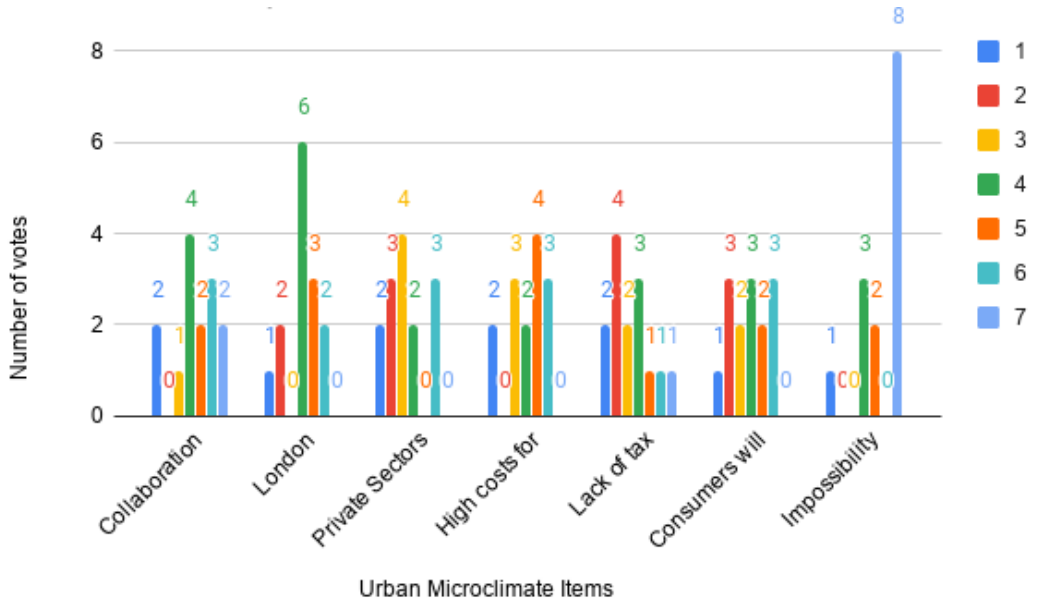


Figure 28. Chart Q5, Number of votes x Urban Microclimate Items (author).

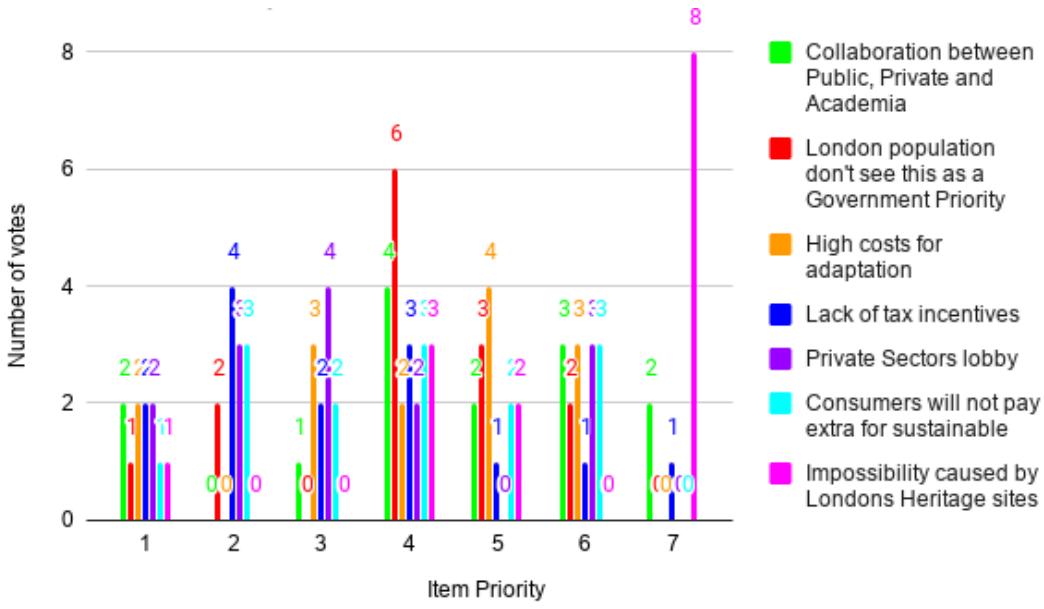


Figure 29. Chart Q5, Number of votes x Item Priority (author).

When we analyze the responses by sector, we will see that the motive that least matter is a consensus 'impossibility caused by Londons heritage sites', as the primary motive the three sectors agree with 'lack of tax incentives', however, the public and academia sectors 'private also point for 'private sectors lobby'.

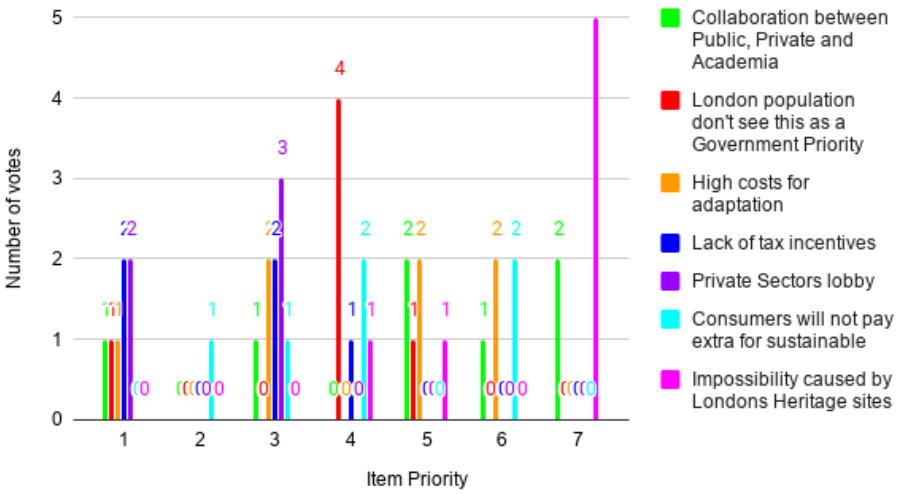


Figure 30. Chart Q5 – Academic, Number of votes x Item Priority (author).

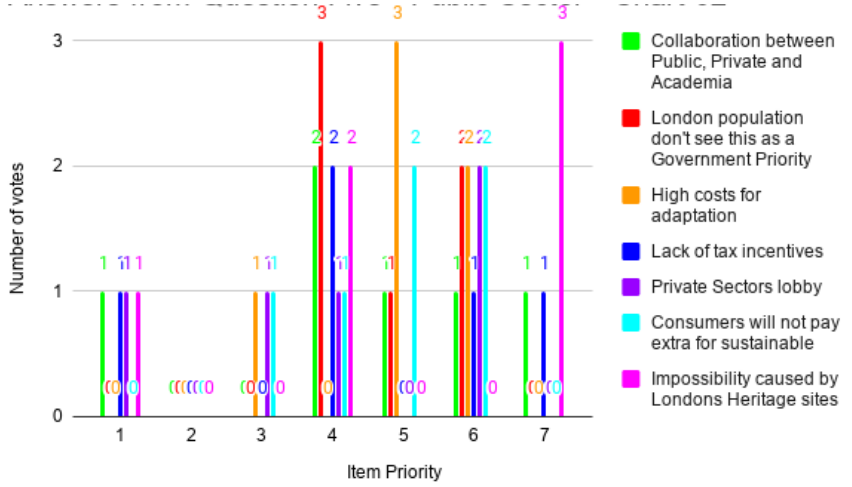


Figure 31. Chart Q5 – Public Sector, Number of votes x Item Priority (author).

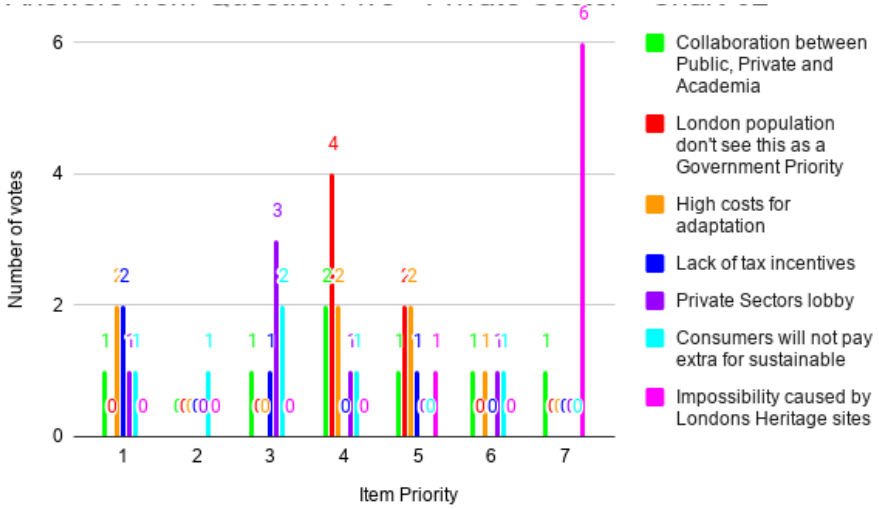


Figure 32. Chart Q5 – Private Sector, Number of votes x Item Priority (author).

However, when looking at the graphs of each possible reason, we can see some patterns. For example, 'London population do not see this as a Government Priority' (Figure 33), which most of its answer are in the middle of the graph, not been neither most important but neither less. Unlike what happens with 'private sectors' lobbying' (Figure 34) and 'lack of tax incentives' (Figure 35) where responses are concentrated in front of the chart, showing a tendency for those been considered more important reasons. Contrary to what happens with 'collaboration between Public, Private and Academia' (Figure 36) with the responses concentrated at the back of the graph, showing that the lack of collaboration would not be one of the reasons for the non-implementation of microclimate policies in London.

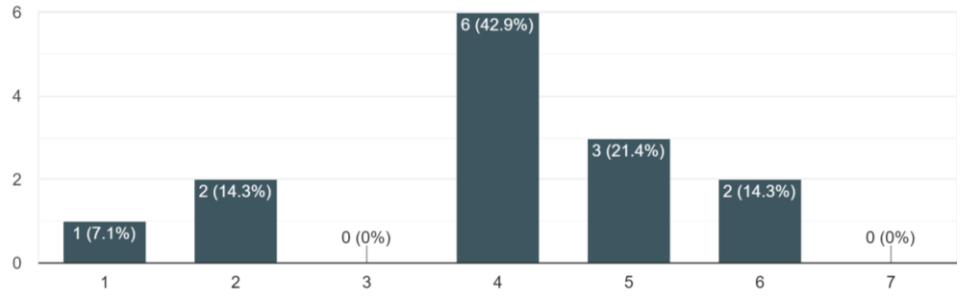


Figure 33. London population do not see this as a Government Priority - number of responses x order of importance (author).

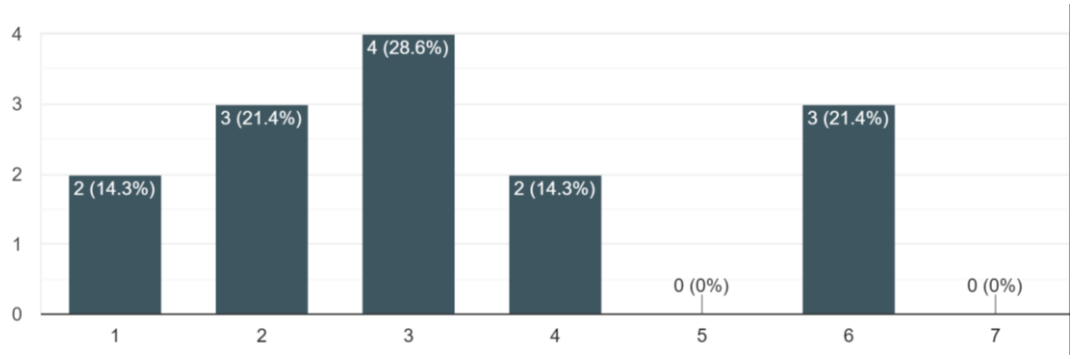


Figure 34. Private Sectors lobby - number of responses x order of importance (author).

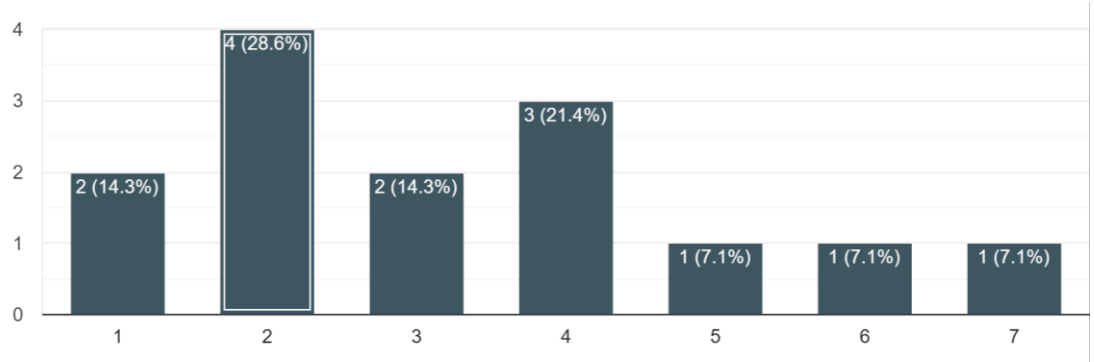


Figure 35. Lack of tac incentives - number of responses x order of importance (author).

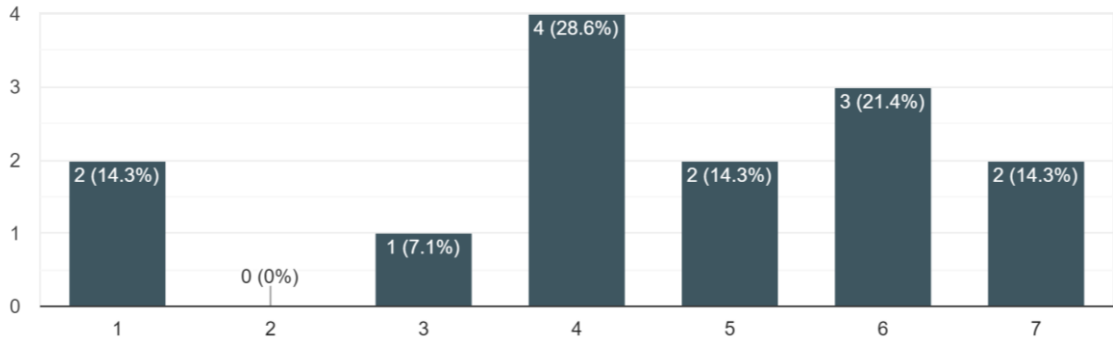


Figure 36. Collaboration between Public, Private and Academia - number of responses x order of importance (author).

5. DISCUSSION

5.1 Questionnaire Analysis

Analyzing the results obtained in the questionnaire conducted in July 2020, it is possible to make some interpretations. The first question deals with the urban factors that would have the most significant impact on the London microclimate. Accordingly, with the experts, these factors would be 'heat generated from cars and buildings', followed by 'materials', factors that have proven relevance concerning urban temperature. The issue of materiality is linked to radiation and heat emission, so it is indeed paramount for the urban microclimate. Anthropogenic heat (basically consists of the heat generated by cars and consumption of buildings) as shown above, has a direct impact on the UHI effect with a 1 to 3C increase. However, energy consumption is linked to urban density, being higher in the densest areas of the city. Nevertheless, it is possible to state that denser cities reduce the need for commuting by cars, so there would be a reduction in the emission of gases from cars. These facts show that the issues related to anthropogenic heat are complex and must be analyzed along with other factors.

In Q2, specialists receive a list in which they should 'agree' or 'disagree' with the suggestions for dealing with overheating in London, almost all statements received positive responses between 'strongly agree' and 'agree', however, the solution 'decrease energy consumption' was the answer that received the most 'strongly agree' (10 out of the 14 respondents). The best way to deal with overheating in London is by reducing energy consumption, as previously seen approximately half of the effects of UHI are caused by energy consumption (Hebbert and Jankovic, 2013). Moreover, in a coherent way, the suggestion that received the most focused responses to 'neutral' and 'disagree' was 'Increase of Urban Density, which as already seen is directly related to the increase in energy consumption. However, some questions need to be considered in this regard. The reduction of energy consumption is undoubtedly a factor that needs to be reduced. However, to achieve this adequately in cities, it is necessary to think not only about consumption separately, but in conjunction with other aspects that influence its uses - mainly regarding heating and cooling. Therefore, energy consumption ends up being related to other aspects, such as urban form, materials, green spaces and density.

Q3 was a 'true or false' question where specialists should evaluate the following statement "the urban heat island effect helps London to save in energy consumption in heating". Most respondents (9 out of 14) marked the alternative as false. However, the alternative is right: the UHI in London today helps to reduce energy consumption when it comes to heating. Nevertheless taking into account the projected temperature increase for 2050, there will be an increase of energy consumption for cooling (the projections are for a five-

fold increase in carbon emissions in buildings), since many buildings will need AC to maintain thermal comfort. One of the possible alternatives for not having this energy expenditure would be the investment in materials with more infrared emittance that increase the albedo and help in the reduction of UHI, reducing the demand for AC and improving the quality of the urban microclimate (Kolokotroni et al., 2012).

In Q4, it was used to understand the experts' view of London's urban environmental policies. In the question, statements were made, and the participants should agree or disagree with them. The first statement was *'I understand that the Urban Policy that we have today in London is enough for the problems that we face today with climate change'*, this question did not have any positive answer, demonstrating that dissatisfaction with urban environmental regulations is unanimous among the different sectors. The second and third statements questioned the mitigatory or adaptive order of urban environmental legislation, both received the majority of positives answers. However, the alternative that spoke about 'mitigation' received 8 'agrees' versus 5 for 'adaptive', so it is possible to presume that the experts see London regulations more focused on mitigating climate issues than merely adapting. Statements 4 and 5 were about the 2015 CIBSE Guideline A, in the fourth statement it said 'it was satisfactory for buildings' and in the fifth for 'urban spaces'. Both alternatives received the same answers: 6 were unable to answer, 4 were neutral, and the rest disagreed with the statement. These responses show a tendency that CIBSE Guideline A has not yet achieved the objectives expected by the experts. Nevertheless, due to the number of people who claimed 'do not know' (6) and neutral (4), it is possible that many of the interviewees are not familiar with the CIBSE guideline. Finally, statements 6 and 7 questions whether the existing legislation is seen as 'mandatory' or as 'suggestions', with the majority of the affirmative responses being mandatory and the majority of the 'suggestion' responses being negative, this demonstrates the credibility that London regulations have among the specialists.

In Q5, were asked about the main barriers to the implementation of urban environmental policies. Among the options presented, specialists point out among the options which they believed to be the main reason down to the last. Despite the varied responses, it is possible to notice some bias, for example, the option 'Private Sectors lobby' had most of its answers (9) among the top 3 positions. However, when we analyze the questionnaire by sector, we will see that it was the academia and the public sector that most pointed to this problem. For the private sector, the main barrier was 'lack of tax incentives'. Here it is possible to observe a dispute of interests, within the different points of view and needs of each sector. Nevertheless, we will see unanimity on this issue when we talk about 'impossibility caused by Londons heritage sites', this was placed in the last position by all sectors, so heritage issues being the least relevant of the barriers. That answer may demonstrate functional adequacy of heritage policies or even appropriate flexibility between the preservation department with the environmental department.

Finally, a comment box was left so that experts, if they wanted to, could express themselves more freely. In this category, three responses were received. One from the Private Sector: “Electric cars + walking = quieter street + lot more trees = natural vent opening windows + transpiration cooling = no AC + low energy buildings + low energy cars = less heat emitted = reduced UHI temperatures = temperature headroom for climate change. All these policies need quantifying and joining together". In addition to this statement, the following was presented by a public sector specialist: "Through the planning process press importance of the use of the Urban Greening Factor for all new developments; use of SUDS (Sustainable Drainage System); applying the Cooling Hierarchy as set out in the Draft New London Plan; and, need to raise more investment for retrofitting existing homes. Covid-19 has exposed those that are vulnerable, how important it is to engage the public and the positive impacts that behavior change can have." Both demonstrate the interconnection between the different urban factors that influence urban climate, signalling the need for a relationship between the various factors and tools of urban design. Lastly, one of the experts who identifies himself as being from the three sectors commented "lack of knowledge", showing that some of the interviewees believe that more studies on the subject are needed.

5.2 London Simulations

Experts cited the issues related to anthropogenic heat (heat generated by vehicles and buildings) as the leading cause of overheating in the London microclimate. That is why it is appropriate at this point in the work to show some simulations, studies, models made that deal with this subject previously. Besides, studies showing the effect of green infrastructure and urban form also have impacts in London so that will be present in this chapter.

The work of Hamilton et a. (2009) shows the emissions generated by anthropogenic heat in London. The research shows a that the average anthropogenic heat emissions for London are about 9w per ground area, with the densest areas of the city (central London) being those that opt for higher emission (Figure 37). The parts of the city with higher density and with deep canyons, in winter days, can emit between 3 and 25 times more anthropogenic heats than incident solar radiation. However, with the increase of urban heat island effect and mean temperatures the need for air conditioning during the summer days will be higher, so it is necessary to think about strategies to mitigate this energy use.

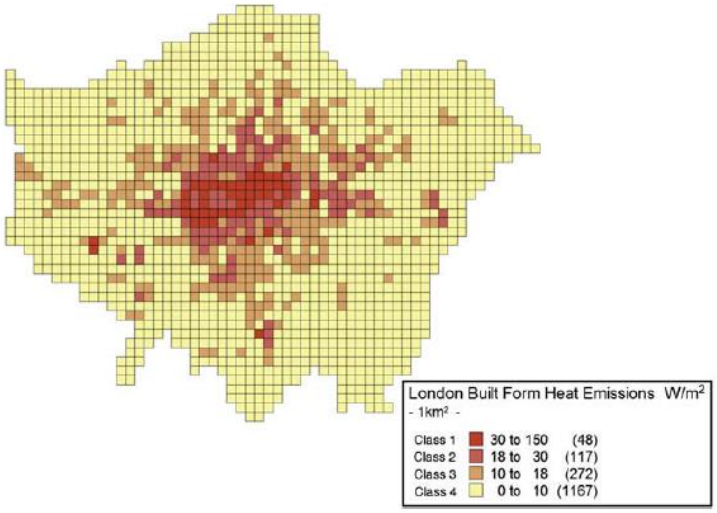


Figure 37. Annual average heat emissions from buildings in London for a 1km² grid (2005)(Hamilton et a. 2009).

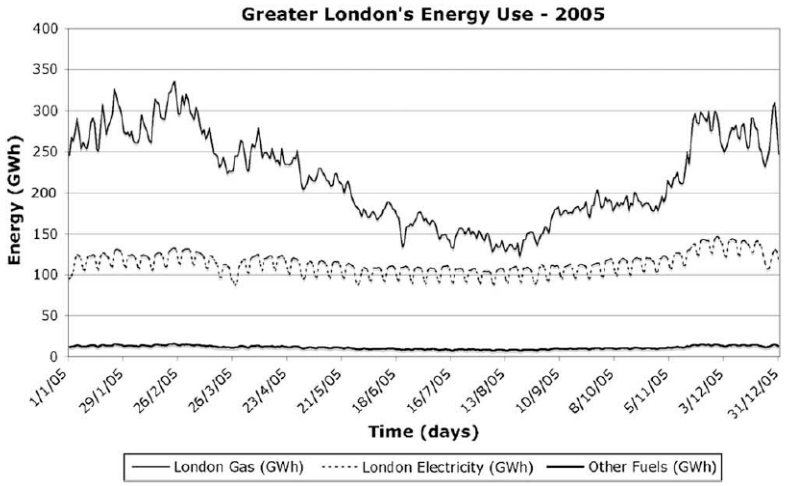


Figure 38. Annual average gas, electricity and 'other' fuel use in Greater London (Hamilton et a. 2009).

Progressing on issues related to Anthropogenic heat, the work of Iamarino, Beevers and Grimmond (2011) shows the growth of heat emissions in the Central Activities Zone (CAZ) in London due to the increase in activities in the area. The work begins by showing the main contributors to the anthropogenic heat "energy consumption in buildings + transport sector + human metabolism", and for London, 80% of the contribution comes from buildings - 42% of which are domestic and 38% industrial. After buildings, the most significant contribution comes from transportation, 15% of the total of which 10% are cars only. The unique variation is shown in Figure 39, showing the total of emission in X(d). The CAZ region occupies 2% of the total surface of London. However, it is responsible for the energy consumption of one-third of the total. Finally, the work presents projections for 2025 (Figure x) and concludes that the building sector will be the largest contributor to the great increase in energy consumption.

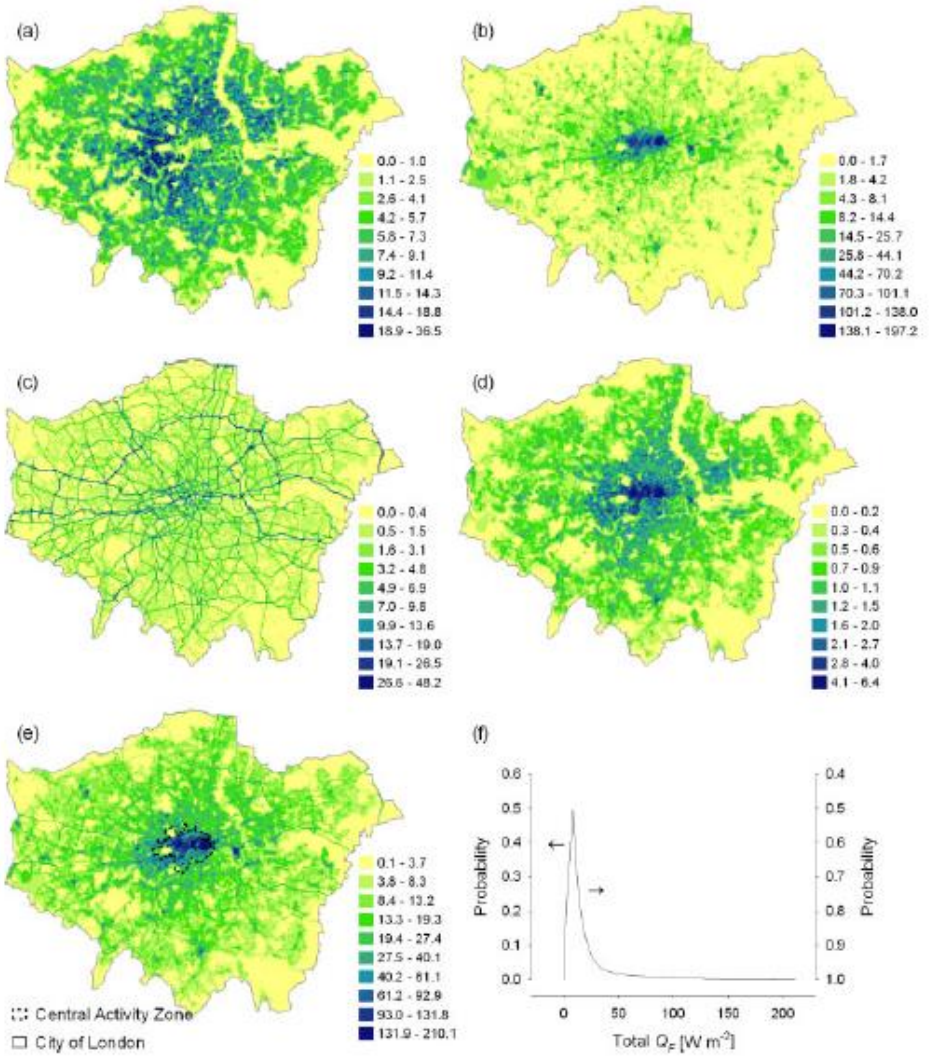


Figure 39. Spatial variability of heat emissions (average for 2005-2008) by sector: (a) domestic, (b) industrial, (c) road traffic, (d) metabolism and (e) total and (f) cumulative distribution. Values in W m^{-2} (Iamarino, Beevers and Grimmond, 2011).

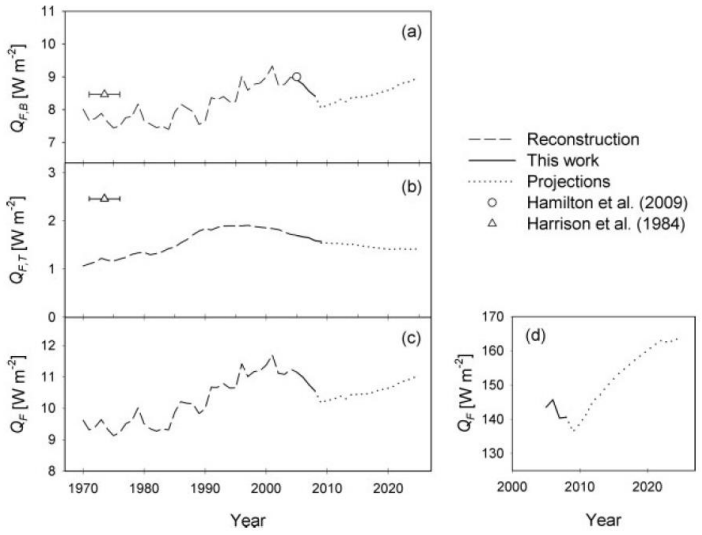


Figure 40. Heat emissions in Greater London for 1970 – 2015 for (a) building sector, (b) road and (c) total: and (d) total emissions in the City of London for 2005 – 2025 (Iamarino, Beevers and Grimmond, 2011)

In addition to the issues involving anthropogenic heat, one of the factors mentioned by the specialists is linked to green infrastructure, often placing it as not crucial as others. However, according to the study by Vaz Monteiro et al. (2016) where the impact analysis of green spaces, of different sizes in different locations in London is made (Figure x), shows that these spaces have a significant cooling effect. The analyses were carried out during calm summer nights with sensors scattered around the studied areas (Figure x).

Period	Greenspace	Typology	Area (ha)	Perimeter (m)	Mean span (m)	Coverage (ha and correspondent % of greenspace boundaries)			
						Tree canopy	Grass	Hard Surfaces	Buildings
20/06 to 04/07	Grosvenor Gardens	Garden Square	0.3	241	72	0.4	0.2	0.1	0.0
						131%	73%	26%	1%
20/06 to 04/07	Ebury Square Gardens	Garden Square	0.2	198	50	0.4	0.2	0.1	0.0
						174%	68%	29%	0%
12/07 to 02/08	Warwick Square	Garden Square	0.8	439	113	0.7	0.6	0.1	0.0
						77%	75%	17%	0%
13/09 to 02/10	Russell Square	Garden Square	2.5	586	160	1.6	1.9	0.6	0.0
						64%	75%	22%	1%
13/09 to 02/10	Lincoln's Inn Fields	Garden Square	2.9	668	175	2.0	2.0	0.8	0.0
						69%	67%	26%	1%
12/07 to 02/08	Vincent Square	Sports Field	3.8	785	200	1.8	3.6	0.0	0.1
						48%	93%	0%	1%
12/07 to 02/08	Acton Park	Park	10.1	1398	338	4.7	8.0	0.8	0.3
						47%	80%	8%	3%
09/08 to 29/08	Queen's Park	Park	12.1	1480	395	6.3	11.0	0.8	0.1
						52%	91%	6%	0%

Figure 41. Table 01- description of greenspaces, including the typology, size, tree canopy and land cover composition (grass, hard surfaces and buildings). Mean span is the average of the width and length of each greenspace (Vaz Monteiro et al., 2016).

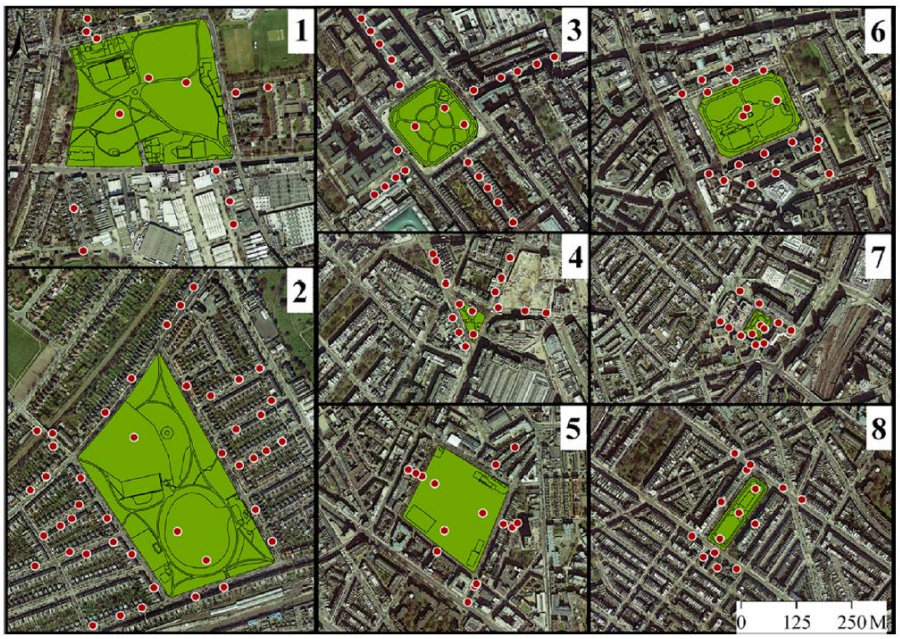


Figure 42. Location of sensors, (1) Acton Park, (2) Queen's Park, (3) Russell Square, (4) Grosvenor Gardens, (5) Vincent Square, (6) Lincoln's Inn Fields, (7) Ebury Square Gardens and (8) Warwick Square (Vaz Monteiro et al., 2016).

The study shows that the cooling effects increase linearly as the distance from the green space increases. The cooling distance showed a stronger relationship with the tree canopy density, while the amount of cooling was linked to the amount of green cover (Figure 43). The study points to the importance of these spaces, considering the increase in the number of hot nights for future projections. Finally, it shows that green areas with areas between 3-4ha, located at 100 - 150m can provide a reduction of up to 0.7C in London (Vaz Monteiro et al., 2016).

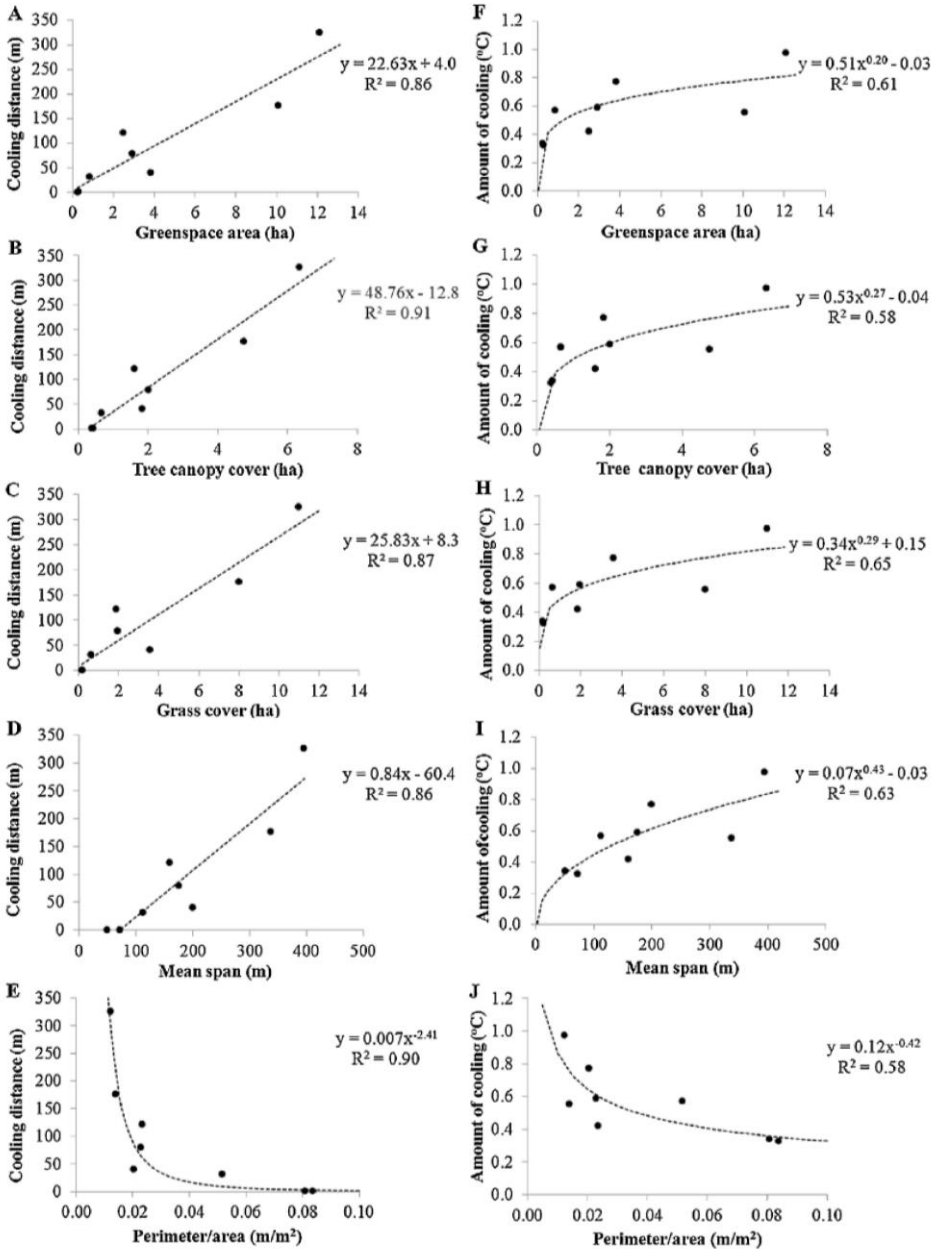


Figure 43. Relationship between the mean cooling distance and magnitude modelled for eight greenspaces on selected nights and the areas of greenspaces, tree canopy and grass, mean span and perimeter/area ratio (Vaz Monteiro et al., 2016).

In the case of Urban Form, we will analyze three research, the first of which was done by Demanuele et al. (2011) analyzes the practice of the evaluation criteria for overheating of buildings that are often made from generic data without considering the particularities of each site. The analysis carried out different points in London (Figure 44), shows that factors such as the distance from the city centre and the individualities of the microclimate around the building also affect internal comfort. Also, other site characteristics such as artificial surface coverage ratio, green surface coverage ratio and ground floor space index need to be taken into account. Besides, the analysis by Demanuele et al. points to the importance of night ventilation for reducing internal temperature. Finally, the work concludes that its findings imply that buildings may be mistakenly being approved by the city government since they use a generic file for their compliance for building regulations. The research suggests that more tailored files need to be used, more specifically for the location of buildings, and that evaluation methodology needs further studies given the complexity of the subject.

Figure 44. Local temperature measurement sites (Demanuele et al. 2011).

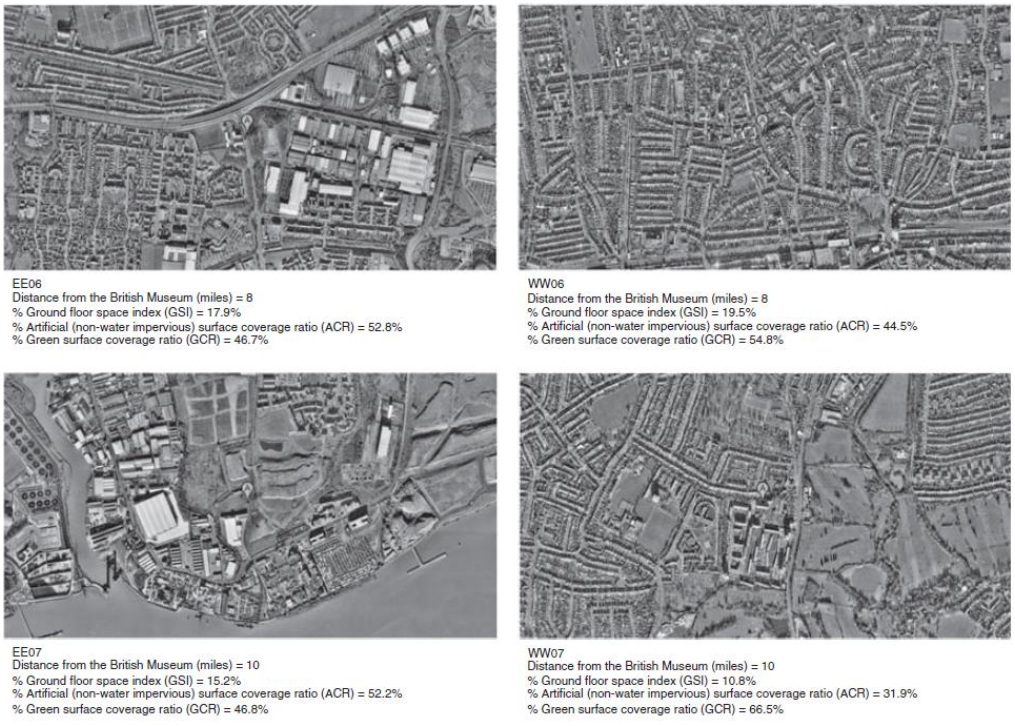


Figure 45. Classification of four of the selected measurement sites (Demanuele et al. 2011).

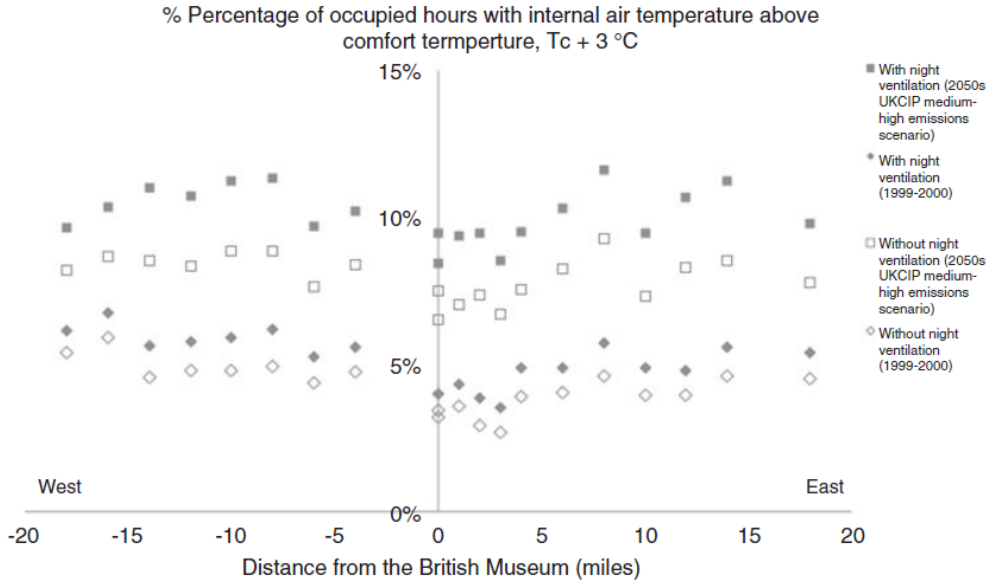


Figure 46. Variation in percentage occupied hour 3°C above the adaptative thermal comfort temperature Confort temperature (Tc) with distance from the British Museum, with and without ventilation (source: Demanuele et al. 2011).

The second work research the thermal sensational dynamic in densely interconnected spaces to understand the impact of urban morphology on the microclimate through thermal perspective. For this, the work of Vasilikou and Nikolopoulou (2019) used a questionnaire (figure 47) with 314 people focusing on the variation of comfort state in the cities of London and Rome (figure 48) during August. The study concluded that in summer, streets have a more significant potential for cooling variation than the squares. Also, the study shows the importance of adjacent spaces and how the verification and function of these spaces cause critical thermal transitions. Still, the results found are between the 'comfortable, uncomfortable and warm' spectrum.

Question 1 (ASV)				
How do you find the thermal environment at this precise moment?				
Temperature				
a) Cold	b) Cool	c) Neither warm nor cool	d) Warm	e) Hot
Wind				
a) No wind	b) Breeze	c) OK	d) Windy	e) Too windy
Sun				
a) Would like more	b) OK	c) too much sun		
Question 2 (dASV)				
Do you feel a thermal variation in relation to your previous sensation?				
a) Colder	b) Cooler	c) No variation	d) Warmer	e) Hotter
Question 3 (PTC)				
You find this:				
a) Uncomfortably cold	b) Uncomfortably cool	c) Comfortable	d) Uncomfortably warm	e) Uncomfortably hot

Figure 47. The questionnaire was designed to record changes in the thermal sensation of pedestrians during their movement (in 5-point scale; colder, cooler, none, warmer, hotter) and perceived comfort conditions (Vasilikou and Nikolopoulou, 2019).

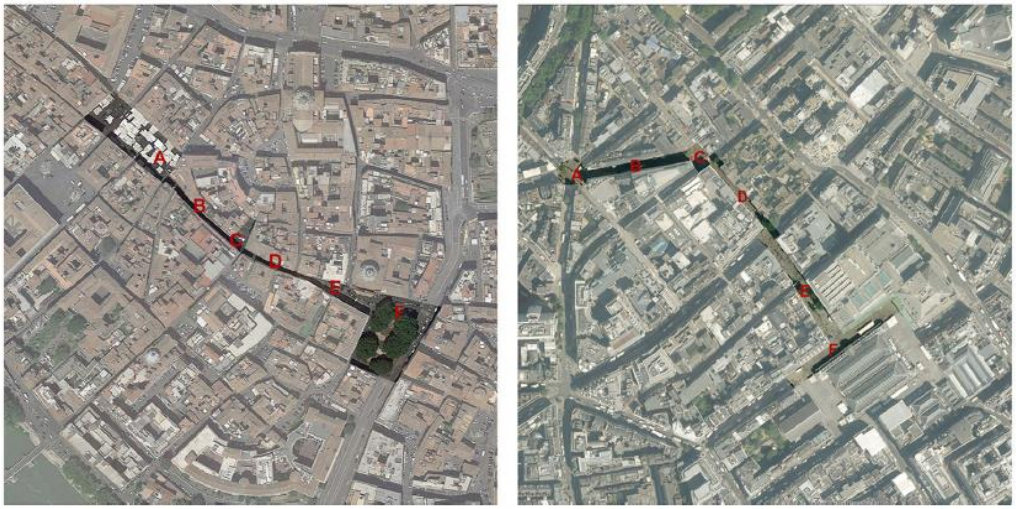


Figure 48. The routes of thermal walks in Rome (left) and London (right) (Vasilikou and Nikolopoulou, 2019).

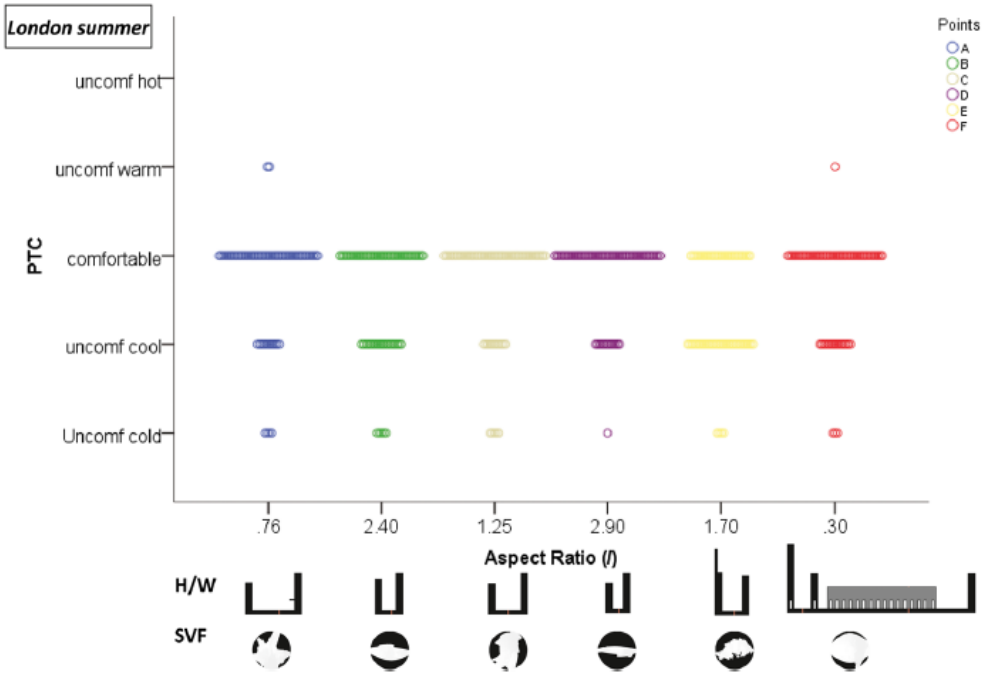


Figure 49. Summer variation in Perceived Thermal Comfort (PTC) between focus point during the thermal walk (Vasilikou and Nikolopoulou, 2019).

Finally, the study of Futcher, Kershaw and Mills (2013) which examines the energy expenditure of a 'stand-alone' building in comparison within an urban context, both buildings have the same floor area and external glazing and building envelop fabrication with the distinction only of its footprint (Figure 50). In the isolated context, the buildings had very close energy costs; however, when considering the function, office buildings need more energy for cooling, while the residential ones need heating. When it comes to their performance within the urban context, it was found that the daylight shadowing improves the performance of offices, but increases energy expenditure in residency. Also, Canopy level UHI (nighttime phenomenon) reduces the energy expenditure of residential buildings, while increasing the expenditure of offices. The effects of UHI were less effective compared to shadowing. The work concludes that a project whose main guideline is its form within the urban context and its purpose offers better opportunities for energy management.

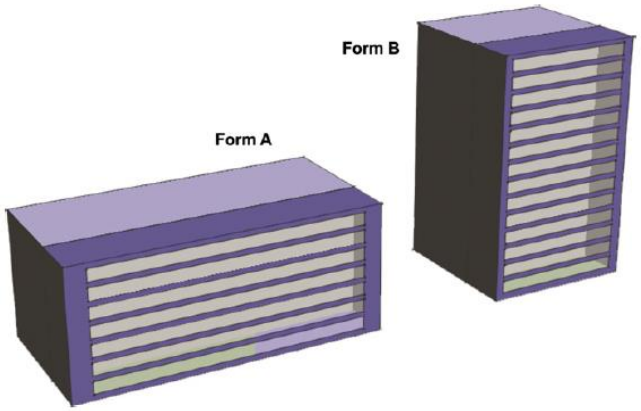


Figure 50. Form A and B. The pale area represents the boundary conditions (the adjacent zones). These areas are assigned identical properties and building parameters as the zones under investigation (Futcher, Kershaw and Mills, 2013).

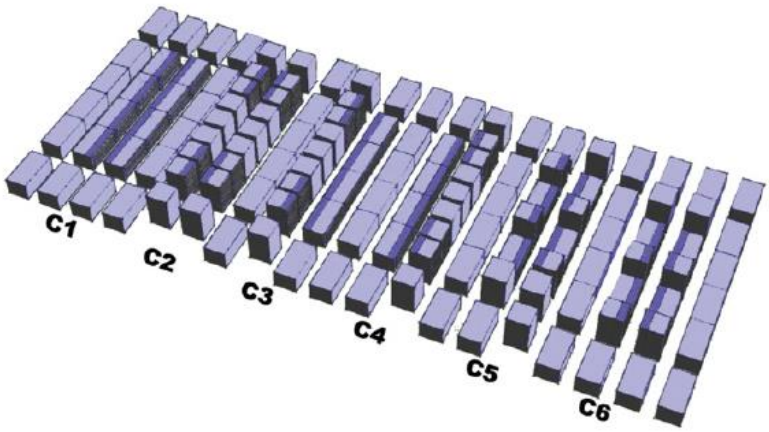


Figure 51. Geometric arrangement for the 2 building forms (A and B) arranged along with the six canyon configurations (C1 – C6) (Futcher, Kershaw and Mills, 2013).

5.3 London Governance

As shown earlier, urban governance issues are fundamental to build a city that is prepared for future climate challenges. When analyzing the responses of the meeting held by the ARCC in 2017, the main factors of how to deal with the issues raised so far are regulations and modelling tools. However, modelling is cited as a factor that still needs further investigation, so Governance is a tool the city already has, but needs to adapt to new climate demands. In the questionnaire carried out in 2020 with specialists in the urban environment of London, questions were raised about the current Governance and how it deals with issues involving the microclimate for the city's developments. The responses obtained were mostly dissatisfied with the legislation, requiring an improvement. Besides, experts see the existing legislation as an obligation, not as a suggestion, showing the legitimacy it has towards the practitioners and, finally, the regulations that exist are seen as ways

of mitigating climate challenges, so it is possible to think of strategies that are also used adapt to new temperatures.

Issues related to tax incentives were raised both in 2017 and in the 2020 questionnaire, the latter being pointed out as the main barrier to the implementation of microclimate policies. However, some cities are dealing with climatic factors (green spaces and energy-efficient buildings) through incentives. The city of Stuttgart in Germany already works with financial incentives to implement green roofs, and New York City also provides tax incentives to retrofit existing buildings in the areas called "Green Zones". Also, Tokyo has a policy that tackles not only the climate issue but housing as well; the city promotes public + private partnerships for building energy-efficient by building homes in public land. The municipally enter with the land, and the private sector is responsible for the construction, but it has to fit climate change standards.

About green areas, in 2020 questionnaire, this factor does not appear as a factor of significant impact for the London microclimate. However, it appears as a tool for the improvement in the microclimate. As previously seen, green spaces play an essential for cities microclimate and can help to reduce the energy consumption of buildings. Therefore, thinking about alternatives for the preservation and implementation of these spaces is fundamental for the maintenance and mitigation of the current overheating and future forecasts. The city of Stuttgart, as previously mentioned, has inventive strategies for these spaces. One is the municipal regulation that obliges regions to have a minimum percentage of green spaces, and the other is activities that involve citizenship and literacy such as "adopt a tree" where residents are encouraged to adopt a tree in the city. Another successful example of urban planning is the "Kankyojuli" spaces in Tokyo. These are green infrastructures that have a continuous connection, green masses that connect in different forms / urban functions: parks + green sidewalks + linear parks + gardens + coasts urban rivers.

Among the factors that influence the London microclimate, the most cited in the questionnaire carried out in 2020 were those linked to the anthropogenic heat: energy consumption and use of private cars. Also, during the 2017 meeting, energy concerns had already been mentioned as well. It is important to remember that building energy expenditure is linked to several urban factors, such as proximity to green spaces, urban shape, density, shading, materiality and function. All of these have a direct influence on energy consumption, so it is necessary to think of policies that integrate these various factors, and so far, one of the solutions for adequate for this issue is the development of modelling tools that take into account the microclimate of each region of the city. Furthermore, about land use and fossil fuel reduction policies, it is possible to see the example used in Toronto. The largest city in Canada prohibits the implementation of paid parking in some areas of the city; these are those with greater access to public transport. This initiative discourages the use of individual vehicles and can be implemented in London in conjunction with other means of public transport + pedestrians + bicycles.

At the meeting held in 2017, one of the main factors cited both about what still "need to know" and "how to tackle" was the issues related to climate simulation models. The simulations have the potential to verify issues such as density, ventilation, shading, among others, using a tool that integrates urban form with its thermal impact. The expert group comments at the ARCC meeting that one of the ways to resolve London's climate issues would be through better detail of the microclimate, UHI being in urban planning, use of big data and better planning scale. These questions directly involve the use of simulation tools. Singapore has a research group called "Cooling Singapore", the group is a partnership between the public, private and academic sectors (including ETH Zurich). One of the main objectives of the group is the development of an Outdoor Thermal Confort (OTC) performance tool for the city.

Finally, one of the main tools for good climate governance is integration. Firstly, it is necessary to have clear objectives. These objectives must be established with the help of representatives from all sectors involved, public, private, university and also the civils. A legitimate example happens in the city of São Paulo in Brazil, where a committee was formed, and representatives meet monthly to discuss the public policies that should be implemented and how in the city. Decentralization of decision making and ignorance of technologies,

or inaccessibility of them, disqualifies possible alternatives, such as a simulation tool that does not have an easy and widespread understanding in the construction industry. Alternatives like 'Cooling Singapore' are legitimate to develop simulation tools. Also, urban climate planning such as that of Stuttgart, which has the Klimaatlas' of the city, which functions as zoning for the climatic factors that influence each region of the city.

6. CONCLUSIONS

From the results obtained in the questionnaire carried out in 2020 and the 2017 meeting with 65 experts in the area of architecture and urbanism in London, together with a literature and documentary review, it was possible to reach some conclusions. The first of them concerns the matter raised by the questionnaire on what the public sector + academia and the private sector see it as the main barrier to the implementation of more effective climate policies in London. While academia and the public sector see the private sector Lobby as the main barrier, it sees the lack of tax incentives as problematic. This shows that it is necessary to deepen the investigation around a regulatory strategy as close as possible to a 'win-win' situation. This can be done through dialogue between the parties where each one analyzes how much they can give in without harming themselves financially. Solutions will not arrive quickly, but somewhat flexible and adjusted as the demands are changing.

The main factor contributing to London's urban overheating according to the results of the 2020 questionnaire, which goes according to the review of the simulations in London, is anthropogenic heat (heat generated from buildings + cars + human heat). As we saw in the simulations, the energy expenditure of buildings is directly related to urban density. However, this same density is the one that allows less mobility for individual vehicles, thus contributing to the reduction of the heat generated from cars. Density issues are linked to the use of heating by residential buildings and air conditioning for office buildings. These issues can be reduced through the use of more suitable materials, better distribution of green infrastructure, ventilation, shading and other factors linked to urban form. Therefore, density should not be seen as the problem, mainly because the opposite would be a greater spread of the city, increasing the displacement by cars, increasing the number of roads and reducing natural cover.

The various factors that affect the anthropogenic heat issue show us how the topics related to the urban microclimate cannot be treated in isolation. There is a codependency between the factors and their intensity. Green spaces affect the urban shape, shading, air humidity, as well as the urban shape influencing ventilation, shading and so on. For this reason, the urban factors present in the regulations cannot be thought of in isolation. It is necessary that these factors are worked together to improve their efficiency; and when necessary reducing their effects in favour of improving the city's microclimate for both users and energy expenditure. This aggregation of factors can be better evaluated through simulation tools, such as Outdoors Thermal Confort (OTC). This is one of the main questions raised during the ARCC meeting about the subjects "need to know" and "how to tackle". Today, however, alternatives exist that are either very limited or difficult to access for most practitioners. Therefore, the development of easy-to-access simulation tools that integrate the available data, which are specific to each region of the city, are fundamental for the qualification of both the design of projects and evaluation by the public sector.

Topics involving urbanism are wicked, the city is a dynamic organism, and urban planning has always been a complex issue. In this context, the climate subject would not be an easy matter. Therefore, to deal with the microclimate issues in cities, it is necessary to develop an evaluation methodology that takes into account the range of factors that influence urban life. It is possible that initially, this makes the analysis system even more complicated, so there is a need to invest in dynamic assessment systems that associate different sectors of the municipality, not only those that deal with urban space but also health, financial, educational sectors that are also impacted by decisions made in the planning sector. The creation of multi-disciplinary committees, along with zoning the city in climatic areas (as Stuttgart) and from there creating data for an evaluation of

future development and investment in the retrofit of existing buildings can be a start for microclimate regulation in London.

7. FUTURE WORKS

From the conclusions reached in this work, it is possible to ascertain the need for qualification of OTC simulation tools. These tools need a more 'user-friendly' system for both the public and private sectors to facilitate their adoption. Also, the question involving data and big data are fundamental; what type of data is needed and how can it be collected to feed the simulation systems. Once with a simulation tool, it is fundamental to think about evaluation methodologies, what will be evaluated (energy consumption, internal and external thermal comfort, green spaces, etc.) and how it will be evaluated. Which city guidelines will be rigid in terms of values or malleable according to the needs of each location. Also, there must be verifications about if it is necessary and if it has in which aspects the policies can have popular participation. Furthermore, how it would be possible to work with more than one secretariat for urban planning and how often the measures adopted will be reassessed, so it will not become obsolete.

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9. APPENDICES

Appendix A: ARCC Meeting: “What we already know” responses chart.

Name (s)	Your Idea	Topic			Which option does your Idea apply to?	Is it a challenge or a solution?		Detailed Description	Sector
		Urban climate	Uban microclimate ate	Greening cities	What do we already know but are not using, and why?	Challange	Solution		
Mark Jenkinson	Make it simpler for public / Policy Makers	x			x			A formula can we link it to health/ liveability etc.?/ Need tools to quantify (e.g., the question from Southwark on old kent rd)? Utilize information from Lee Charman's + other sensors, quality permitting	
			x		x			Know - even when we know about it? What we know about the aggregate effect of material things. (need) want to know the relative importance factors agency micro-climate UHI, e.g. vehicles/ transport anthropogenic heat from buildings solar - with vegetation, low albedo, solar without hi already	
Cris Town		x	x		x	x	x	Correct Planning Policy on Daylight sun/ wind/ No minimum daylight stipulated no minimum solar access stipulate/ Lawson Criteria = are for 1970's safety - not today's expectation of pedestrian 'comfort.'	
Cris Town		x	x		x		x	Major miss-match of policy/ air sourced heat pumps encouraged but significantly added to microclimate overheating/ based on evidence the current policy need qualification	
Darren Robson, Natalie (?), Scarlet Franklin, (?) Peng	how can we make our urban research models accessible to practitioners?	x			x	x		Are practitioners using research models? Are they better than commercial 'black box' models do suitable data sets exist? Should local authorities be mandated to collect these? How can we make the models useable for practitioners (academics) want from a model? How can we cross multiple scales?	University of Sheffield
Jo Harris		x			x	x		accessibility to modelling tools and real data to make better decisions (info) trends are needed too expensive/ complicated to use inaccessible to practising engineers (building and urban design professionals) too time-consuming	BSRIA
Gerald Adams		x			x	x		I think we have enough scientific knowledge to make decisions of different scales on climate. I am not sure however how these are integrated with other (planning) tools and other professionals know to do this	
		x			x			need to know what is available not keen awareness of stuff that is know/ we do have models and we do have data we do not use models cos they are academic tools/ also data validated models/ also academic may produce info in more detail than practice needs or wants	

					x			A building scale, performance gaps persist/ are we doing enough to tackle this head-on patterns of behaviour for different buildings types are available but not widely known/ used also can be deduced from optimising models knowledge from the other countries (e.g. Maisel?) massive amount of data available (e.g. DEFRA) but not in a format that can be used by third parties	
Chris Jones					x	x		We do not talk enough about resource depletion. We face many challenges due to dependencies on widely deployed technology and slow transition, yet cities are highly vulnerable to external resource shocks the principle urgency being oil	
Gerald Mills					x	x		We seem to know a great deal about individual buildings but little about buildings groups? And neighbourhoods/ incomplete energy efficiencies into property? Evaluation: Steadman	
Tristan Kershaw	Greening to reduce UHI		x		x		x	The UHI is not only due to reduce evapotranspiration but reduce surface convection efficiency. Since the UK gov has no policy to reduce the UHI apart from greening we need some guidance on what sort of greening is required horizontal or vertical grass trees or shrubs large or small networks	University of Bath
Richard Lorch	Change energy modelling for practitioners and planners		x		x	x		Modelling of building energy use needs to incorporate: 1- local microclimate conditions (light, microclimate, reflectance) 2 - contemplate future scenarios (both new climate models and interactions with the surroundings) more thinking and acting about performance overtime policy, there needs to be clear performance standards	Building Research & Information
Antonio Messina					x	x		FM companies traditionally aim at making buildings work. The next step is making them working efficiently by implementing good practice from energy management into standard FM? Regimes this integration should be promoted at all levels from everyday maintenance to senior management level and become the new minimum standard/ Breeam IN_USE should be promoted	CIBSE Resilient Cities Group and Ramboll
Maria Kolokotroni	HVAC & lighting combined n wellbeing perception				x			Combined thermal environment verification and lighting impact on the perception develops a combined indicator / does the absence of one compensate for the other	Brunel University London
	This was not covered in the session			x	x		x	i-tree & US experiment with trees in an urban environment improved social aspect crime reduction feel of the city tree design action group (TDAG) are aware feed into the next event	
Maria Kolokotroni	Green spaces - Impact on IAO thermal environment, social activities health apart from IA2			x	x			If green spaces do not contribute effectively to IAQ improvement the: !) thermal environment improvement 2) social, physiological enjoyment are the main focus for greening cities can measure these? Are there any other strategies to achieve the same results are there other benefits	Brunel University London
Eric Peterson					x			Temperature what can i do about my backyard?	
TABLE									
Dorte's		X			BRE has created a UHI Mapa and book;cooling xxx in London effects on UHI (2008) London Plan does include this (** JF limited)				Atkins

Table 3		x			New info on people perception of heat? (GLA) - see axe (?) website/ Need to update models with bug data/ Big data swap data on the phone not easily accessible yet				
Table 4		x			UHI causes and impacts/ incremental site by site approach/ Tools to measure and model availability/ microclimate data and big data				
Table 5		x			Cost constraints/ academic tool available but not user-friendly/ skill gap - planner's developers/ value engineering				
Table 6		x			Not just where peeps/ Different types of the census, where peeps working - is UHI a problem where nobody lives? Frame to influence planning and design linked to? Definition of high density/ other factors - quality not just density/ Approx. Density universal? The density of - peeps, pollutant, bids, etc. / Clarify/ surface areas - data? we have but do planners? more data urban environments and how works/ what data already exists/ building footprint surface area etc/ hard data to get other cities to have cities that address aspects of density				
Table 7		x			Not using local planning authorities - data needs simplifying and simples usable tools for office es to use				
Table 9 (Mark Jenkinson)					Cost & Human behaviour is an obstacle/ DECC data is very confidential/ Building regs lead to certain approaches, e.g. compliance v. performance conflicting guideline/ information				Siemens plc
Table 7					we know how to model a building but not the neighbourhood scale				
Table 1 (Dorte's)			x		There are rights os light of existing domestic buildings have guidance from one on daylight and sunlight indicators from residential which is applied				Atkins
Table 5 (Y)			x		Higher building use more energy than low rise/ developments and most of the carbon saving measures are down to technology rather than architecture. However they make economic sense for developers more emphasis should be focused on albedo green facades, green energy improvement how these factors increase value productivity etc. not just energy				
Table 3 (Robin)			x		Interseasonal heat storage/ why don't we use flooded roofs for cooling				Cullinan Studio
Table 4			x		some tools to measure daylight and sunlight - BRE guidelines				
Table 2 (mark Jenkinson)			x		use of materials, e.g. white buildings more prevalent in Germany impact on climate change				Siemens plc
Table 6 (Z)			x		Costs? Ignorance? Skills? Some energy modelling too generic model building performance and how it will perform in 20 years how to convey prob of buildings xxx? Infrastructure? Who cares about it?				
Table 7			x		How to improve thermal environments in a moderate climate				

Table 01 (Dorte's)				x	Rob Mackenzie research provides helpful rules of thumbs, which is at its early stage/development so not yet applied output from Audrey de Nazalle research is available in academia which needs to be assimilated effectively xxxx				Atkins

Table 2 (mark Jenkinson)				x	London has 40% green spaces, only 45 of the UK is built on				Siemens plc
Table 3 (Robin)				x	Baking bread is full of danger; wood smoke is a pollutant				Cullinan Studio
Table 5				x	Academic studies have been carried out, but they have not reached the wider public audience, not just a knowledge barrier then, but also a political issue people outside London simply cannot rely on public transport for example				
Table 7				x	The design issue as discussed is too simplistic - 'good density' means nothing				
Table 4				x	Trees can alleviate air conditions tress cannot mitigate all air pollution, good forwellbeing/ flooding				
Table 1 (Dorte's)					guides on lighting and health, and site and planning fr daylighting and surveying for housing only London plan has open space provision in simple mandatory (?) guidance, but open spaces are xxx (?) due to lack of xxx at loch(?)				Atkins
Table 2					Right to light BSF Design Requirements/ dictates more glazing potentially ignoring heat effect				
Table 5					added value is difficult to be quantified in the short term				
Table 4					Epidemiology - links between exposure to daylight and health and wellbeing				
Table 7					How can we better quantify wellbeing?				
Table 3 (Robin)					Are local authorities health obligation working more M-D?				Birmingham Institute of Forest Research
Anonymous					need a vision making it happen - Ebenezer Howard Patrick Geddes notation of life wellbeing is profound and complex transdisciplinary/ knowledge no silos value v. public perception				

Appendix B: ARCC Meeting: “What we already know” responses chart with Urban Factors

Name (s)	Topic			Is it a challenge or a solution?		Detailed Description	Sector	Notes	Factors
	Urban climate	Uban microclimate	Greening cities	Challange	Solution				
1	x					The formula can we link it to health/ liveability etc.?/ Need tools to quantify (e.g., a question from Southwark on old kent rd)? Utilize information from Lee Charman's + other sensors, quality permitting		URBAN CLIMATE LINK TO HEALTH	HEALTHY
2	x					Know - even when we know about it? What we know about the aggregate effect of material things. (need) want to know the relative importance factors agency micro-climate UHI, e.g. vehicles/ transport anthropogenic heat from buildings solar - with vegetation, low albedo, solar without hi albedo		FACTORS IN INSOLATION	FACTORS INTO GOVERNANCE

3	x	x	x	x	Correct Planning Policy on Daylight sun/ wind/ No minimum daylight stipulated no minimum solar access stipulate/ Lawson Criteria = are for 1970's safety - not today's expectation of pedestrian 'comfort.'		MINIMUM INSOLATION	THERMAL EFFECTS
4	x	x		x	Major miss-match of policy/ air sourced heat pumps encouraged but significantly added to microclimate overheating/ based on evidence the current policy need qualification		FACTORS DON'T MATCH POLICIES	FACTORS INTO GOVERNANCE
5	x		x		Are practitioners using research models? Are they better than commercial 'black box' models do suitable data sets exist? Should local authorities be mandated to collect these? How can we make the models useable for practitioners (academics) want from a model? How can we cross multiple scales?	University of Sheffield	MODELS + PRACTIONERS	FACTORS INTO GOVERNANCE
6	x		x		accessibility to modelling tools and real data to make better decisions (info) trends are needed too expensive/ complicated to use inaccessible to practising engineers (building and urban design professionals) too time-consuming	BSRIA	SIMPLER DATA/ MORE KNOWLEDGE IN MODELING	MODELING
7	x		x		i think we have enough scientific knowledge to make decisions of different scales on climate. I am not sure however how these are integrated with other (planning) tools, and other professionals know to do this		INTEGRATED KNOWLEDGE WITH PRACTICE	FACTORS INTO GOVERNANCE
8	x				need to know what's available not strong awareness of stuff that is know/ we do have models and we do have data we don't use models cos they are academic tools/ also data validated models/ also academic may produce info in more detail than practice needs or wants		MODELS FOR PRACTITIONERS	FACTORS INSIDE ACADEMIA
9					A building scale, performance gaps persist/ are we doing enough to tackle this head-on patterns of behaviour for different buildings types are available but not widely known/ used also can be deduced from optimising models knowledge from the other countries (e.g. Maisel?) massive amount of data available (e.g. DEFRA) but not in a format that can be used by third parties		KNOW BUILDING SCALE	BUILDING FORM
10			x		we do not talk enough about resource depletion. We face many challenges due to dependencies on widely deployed technology and slow transition, yet cities are highly vulnerable to external resource shocks the principle urgency being oil		TRANSPORT	TRANSPORT
11			x		we seem to know a great deal about individual buildings but little about buildings groups? And neighbourhoods/ incomplete energy efficiencies into property? Evaluation: Steadman		BUILDINGS GROUPS	BUILDING FORM
12		x		x	The UHI is not only due to reduce evapotranspiration but reduce surface convection efficiency. Since the UK gov has no policy to reduce the UHI apart from greening we need some guidance on what sort of greening is required horizontal or vertical grass trees or shrubs large or small networks	University of Bath	GREENING FOR UHI	GREEN INFRA
13		x	x		Modelling of building energy use needs to incorporate: 1- local microclimate conditions (light, microclimate, reflectance) 2 contemplate future scenarios (both new climate models and interactions with the surroundings) more thinking and action about performance overtime policy, there needs to be clear performance standards	Building Research & Information	CLEAR PERFORMANCE STANDARDS	FACTORS INTO GOVERNANCE
14			x		FM companies traditionally aim at making buildings work, the next step is making them working efficiently by implementing good practice from energy management into standard FM? Regimes this integration should be promoted at all levels from everyday maintenance to senior management level and become the new minimum standard/ Breeam IN_USE should be promoted	CIBSE Resilient Cities Group and Ramboll	KNOWS HOW MAKING BUILDINGS WORK	BUILDING FORM
15					Combined thermal environment verification and lighting impact on the perception develops a combined indicator / does the absence of one compensate for the other	Brunel University London	COMBINED THERMAL AND LIGHTING IMPACT	THERMAL EFFECTS
16				x	i-tree & US experiment with trees in an urban environment improved social aspect crime reduction feel of the city tree design action group (TDAG) are aware feed into the next event		GREEN DESIGN	GREEN INFRA
17					If green spaces do not contribute effectively to IAQ improvement the: !) thermal environment improvement 2) social, physiological enjoyment are the main focus for greening cities can measure these? Are there any other strategies to achieve the same results are there other benefits	Brunel University London	IMPORTANCE OF GREEN SPACES	GREEN INFRA
18					Temperature what can i do about my backyard?		BACKYARD - THERMAL	GREEN INFRA

TABLE

19	X					Atkins	BRE HAS A UHI MAPA/ OOF SPACE FOR UHI/ BIRMINGHAM UHI POLICY	THERMAL EFFECTS
20	x						PEOPLES PERCEPTION ON HEAT/ BIG DATA/ SINGAPORE MODEL GREEN MEASUREMENTS	THERMAL EFFECTS
21	x						MICROCLIMATE DATA/ URBAN FORMA AND MICROCLIMATE/ TOOLS FOR URBAN CLIMATE	THERMAL EFFECTS
22	x						TOOLS NOT USER FRIENDLY / ECONOMIC VALUE/ CHEAPER TO HAVE CONCRETE OF GREEN	FACTORS INSIDE ACADEMIA
23	x						QUALITY NOT JUST DENSITY. HOW OTHER CITIES ARE DOING IT/ SCALE DECISION, USER FRIENDLY	FACTORS INSIDE ACADEMIA
24	x						SIMPLER DATA/ MORE KNOWLEDGE IN MODELING	FACTORS INTO GOVERNANCE
25							NEIGHBOR SCALE/ CHANGE BUILDING REGULATION	BUILDING FORM
26		x				Atkins	RIGHT FOR THE LIGHT/ OTHER BUILDINGS IMPACT	FACTORS INTO GOVERNANCE
27		x					TELLER BUILDINGS/ WE SHOULD FOCUS ON FORM/ FM/ NEW REGULATIONS	ENERGY CONSUMPTION
28		x				Cullinan Studio	USE OF THE ROOFS/ COORDINATE SEPARATED FACTORS/ HEAT PUMPS PROBLEMS, MINIMUM DAYLIGHT	BUILDING FORM
29		x					MEASURE DAYLIGHT AND SUN/ WHICH TOOLS ARE THE BEST/ STRONGER PLANNING POLICY	THERMAL EFFECTS

.

30		x					Siemens plc	MATERIALS/ IMPACT OF WIND/ LIGHT/ HEAT	THERMAL EFFECTS
31		x						COSTS/ SKILLS/ MODELING/ THINK FURTHER	MODELING
32		x						THERMAL ENVIRONMENT	THERMAL EFFECTS
33			x				Atkins	VALUE OF GREEN SPACES - MANCHESTER CITY	FACTORS INSIDE ACADEMIA
34			x				Siemens plc	GREEN SPACES	GREEN INFRA
35			x				Cullinan Studio	AIR POLLUTANT	HEALTHY
36			x					BETTER PUBLIC TRANSPORT/ BUILDING DESIGN IS THE KEY	FACTORS INSIDE ACADEMIA
37			x					TREES	GREEN INFRA
38								LIGHT	THERMAL EFFECTS
39								DAYLIGHT AND WELLBEING - STANDARD FOR DAY AND SUNLIGHT	HEALTHY
40								QUANTIFY WELLBEING	HEALTHY
41							Birmingham Institute of	healthy	HEALTHY
42								ENGAGE PUBLIC / URBAN WELLBEING/ STANDARD CODES	HEALTHY

Appendix C: ARCC Meeting: “What we need to know” responses chart.

Name (s)	Your Idea	Topic			Which option does your Idea apply to?	Is it a challenge or a solution?		Detailed Description	Sector
		Urban climate	Uban microclima	Greening cities	What do we need to know?	Challange	Solution		
			x		x			Know - even when we know about it? What we know about the aggregate effect of material things. (need) want to know the relative importance factors agency micro-climate UHI, e.g. vehicles/ transport anthropogenic heat from buildings solar - with vegetation, low albedo, solar without hi albedo	
Maria	Indoor/ outdoor IAQ and Noise		x		x			HVAC strategies building fenestration and outdoor air quality qhat is the impact on internal conditions? How would noise affect passive strategies design and acceptance?	Brunel University London
Grid	The parametrisation of microclimate environment variables		x		x			Impact of solar radiation on microenvironments is not well understood	University of Kent
Julie Futcher			x		x		x	more detailed understanding of the timing of the UHI and the timing of building function	
Lee Chapman			x		x	x		Adaptative thermal control: how can we take into account? In building design?	

George Adams			x		x	x		What scale of the city area management? Should be defined? i.e. 1km2?, 10km2? 100km2?/ How we choose to focus attention on dealing with energy pollution, microclimate into manageable zones.	
Girid Haran	Develop a lifestyle profile for various communities				x	x		The modelling uncertainty comes largely from a lack of knowledge on the lifestyle of people	University of Kent
Tristan Kershaw	Greening to reduce UHI		x		x		x	The UHI is not only due to reduce evapotranspiration but reduce surface convection efficiency. Since the UK gov has no policy to reduce the UHI apart from greening we need some guidance on what sort of greening is required horizontal or vertical grass trees or shrubs large or small networks	University of Bath
Eric Peterson					x			Temperature what can i do about my backyard?	
TABLE CHAIR NOTES									
Dorte's		X			More information about other climates than London. How to use a space on a roof to solve heat island effects or to use it for renewable energy fro low cities?				Atkins

Table 3		x			How to engage a broad cross-section of xxx (?) (not just xxx?) whit (?) and retrieve (?)/ Min and Max standards for developers social-economic standards impact of big data/ Ho the analyse on bug data / make it competitive (?); quality control (?) / Air quality - tricky/ multi: (?) need to star somewhere (?), e.g. temp. GLA working with Kingston campaign/ awareness-raising				
Table 4		x			Useful tools to measure and mitigate mapping how urban form relates to micro-climate beyond wind tunnels effect				
Table 5		x			Actual data - high quality/ correct real data monitoring/ bridging the gap between the academic and professional world				

Table 6		x			Even if we have data need to have models and translation to make useful for decisions (?) and codes, need to combine with visions/ scale decisions making? Impact of a single building. 20FC, for example, disturb wind flow				
Table 7		x			Too early in our knowledge of modelling still investigating/ Cause - effects too complex to predict				
Table 9 (Mark Jenkinson)					lack of data to make decisions on * design v. performance * cities do not generally have building data				Siemens plc
Table 7					The unpredictability of model outputs due to a variability; therefore, how maybe we already know enough no return on further/ future complexity?				
Table 1 (Dorte's)			x		similar guidance for office books that the BRE has proxxxx for residential needs the above guidance needs to include both				Atkins

					daylight and sunlight and other key measures from the urban micro-climate palette				
Table 5 (Y)			x		Post-occupancy/ post-construction evaluations more emphasis on practicalities (commissioning/ soft-landing's) UHI Impacts: positive negative in London latitudes? Decision-makers(planners and developers) need to be more knowledgeable				
Table 3 (Robin)			x		How to improve thermal environment cities - albedo effect/ how to coordinate all the separate factors - albedo, daylight, etc. Can we capture this surplus here				Cullinan Studio
Table 4			x		which tools work best are easy to use by different professionals/ financial impacts cumulative/ illumination				

					effects				
Table 2 (mark Jenkinson)			x		impact of wind on urban microclimate Link to SBI/ aperture index on cost/ saving yo light/ heat building Research/ work to convert it into practical - Simple, usable guidelines policy and buildings menos/ parameters stronger planning policy London Plan enough?				Siemens plc
Table 7			x		Sufficiently robust evidence already exits definitive? Performance standards are gong but its all location-specific beyond just xxx geographical context is paramount is not a straight forward black/ white application				
Table 01 (Dorte's)				x	some of the rules of xxx may xxx other parameters like xxx in a high dense area. Xxx cooling research work needs to				Atkins

					be done xxx multi-disciplinary sense type (?)				
Table 2 (mark Jenkinson)				x	More info on the impact of the typography of cities on pollution				Siemens plc
Table 3 (Robin)				x	Can keep modelling - noise is new/ Cheaper air quality monitors/ Biodiversity support - green walls etc. do not support animals				Cullinan Studio
Table 5				x	very interesting graphs and charts on the relationship between cycling/ walking times and the threshold between negative and positive effect! More of these insights should be circulated across the industry				
Table 4				x	Strategy for cities without or with little infrastructure/ how to retrofit - especially in densely build areas that are affected by overshadowing				
Table 1 (Dorte's)					How can guidance be developed wider?				Atkins

					Applications beyond residential for light and sunlight				
Table 2					Have we, ok our children had enough UVB? How do we monitor				
Table 5					beneficial effects at all levels should be circulated across all stakeholders				
Table 3 (Robin)					How might one make a resilient city with such a range of wealth from the super-rich to homeless/urban well - standard sick cities? Is the well standard benefitting from the demise of BREEAM/ CHSs etc				Birmingham Institute of Forest Research (BIFoR)
Anonymous					Engage the public to increase awareness monitoring xxx? VR + mortality figures usually make an impact we know a lot but have a lot to learn need input APPG on smart cities/ urban health wellbeing design/ guide standards codes handbooks people central				

					community				

Appendix D: ARCC Meeting: “What we need to know” responses chart with Factors.

Topic			Which option does your Idea apply to?	Detailed Description	Note	Factor
Urban climate	Urban microclima	Greening cities	What do we need to know?			
	x		x	Know - even when we know about it? What we know about the aggregate effect of material things. (need) want to know the relative importance factors agency micro-climate UHI, e.g. vehicles/ transport anthropogenic heat from buildings solar - with vegetation, low albedo, solar without hi albedo	UNDERSTAND THE RELATIONS BETWEEN MATERIAL, FORM UHI, TRANSIT, ETC	URBAN FORM
	x		x	HVAC strategies building fenestration and outdoor air quality qhat is the impact on internal conditions? How would noise affect passive strategies design and acceptance?	NOISE + INTERNAL/ EXTERNAL CLIMATE	URBAN FORM
	x		x	Impact of solar radiation on microenvironments is not well understood	IMPACT OF SOLAR RADIATION	THERMAL EFFECTS
	x		x	more detailed understanding of the timing of the UHI and the timing of building function	TIMING UHI AND USING	THERMAL EFFECTS
	x		x	adaptative thermal control: how can we take into account? In building design?	ADAPTATIVE THERMAL CONTROL	THERMAL EFFECTS

	x		x	What scale of the city area management? Should be defined? i.e. 1km2?, 10km2? 100km2?/ How we choose to focus attention on dealing with energy pollution, microclimate into manageable zones.	MICROCLIMATE SCALE	URBAN FORM
			x	The modelling uncertainly comes largely from a lack of knowledge on lifestyle of people	EXPLORE PEOPLES LIFESTYLE	BEHAVIOUR
	x		x	The UHI is not only due to reduce evapotranspiration but reduce surface convection efficiency. Since the UK gov has no policy to reduce the UHI apart from greening we need some guidance on what sort of greening is required horizontal or vertical grass trees or shrubs large or small networks	GREENING FOR UHI	GREEN INFRA
			x	temperature what can i do about my backyard?	BACKYARD - THERMAL	GREEN INFRA
X			More information about other climates than London. How to use a space on a roof to solve heat island effects or to use it for renewable energy fro low cities?		ROOF SPACE UHI	THERMAL EFFECTS
x			How to engage a broad cross-section of xxx (?) (not just xxx?) whit (?) and retrieve (?)/ Min and Max standards for developers social-economic standards impact of big data/ Ho the analyse on bug data / make it competitive (?); quality control (?) / Air quality - tricky/ multi: (?) need to star somewhere (?), e.g. temp. GLA working with Kingston campaign/ awareness-raising		MIN MAX FOR SOCIAL DEVELOPMENT - HOW to ANALYSE BIG DATA - BIG DATA IMPACT	MODELING/ DATA

x			Useful tools to measure and mitigate mapping how urban form relates to micro-climate beyond wind tunnels effect		HOW URBAN FORM RELATES TO MICROCLIMATE	URBAN FORM
x			Actual data - high quality/ correct real data monitoring/ bridging the gap between the academic and professional world		HIGH-QUALITY DATA/ GAP BETWEEN ACADEMIA AND PROFESSIONAL	MODELING/ DATA
x			Even if we have data need to have models and translation to make useful for decisions (?) and codes, need to combine with visions/ scale decisions making? Impact of a single building. 20FC, for example, disturb wind flow		SCALE DECISION MAKING	URBAN FORM
x			Too early in our knowledge of modelling still investigating/ Cause - effects too complex to predict		MORE KNOWLEDGE IN MODELING	MODELING/ DATA
			lack of data to make decisions on * design v. performance * cities do not generally have building data		FM/ LACK OF DATA	MODELING/ DATA
			The unpredictability of model outputs due to a variability; therefore, how maybe we already know enough no return on further/ future complexity?		UNPREDICTABILITY OF MODEL OUTPUTS	MODELING/ DATA
	x		similar guidance for office books that the BRE has proxxxx for residential needs the above guidance needs to include both daylight and sunlight and other key measures from the urban micro-climate palette		MORE GUIDANCE FOR OTHER BUILDINGS IMPACT	GOVERNANCE

	x		Post-occupancy/ post-construction evaluations more emphasis on practicalities (commissioning/ soft-landing's) UHI impacts: positive negative in London latitudes? Decision-makers(planners and developers) need to be more knowledgeable		UHI IMPACTS	THERMAL EFFECTS
	x		How to improve thermal environment cities - albedo effect/ how to coordinate all the separate factors - albedo, daylight, etc. Can we capture this surplus here		COORDINATE SEPARATED FACTORS (ALBEADO, DAYLIGHT...)	URBAN FORM
	x		which tools work best are easy to use by different professionals/ financial impacts cumulative/ illumination effects		BETTER TOOLS	MODELING/ DATA
	x		impact of wind on urban microclimate Link to SBI/ aperture index on cost/ saving yo light/ heat building		MATERIALS/ IMPACT OF WIND/ LIGHT/ HEAT	URBAN FORM
	x		Research/ work to convert it into practical - Simple, usable guidelines policy and buildings menos/ parameters stronger planning policy London Plan enough? Sufficiently robust evidence already exits definitive? Performance standards are gong but its all location-specific beyond just xxx geographical context is paramount is not a straight forward black/ white application		STRONGER POLICY/ ROBUST EVIDENCE	GOVERNANCE
		x	some of the rules of xxx may xxx other parameters like xxx in a		MORE MULTI DISIPLINARY	KNOWLEDGE BRIDGE

			highly dense area. Xxx oling research work needs to be done xxx multi-disciplinary sense type (?)			
		x	More info on the impact of the typography of cities on pollution		MORE INFOR ABOUT AIR POLLUTION	TRANSPORT
		x	Can keep modelling - noise is new/ Cheaper air quality monitors/ Biodiversity support - green walls etc. do not support animals		CHEAPER AIR QUALITY MONITORS / BIODIVERSITY	TRANSPORT
		x	very interesting graphs and charts on the relationship between cycling/ walking times and the threshold between negative and positive effect! More of these insights should be circulated across the industry		AIR QUALITY	TRANSPORT
		x	Strategy for cities without or with little infrastructure/ how to retrofit - especially in densely build areas that are affected by overshadowing		RETROFIT IN DENSE AREAS WITH OVERSHADOWING	URBAN FORM
			How can guidance be developed wider? Applications beyond residential for light and sunlight		GUIDANCE	GOVERNANCE
			Have we, ok our children had enough UVB? How do we monitor		MORE LIGHT	URBAN FORM
			beneficial effects at all levels should be circulated across all stakeholders		BENEFICIAL EFFECTS AT ALL LEVELS	KNOWLEDGE BRIDGE
			How might one make a resilient city with such a range of wealth from the super-rich to homeless/urban well - standard sick cities? Is the well standard		SOCIAL GAP	SOCIAL

		benefitting from the demise of BREEAM/ CHSs etc			
		Engage the public to increase awareness monitoring xxx? VR + mortality figures usually make an impact we know a lot but have a lot to learn need input APPG on smart cities/ urban health wellbeing design/ guide standards codes handbooks people central community		ENGAGE PUBLIC / URBAN WELLBEING/ STANDARD CODES	GOVERNANCE

Appendix E: ARCC Meeting: "How are we going to tackle or take it forward" responses chart.

Name (s)	Your Idea	Topic			Which option does your Idea apply to?	Is it a challenge or a solution?		Detailed Description	Sector
		Urban climate	microclim	Greening cities	How are we going to tackle or take it forward?	Challange	Solution		
Andrew Sconnes	Propose a standard for city modelling	x		x	x		x	Plataform consistency/ Data: density, etc/ Interoperability/ Internacional/ Scaleable/ Potencial to combine, cross examine.	ngenuity
Susie Damond	Staring of Big data	x	x	x	x	x		Big Data - costs of failed collectins need to ensure max use. (?)	
Mark Jenkinson	Make it simpler for public / Policy Makers	x			x			The formula can we link it to health/ liveability etc.?/ Need tools to quantify (e.g., a question from Southwark on old kent rd)? Utilize information from Lee Charman's + other sensors,	

					quality permitting	
Marianne Heaslip		x	x	x	How do we make existing tools + modelling more accessible to those in practice? Currently, tools are often difficult to access, difficult to use and understand(even if you are committed to using them)? The second issue is justifying time (therefore fees) sent on this to hard-nosed developers (likely to require benefits to be quantified	URBED (Urbanism Environment and Design Ltd)
Dane Virk	Sharing/ Using data from models (?) in everyday decision	x	x	x	Having all these models and data are useful and advance our understanding of the urban climate. These have to be translated to useable outputs for planners and building occupants/ How can data from Hi-Temp and urban climate models be used to affect everyday policy? Heat map? Planning guidance	Atkins
Table by Coffee		x	x		Need to disseminate (?) outputs quickly and supply to practice/industry	
Andrew Sconnes	The age of new cars should be electric	x	x	x	Reduce pollution/ Create a distributed power network	ingenuity
H Devias	The variance between daylight and thermal models	x	x	x	if there is a variance between daylight and thermal models. What are the implications, and how should we deal with the variance? (how wrong is ok?)	

Eric Peterson		x	x		Surface interventions are justified otherwise/ future heat will require AC/ Albedo management or producing shade?/ Standards for daylight?	
		x	x		detailed microclimate (?) pre and post-construction	
R. Lamb @	Valuing Green Space	x	x	x	Being able to put a financial value on green spaces beyond its value for the development	Institute for Environmental Analytics, University of Reading
Kostas Dallas	Towns Constructed without the requirements of vehicles	x	x	x	Can towns be designed to avoid the need to use vehicles for local travel./ all essential amenities within walking/ cycling distance. / Improved public transport.	
Jessica Lewis	tool (?), guidances, (?) and retrofit of green infra	x	x	x	Most of the urban areas are already build, while planning is important, and strategic regional plans are a good starting point. They do not address the fact that most the environment that (?) already exists./ How can greening become mainstream and easy? I think to develop tools and business case would help to address this. these could be used by placemaking in local authorities and by government	London Environment Directors Network
Table by door		x	x		Two presenters dealt with holistic outcomes (sometimes seemingly perverse) what we need to know is a healthy explanation of what	

					the determinations were!	
Marianne Heaslip		x	x	x	gemma Jerone @ Gloucester wildlife trust is developing a benchmarketing tool, aimed at developers, which helps to identify and quantify the value of green infra and includes a consideration of whole life costs na ongoing maintenance costs.	URBED (Urbanism Environment and Design Ltd)
Eric Peterson		x	x		19th C issues today. Olmsted, Rauch, Cerda, Chadwick, Haussman, sunlight, health, sanitation, green space, today, air, pollution, inactivity, traffic, sprawl = bad greenness = good active transport brilliant! Density has benefits but challenges also. rules of thumb #1 sketch neighbourhood scale showing spaces in-between buildings	
Darren Robson, Natalie (?), Scarlet Franklin, (?) Peng	how can we make our urban research models accessible to practitioners?	x	x	x	Are practitioners using research models? Are they better than commercial 'black box' models do suitable data sets exist? Should local authorities be mandated to collect these? How can we make the models useable for practitioners (academics) want from a model? How can we cross multiple scales?	University of Sheffield
Gerald Adams		x	x	x	i think we have enough scientific knowledge to make decisions of different scales on climate. I'm not	

					sure however how these are integrated with other (planning) tools, and other professionals know to do this	
TABLE CHAIR NOTES						
Dorte's		X	Need to consider UHI during the planning and revisit (?) during (?) building regs with a simple approach that does not cover (?) all complexities (?) awareness raise (?) with policymakers and xxx (?)			Atkins
Table 3		x	Tools Chris T - Policymakers do not have time to understand XXX (?) GLA (this are?) what to use xxx (?) Nick G. crowdsourcing is a great opportunity xxx how do GLA engage			
Table 4		x	tools for planning not just look at it in a site by site basis wider master planning of areas in places (?) for urban climates			
Table 5		x	Making existing tools commercially viable/ Making academic staff (competent people) more involved/ Increasing			

			cooperation between planners and consultants/ Demonstrating added value - convert into economics value, not just environmental/ highlight risks			
Table 6		x	Barriers to getting more data? $ tech poss to have 3d wind/ Useful for construction cranes damaged			
Table 7		x	Develop measured protocols communications of results is paramount			
Table 9 (Mark Jenkinson)			make DECC & other data available			Siemens plc
Table 4			legislation behaviour economics (financial incentive) affordability (financial incentive) affordability problem in new buildings role of shutters (external)			
Table 7			change building regulations to reduce energy use			
Table 1 (Dorte's)		x	need policies and mechanisms that are allied xx local authorities that consider the master-plans which enables effective and balance trade-offs of a new tower			Atkins

			block going ahead and surroundings neighbourhood having an impact effectively xxx like the example xxxx of the NY tower ensuring others do not lose daylight			
Table 5 (Y)		x	recirculating and standards need improving being enforced start considering new factors at planning process daylight in the residential sector, albedo levels in city centres, existing building asset improvement/ financial schemes			
Table 3 (Robin)		x	Ai-source heat pumps just heat the environment. How to get planning permission to consider the environment impacts of the neighbourhood. Need to get minimum daylight calls into planning			Cullinan Studio
Table 4		x	more simple tolls transparency stronger planning policy - evidence			
Table 01 (Dorte's)		x	to collect more relevant data and relevant rule of return (?), like Rob Mackenzie work xxx brought to xxx in a good practice guide. To			Atkins

			xxx appxxx Staggs to xxx those like within a local xxx master planning development to demonstrates the economic value of green space will help get			
Table 2 (mark Jenkinson)		x	encourage e-car sharing (inner) London transport is easy to use - unfortunately not the case for other cities, e.g. Bath			Siemens plc
Table 3 (Robin)		x	A vision that active travel is a better use of roads than cars - do we need an App to encourage us Swales and green - no roads/ Get rid of cars like Paris			Cullinan Studio
Table 4		x	Need to plant the right type of trees planning good at protecting existing infrastructure but could be better at creating new space/ planting congestion charge incentives for electric cars			
Table 1 (Dorte's)			need to ensure that all designs are varied out considering H&W with access to open space that provides effective (?) value for local community chich provides more social xxx (?) and xxx (?)			Atkins

Table 2			More light sensors required, properly used how do you codify (sky) light indices such as in schools (offices)? To link productivity			
Table 5			review current regulation			
Table 4			need a level of standard for daylight/ sunlight			
Table 7			research project need to increase understanding and measure European wellbeing centre of environment health increase research on a controlled experiment			

Appendix F: ARCC Meeting: "How are we going to tackle or take it forward" responses chart with factors.

Name (s)	Your Idea	Is it a challenge or a solution?		Detailed Description	Sector	Notes	Factor
		Challange	Solution				
1	Propose a standard for city modelling		x	Plataform consistency/ Data: density, etc/ Interoperability/ Internacional/ Scaleable/ Potencial to combine, cross examine.	ngenuity	STANDARD MODELLING	MODELING/ DATA
2	Staring of Big data	x		Big Data - costs of failed collectins need		USE OF BIG DATA	MODELING/ DATA

		to ensure max use. (?)			
3	Make it simpler for public / Policy Makers	The formula can we link it to health/ liveability etc.?/ Need tools to quantify (e.g., a question from Southwark on old kent rd)? Utilize information from Lee Charman's + other sensors, quality permitting		MAKING POLICY SIMPLER FOR PUBLIC	REGULATIONS
4	x	How do we make existing tools + modelling more accessible to those in practice? Currently, tools are often difficult to access, difficult to use and understand(even if you are committed to using them)? The second issue is justifying time (therefore fees) sent on this to hard-nosed developers (likely to require benefits to be quantified	URBED (Urbanism Environment and Design Ltd)	MAKE MODELLING MORE ACCESSIBLE	MODELING/ DATA
5	Sharing/ Using data from models (?) in everyday decision	x	Having all these models and data are useful and advance our understanding of the urban climate. These have to be translated to useable outputs for planners and building occupants/ How can data from Hi-Temp and urban climate models be used to affect	Atkins	MODELING IN PLANNING	MODELING/ DATA

			everyday policy? Heat map? Planning guidance			
6			Need to disseminate (?) outputs quickly and supply to practice/industry		BETTER DISSEMINATE OUTPUTS	MODELING/ DATA
7	The age of new cars should be electric	x	Reduce pollution/ Create a distributed power network	ingenuity	ELECTRIC CARS	TRANSPORT
8	The variance between daylight and thermal models	x	if there is a variance between daylight and thermal models. What are the implications, and how should we deal with the variance? (how wrong is ok?)		BETTER MODELS	MODELING/ DATA
9			Surface interventions are justified otherwise/ future heat will require AC/ Albedo management or producing shade?/ Standards for daylight?		STANDARD FOR BUILDING FORM	REGULATIONS
10			detailed microclimate (?) pre and post-construction		DETAILED MICROCLIMATE	REGULATIONS
11	Valuing Green Space	x	Being able to put a financial value on green spaces beyond its value for the development	Institute for Environmental Analytics, University of Reading	REAL VALUE OF GREEN	GREEN INFRA
12	Towns Constructed without the requirements of vehicles	x	Can towns be designed to avoid the need to use vehicles for local travel./ all essential amenities within walking/ cycling distance. / Improved public transport.		REDUCTION OF AUTO	TRANSPORT

13	tool (?), guidances, (?) and retrofit of green infra	x	Most of the urban areas are already build, while planning is important, and strategic regional plans are a good starting point. They do not address the fact that most the environment that (?) already exists./ How can greening become mainstream and easy? I think to develop tools and business case would help to address this. these could be used by placemaking in local authorities and by government	London Environment Directors Network	GREEN + PLACEMAKING - ADRESS QUALIFY RETROFIT	GREEN INFRA
14			Two presenters dealt with holistic outcomes (sometimes seemingly perverse) what we need to know is a healthy explanation of what the determinations were!		HEALTHY DATA	HEALTHY
15		x	gemma Jerone @ Gloucester wildlife trust is developing a benchmarketing tool, aimed at developers, which helps to identify and quantify the value of green infra and includes a consideration of whole life costs na ongoing maintenance costs.	URBED (Urbanism Environment and Design Ltd)	GEMMA JERONE GREEN VALUE TOOLS - GLOUCESTER WILDLIFE	GREEN INFRA

16			19th C issues today. Olmsted, Rauch, Cerda, Chadwick, Haussman, sunlight, health, sanitation, green space, today, air, pollution, inactivity, traffic, sprawl = bad greenness = good active transport brilliant! Density has benefits but challenges also. rules of thumb #1 sketch neighbourhood scale showing spaces in-between buildings		SCALE BETWEEN BUILDINGS	URBAN FORM
17	how can we make our urban research models accessible to practitioners?	x	Are practitioners using research models? Are they better than commercial 'black box' models do suitable data sets exist? Should local authorities be mandated to collect these? How can we make the models useable for practitioners (academics) want from a model? How can we cross multiple scales?	University of Sheffield	MODELS + PRACTITIONERS	MODELING/ DATA
18		x	i think we have enough scientific knowledge to make decisions of different scales on climate. I am not sure however how these are integrated with other (planning) tools, and other professionals knows to do this		INTEGRATED KNOWLEDGE WITH PRACTICE	KNOWLEDGE BRIDGE

TABLE

CHAIR NOTESS					
19			Atkins	UHI INTO PLANNING	REGULATIONS
20				USO OF BIG DATA IN PLANNING	REGULATIONS
21				PLANNING SCALE	REGULATIONS
22				BETTER TOOLS / ACADEMIC ENGAGEMENT	KNOWLEDGE BRIDGE
23				MORE DATA, MODEL FOR WIND	MODELING/ DATA
24				MEASURED PROTOCOLS	REGULATIONS
25			Siemens plc	MORE DATA	MODELING/ DATA
26				INCENTIVES	COSTS
27				REGULATIONS TO REDUCE ENERGY USE	REGULATIONS
28			Atkins	RIGHT FOR THE LIGHT/ OTHER BUILDINGS IMPACT IN POLICY	REGULATIONS

29				REGULATIONS AND DAYLIGHT	REGULATIONS
30			Cullinan Studio	PLANNING PERMISSION TAKING THE NEIGHBORHOOD IMPACTS	REGULATIONS
31				STRONGER PLANNING POLICY	REGULATIONS
32			Atkins	PLANNING - DEMONSTRATE ECONOMY VALUE OF GREEN	REGULATIONS
33			Siemens plc	CAR SHARING	TRANSPORT
34			Cullinan Studio	LESS CARS	TRANSPORT
35				PLANNING RIGHT TYPES OF TREES	GREEN INFRA
36			Atkins	VALUE OF GREEN	GREEN INFRA
37				MORE NATURAL LIGHT	URBAN FORM
38				REVIEW REGULATIONS	REGULATIONS
39				STANDARD DAYLIGHT AND SUNLIGHT	REGULATIONS

Appendix G: Web Questionnaire – Questions.

London Urban Climate, influencing factors and policies

* Required

What is your activity? (you can choose more than one) *

- [ ] Academia
- [ ] Public Sector
- [ ] Private Sector

QUESTION 1: Which of the items below do you believe has the most impact on the London Urban Microclimate? (please don't repeat the numbers).

Green Spaces *

	1	2	3	4	5	
most important	○	○	○	○	○	least important

The heat generated from buildings and cars *

	1	2	3	4	5	
most important	○	○	○	○	○	least important

Urban Morphology *

	1	2	3	4	5	
most important	○	○	○	○	○	least important

Urban Density *

	1	2	3	4	5	
most important	○	○	○	○	○	least important

Materials *

	1	2	3	4	5	
most important	○	○	○	○	○	least important

QUESTION 2: What do you think is the most effective way to deal with overheating risks in London?

*

	strongly agree	agree	neutral	disagree	strongly disagree	Do not know
discourage the use of cars	○	○	○	○	○	○
Increase of green areas	○	○	○	○	○	○
Urban Ventilation	○	○	○	○	○	○
Decrease energy consumption	○	○	○	○	○	○
Increase Urban Density	○	○	○	○	○	○
Building Retrofit	○	○	○	○	○	○
Increase Shading Forms	○	○	○	○	○	○
Use of Renewable Energy	○	○	○	○	○	○
User Behaviour	○	○	○	○	○	○

QUESTION 3: Considering the Urban Heat Island as a temperature effect that results in the characteristic warming of an urban area compared to the non-urbanised surroundings, what can we say about the statement below:

"The urban heat island effect helps London to save in energy consumption in heating." *

- ○ True
- ○ False

QUESTION 4: About Urban Climate Governance in London, how do you agree with the statements below:

*

	strongly agree	agree	neutral	disagree	strongly disagree	Do not know
I understand that the Urban Policy that we have today in London is enough for the problems that we face today with climate change.	○	○	○	○	○	○
The policies that we have today are mitigation ones.	○	○	○	○	○	○
The policies that we have today are adaptation ones.	○	○	○	○	○	○
The guidelines found on CIBSE Guide (A) 2015 for buildings are satisfactory when it comes to delivering a climate-responsive development	○	○	○	○	○	○
The guidelines found on CIBSE Guide (A) 2015 for urban spaces are satisfactory when it comes to delivering a climate-responsive development	○	○	○	○	○	○
I understand the London environmental legislation as obligations.	○	○	○	○	○	○
I understand the London environmental legislation as a suggestion	○	○	○	○	○	○

QUESTION 5: What are the barriers for microclimate policies improvement in London? (please don't repeat the numbers).

Collaboration between Public, Private and Academia *

	1	2	3	4	5	6	7	
most important	○	○	○	○	○	○	○	least important

London population don't see this as a Government Priority *

	1	2	3	4	5	6	7	
most important	○	○	○	○	○	○	○	least important

Private Sectors lobby *

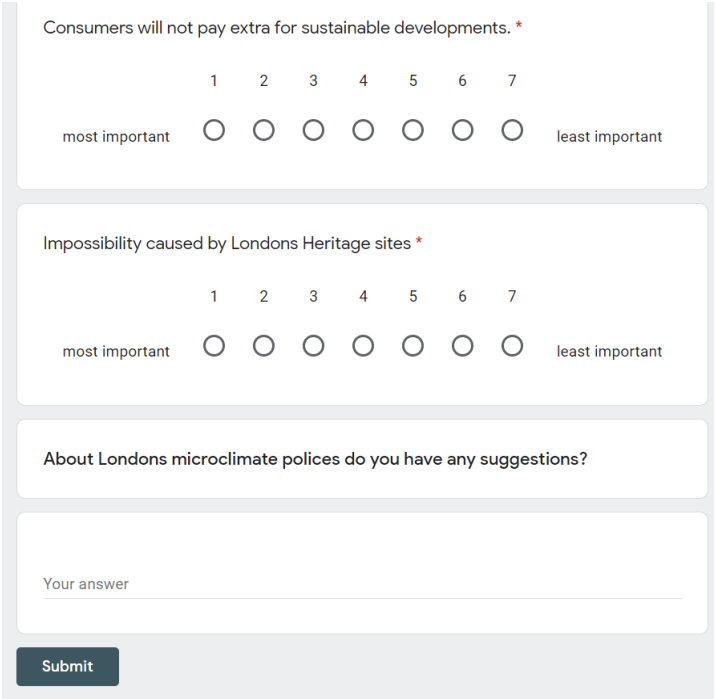
	1	2	3	4	5	6	7	
most important	○	○	○	○	○	○	○	least important

High costs for adaptation *

	1	2	3	4	5	6	7	
most important	○	○	○	○	○	○	○	least important

Lack of tax incentives *

	1	2	3	4	5	6	7	
most important	○	○	○	○	○	○	○	least important



Appendix H: Web Questionnaire – Answers.

Timestamp	What is your activity? (you can choose more than one)	Green Spaces	The heat generated from buildings and cars	Urban Morphology	Urban Density	Materials
7/8/2020 14:21:43	Public Sector	4	4	3	4	2
7/8/2020 14:25:43	Public Sector	4	3	5	2	1
7/8/2020 14:39:49	Public Sector	5	4	4	4	4
7/8/2020 14:43:55	Academia	3	2	5	1	4
7/8/2020 18:08:51	Academia, Public Sector, Private Sector	1	1	3	4	5
7/8/2020 19:33:26	Academia, Public Sector, Private Sector	1	2	2	3	1
7/9/2020 15:18:04	Private Sector	2	1	4	3	5
7/9/2020 15:50:32	Academia	5	1	3	4	2
7/9/2020 17:23:48	Academia	1	2	2	2	3
7/10/2020 12:28:56	Academia, Private Sector	4	5	1	2	3
7/10/2020 14:30:45	Public Sector	5	3	1	2	4
7/10/2020 17:29:52	Private Sector	5	3	4	3	2
7/17/2020 11:59:32	Private Sector	4	5	3	4	4
7/17/2020 22:35:07	Academia, Private Sector	4	1	5	3	2

Timestamp	What is your activity? (you can choose more than one)	[Increase of green areas]	[Urban Ventilation]	[Decrease energy consumption]	[Increase Urban Density]	[Building Retrofit]	[Increase Shading Forms]	[Use of Renewable Energy]	[User Behaviour]
7/8/2020 14:21:43	Public Sector	strongly disagree	agree	agree	neutral	agree	agree	agree	agree
7/8/2020 14:25:43	Public Sector	strongly agree	Do not know	strongly agree	disagree	strongly agree	strongly agree	strongly agree	agree
7/8/2020 14:39:49	Public Sector	strongly agree	agree	strongly agree	agree	strongly agree	strongly agree	strongly agree	strongly agree
7/8/2020 14:43:55	Academia	strongly agree	strongly agree	neutral	disagree	disagree	strongly agree	disagree	agree
7/8/2020 18:08:51	Academia, Public Sector, Private Sector	agree	agree	agree	agree	agree	agree	agree	agree
7/8/2020 19:33:26	Academia, Public Sector, Private Sector	strongly agree	strongly agree	strongly agree	neutral	strongly agree	strongly agree	strongly agree	strongly agree
7/9/2020 15:18:04	Private Sector	strongly agree	neutral	strongly agree	agree	agree	agree	neutral	agree
7/9/2020 15:50:32	Academia	neutral	neutral	strongly agree	neutral	strongly agree	agree	neutral	strongly agree
7/9/2020 17:23:48	Academia	agree	agree	strongly agree	disagree	neutral	neutral	agree	agree
7/10/2020 12:28:56	Academia, Private Sector	agree	agree	agree	neutral	agree	agree	agree	strongly agree
7/10/2020 14:30:45	Public Sector	agree	agree	strongly agree	disagree	agree	agree	strongly agree	agree
7/10/2020 17:29:52	Private Sector	strongly agree	neutral	strongly agree	neutral	agree	strongly agree	neutral	neutral
7/17/2020 11:59:32	Private Sector	strongly agree	agree	strongly agree	neutral	neutral	agree	neutral	agree
7/17/2020 22:35:07	Academia, Private Sector	agree	agree	strongly agree	strongly agree	strongly agree	agree	strongly agree	strongly agree

Timestamp	What is your activity? (you can choose more than one)	"The urban heat island effect helps London to save in energy consumption in heating."
7/8/2020 14:21:43	Public Sector	FALSO
7/8/2020 14:25:43	Public Sector	FALSO
7/8/2020 14:39:49	Public Sector	FALSO

7/8/2020 14:43:55	Academia	FALSO
7/8/2020 18:08:51	Academia, Public Sector, Private Sector	FALSO
7/8/2020 19:33:26	Academia, Public Sector, Private Sector	VERDADEIRO
7/9/2020 15:18:04	Private Sector	FALSO
7/9/2020 15:50:32	Academia	VERDADEIRO
7/9/2020 17:23:48	Academia	FALSO
7/10/2020 12:28:56	Academia, Private Sector	VERDADEIRO
7/10/2020 14:30:45	Public Sector	FALSO
7/10/2020 17:29:52	Private Sector	FALSO
7/17/2020 11:59:32	Private Sector	VERDADEIRO
7/17/2020 22:35:07	Academia, Private Sector	VERDADEIRO

Timestamp	What is your activity? (you can choose more than one)	Collaboration between Public, Private and Academia	London population don't see this as a Government Priority	Private Sectors lobby	High costs for adaptation	Lack of tax incentives	Consumers will not pay extra for sustainable developments.	Impossibility caused by Londons Heritage sites
7/8/2020 14:21:43	Public Sector	4	4	6	5	4	5	4
7/8/2020 14:25:43	Public Sector	4	6	4	5	7	6	1
7/8/2020 14:39:49	Public Sector	6	5	6	6	6	4	4
7/8/2020 14:43:55	Academia	5	1	3	6	2	4	7
7/8/2020 18:08:51	Academia, Public Sector, Private Sector	7	4	3	5	1	6	7
7/8/2020 19:33:26	Academia, Public Sector, Private Sector	5	4	1	6	2	3	7
7/9/2020 15:18:04	Private Sector	6	2	3	4	5	1	7
7/9/2020 15:50:32	Academia	7	2	1	3	4	6	5
7/9/2020 17:23:48	Academia	6	4	2	3	3	2	4
7/10/2020 12:28:56	Academia, Private Sector	3	5	2	5	1	4	7
7/10/2020 14:30:45	Public Sector	1	6	2	3	4	5	7
7/10/2020 17:29:52	Private Sector	4	5	6	1	2	3	7
7/17/2020 11:59:32	Private Sector	4	4	4	4	2	2	5
7/17/2020 22:35:07	Academia, Private Sector	1	4	3	1	3	2	7

Timestamp	What is your activity? (you can choose more than one)	[I understand that the Urban Policy that we have today in London is enough for the problems that we face today with climate change.]	[The policies that we have today are mitigation ones.]	[The policies that we have today are adaptation ones.]	[The guidelines found on CIBSE Guide (A) 2015 for buildings are satisfactory when it comes to delivering a climate-responsive development]	[The guidelines found on CIBSE Guide (A) 2015 for urban spaces are satisfactory when it comes to delivering a climate-responsive development]	[I understand the London environmental legislation as obligations.]	[I understand the London environmental legislation as a suggestion]
7/8/2020 14:21:43	Public Sector	disagree	agree	agree	Do not know	Do not know	agree	disagree
7/8/2020 14:25:43	Public Sector	strongly disagree	neutral	neutral	Do not know	Do not know	strongly disagree	Do not know
7/8/2020 14:39:49	Public Sector	strongly disagree	agree	agree	neutral	neutral	strongly disagree	strongly disagree
7/8/2020 14:43:55	Academia	strongly disagree	agree	disagree	strongly disagree	strongly disagree	agree	disagree
7/8/2020 18:08:51	Academia, Public Sector, Private Sector	disagree	agree	agree	Do not know	Do not know	Do not know	Do not know
7/8/2020 19:33:26	Academia, Public Sector, Private Sector	strongly disagree	Do not know	Do not know	Do not know	Do not know	Do not know	Do not know
7/9/2020 15:18:04	Private Sector	strongly disagree	agree	neutral	strongly disagree	strongly disagree	neutral	agree
7/9/2020 15:50:32	Academia	strongly disagree	disagree	disagree	disagree	disagree	agree	neutral
7/9/2020 17:23:48	Academia	neutral	neutral	neutral	neutral	disagree	neutral	neutral
7/10/2020 12:28:56	Academia, Private Sector	disagree	agree	agree	disagree	neutral	neutral	neutral
7/10/2020 14:30:45	Public Sector	disagree	agree	neutral	neutral	neutral	neutral	neutral
7/10/2020 17:29:52	Private Sector	neutral	agree	neutral	neutral	neutral	neutral	neutral
7/17/2020 11:59:32	Private Sector	Do not know	Do not know	Do not know	Do not know	Do not know	Do not know	Do not know
7/17/2020 22:35:07	Academia, Private Sector	neutral	strongly agree	agree	Do not know	Do not know	agree	disagree

Timestamp	What is your activity? (you can choose more than one)	Suggestion
7/8/2020 14:21:43	Public Sector	
7/8/2020 14:25:43	Public Sector	
7/8/2020 14:39:49	Public Sector	Through the planning process press importance of the use of the Urban Greening Factor for all new developments; use of SUDS; applying the Cooling Hierarchy as set out in the Draft New London Plan; and, need to raise more investment for retrofitting existing homes. Covid-19 has exposed those that are vulnerable, how important it is to engage the public and the positive impacts that behaviour change can have.
7/8/2020 14:43:55	Academia	
7/8/2020 18:08:51	Academia, Public Sector, Private Sector	lack of knowledge
7/8/2020 19:33:26	Academia, Public Sector, Private Sector	
7/9/2020 15:18:04	Private Sector	Electric cars + walking = quieter street + lot more trees = natural vent opening windows + transpiration cooling = no AC + low energy buildings + low energy cars = less heat emitted = reduced UHI temperatures = temperature headroom for climate change. All these policies need quantifying and joining together
7/9/2020 15:50:32	Academia	
7/9/2020 17:23:48	Academia	
7/10/2020 12:28:56	Academia, Private	

	Sector	
7/10/2020 14:30:45	Public Sector	
7/10/2020 17:29:52	Private Sector	Tbh - I don't know them v well at all. These questions were good.
7/17/2020 11:59:32	Private Sector	
7/17/2020 22:35:07	Academia, Private Sector	