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# Moving Towards Climate Change Resilience

## Indicators for The University of Manchester

Jeremy Carter, Angela Connelly, Andrew Snow and SM Labib

THE UNIVERSITY OF MANCHESTER

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# 1 Introduction

The University of Manchester's Living Campus Plan was published in 2017 as an element of the environmental sustainability strategy. It aims, 'specifically to address the challenges of a growing urban campus alongside the opportunities a healthy environment provides for people and nature.' (UoM, 2017, p. 3). A range of related initiatives are promoted within the plan, such as increasing the amount of green space across the university, and establishing a network of Living Campus champions.

As well as ensuring that the University of Manchester campus works with the natural environment and delivers health and well-being benefits to students, staff and visitors, strengthening the resilience of the campus to climate change and associated extreme weather events is also important. Ensuring that the campus is resilient to related risks, through implementing a range of structural and non-structural interventions, becomes ever more important. The campus contains buildings and infrastructure that have a long lifespan, with ongoing new developments adding buildings that will be standing for decades and will therefore experience a change climate. As a result, adapting and building resilience to climate change is not a topic for future planners and decision makers who will come to work at the University of Manchester. It is a pressing issue that demands attention in the present day.

To support activity targeted at adapting and building the resilience of the University of Manchester estate to extreme weather and climate change, it is necessary to develop indicators that can monitor progress made towards the achievement of this goal. This report outlines a series of indicators that can be used by the University for this purpose. It builds on a previous study of the University of Manchester's extreme weather and climate change impacts, risk and adaptation responses (Carter and Connelly 2015).

## 1.1 Climate change adaptation and resilience

Globally, recent reports from the Intergovernmental Panel on Climate Change (IPCC) emphasise both the severity of future climate change projections, and also the rapid socio-economic changes needed in order to have a chance of avoiding some of the most negative impacts associated with the changing climate. The focus of contemporary climate change debates is on the reduction of greenhouse gas emissions that are driving changes in weather and climate, and also actions that can be taken to adapt and build resilience to these changes. The focus of this report and the one that preceded it (Carter and Connelly 2015) is on adaptation and resilience. Climate change projections highlight the potential for significant shifts in Manchester's climate. In addition to gradual increases in temperature and shift in rainfall patterns, climate change projections indicate the threat of an increase in the frequency and intensity of extreme weather events such as floods and heatwaves for the city (Cavan 2011). Details of Manchester's climate change projections, risks associated with these changes to the University of Manchester estate and potential responses to adapt

and build resilience to these are outlined in an associated report (Carter and Connelly 2015). This report found that the key risk comes from flooding; whilst heat stress, currently a low risk, may increase in the future (Carter and Connelly 2015).

### *1.1.1 Policy framework*

Over recent years, the attention paid to climate change adaptation and resilience has grown as experience of extreme weather events has increased, the science underlying climate change has narrowed the window for a meaningful response and the public has cycled back into a period of heightened climate change awareness. Nationally, adaptation and resilience objectives are fed down via the Climate Change Act (2008) with its overarching aim of "dynamic and adaptive approaches to building resilience to climate change" to DEFRA's (2018) 'National Adaptation Programme'. This builds on the 5-yearly Climate Change Risk Assessment (CCRA), undertaken by the Committee on Climate Change and the Adaptation Sub-Committee, most recently updated in 2017. The CCRA 2017 found that 'flooding and coastal change risks to communities, businesses and infrastructure' and 'risks to health, wellbeing and productivity from high temperatures' were the top two areas of inter-related climate change risks where more action is needed and where the risk magnitude is high. Not only does this align with the risks facing Manchester and the principal themes of the existing climate change impact, risk and adaptation report (Carter and Connelly 2015), but also indicates that adaptation actions to increase the university's resilience to these risks can help to meet national objectives.

In respect of broader environmental targets, DEFRA's (2018) recently published 25-year environment plan 'A Green Future: Our 25 Year Plan to Improve the Environment' sets out a series of goals and attendant measures to achieve them. **Table 1** sets out those goals and measures which are relevant to climate change and the risks posed to Manchester and the University of Manchester.

| Goal/target | Measures |
|---|---|
| Reducing the risks of harm from environmental hazards | • making sure that decisions on land use, including development, reflect the level of current and future flood risk<br>• boosting the long-term resilience of our homes, businesses and infrastructure |
| Enhancing beauty, heritage and engagement with the natural environment | • making sure that there are high quality, accessible, natural spaces close to where people live and work, particularly in urban areas, and encouraging more people to spend time in them to benefit their health and wellbeing |
| Mitigating and adapting to climate change | • making sure that all policies, programmes and investment decisions take into account the possible extent of climate change this century |

***Table 1: UK Government's 25 Year Environment Plan – Manchester and University of Manchester applicable targets***

Greater Manchester (GM) and the city of Manchester both have strategies in place that recognise the risks associated with extreme weather and climate change and encourage the development of responses to adapt and become more resilient to these risks. At the GM level, the Greater Manchester Combined Authority (GMCA) has established adaptation measures as part of its Climate Change and Low Emission Strategies. Relevant actions to the climate risks posed to The University of Manchester campus include:

- A8: Strengthen the resilience of building stock to a changing climate via developing guidance and pilots.
- A9: Integrate responses to extreme weather into key public building management systems and staff communications.

The 5-Year Environment Plan for Greater Manchester also includes a climate change adaptation and resilience theme, and identifies four priorities to progress over the period 2019-2024. These are (GMCA 2019):

1. Embedding climate change resilience and adaptation into all policies
2. Increasing the resilience of and investment in our critical infrastructure
3. Implementing a prioritised programme of nature-based climate change adaptation
4. Improving monitoring and reporting

The programme of activities linked to addressing these priorities connect to ongoing initiatives linked to adapting and building the resilience of the university to extreme weather and climate change. Priority 4 links directly to this report, and notes that:

> *"Monitoring and evaluation is critical, so that we can identify how best to reduce vulnerability and build resilience to climate change. This is complex, so clear indicators need to be developed to understand how Greater Manchester is prepared for future impacts and that this can be monitored over the long term." (GMCA 2019: 78).*

The city of Manchester also has a climate change strategy and implementation plan, which includes a theme on resilience to climate change, which identifies the following objective:

> *"The city's communities, public sector, businesses and third sector will become increasingly resilient to the changing climate" (Manchester Climate Change Agency 2016).*

Manchester's climate change strategy is 'owned' by the city's citizens and organisations, all of whom will need to be mobilise in order to meet its objectives. The successful implementation of the strategy is dependent on collective action. In addition, Manchester City Council adopted the Manchester Climate Change Agency's (MCCA) science-based targets for carbon reduction in 2018. As part of the "Playing Our Full Part" report produced by the MCCA, its technical appendices advising businesses and individuals on the benefits of taking action to reduce carbon emissions contains an 'action required' in the 'natural

capital' sector of 'tree planting and peatland restoration'. For Manchester's carbon reduction targets to be met, 3m trees need to be planted by 2030 and 5m by 2050. While not explicitly included for the purposes of adaptation within this action plan, this form of natural capital has obvious resilience co-benefits particularly in relation to the university's key overarching risks of increased flooding and rising temperatures. The Oxford Road corridor has also been identified in the Manchester Green and Blue Strategy as possessing opportunities for 'biodiverse planting and management'.

The University of Manchester has a clear responsibility to adapt and build resilience to the changing climate. This is driven by a strong framework of climate science, a series of evolving policy drivers, and also because a lack of response could negatively impact on the achievement of the university's own strategic objectives. This report is intended to support the University of Manchester in moving towards becoming better adapted and more resilient to climate change and associated extreme weather events, and in doing so contributing to realisation of related national and GM policy goals.

### *1.1.2 Developing climate adaptation and resilience indicators*

The central focus of this report is on identifying, describing and providing a baseline for appropriate indicators to provide a framework to monitor The University of Manchester's progress towards becoming better adapted and more resilient to climate change. This report and the indicators that it contains underpin the university's Living Campus Plan, and also helps to develop understanding of the actions and approaches that can support a robust response to climate change impacts and risks. The Living Campus Plan includes several indicators, such as increasing the number of trees and green roofs. However, further understanding is needed on additional indicators that may support climate change adaptation and resilience and, allied to this, the identification of a current baseline from which progress can be tracked.

The climate and socio-economic future facing The University of Manchester is uncertain. Whilst there are some known risks, the remaining level of uncertainty means that a range of possible future scenarios exist, all of which The University of Manchester system has to have the potential to adapt to and build resilience towards. As the university faces a dynamic and evolving future, it is clear that being well adapted and resilient to climate change is not an endpoint. Instead, it is more appropriate to view this as a process of strengthening the capacity of the university and its estate to adapt and become more resilient to climate change. In order to operationalise this approach as a series of indicators, different capacity types can be identified which relate to the university's ability to anticipate, absorb, adapt, and transform in response to climate-related risks and impacts. These indicators can be understood as performance measures that enable progress to be monitored and evaluated as the university system evolves and responds to climate change and multiple other socio-economic drivers of change that influence its form and function. It is important to acknowledge that indicators should not be viewed in isolation, and progress across each

capacity type is ultimately needed in order to build a robust response to the changing climate.

**Table 2** outlines a series of indicators that connect to the four capacity types that collectively provide a foundation for adapting and becoming more resilient to climate change. This capacity-based framework helps to structure and build understanding of the indicators. In addition to organising the indicators according to the capacity type that they connect to, it is also apparent that they can be further divided into those that relate to land cover and those that concern issues of policy and governance. Again, progress across both themes is needed in order to strengthen capacity to respond to climate change impacts and risks.

| Capacity | Attributes | UoM Indicator |
|---|---|---|
| Anticipatory | The ability to plan and prepare for climatic change | • Coverage of climate change adaptation and resilience within key UoM policies and plans<br>• Number of stakeholders engaged with in relation to climate change adaptation and resilience<br>• Adequate level of insurance cover for extreme weather events<br>• Change in land surface temperature |
| Absorptive | The extent to which a system can absorb shocks and maintain stability and function during and immediately after their occurrence | • Soil type underneath open areas<br>• Accessibility to cooling spaces<br>• Proportion of green and grey surface |
| Adaptive | The extent to which the system is able to make incremental adjustments to altered conditions | • Coverage of climate change adaptation and resilience within key UoM policies and plans<br>• Number of stakeholders engaged with in relation to climate change adaptation and resilience |
| Transformative | The ability to make radical changes in a system's organisation and/or function where climate-related impacts demand it | • Number of adaptation and resilience related community projects |

***Table 2: Capacity types (based on DFID (2016), FSIN (2014), IPCC (2012), BRACED (2015))***

# 2 Land cover indicators

## 2.1 LCI1: Proportion of green and grey surface.

**Domain**

Absorb

**Overview**

This indicator is established to monitor the proportion of green and grey surface across the campus. Monitoring the campus green to grey ratio will support understanding of how land use on the campus is changing. This change will have implications on variables such as land surface temperature, which is captured as an indicator within this report (LCI2**: Land surface temperature**). To move toward a better adapted and resilient University campus, the proportion of green surface should be as high as possible due to the role that green spaces and specific types of green infrastructure (e.g. green roofs) play in absorbing rainfall and moderating temperatures. Green spaces and green infrastructure offer a wide range of additional benefits, from air quality improvements to enhancing health and wellbeing. This indicator can help to inform building and open space design, and the targeting of measures to adapt and become more resilient to climate change, such as creating green walls or green roofs.

**Current Situation**

The analysis of satellite images enables the location of green and grey areas within the campus boundary to be identified, and changes in green and grey areas to be assessed between 2015 and 2018. As part of this analytical approach Built-Up index (BUI) is applied, on Sentinel-2 and Landsat images (for 2015). Further details of the methodology are provided in the monitoring section below. After identifying the Green and Grey areas from BUI maps, further calculations have been applied to estimate the amount of green and grey areas in the three campus areas (Victoria Park, Owens Park and the South Campus). The overall result of this analysis is presented in **Table 3**.

**Table 3** highlights that aside from the South Campus, the other areas have green-grey ratio more than value of 1. This implies that both the Victoria Park and Owens Park have more green than grey surface, whereas the South Campus has more grey than green surface area. The average green-to-grey ratio for the South Campus over the last four years is around 0.4, where the average ratio for Victoria Park is 3.19, and 1.73 for Owens Park.

| Campus Area | Attribute | Year 2015 | Year 2016 | Year 2017 | Year 2018 |
|---|---|---|---|---|---|
| **South Campus** | Green (sqkm*) | 0.187 | 0.147 | 0.120 | 0.129 |
| | Grey (sqkm) | 0.327 | 0.366 | 0.393 | 0.384 |
| | Total Area (sqkm) | 0.51 | 0.51 | 0.51 | 0.51 |
| | **green/grey ratio** | **0.572** | **0.402** | **0.305** | **0.336** |
| | **Green %** | **36.452** | **28.655** | **23.392** | **25.146** |
| **Victoria Park Campus** | Green (sqkm) | 0.077 | 0.077 | 0.067 | 0.077 |
| | Grey (sqkm) | 0.022 | 0.021 | 0.031 | 0.022 |
| | Total Area (sqkm) | 0.098 | 0.098 | 0.098 | 0.098 |
| | **green/grey ratio** | **3.542** | **3.612** | **2.153** | **3.466** |
| | **Green %** | **78.061** | **78.878** | **68.776** | **78.163** |
| **Owens Park Campus** | Green (sqkm) | 0.203 | 0.177 | 0.183 | 0.171 |
| | Grey (sqkm) | 0.091 | 0.113 | 0.107 | 0.120 |
| | Total Area (sqkm) | 0.29 | 0.29 | 0.29 | 0.29 |
| | **green/grey ratio** | **2.228** | **1.574** | **1.706** | **1.426** |
| | **Green %** | **69.828** | **61.172** | **63.069** | **58.793** |

***Table 3: Green and Grey surface area for each campus area from 2015 to 2018 (*sqkm = Square kilometers)***

The percentage of green cover is also estimated for the three campus areas over the study period. For the South Campus, the trend is for a falling percentage of green cover for the period 2015-2017, although there is a slight increase in the percentage of green cover observed for 2018. For Victoria Park the average green cover is 75.9%, however this figure fell in 2017 compared to other years. For Owens Park, on an average 63.2% of the total surface area is green cover, although this figure fell for 2018 to 58.79%.

Detailed maps of green and grey areas for the three campus areas are provided (**Figure 1** - **Figure *6***). In addition to mapping green and grey areas, the changes in green and grey areas between 2016-2017, 2017-2018 and 2016-2018 have been identified and mapped for all three campuses. These changes are around 70-80% accurate in terms of their location. Several caveats need to be considered before interpreting these maps, which are discussed in the following section.

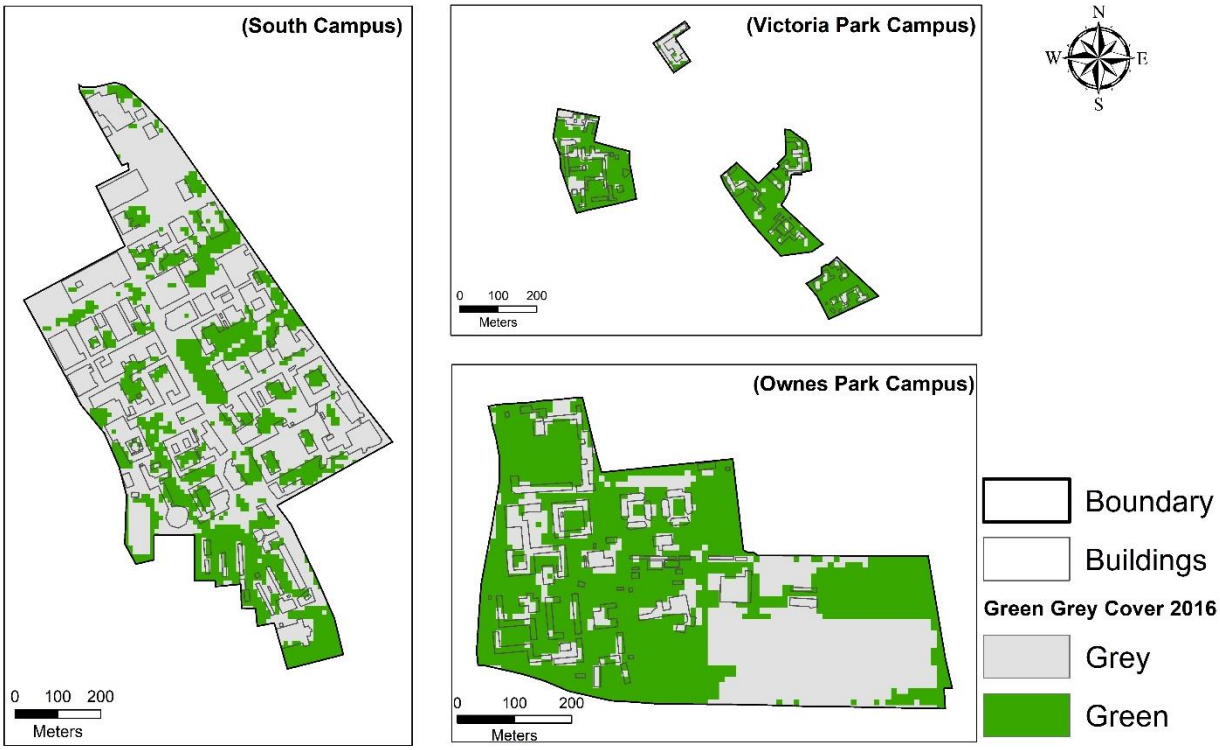



***Figure 1: Green and grey areas for three campuses in 2016.***

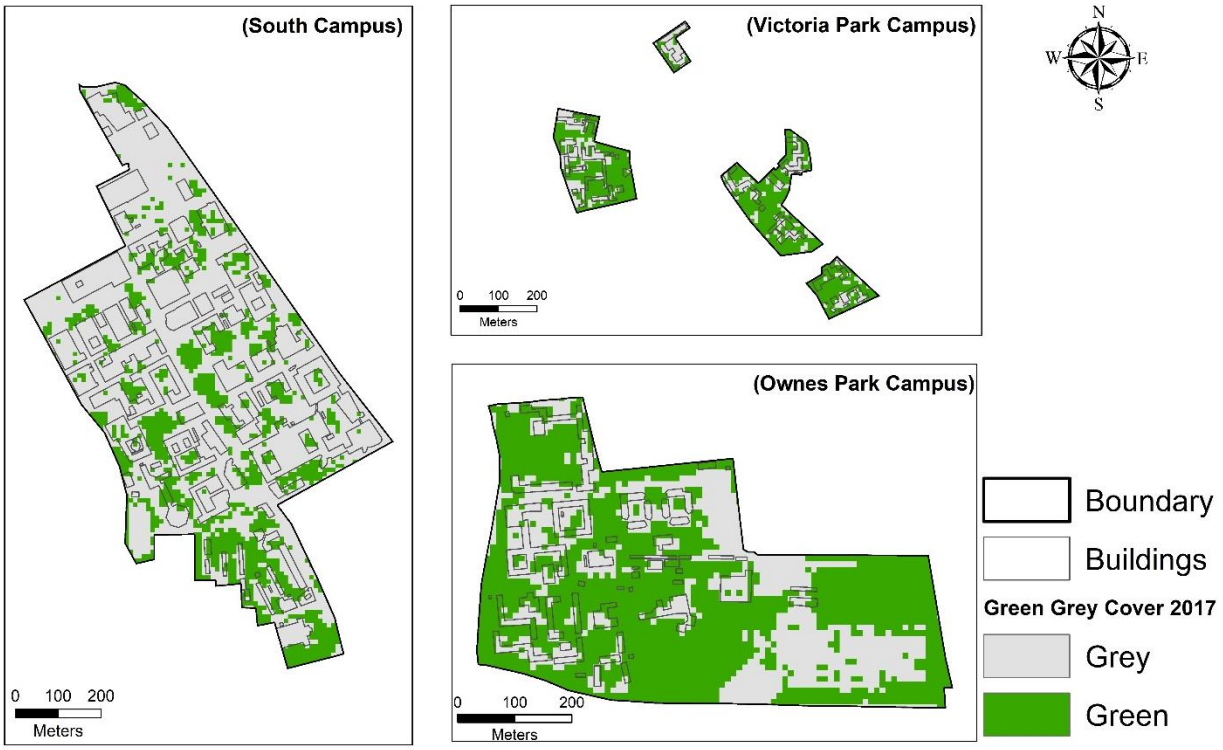



***Figure 2: Green and grey areas for three campuses in 2017.***

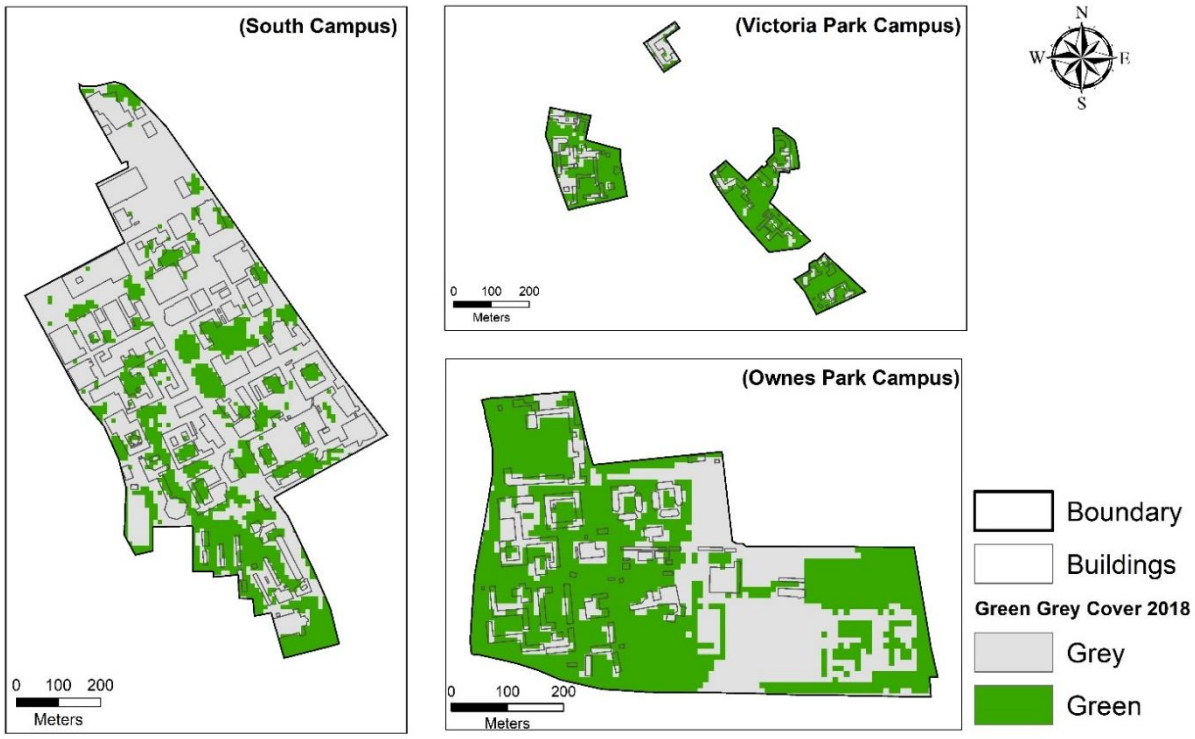



***Figure 3: Green and grey areas for three campuses in 2018.***

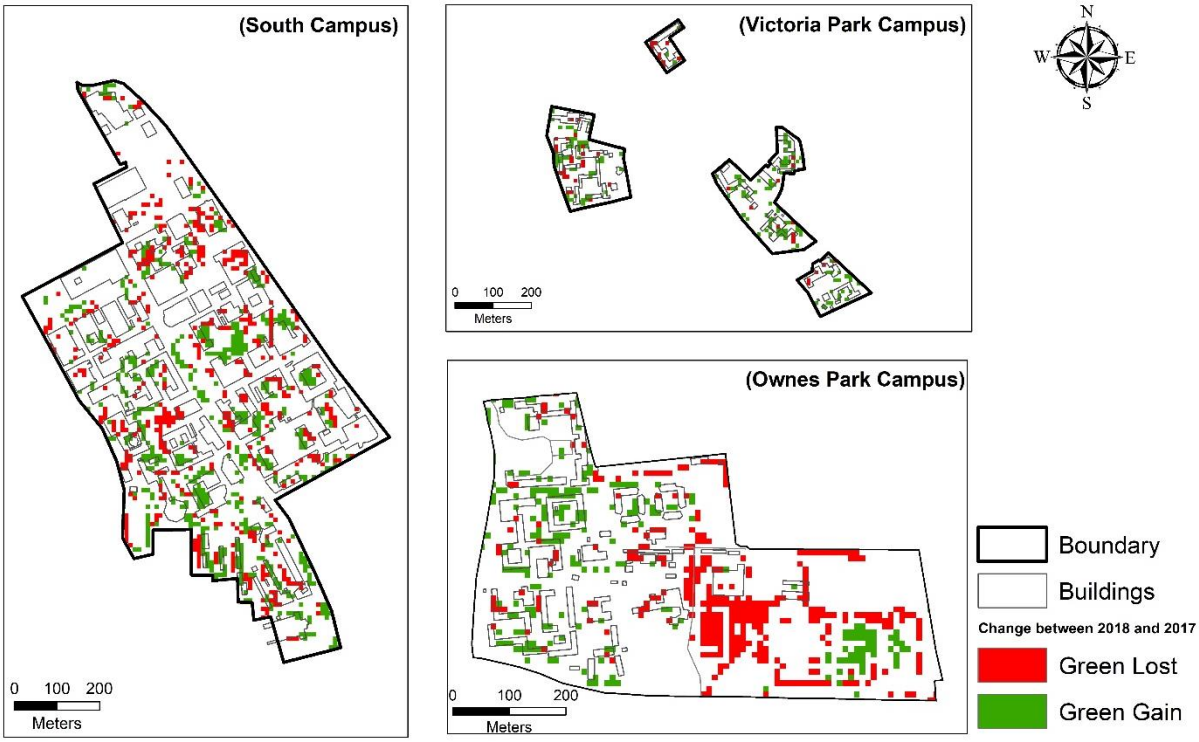



***Figure 4: Green and grey lost or gain for three campuses 2017-2018.***

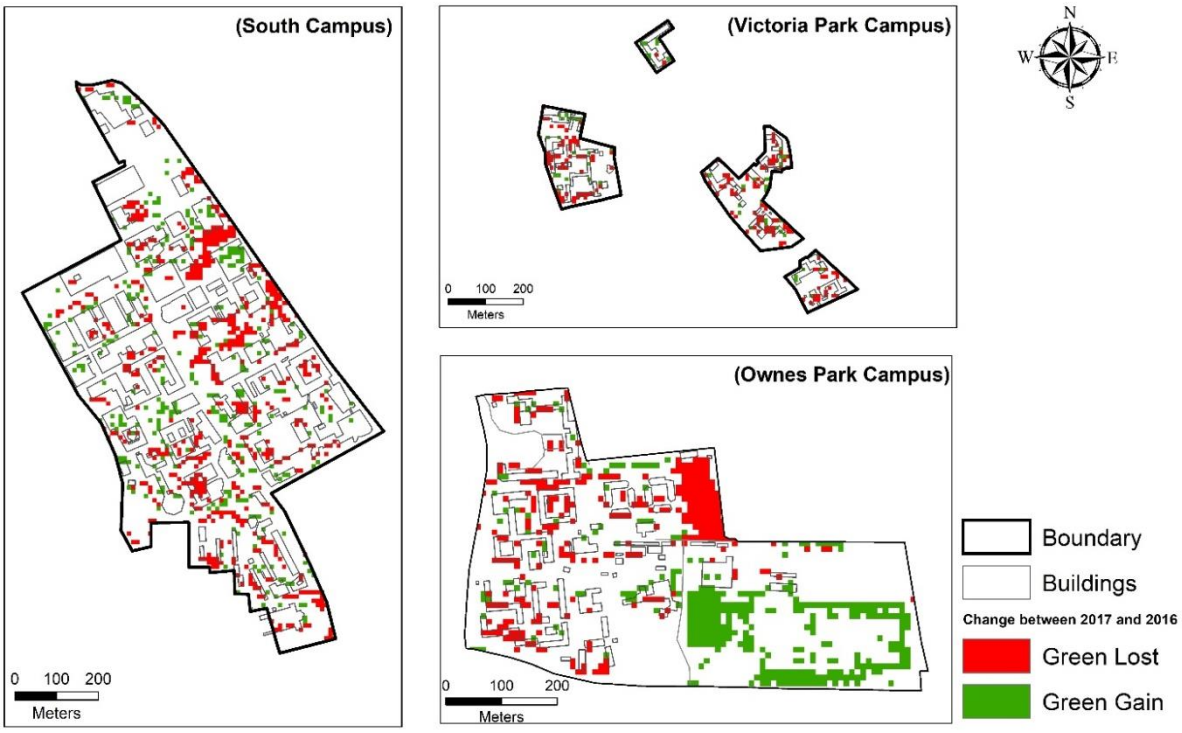



***Figure 5: Green and grey lost or gain for three campuses 2016-2017.***

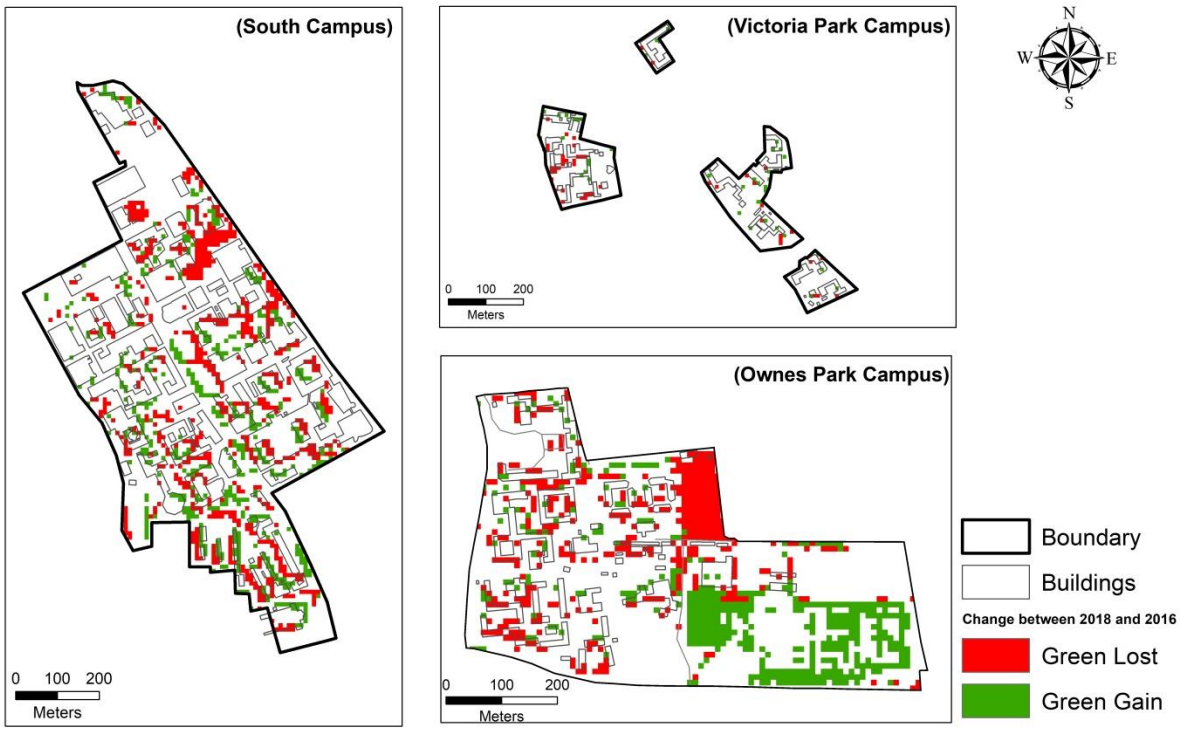



***Figure 6: Green and grey lost or gain for three campuses 2016-2018.***

**Caveats**

Before interpreting these maps of change in grey and green cover across the University of Manchester campus areas, several caveats need to be raised.

- Whilst the Sentinel-2 satellite images (which are freely available and were used for this analysis) are quite robust, analysis of land cover using this data (i.e. whether it is grey or green) has an overall accuracy of around 80-85% in urban areas. The land cover maps produced to support this indicator have a 10 metres spatial resolution, and therefore some land cover may be miss-classified, for example some green areas may appear on top of buildings.
- There are temporal differences regarding the acquisition of the data with some images collected in June, and some in July. Minor changes may have been observed due to temporal differences, for example some vegetation may not have been widely visible in June, compared to July.
- For 2015, cloud free sentinel-2 data was unavailable. Green and grey areas were therefore extracted from another satellite image (Landsat-8), which has a spatial resolution of 30 metres, therefore for 2015 additional miss-classification errors may have occurred in the analysis.

In order to be able to create more accurate maps in the future, very high-resolution images (e.g. 0.4 m resolution, Worldview-2 images) would need to be purchased from commercial providers (e.g. Digitalglobe, Airbus).

**Indicator interpretation**

This analysis provides an overview of the location of green and grey areas across the three University of Manchester campus areas and presents the green to grey cover ratio of these sites. In addition, an indication of the extent of change from grey to green, and green to grey, is also presented. Although there are caveats associated with this analysis that need to be acknowledged, the changes in the green to grey ratio and spatial patterns of grey and green coverage are nevertheless indicative of land cover change that has taken place over recent years. There has been a clear decline in the green to grey ratio, and corresponding reduction in the percentage of green cover, across the South Campus over recent years. Given that green cover and green infrastructure has an important role to play in adapting and building resilience to climate change, this finding is significant. It emphasizes the importance of protecting existing green spaces on the South Campus and taking opportunities to enhance green cover and incorporate green infrastructure (such as green roofs and street trees) where these are presented.

Two other indicators are closely connected to this indicator on the proportion of green and grey surface. These are the land surface temperature and accessibility to cooling spaces indicators. Land surface temperature is related to land use. Areas where the proportion of green cover is relatively low are more likely to be associated with higher surface

temperature values. These are also areas where there is lower accessibility to cooling spaces from buildings close by. Consequently, these are areas were investment in green infrastructure would be of higher relative priority, compared to other areas across the campus, in order to help moderate surface temperatures during periods of hot weather and also to increase accessibility to cooling spaces. These indicators can be used to build a case for investment in green infrastructure in targeted locations, for example when new developments are proposed or when building retrofit or open space redesign is proposed.

**Monitoring Requirements**

Future monitoring of this indicator requires the collection and analysis of satellite images to estimate total amount of green and grey areas across the University of Manchester campuses. To estimate the proportion of green and grey area for each campus, a satellite image-based index is applied (which was used in the original analysis of this indicator). The Built-Up index (BUI) was chosen, which is calculated from the normalized difference vegetation index (NDVI), and normalized difference built-up index (NDBI). The formula to estimate BUI is:

- BUI = NDBI- NDVI

The BUI index value ranges between -2 to +2, where higher value indicates more Built-up areas. A threshold value is used to categories green and grey areas. In this case Sentinel-2 images (with a 10m spatial resolution) have been utilized for this satellite derived BUI, and any value below -0.25 is classified as vegetation (green), and any value above that threshold is classified as built-up area (grey). The methodology is around 80-85% accurate in identifying green and grey areas. For future monitoring of this indicator applying this methodology, basic remote sensing skills will be required to estimate the proportion of green to grey surface cover. For future calculations of the NDBI and NDVI, which are captured and mapped using Google Earth Engine, code is provided as an Appendix.

## 2.2 LCI2: Land surface temperature

**Domain**

Anticipate

**Overview**

This indicator monitors the overall surface temperature over the University campus. This indicator is vital to understanding the dynamics of surface temperature due to changing climatic and weather conditions. It is one of the key indicators that can be used to understand the impact of heat waves and extended periods of overheating during the summer months. This indicator provides several spatially explicit heat maps of the campus areas and identifies trends in changes in temperature over recent years. These maps can

support the targeting of adaptation measures aimed at moderating impacts associated with high temperatures and heat waves.

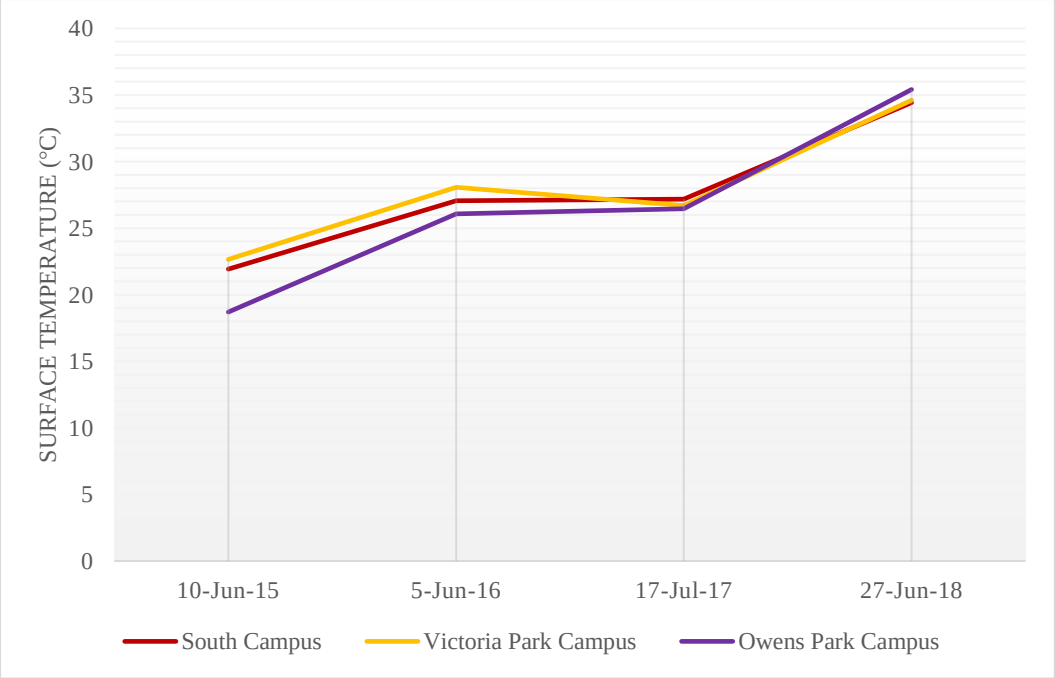
**Current Situation**

Based on satellite image analysis, Lands Surface temperature (LST) maps were produced for all three campus areas for the period 2015-2018. Satellite images of summer the days with the clearest sky condition. Based on these maps, trends in changes in LST were identified for all each campus area. The results of LST analysis for these years are summarised in **Table 4** and **Graph 1**.

| Campus Area | LST Measure | 10-Jun-15 | 5-Jun-16 | 17-Jul-17 | 27-Jun-18 |
|---|---|---|---|---|---|
| South Campus | **Average** | 21.922 | 27.055 | 27.1808 | 34.425 |
| | **Min** | 17.862 | 16.671 | 22.321 | 29.596 |
| | **Max** | 25.031 | 33.827 | 29.603 | 37.236 |
| Victoria Park Campus | **Average** | 22.654 | 28.057 | 26.698 | 34.604 |
| | **Min** | 20.527 | 26.237 | 24.593 | 32.612 |
| | **Max** | 24.984 | 30.339 | 28.899 | 36.275 |
| Owens Park Campus | **Average** | 18.699 | 26.071 | 26.459 | 35.4101 |
| | **Min** | 12.462 | 20.705 | 21.645 | 28.333 |
| | **Max** | 24.529 | 30.877 | 31.852 | 43.3107 |

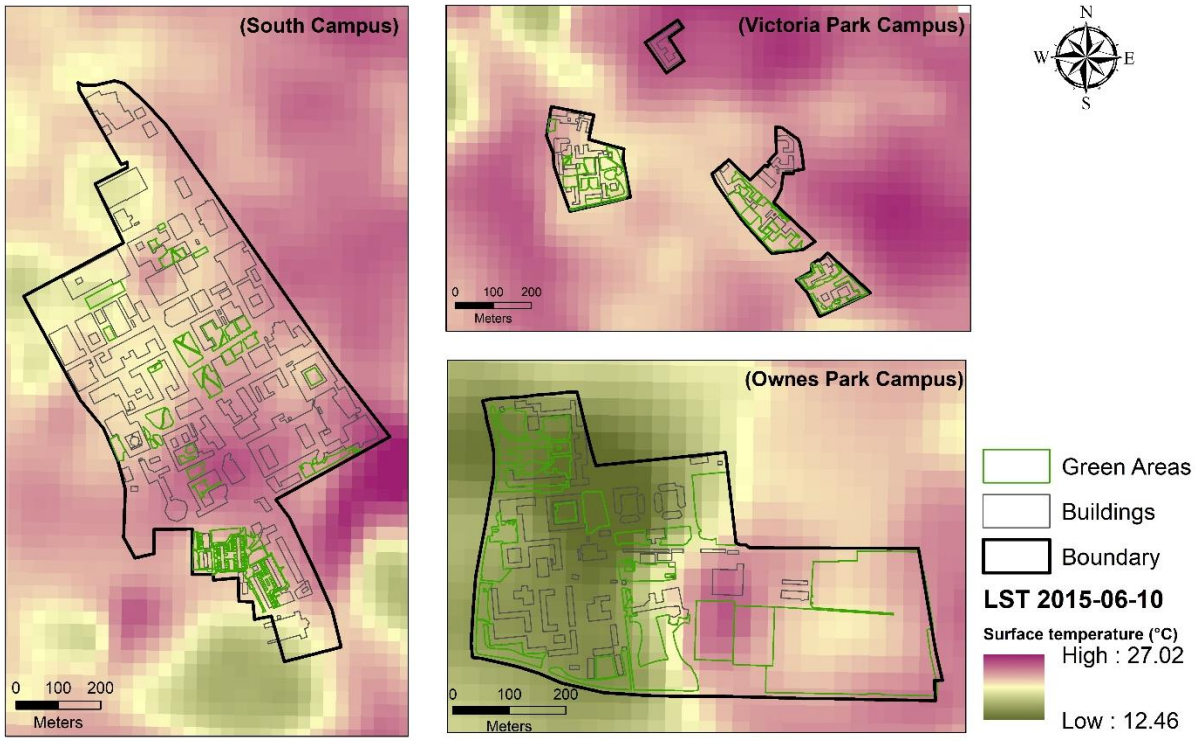
***Table 4: LST average, minimum and maximum temperature values (°C) for each campus area (2015-2018).***

**Table 4** presents the average, minimum and maximum temperature for the three campus for particular days in each year, where cloud cover was low and the clarity of the satellite images was high. The colour of each cell indicates the relative temperature gradient (green is the coolest and red indicates extreme heat). It can be seen that the average temperature was below 25°C for all three campus areas in 2015. In contrast, the average temperature was more than 34°C for the campus areas in 2018. There a clear indication of an increasing surface temperature trend for the period 2015-2018, with 2018 recording the highest temperature for each of the campus areas. This is illustrated in **Graph 1**.



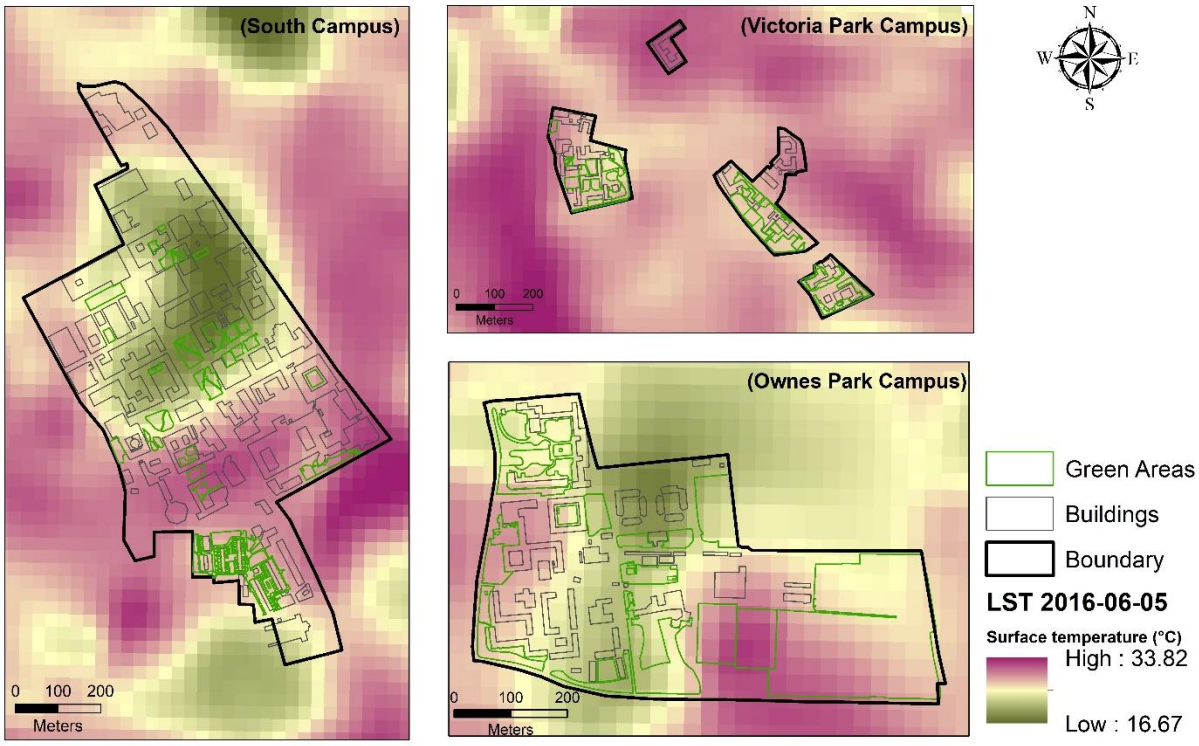

***Graph 1: Trend in surface changes over between 2015-2018.***

**Figure 7** - **Figure *10*** illustrate the surface temperature variations for each campus over the study period (2015-2018). The maps display the campus areas and their surroundings. The green spaces within the campus areas and the building footprints are visualised within the maps. The maps enable LST patterns to be observed. This emphasises that the South campus has higher temperatures than the other campus areas. The Owens Park campus displays considerable variation in temperature across the site and experienced extremely hot temperatures in some areas in 2018.



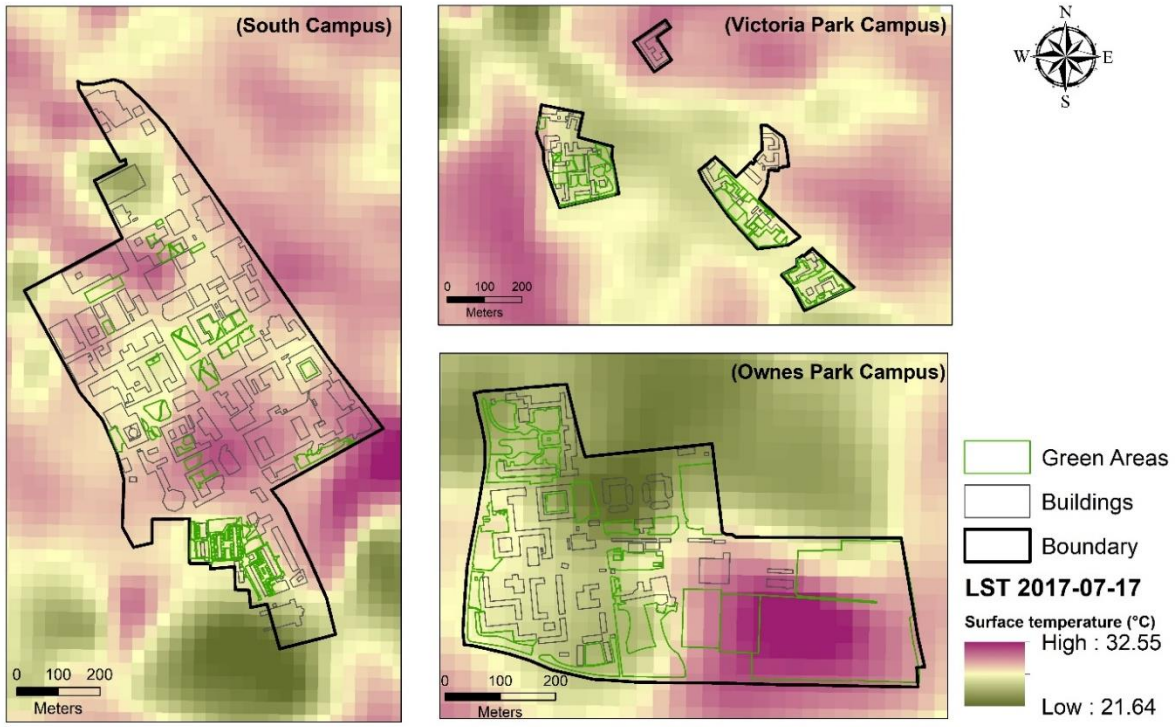

Land Surface Temperature (LST) data generated from Landsat-8 Satellite Images. Each Cell size is 30 metres.

***Figure 7: LST for all three campuses for 2015 (10 June, 2015).***



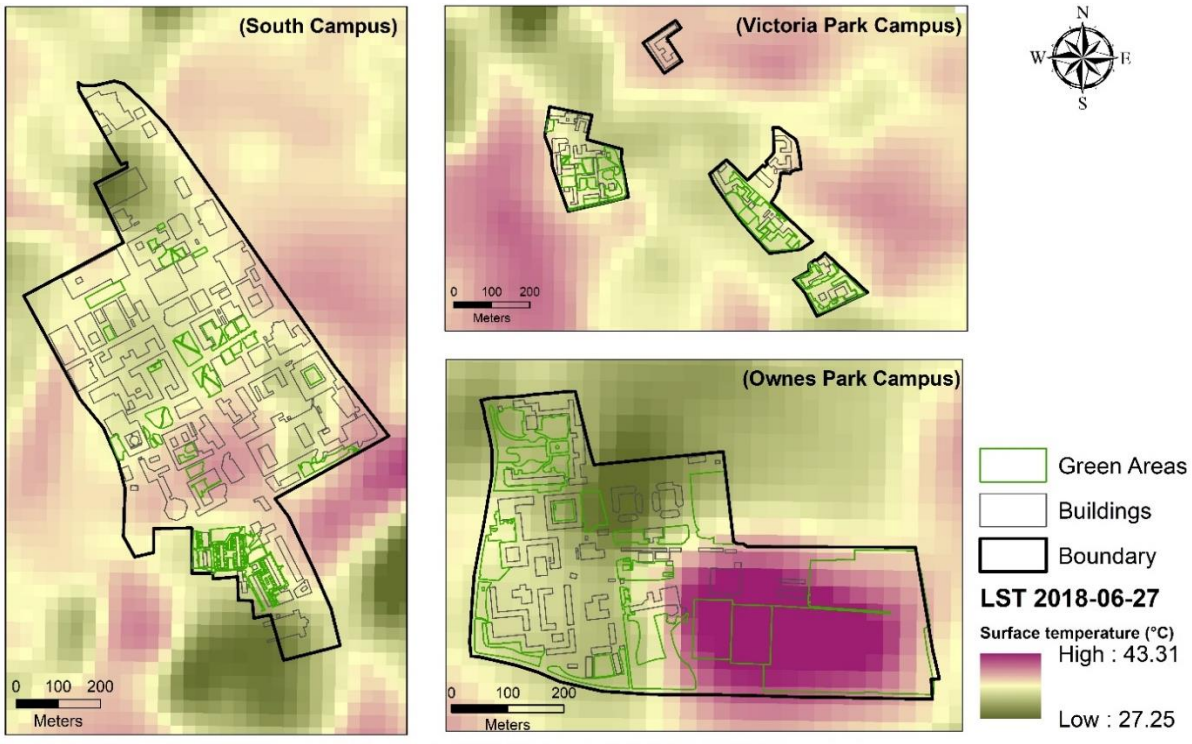

Land Surface Temperature (LST) data generated from Landsat-8 Satellite Images. Each Cell size is 30 metres.

***Figure 8: LST for all three campuses for 2016 (05 June, 2016).***




Land Surface Temperature (LST) data generated from Landsat-8 Satellite Images. Each Cell size is 30 metres.

***Figure 9: LST for all three campuses for 2017 (17 July, 2017).***




Land Surface Temperature (LST) data generated from Landsat-8 Satellite Images. Each Cell size is 30 metres.

***Figure 10: LST for all three campuses for 2018 (27 June, 2018).***

**Caveats**

The LST maps were produced using Landsat-8 satellite images (thermal bands), which captures images with a spatial resolution of 30 metres. At this spatial resolution there is the potential for estimation errors to be introduced, which would be less likely to occur if higher resolution images (e.g. 5 metres) were used. Whilst Landsat-8 is the satellite sensor most commonly used to produce LST outputs, and often provides the best estimation, care should be taken when undertaking a detailed interpretation of maps produced using this data. This is because some areas may not actually reflect the observed temperature in reality, as experienced by people.

Further, these maps were produced for certain days within the summer months where cloud cover was lowest and the clarity of the satellite images was high. Consequently, these maps should not be interpreted as providing average summer temperature for the campus areas. Rather, these maps provide an indication of LST on a day with clear skies, which during the summer months is often when temperatures are also high.

**Indicator interpretation**

This indicator has established that there is considerable spatial variation between the three campus areas covered by this study, and also within these campus areas, in terms of LST values observed during periods of hot and dry summer weather with clear skies. There are clear hot and cool spots across the campus areas. Although there are caveats associated with the use of this indicator data, it is nevertheless valuable to be able to better understand which areas of the campus suffer from high surface temperatures on hot days. These areas are potential targets for interventions that can provide shading and cooling, particularly through tree planting. Equally, the maps also provide an indication of cool spaces that can provide a valuable function during periods of hot weather.

**Monitoring**

Satellite images from the summer months (usually June and July) for each year (2015-2018) were analyzed. The images used in this study had low cloud cover were taken during a week characterized by hot summer weather condition. Google earth engine online platform has been used to prepare the LST maps, the code is openly available and can be repeated over and over (the LST code is included as an Appendix). The collection and analysis of satellite images (e.g. Landsat-8) was therefore the method used to estimate LST. This method can be conducted by a person with experience of of remote sensing and coding. Online portals do exist that can be used to estimate LST. This indicator can further be monitored annually, for a comparable day with low cloud cover and high summer temperatures.

## 2.3 LCI3: Soil type underneath the university campus area.

**Domain**

Absorb

**Overview**

This indicator is focused on assessing the type of soil underneath The University of Manchester's buildings and green areas. It also looked at the water storage capacity of these soils.

**Current Situation**

The soil type analysis underneath the open areas across the three campus areas was conducted using the Horizon hydraulics data from Cranfield University's soil database layers. The complete university area (all campuses and immediate surroundings areas) has a single soil type under the surface. The soil type is: BRICKFIELD 3[1] (0713g). The basic soil characteristics are described as:

> *'Slowly permeable seasonally waterlogged fine loamy fine loamy over clayey and clayey soils.'*

This type of soil is generally suitable for grass surfaces. The water capacity analysis of this soil type indicated that, approximately 101-150 mm water is available within the top 50 cm (surface) of the soil layer for grass. This implies grasses with a root depth of up to 50 cm can obtain adequate water as long as excessive water loss does not occur due to evapotranspiration during an extended period of hot summer days. For trees, around 150-160 mm water is available within top 100 cm soil layer. Except for extended period of hot summer days, trees are likely to have sufficient water within the soils at their general rooting depth (which is approximately 100 cm).

**Indicator interpretation**

Soil type is an important factor for climate change adaptation and resilience as it is directly associated with the ability of the soil to store water. Some soil has a higher water storage capacity than others, and these soils are therefore an important resource when considering approaches to reduce surface water flood risk. Identifying soil type and related surface water availability can also aid in understanding which green spaces might need more irrigation during the summer months, especially during periods of extended hot days, in order to function effectively and provide climate change adaptation and resilience benefits such as shading and cooling.

[1] Full Details of this soil type is available at https://www.landis.org.uk/services/soilsguide/mapunit.cfm?mu=71307

The University of Manchester has a consistent soil type across all campus areas. Although there are not certain patches of soil with particularly high-water storage capacity, all open areas across the three campus areas have soils underneath that provide water storage capacity, and water resources for grasses, shrubs and trees. Loss of soils to development should be views as a loss of capacity to absorb water during periods of intense rainfall. Where this does take place, sustainable urban drainage (SUDS) schemes should be considered to help ensure that the capacity of the campus to capture and store water is maintained.

**Monitoring Requirements**

Analysing soil type underneath the university campus utilised the national soil map and Horizon hydraulics data from Cranfield university's soil database. This data is not freely available and was purchased previously as part of UoM's involvement the EU Horizon2020 RESIN project. However, future monitoring and mapping is not relevant for this indicator as the soil type generally remains unchanged.

## 2.4 LCI4: Greenspace accessibility indicator

**Domain**

Absorb

**Overview**

This indicator identifies the level of accessibility of the users of different buildings within the South Campus to the green spaces within this campus. Accessibility to green space is related to several health and wellbeing benefits, and has a key role to play under climate change conditions. Research indicates that green spaces provide a natural cooling function that extends to surrounding areas in close proximity. Depending on the size of the green space, the cooling extent can vary. Larger green spaces have a wide cooling effect, extending further beyond their boundaries, than the smaller spaces. In general, a building in proximity to larger green spaces might have an increased cooling efficiency and users of the building have access to cooler spaces during high temperatures and heat wave conditions. These green spaces can also increase people's health and well-being since contact with nature has been shown to improve mental health, for example. Taking these issues into account, the level of accessibility to different green spaces from each building within the South Campus is considered to be an important climate change adaptation and resilience indicator.

**Current Situation**

In order to access the current situation of green space accessibility from the South Campus buildings, GIS data layers of building and green space were collected from Ordnance Survey

map database via Digimap portal. These data layers contain the spatial footprint of the buildings and green spaces as polygons. In the case of accessibility to green space, analysis has only been conducted for the South Campus. For the Victoria and Owns park campuses, the previous analysis of green and grey surface indicated that there is more green coverage compared to grey surfaces, and overall those campus have relatively high coverage of green spaces compared to South Campus. Therefore, the South Campus became the focus of the assessment regarding the level of access to green spaces from each building.

GIS analysis identified 81 polygons as the buildings and 28 polygons as green spaces within the South Campus. Among these 28 green space areas; a size distribution is presented in **Table 5**.

| **Size in hectare (ha)** | **Frequency** |
|---|---|
| Above 0.5 | 1 |
| 0.25-0.5 | 3 |
| 0.1-0.25 | 4 |
| Less than 0.1 | 20 |

***Table 5: Size distribution of green spaces in South Campus.***

It is clear from **Table 5** that, the South campus only has a few larger green spaces that can provide significant cooling and shading functions. The majority can be considered as 'pocket parks' (below 0.1 hectare or 1000 square meters), which can also provide some cooling and shading functions, but not to the same extent as larger green spaces. This accessibility analysis has therefore considered access to larger green spaces as being more valuable than access to smaller green spaces.

In analysing the level of accessibility, as a general rule of thumb, planning policy indicates that people should be within a five-minute walk of their nearest green space, which roughly equates to 300 m. This is based on Natural England's Accessible Natural Green space Standard (ANGSt). Some local councils in the Scotland have reduced this requirement to two and a half minutes (or 150 m) to account for people with health conditions or mobility issues. The 150 m buffer has been selected for this indicator. A classification scheme has been formulated to measure the level of accessibility depending on the size of the green spaces:

- **Very high** = access to green space within 150m, space size greater than 0.5ha;
- **High** = access to green space within 150m, space size between 0.25 and 0.5ha;
- **Moderate** = access to green space within 150m, space size between 0.1 and 0.25ha;
- **Low** = access to green space within 150m, space size less than 0.1ha;
- **Very low** = no green space accessible within 150m.

Based on these classification ranges, using a circular buffer of 150 m from the edge of green spaces, buffer zones have been produced for the different level of accessibility. This analysis is presented in **Table 6** and **Figure 11**.

| **Level of access** | **Number of Buildings** | **Building Surface Area (Square meters)** | **Percentage of Building** | **Percentage of Built Surface Area** |
|---|---|---|---|---|
| **Very low** (no access within 150 m) | 7 | 11654 | 8.6 | 6.5 |
| **Low** (access to GS size less than 0.1ha within 150 m) | 9 | 17171 | 11.1 | 9.7 |
| **Moderate** (access to GS size between 0.1-0.25ha within 150 m) | 26 | 54043 | 32.1 | 30.4 |
| **High** (access to GS size between 0.25-0.50ha within 150 m) | 17 | 52795 | 21.0 | 29.7 |
| **Very high** (access to GS size more than 0.50ha within 150 m) | 22 | 42142 | 27.2 | 23.7 |
| **Total** | **81** | **177805** | **100.00** | **100.00** |

***Table 6: Level of accessibilities for building in the South Campus.***

As presented in **Table 6**, out of 81 buildings 22 (27.2%) have a very high accessibility level. Cumulatively, around 52% of buildings have very low to moderate level of accessibility (red, orange and yellow shaded buildings in **Figure 11**). Overall, across the south campus, around 48% of the buildings have high or very high accessibility to green space.

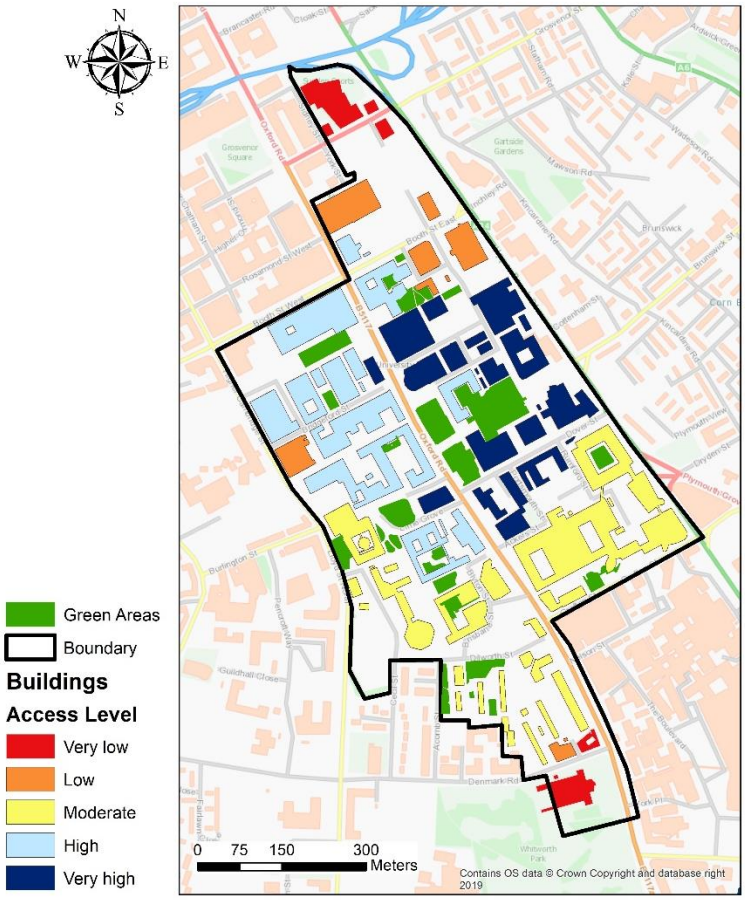



***Figure 11: Level of accessibility of the South Campus building to different campus green spaces.***

**Indicator interpretation**

This analysis has identified that buildings across the South Campus have quite different levels of accessibility to greenspace, according to the method used to create this indicator within this project. Buildings in close proximity to Brunswick Park show particularly high levels of accessibility to green space (Figure 11, Dark Navy shaded buildings). Conversely, buildings immediately to the north and south of Booth Street East have relatively low levels of green space accessibility, and are areas where significant further development activity is ongoing (at the time of report publication). This indicator output provides a potentially valuable resource that can inform planning and decision making over future campus design and development around themes linked to green space accessibility, and related issues such as productivity and health and wellbeing.

**Caveats**

Only green spaces within a boundary of the campus have been considered in the analysis. This consideration excluded the green spaces situated just outside the campus boundary to be considered as an accessible place for the buildings at the edge of the campus boundary. This approach caused some buildings at the edge of the boundary to not have access to

green space within the 150 m buffer distances. For example the Whitworth Art gallery is just inside the campus boundary, but Whitworth Park is not considered as campus green space, therefore despite being located in just at the edge of the park, the calculation identified that building to have no access to green space within 150 m. For future analysis, parks or green spaces just outside the campus boundary could also be considered for accessibility assessment. It would also be useful to better understand how University staff and students uses these spaces in periods of hot weather.

**Monitoring Requirements**

Monitoring of the level of accessibility to green space requires GIS data of buildings and green space, which can be collected from Digimap. This data is periodically updated, and is available online. Annual monitoring of this indicator might be unnecessary unless major changes in the landscape of the campus has been undertaken. After any major green space related changes (e.g. adding or removing green spaces) this indicator could be usefully updated. A person with basic GIS skills (e.g. Buffering, data editing) can easily do these analyses.

# 3 Policy and governance indicators

## 3.1 PGI1: Number of stakeholders engaged with in relation to climate resilience

**Domain**

Anticipate/adapt

**Overview**

Building resilience to climate change is a complex challenge. Strong, functioning stakeholder networks are important to addressing this challenge: not only are different types of expertise important to include, but also there are a vast number of other actors that are important to take account of when trying to build overall system resilience (Cole 2011). Stakeholder networks are important at all domains of resilience: from anticipating the shock, to absorbing the shock through recovery, to adaptation and transformation. That said, stakeholders will have different drivers and barriers towards addressing the building of resilience: some may be statutorily obliged whilst others may have limited time and resources. Understanding those drivers and barriers is important to realising resilience and can help to align the motivations. In addition, active stakeholder engagement can help to share useful resilience-building information across diverse organisations (Geerdink et al. 2015). However, stakeholder networks are often fragmented and difficult to resource effective maintenance whether through limited time, money and/or human resources.

UoM is embedded within a wider system that will have an effect on the estate should an extreme weather event occurs. For example, travel may be disrupted which will inhibit connectivity to the campus and it is essential that there are lines of communication between UoM and TfGM. Analysing who the relevant stakeholders are is only a first step. A successful resilience-building effort will need to ensure that relevant stakeholders are actively engaged. Moreover, their particular interests should be identified as well as existing relationships and communication between them (Sinek, 2015). An understanding of the associated stakeholders along with the levels of engagement with them can provide an indication that the issue of resilience is continually being monitored.

Given the time and resources, an accurate baseline could not be produced for this indicator as the information is currently hard to identify. Therefore, we have produced an idealised stakeholder map that identifies key organisation that the UoM estates should engage with. This stakeholder review will:

1. Produce an initial map of the stakeholder community who have a role (or interest) in making the UoM estate more resilience;
2. Identify, from within this wider community, a group of direct stakeholders whose role and activities more closely relates to the resilience of the UoM estate (in terms of preparing, responding, and recovering);

3. Assess the extent to which the group of external direct stakeholders are currently engaged in resilience activities with UoM and/or more generally, as well as any statutory responsibilities they may have; and through an initial desk-based analysis of their key plans/strategies (and activities); and
4. Produce an excel spreadsheet that categorises stakeholders and can be used for further monitoring.

**Current situation**

The identification of other stakeholders can provide insights into which groups/organisations could contribute to the resilience of the University of Manchester campus. On a secondary level, it is crucial to identify those groups/organisations affected by decisions made by the University of Manchester. Such an analysis can clarify roles, responsibilities and functions, and relevant knowledge brokers. This can help to identify who should be involved and what their potential contribution might be. Different actors will have different spheres of influence (e.g. access to resources, information sharing, and so on) (Reed et al. 2009). Therefore, each group/organisation needs to be categorised in terms of their role, how much influence they have, and their level of interest. Understanding the institutional arrangements is also important. This includes the formal and informal governance structures that shape group behaviour and facilitate their coordination. This may derive from particular policies and management processes. Therefore, understanding statutory requirements and non-statutory obligations may frame the analysis of each stakeholder. Further analysis could be undertaken in order to understand barriers and challenges when bringing stakeholders together. Annex 1 outlines the detailed methodology that was used to comprise the baseline.

In total, 22 stakeholders were identified (**Annex 1**) and cover a range of different interests from students to the NHS to local schools. There are a number of stakeholders who currently are important, interested and/or influential in making the UoM estate more resilient. Levels of interest and influence were gathered from a desk-based analysis of organisational websites and documents. Some of the stakeholders are categorised as internal to the university (staff, students, and so on), whilst external stakeholders can be directly related to the climate resilience of the estate, such as the Greater Manchester Combined Authority's Civil Contingencies and Resilience Unit, where others are only weakly connected (such as Trinity High School).

Stakeholders have, based on an understanding of their importance to UoM and their levels of influence, been grouped into four categories. Each category begins to outline the relationship that UoM may have with them (**Table 7**). For instance, students are a very important group of stakeholders in a reputational sense but they have very little influence on the agenda. Therefore, they are representative of the category 'Directly Engage'. The Civil Contingencies and Resilience Unit (CCRU) are both important and influential, and

therefore can be considered as a 'Key Player' with whom intense negotiations can occur. Bruntwood are a major property developer on the Oxford Road Corridor and, whilst holding less influence and importance to the university, should be kept informed about university strategies and activities. Another set of loosely connected stakeholders have very little influence and are less important to the UoM estates, such as co-located businesses, but UoM estates should show some consideration to their needs when developing climate change resilience strategies and plans. **Figure 12** plots each of the stakeholders onto a diagram to show their levels of importance and influence.

| Category | Description | Colour |
|---|---|---|
| Show consideration | Stakeholders who are less important and have less influence on the resilience agenda in the UoM estate. Communication with these stakeholders should be evident but should aim to share information on each other's activities. | Red |
| Directly engaged | Stakeholders who are important but who exert less influence. Their needs will have to be considered and they will need to be communicated with on a regular basis. | Blue |
| Keep informed | Stakeholders here are influential and show interest in the agenda but are less important to the estate. They should be communicated with on a regular basis | Gold |
| Key Players | Stakeholders here are influential (potentially) and important to the resilience of the UoM estate. Regular meetings should take place with them and it will be important to buy them into any plans and policies. | Green |

***Table 7: Outline of each stakeholder category and colour code for Figure 12***

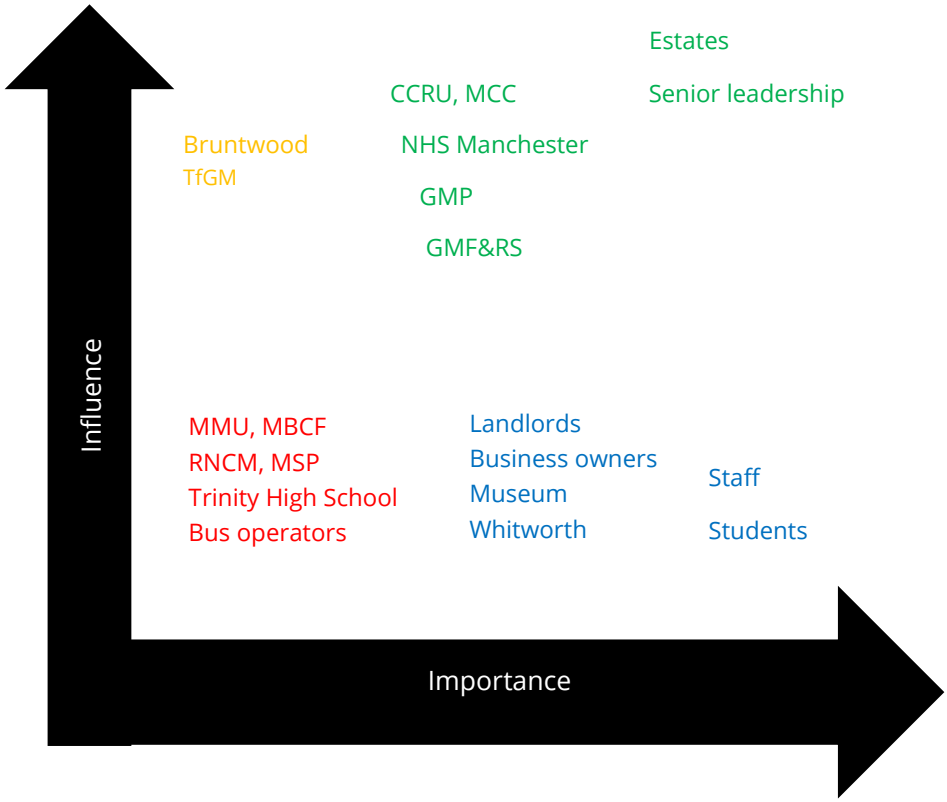



***Figure 12: Draft outline of stakeholder categories***

**Indicator interpretation**

Currently, the stakeholder map outlines those who may be directly or indirectly impacted or influential on the resilience of the UoM estate. Whilst largely subjective and normative, the baseline map can help to inform which group of stakeholders require which level of communication from the UoM estates team. The next step is to build up a picture of whether and when UoM estates team currently engage with each stakeholder on the issues of weather and climate resilience. Following this, dialogue can be opened up to try to assess the best means of engagement and at which points in time. Different relationships and methods of communication may be necessary for each stakeholder. For example, nine of the twenty-two stakeholders sit on the Oxford Road Corridor Board and existing lines of communication are open even though these may not necessarily be about climate change resilience.

**Caveats**

The current stakeholder map is subjective. It should also be noted that the desk-based analysis of documents and websites may not have fully uncovered particular plans and strategies around climate resilience depending on the function of the website and the visibility of business continuity plans.

**Monitoring**

The excel spreadsheet provides a sheet where meetings and communications can be directed to each stakeholder group. There is no target as such as this will largely depend on whether or not there is an extreme weather event on campus. The aim should be to identify those stakeholders who are not currently engaged but should be. Work can then focus on reaching out to these groups.

The stakeholder map should be reviewed following the methodology outlined in Annex 1 on an annual basis or after an extreme weather event.

**Monitoring Requirements**

Annual analysis against the Baseline stakeholder map to assess stakeholder engagement, keeping records of key meetings attended during year where climate change adaptation and resilience has featured on the agenda.

## 3.2 PGI2: Coverage of climate change adaptation and resilience within key UoM policies and plans

**Domain**

Anticipate/adapt

**Overview**

The long-term planning that is necessary in the context of an uncertain and changing climate, with associated changes in the frequency and intensity of extreme weather events, demands a forward-thinking approach to policymaking. As a complex system of interdependent forces and variables, UoM's policies, strategies and plans must cover a diverse range of sectors and themes, ranging from research project risk assessments to business continuity planning for individual buildings to major incident response planning. The extent to which this overall planning framework accounts for climate change is a key indicator of UoM's anticipatory capacity. Not only does the presence of climate change adaptation and resilience themes within key policies and strategies increase the likelihood that action is taken, but it also provides an increased level of preparedness for the range of possible future scenarios associated with climate change. Without this framework, UoM lacks the clear processes necessary to deal with the consequences of climate change, such as more intense extreme weather events, if, when and where they occur. Any delay in response or uncertainty when dealing with these consequences will have a knock-on effect on UoM's capacity to fulfil its key functions. The complex interdependencies of the UoM system means that any sub-system not linked into this planning framework will hamper the preparedness, recovery and response capacity of the University as a whole.

To evaluate UoM's anticipatory planning capacity, the indicator CRI7 has been developed. This measures the coverage of climate change adaptation and resilience in UoM's key policies and plans. Each document is reviewed individually, and the results of these individual evaluations are combined to provide an overall assessment of the level of current performance against this indicator.

**Methodology**

Once explicitly recognised as a potential threat and included as part of planning and policy programs, climate change can be interpreted as necessitating forms of action which can be categorised according to four broad themes which have been listed below in **Table 8**.

| Theme | Forms of action |
|---|---|
| Responses to changes in climate and weather, both gradual and extreme | Identifying likely future trends in climate and their gradual impacts upon a system's functions<br>Planning for extreme weather events and their capacity to shock a system |
| Planning for the possible eventuality of multiple future climate scenarios | Recognising that the complexities and interdependencies of human and natural systems mean that it is necessary to acknowledge a range of different future scenarios<br>Mapping out a range of different scenarios as part of a plan/policy and using these to inform strategy |
| Identifying actions and measures to reduce risk and/or vulnerability to climate hazards | Addressing climate-related risks through actions and measures which are appropriate to the severity of risks and their likelihood of occurrence<br>Developing a suite of actions and measures which address the widest possible range of risks |
| Modelling and planning for the uncertainties associated with climate predictions | Recognising that the interactions between climate change and complex, interdependent human and natural systems mean that any predictions of future climate change are inherently uncertain (and hence why different climate scenarios should be considered)<br>This uncertainty must form part of any assessment of risk and be modelled into the range of actions and measures proposed to ensure the system is prepared for the widest range of possible eventualities |

***Table 8 Thematic groups and forms of action required when planning for climate resilience***

To incorporate these themes into an evaluation of UoM's climate resilience a checklist was developed and is shown in (shown in **Annex 3**). This has been sub-divided into five sections which correspond with the thematic groups shown in **Table 8** in addition to an introductory section evaluating a policy/plan's engagement with the issue of climate change. Each section has two to three questions under each. Each question contributes a score for each section which are then combined to give an overall score. Each document identified was assessed and scored using this checklist.

It is important to note that **Table 8** includes a range of themes that collectively represent a good practice approach to planning for climate resilience. It is not anticipated that all policies and plans will comprehensively address each of these themes. However, evaluation against these themes does enable their strengths and weaknesses to be identified, offering insights that can be used to inform future reviews of policies and plans.

In terms of evaluating the data from completed responses, a traffic light warning system has been developed, shown in **Table 9**. This is used to evaluate UoM overall policy and planning response in terms of the anticipatory capacity it provides. This overall rating is arrived at by combining the weighted scores (see: **Table 10**) of each individually assessed document into an overall score. Each of the four ratings (green, light green, amber and red) corresponds with a threshold against which UoM's overall rating can be measured.

| *Rating* | *Evaluative summary* |
|---|---|
|  **Score: 1,260 and above** | High anticipatory capacity<br>Prepared for a range of climate change events (e.g. high probability, low intensity as well as low probability, high intensity events)<br>Identifies multiple scenarios to consider the fullest range of uncertainties associated with future changes in climate and their impacts upon system functionality<br>Details specific measures/actions to deal with a range of clearly identified risks/scenarios<br>University is at its highest reasonable level of preparedness |
|  **Score: between 840 and 1,259** | Medium anticipatory capacity<br>Prepared for certain high probability climate change events OR prepared for a range of climate change events (e.g. high probability, low intensity as well as low probability, high intensity events)<br>Identifies a limited number of scenarios incorporating a low level of uncertainty into its planning, therefore missing a comprehensive consideration of potential future impacts upon system functionality OR identifies multiple scenarios to consider the fullest range of uncertainties associated with future changes in climate and their impacts upon system functionality<br>Details specific measures/actions to deal with a range of clearly identified risks/scenarios OR details specific measures/actions to deal with a limited range of clearly identified risks/scenarios OR proposes more general measures/actions with no specific detail<br>University planning framework requires some improvement but is performing well in some/most areas. Is missing consideration of extreme events, wider range/more specific forms of action, a comprehensive analysis of future climate scenarios and/or a greater consideration of uncertainty |
|  **Score: between 420 and 839** | Low anticipatory capacity<br>Prepared for certain high probability climate change events<br>Identifies a limited number of scenarios incorporating a low level of uncertainty into its planning, therefore missing a comprehensive consideration of potential future impacts upon system functionality<br>Details specific measures/actions to deal with a limited range of clearly identified risks/scenarios OR proposes more general measures/actions with no specific detail<br>University planning framework requires improvement. Is missing consideration of extreme events, wider range/more specific forms of action, and/or a comprehensive analysis of future climate |

| | |
|---|---|
| | scenarios |
|  **Score: below 420** | No anticipatory capacity<br>No mention of and thus unprepared for climate change events<br>No consideration of future changes in climate<br>No reference to measures/actions<br>University planning framework requires reworking to include climate change considerations |

***Table 9: Anticipatory capacity performance ratings for UoM plans and policies***

This method provides a means of measuring increases/decreases in anticipatory capacity over an agreed period of time. **Table 10** has been provided to enable an evaluation of UoM's rating according to each climate resilience theme. This provides a more detailed baseline upon which future climate resilience policy- and plan-making can be built, allowing the University to target the areas where it is weakest and generate a more well-rounded overall planning/policy response. In accordance with the immediacy of some of the issues facing UoM (e.g. the need to plan for and deliver flooding and heat stress adaptation measures) some sections have been weighted accordingly. This should not diminish the argument for a well-rounded approach to climate adaptation and resilience planning. However, in the 2019 context it was considered appropriate to weigh 'Planning for changes in weather', 'Introducing climate change as an issue in need of attention', and 'Identification of actions or measures' according to the immediacy of the impacts of climate hazards on UoM function.

| Section | Total score (out of possible)* | Weight (weighted total) | Section rating** |
|---|---|---|---|
| Introducing climate change as an issue in need of attention | /80 | x2 (/160) | |
| Planning for changes in weather | /240 | x2 (/480) | |
| Scenario planning and analysis | /280 | x1 (/280) | |
| Identification of actions or measures | /240 | x2 (/480) | |
| Consideration of uncertainty | /280 | x1 (/280) | |

***Table 10: Section-by-section scores *number of documents x overall section score **threshold for each rating equals overall possible weighted section score divided by four***

**Current situation**

This section will provide a section-by-section scores and an overall rating for UoM. The scores and summaries for each individual document analysed alongside each filled in checklist are available in **Annex 4**.

**Weighted score:**

935/1,680 (see **Table 11** for section-by-section breakdown)

**Strongest performing area:**

Introducing climate change as an issue in need of attention, Identification of actions or measures

**Weakest performing area:**

Consideration of uncertainty

**Rating:**

Medium  anticipatory capacity

Prepared for certain high probability climate change events, most notably heatwaves and floods.

At times, does well in identifying multiple scenarios to consider the fullest range of uncertainties associated with future changes in climate and their impacts upon system functionality, but mostly a single vaguely defined future scenario is used.

Generally, details specific measures/actions to deal with a limited range of clearly identified risks/scenarios.

University planning framework requires some improvement but is performing well in the most immediately pressing area areas. Is missing consideration of low probability extreme events, more comprehensive analyses of future climate scenarios and a greater consideration and incorporation of uncertainty.

**Caveats**

While UoM is performing noticeably well in certain areas and can therefore be considered to have medium-to-high anticipatory capacity, this depends on a select number of high-performing strategic documents (e.g. the Living Campus Plan and Extreme Weather and Climate Change Impacts, Risks and Adaptation Responses document). Some key strategic documents (e.g. Manchester 2020 and the Campus Masterplan) have noticeably lower scores. Other documents also score highly in particular sections while not scoring at all in others.

The overall score is determined significantly by the weights given to each section. The University's unweighted score puts its anticipatory capacity at a low instead of a medium level. In future, these weights are likely to require revision in light of the future stress climate change will place on UoM.

| Section | Weighted score (unweighted score) | Section rating |
|---|---|---|
| Introducing climate change as an issue in need of attention | 120/160 (60/80) |  |
| Planning for changes in weather | 300/480 (150/240) |  |
| Scenario planning and analysis | 90/280 |  |
| Identification of actions or measures | 400/480 (200/240) |  |
| Consideration of uncertainty | 25/280 |  |

***Table 11: Section-by-section scores and ratings for UoM's policy and planning framework***

**Indicator interpretation**

UoM's policy and plan framework has been evaluated as possessing 'medium' anticipatory capacity. As things currently stand, it clearly identifies climate change as a pressing concern, incorporates into its plan the key climate-related risks of flooding and heat, and provides a number of measures to combat this. The presence of a clearly identified 'sustainable' strategy in the form of the Living Campus Plan provides a key reference point for those seeking direction on climate adaptation and resilience issues. Other documents, such as the Landscape Masterplan and Green Wall Policy and Guidance, provide assessments of the University's campus, both in terms of its current state and future potential. Collectively, these documents posit a broad strategic direction while also detailing the specific types of measure (e.g. the numbers, types and locations of green infrastructure and construction and maintenance best practices) to support this. This means that the University is supported in a strategic sense by an understanding of climate risks, assessments of their probability and locational need, and details of adaptation options.

However, as per the caveats listed above, performance is inconsistent across all policies and plans. The danger of specific documents being attributed the majority of UoM's anticipatory

capacity is that these might become siloed in practice. While, for example, the Living Campus Plan makes explicit reference to the Extreme Weather and Climate Change Impacts, Risks and Adaptation Responses document, in other cases this does not happen. While this is understandable in several cases as a result of publication dates, the risk to UoM is that their planning response becomes piecemeal and climate change is treated as one issue among many rather than the driving force for campus planning and management. The failure of several documents to even mention climate change adaptation is a case in point.

Relatedly, while UoM's low performance in 'Scenario planning and analysis' and 'Consideration of uncertainty' is not immediately concerning, its continuation is likely to hamper UoM's anticipatory capacity in future. Integrating scenario planning and uncertainty into the highest levels of strategic decision-making ensures the fullest extent of possible climate change is being considered and planned for. Without the consideration of a range of future scenarios or an incorporation of uncertainty into strategic decision-making, UoM risks closing off future pathways which may leave it vulnerable to future fluctuations in climate. Overconfidence in its predictions and measures may also lead to the pursuit of maladaptive solutions to eventually realised climate hazards.

**Monitoring**

It is recommended that revisions to the policies/plans included in this evaluation are made yearly. The documents chosen were based on discussions with the Environmental Sustainability team at UoM in 2019. Any subsequent documents of a strategic nature which could form part of this framework should be identified and incorporated into the overall score using the assessment checklist in **Annex 3**.

Updates or revisions to any of the policies/plans should be re-assessed as soon as possible.

Discussions should take place yearly with the Environmental Sustainability team to reflect upon the weightings attributed to each section in this assessment.

### **3.3** PGI3: Adequate level of insurance cover for extreme weather events

**Domain**
Anticipate

**Overview**
Insurance is recognised as a key means of helping property owners and businesses to adapt to climate change. Insurance can, but not always, provide coverage to compensate in the case of extreme weather events. Given that risk changes over time, there is a need to ensure that the associated insurance cover is adequate. Indeed, GM's 5 year Environment Plan (2019) urges businesses to check that their insurance cover is at an adequate level.

**Current situation**

The University maintains property damage and business interruption insurance. This covers physical loss or damage to University property arising from floods and storms. Allied to this insurance cover, the University also maintains an Emergency Management Plan and an associated Major Incident Response Plan. The Emergency Management Plan describes the framework for the management of smaller incidents that do not require a significant response at the University level. The Major Incident Response Plan provides a framework for major incident preparedness. Business Continuity Plans exist for certain strategic assets and buildings. Business Continuity Plans are aimed at recovering business operations following major disruption to normal business, which may involve moving the operation to another location to continue while the building/asset is being rebuilt or reinstated. They are not specifically focused on extreme weather such as floods and storms, although would cover these events should they occur.

**Indicator interpretation**

It is apparent that the University maintains appropriate insurance cover for extreme weather events including floods and storms. There is also a system of plans and strategies in place, linked to business continuity and emergency planning, which look to aid response and recovery in the event of hazards or perils impacting on the University. This takes the indicator beyond insurance specifically, although business continuity and emergency planning capacity links to obtaining insurance against hazards and perils. Further work into this aspect of the indicator would be useful in order to understand the particular aspects of business continuity and emergency planning that relate to extreme weather events, and to consider whether this is adequate in the context of climate change and the projected increase in frequency and intensity of extreme weather.

**Monitoring requirements**

Undertake an annual check of insurance cover, or review this when insurance comes up for renewal. It would be useful to identify whether business continuity plans are available for buildings and assets potentially exposed to flooding, as identify within the report on climate change impacts and risks (Carter and Connelly 2015).

### 3.4 PGI4: Number of resilience related community projects

**Domain**

Transform

**Overview**

UoM is embedded within a wider system that will have an effect on the estate should an extreme weather event occurs, and this may suggest a wider responsibility to the

communities in the vicinity of UoM's campus. In addition, the social responsibility agenda dictates that UoM should reach out to the wider community in Manchester. The UoM Sustainability Plan includes an action around taking part in one biodiversity-related community project per year. For this reason, an indicator that encourages action around climate-related community resilience projects has been proposed. Such an indicator fits with the focus on social responsibility whilst also adhering to the promotion of environmental volunteering amongst employees that the Greater Manchester 5 Year Environment Plan (2019) suggests for Greater Manchester businesses.

**Current situation**

Given time and resources, a baseline has not been gathered for this indicator. Indeed, in a sense, this indicator is not measuring a trend but simply aiming for an action of at least one project per year from across the various departments of the university. Previous staff projects include Jana Wendler and Emma Shuttleworth's (2019) development of the Downpour! Within this street game, participants are cast as potential flood risk managers and given scenarios to deal with.

**Indicator interpretation**

As no baseline has been developed for this indicator, no interpretation of the current situation can be made. However, it may be prudent to offer an annual prize/token of acknowledgement to encourage potential participants to undertake activities and to encourage self-reporting.

**Monitoring**

Monitoring of this indicator needs to take place on an annual basis. There are a number of routes to doing so:

- Liaising with the social responsibility team to identify climate-resilience related projects.
- Annual email to all staff and student mailing lists to try and encourage staff/student self-reporting according to a template/survey that gathers an overview of the activity; the activity timings; the funder (if applicable); the community groups involved; and the main impacts.

**Monitoring Requirements**

Review of staff/student involvement in community based climate resilience projects (e.g. annual mailing list, development of an online survey)

## 4 Conclusions and next steps

Climate change poses a current and future threat to The University of Manchester and the delivery of its strategic objectives. While the university might currently be able to absorb irregular, one-off extreme weather events, the increased regularity with which these are projected to occur over the coming decades may threaten its capacity to meet its strategic objectives. Planners and decision-makers have both a responsibility and imperative to not only reduce greenhouse gas emissions associated with their activities, but also to implement measures which respond to, prepare for, and allow recovery from, climate-related impacts. Climate change adaptation and resilience are set to become increasingly important considerations for the University of Manchester. A previous study identified flood risk and heat stress as the most significant climate related risk facing the university over the coming decades (Carter and Connelly 2015). The report recommended that the University estates department should:

- Look for opportunities to expand green cover, particularly within the south campus and in areas prone to surface water flooding.
- Take the opportunity to consider adaptation options to build resilience to flooding and heat stress, such as protecting and increasing green cover, during building refurbishments.
- Request that project teams responsible for new builds take weather and climate risk into consideration. Project teams should demonstrate how buildings will be resilient to future risks whilst not exacerbating risk to other buildings on the estate.
- Update emergency and contingency plans to reflect knowledge of weather and climate risks, particularly for buildings shown to be at high risk from flooding.
- Support student projects to build knowledge and awareness of weather and climate risks and adaptation responses on the estate.

It is clear from this set of recommendations that adapting and building resilience to climate change involves physical interventions, targeting buildings and the spaces around buildings, in order to reduce risks associated with climate change hazards. The recent re-development of the Brunswick Park and the University Green sites highlight the potential of increasing the University's attractiveness to prospective staff and students while also delivering climate adaptation benefits. Speaking to members of the University Estates team, this was identified as a key strength of the green space agenda moving forward. John Lumbert, Head of Estate and Space Management, reflected on this issue:

> *"I think in the past 3 to 4 years there's been a significant improvement. Brunswick Park – which is the closure of the street… the work that's gone in front of AMBS, University Green, those green spaces… visibly and physically have improved things. Whether that was because we thought we needed more green space from this point of view (climate resilience*

*and adaptation) I would doubt, but it's certainly… from a student experience, wellbeing (perspective) it might be a by-product of that".*

Looking to move the green space agenda forward in the future, Emma Gardner, Head of Environmental Sustainability, discussed the potential of:

*"as well as doing the big pieces that you can see, there are buildings that have quads and it would be nice to use them (for green infrastructure)".*

It is also important to recognise the importance of building connections between green spaces across the University campus, in effect moving towards the development of a network of interconnected green spaces. As this report has shown, accessibility to green space is an important issue moving forward. Utilising the indicators developed here strengthens the case for green infrastructure, increasing the likelihood of this commitment being fulfilled. As Ms. Gardner states, these indicators provide:

*"a strong tool to negotiate and have an influence… and then to monitor progress".*

However, an important point coming out of discussions with members of the Estates and Environmental Sustainability teams has been the metaphorical distance between climate change issues and UoM's main strategic priorities. To encourage the implementation of physical interventions such as green infrastructure, supportive plans, strategies and governance approaches are needed in order to deliver change 'on the ground'. However, as the analysis for PGI2**: Coverage of climate change adaptation and resilience within key UoM policies and plans** has shown priorities for climate change resilience and adaptation are limited to certain policies and plans. Reflecting on the broader environmental sustainability agenda James Evans, University Lead for Environmental Sustainability (ES), stated that:

*"while ES has a clear place within the University's governance structure, it isn't a particularly central place (and) the big challenge for us over the last few years has been starting to move ES from the periphery nearer to the core".*

Similarly, Ms. Gardner voiced concerns that the policy programme was "all in bits everywhere" and required "knitt(ing) together" to better ensure that climate change adaptation and resilience concerns were integrated into the highest levels of decision-making. Mr. Lumbert also spoke about sustainability issues more generally being "nice to haves" which can get "value engineered out" of proposed developments because of cost issues. This supports this report's recommendation (see: PGI2**: Coverage of climate change adaptation and resilience within key UoM policies and plans**) that UoM must seek to centralise climate change in its policy and governance framework. Staff also highlighted ongoing work around incorporating sustainability issues into the University risk register (J.

Evans and E. Gardner) work which indicators, particularly LCI1 and LCI 4, can potentially support.

Although the indicators included in this report have been presented individually, and can be monitored separately, it is important to view them as a suite of integrated indicators. No one indicator can or should stand on its own. When considering a response such as increasing the amount of green space across the university estate, this will require plans and strategies that encourage this adaptation approach and a stakeholder network that can help ensure that these interventions are appropriately designed and can be well maintained.

Here, it is useful to take a systems view of climate change adaptation and resilience. From a systems-based perspective, the university campus constitutes a high-level system made up of and supported by a series of interdependent sub-systems. For example, the main learning campus, bordered by Higher Cambridge and Upper Brook Street and split by Oxford Road, is dependent on this road network and its associated pedestrian routes (as is the north campus). In addition, accommodation campuses in Fallowfield, Rusholme, and Victoria Park are sites which are also supported by wider travel networks and pedestrianized routes, but also serve to support the UoM learning campuses. If any of sub-systems are negatively impacted by hazards such as floods or heat waves, to the point where they are unable to support the wider UoM campus system, UoM's capacity to fulfil its key functions is threatened.

It is important to recognise the complexity and interdependencies between variables with specifiable systems and sub-systems. Central to this understanding is the evolving and dynamic nature of systems, how they might reorganise and respond to shocks, stresses, and trends over more prolonged periods of time. The UoM system is nested within and has interdependencies with other broader systems, such as transport and energy for example, the resilience of which will impact upon its own resilience. As such, the University should prioritise the wider communities of stakeholders in its work around resilience and adaptation (see: PGI1**:** ). Indeed, as Professor Evans states:

> *"if you can start to say the University's resilience is of this much benefit to the surrounding areas then I think that would get traction with a lot of people who maybe naturally aren't sitting in the sustainability".*

In this sense, the UoM system's future resilience capacity is strengthened if it can be seen to positively impact upon the resilience of its neighbouring areas. Increasing public access to UoM's green spaces, for example, provides accessible shaded and cool areas for neighbouring communities. The potential of this wider community benefit as a case-building tool relates back to seeing these indicators as a suite rather than a collection of isolated measures. In seeing resilience capacity as something to be achieved as a whole, each of these indicators can be brought in to support work how and when they are needed.

Overall, the response of the system to shocks and intervention must be monitored to understand its variability, and this must include a range of ecological and social indicators to identify any potential unexpected or unintended results and better understand the dynamics of the system under consideration. This report has identified and developed a diverse array of indicators, and associated monitoring approaches, and provides the basis for instituting and monitoring a capacity-based approach to responding to climate risk. We are, however, aware of potential future challenges which may limit this capacity associated with following:

- **Availability of data**: this will be particularly important for maintaining the quantitative histories associated with indicators LCI1, LCI2, LCI3 and LCI4. Up-to-date, accurate information will be crucial to ensuring this is maintained. A broad range of datasets will also aid in the development of a scenario-based approach to policy- and plan-making.
- **Limited number of indicators proposed**: while this report has sought to develop a range of indicators, these are limited in number and comprehensiveness. The UK Climate Risk Assessment (2017), for example, covers 56 individual risks under 5 themes. Considering the importance of health and wellbeing to the UoM system's overall functionality, it is worthwhile developing new and/or (where possible) incorporating existing indicators which relate to this to be considered as part of the overall suite.
- **The measurability of indicators**: as raised by Professor Evans, the indicators proposed here are missing an explicit ecosystem services element. As discussed in the previous bullet, ensuring the health and wellbeing of its staff and students is of crucial importance to the functionality of the UoM system. However, while it is possible to collect this data on its own, it is much harder to relate this to (e.g.) the provision of green space. Where possible, the conceptual underpinnings of this report should be revised in light of developments in the literature on climate resilience and ecosystem service valuation in relation to health and wellbeing.
- **Existing state of buildings**: while these indicators have addressed the University's spatial and policy/governance configurations, they do not address the current and future climate resilience potential of UoM's existing estate. There is concern that new developments are potentially maladapted to future climate change, particularly in relation to issues regarding permeability and cover from rainfall (J. Evans). Similarly, the compactness of UoM's estate (E. Gardner and J. Lumbert) means that there is not a lot of room for future transformations should future climate demand it. Care should be taken to assess existing buildings in terms of their resilience to future climate change and incorporate these findings into future designs.

**References**

Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED). 2015. *The 3As: tracking resilience across BRACED*. ODI and UKAid.

Carter, J. and Connelly, A. The University of Manchester: Extreme Weather and Climate Change Impacts, Risks and Adaptation Responses, January 2015

Cavan, G. 2011. Climate change projections for Greater Manchester, version 2. The EcoCities Project.
Available at: http://www.adaptingmanchester.co.uk/documents/climate-change-projections-greatermanchester-version-2

Cole, Raymond J. 2011. "Motivating stakeholders to deliver environmental change." Building Research and Information, 39 (5), pp. 431-435.

Committee on Climate Change. 2016. *UK Change Climate Risk Assessment 2017 Synthesis report: priorities for the next five years*. London: Crown Copyright.

Department for Environment Food and Rural Affairs (DEFRA). 2018. *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*. London: Crown Copyright.

Department for International Development. 2016. *What is resilience?* London: Crown Copyright.

Food Security Information Network (FSIN). 2014. *A Common Analytical Model for Resilience Measurement: Causal framework and methodological options*. Technical Series No. 2. Rome: Food Security Information Network.

Geerdink, T., Willems, R., Bottema, M., Schellekens, E., Knapp, B., Schwingenschloegl, C. 2015. RESIN Actor Analysis for Urban Climate Adaptation. Methods and Tools in support of Stakeholder Analysis and Involvement. Available at: http://www.resin-cities.eu/fileadmin/user_upload/D6.1_Actor_Analysis-V2.pdf

Greater Manchester Combined Authority (GMCA). 2019. 5-Year Environment Plan for Greater Manchester. GMCA, Manchester.

HM Government. 2018. *A Green Future: Our 25 Year Plan to Improve the Environment*. London: Crown Copyright.

Intergovernmental Panel on Climate Change (IPCC). 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. In: Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.) A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

Manchester Climate Change Agency. 2016. Manchester Climate Change Strategy 2017-2050. Manchester Climate Change Agency, Manchester.

Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H. and Stringer, L.C., 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of environmental management*, *90*(5), pp.1933-1949.

Sinek, S. 2015. Start with Why. Available at: https://www.startwithwhy.com/

University of Manchester. *Living Campus Plan*, May 2017. Available at: http://documents.manchester.ac.uk/display.aspx?DocID=33154%20

**Annex 1: Methodology for creating the stakeholder collaboration baseline (PGI1)**

Stakeholders were categorised as to whether they are an INTERNAL stakeholder, a DIRECT stakeholder, or an INDIRECT stakeholder (Figure 1). Stakeholders will be identified by analysing those responsible for responding to extreme weather events in Manchester. In addition, we will identify stakeholders from organisations co-located to the University of Manchester. We will also review groups internal to the university who should be part of any resilience activities. These lists will be cross-checked with the Estates team.

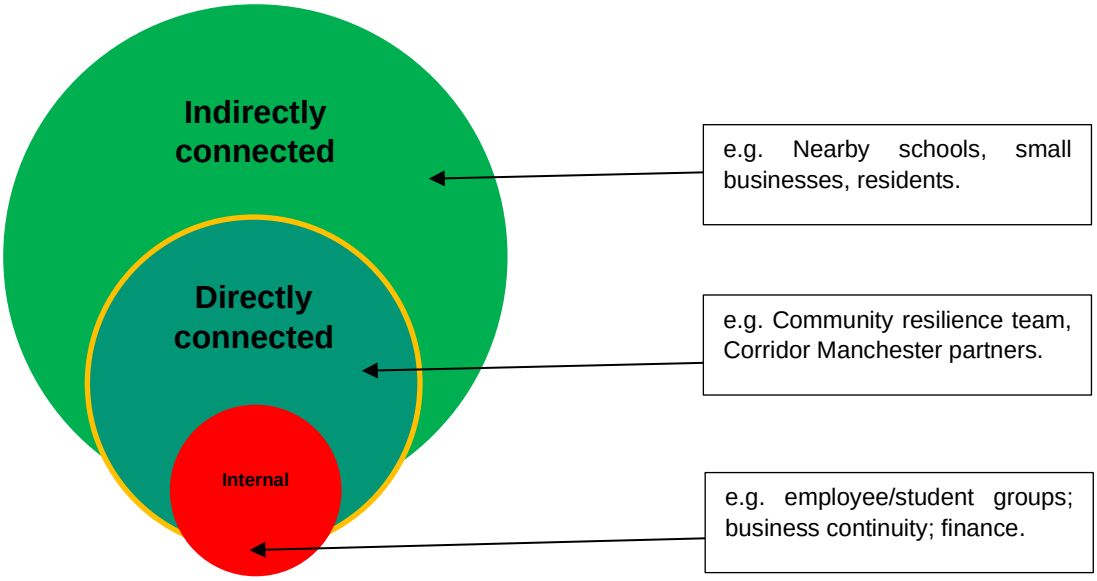



***Figure 13: Diagram showing the relationship of stakeholders to UoM.***

When identified, stakeholders were further analysed in terms of their levels of influence over the resilience of the UoM estate and their level of interest. This was a desk-based and largely subjective analysis. Publicly available internal documentation was analysed to understand a given organisation's role in supporting resilience. Each website or document was searched using the following keywords:

- flood,
- heat,
- climate, and
- resilien*.

Resultant information (even where this was zero) was judged against the following criteria:

- Evidence of identification of weather and climate impacts/risks (current and future)
- Visible policies and strategies on climate change adaptation and resilience
- Defined climate change adaptation/resilience actions
- Wider commitments and areas of activity which could support progress on climate adaptation and resilience.

The review also tried to understand any statutory or non-statutory obligations. All of this information was used to give a score to each organisation based on their relative importance and influence with regards to climate change adaptation and resilience on the UoM estate. In the scoring system, 1 was the least important/influential whilst 5 was the most important/influential. Once the scores were given, each stakeholder could be plotted onto the cross-hairs diagram in Figure 2.

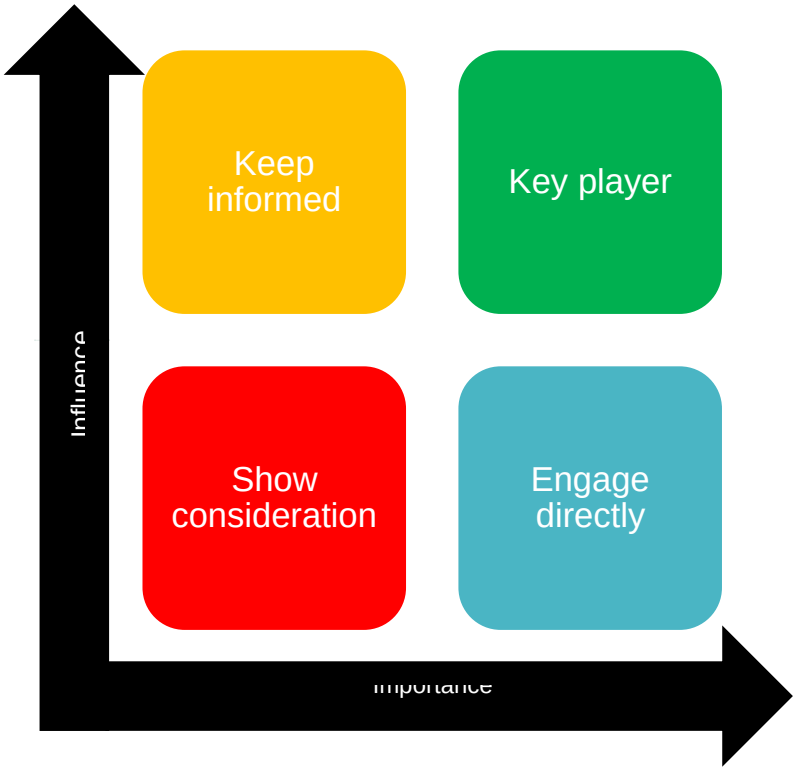



**Figure 2: Levels of influence/importance amongst stakeholders.**

**FINAL OUTPUT**

The final output is an excel spreadsheet that captures the stakeholder, their relationship to UoM, their relative influence and importance (Sheet 1). This will enable the spreadsheet to be updated when necessary.

New stakeholders can be added in, and change over time. Levels of engagement can be tracked against the individual stakeholders (Sheet 3).

**Annex 2: Detailed outline of stakeholder and document analyses (PGI1)**

| Stakeholder | Description | Statutory Duties | Importance ( 1 least important - 5 most important) | Influence (1 least important - 5 most important) | Part of Oxford Road Corridor (Y/N) | Connection | Categorisation |
|---|---|---|---|---|---|---|---|
| Bruntwood | Bruntwood is a major property developer in Manchester. | No | 2 | 4 | Yes | Directly connected | Keep informed |
| Transport for Greater Manchester (TfGM) | Transport for greater Manchester (TfGM) is part of the Greater Manchester Combined Authority with specific responsibilities for coordinating transport across the city including roads, metrolink, and bus travel. | No | 2 | 4 | No | Directly connected | Keep informed |
| Estates staff | The estates staff comprises staff covering a range of different operational issues e.g. sustainability, campus management. | No | 5 | 5 | Yes | Internal to UoM | Key player |
| Senior university leadership | Senior university leadership include the Vice Chancellor, various vice-presidents and deans, as well as the head of finances and human resource management. These people steer the direction of university policy. | No | 5 | 5 | Yes | Internal to UoM | Key player |

| Stakeholder | Description | Statutory Duties | Importance ( 1 least important - 5 most important) | Influence (1 least important - 5 most important) | Part of Oxford Road Corridor (Y/N) | Connection | Categorisation |
|---|---|---|---|---|---|---|---|
| Manchester City Council FRM | Manchester City Council has powers and duties for managing flooding from local sources, namely ordinary watercourses, surface water and groundwater in Manchester. | Yes | 4 | 5 | No | Directly connected | Key Player |
| NHS Manchester | Manchester University NHS Foundation Trust (MFT) is one of the largest acute Trusts in the UK, employing over 20,000 staff. | No | 4 | 3 | Yes | Directly connected | Key player |
| Civil Contingencies and Resilience Unit (and the GM resilience forum) | The Civil Contingencies and Resilience Unit (CCRU), which is part of the Greater Manchester Combined Authority (GMCA) conducts 'emergency planning' on behalf of Manchester City Council.<br><br>The Greater Manchester Resilience Forum (GMRF) is part of CCRU's activities. This partnership of agencies from across Greater Manchester has responsibility for coordinating and overseeing emergency planning. It's overall purpose is to ensure an appropriate level of preparedness for an effective multi-agency response to | Yes | 4 | 5 | No | Directly connected | Key player |

| Stakeholder | Description | Statutory Duties | Importance ( 1 least important - 5 most important) | Influence (1 least important - 5 most important) | Part of Oxford Road Corridor (Y/N) | Connection | Categorisation |
|---|---|---|---|---|---|---|---|
| | emergency incidents which may have significant impact on the communities of Greater Manchester. | | | | | | |
| Greater Manchester Police | Greater Manchester Police (GMP) are the police service covering Greater Manchester and are considered to be first responders during emergency events. | Yes | 3 | 5 | No | Directly connected | Key player |
| Greater Manchester Fire Rescue Service | GM Fire rescue service are considered to be a first responder in an emergency situation. | Yes | 3 | 5 | No | Directly connected | Key player |
| Manchester Business Continuity Forum (Manchester City Council) | The Manchester Business Continuity Forum (MBCF) is a partnership in the city that is a source of free business continuity training, advice and information to help businesses to develop and improve organisational resilience. MBCF will deliver emergency information to its members during an event. Organisations need to sign up to MBCF. | No | 2 | 3 | No | Directly connected | Show consideration |

| Stakeholder | Description | Statutory Duties | Importance ( 1 least important - 5 most important) | Influence (1 least important - 5 most important) | Part of Oxford Road Corridor (Y/N) | Connection | Categorisation |
|---|---|---|---|---|---|---|---|
| Manchester Whitworth Art Gallery | The Manchester Whitworth Art Gallery is an art gallery on Oxford Road, and is part of the University of Manchester | No | 4 | 1 | Yes | Internal to UoM | Engage directly |
| Manchester Museum | The Manchester Museum is a museum on Oxford Road that attracts a large amount of visitors. It is part of the University of Manchester. | No | 4 | 1 | Yes | Internal to UoM | Engage directly |
| Manchester Science Partnerships | Manchester Science partnerships is the UK's leading provider of specialist environments and growth support to science and technology companies on their journey to business success. MSP has a campus facility adjacent to the University of Manchester which offers incubation, laboratory, office and meeting space for businesses. | No | 3 | 1 | Yes | Directly connected | Show consideration |
| Royal Northern College of Music (RNCM) | The RNCM is a world-leading conservatoire with almost 1000 students. The building contains spaces for live music performance). | No | 2 | 1 | Yes | Directly connected | Show consideration |

| Stakeholder | Description | Statutory Duties | Importance ( 1 least important - 5 most important) | Influence (1 least important - 5 most important) | Part of Oxford Road Corridor (Y/N) | Connection | Categorisation |
|---|---|---|---|---|---|---|---|
| Manchester metropolitan University (MMU) | MMU is a university with the All saints campus situated on Oxford Road. | No | 2 | 1 | Yes | Directly connected | Show consideration |
| Stagecoach | Stagecoach buses provide most of the bus services between the city centre and south Manchester. | No | 2 | 3 | No | Indirectly connected | Show consideration |
| Go North West/First Bus | Go North West provide most of the bus services between the city centre and north Manchester. | No | 2 | 3 | No | Indirectly connected | Show consideration |
| Trinity High School | Trinity High School is a co-ed High School located adjacent to the University on Upper Lloyd Street. | No | 2 | 1 | No | Indirectly connected | Show consideration |
| Students + Students Union | There are around 40000 students at the University of Manchester who pay a not insubstantial amount in student fees) | No | 5 | 1 | No | Internal to UoM | Engage directly |
| Staff (General academic, research and support) | More than 12000 people work at the University of Manchester, including around 7000 academics and researchers. | No | 5 | 2 | No | Internal to UoM | Engage directly |

| Stakeholder | Description | Statutory Duties | Importance ( 1 least important - 5 most important) | Influence (1 least important - 5 most important) | Part of Oxford Road Corridor (Y/N) | Connection | Categorisation |
|---|---|---|---|---|---|---|---|
| Business owners on the estate? (AQA, Friska, Takk, Moglai, Blackwell's, Brewdog, etc). | Various business owners are present on the University campus who are not directly employed by the University. | No | 4 | 2 | No | Indirectly connected | Engage directly |
| Student landlords | | No | 4 | 1 | No | Indirectly connected | Engage directly |

**Document Analysis to gauge levels of importance and influence**

| Stakeholder | Evidence of identification of weather and climate impacts/risks (current and future) | Visible policies and strategies on climate change adaptation and resilience | Defined climate change adaptation / resilience actions | Wider commitments which are potentially supportive to progress adaptation and resilience | Overall assessment |
|---|---|---|---|---|---|
| Students + Students Union | None | No | No | No | Students are very important to the university. Some may engage and their may be scope to improve understanding around the issue. This would mainly be to provide risk information where necessary. |
| Staff (General academic, research and support) | None | No | No | Yes | Increasing the resilience of the University campus will help staff to remain productive. There is considerable engagement in this topic in certain academic departments. This can help to spread the message and, particularly, to relay risk. |
| Estates staff | Yes - Landscape Masterplan | Yes | Yes | Yes | The estates department are broadly aware of the issue and this needs to be embedded across all departments. As they have the remit to ensure a resilient campus, this group are very influential and important. |
| Senior university leadership | Very little acknowledgement of climate adaptation and resilience in Strategy | No | No | Yes | There is very influential group and it will be important to gain their support for resilience activities |
| Manchester City Council - Flood Risk management | Directly addresses current pluvial flood management | Yes | Yes | Yes | UoM would need to work to address flood risk management from ordinary watercourses and surface water with MCC in terms of planning and flood risk management functions. They are an important and influential stakeholder. |

| Stakeholder | Evidence of identification of weather and climate impacts/risks (current and future) | Visible policies and strategies on climate change adaptation and resilience | Defined climate change adaptation / resilience actions | Wider commitments which are potentially supportive to progress adaptation and resilience | Overall assessment |
|---|---|---|---|---|---|
| NHS Manchester | Partially - has a heatwave plan | Yes | Yes | Yes | The NHS contains a large site on Oxford Road which connects to the University. They are less important than staff and students and probably less influential than other stakeholders as they will concentrate on their own estate. There is some evidence of planning to cope with extreme weather events. |
| Civil Contingencies and Resilience Unit (and the GM resilience forum) | Very well-developed understanding of flood and heatwave risk | Yes | Yes | Yes | CCRU is very influential and supportive around resilience, flooding in particular. They are of less importance to the University in terms of assets, and so on. |
| Manchester Business Continuity Forum (Manchester City Council) | Some resources for assisting in business continuity for floods | Yes | No | yes | |
| Business owners on the estate? (AQA, Friska, Takk, Moglai, Blackwell's, Brewdog, etc). | Unsure | No | No | No | Business owners are important to the university but seem to have little interest and very little influence. |
| Manchester Whitworth Art Gallery | None (but part of the university so covered elsewhere) | No | No | No | The Whitworth will be part of the university campus masterplan |
| Manchester Museum | None (but part of the university so covered elsewhere) | No | No | No | The Museum will be part of the university campus masterplan |

| Stakeholder | Evidence of identification of weather and climate impacts/risks (current and future) | Visible policies and strategies on climate change adaptation and resilience | Defined climate change adaptation / resilience actions | Wider commitments which are potentially supportive to progress adaptation and resilience | Overall assessment |
|---|---|---|---|---|---|
| Manchester Science Partnerships | No | No | No | No | MSP is of less importance to the university and seem to have little interest and very little influence. |
| Royal Northern College of Music (RNCM) | No | No | No | No | RNCM is of less importance to the university and seem to have little interest and very little influence. |
| Manchester metropolitan University (MMU) | Unclear from strategy | Yes (resilience broadly including a host of non-climate related issues) | No (not visible) | Yes | MMU is of less direct importance to UoM but it would be good to coordinate with them particularly around how they are improving the resilience of their own estate. They will be less influential except in terms of the Manchester Corridor partnership. |
| Bruntwood? | Yes | Not clear from website | Have taken part in tree planting activities | Yes | Bruntwood is of less direct importance to Uom but would be good to coordinate with them. They are receptive to ideas around increasing the resilience of their own estates and are thus influential |
| Transport for Greater Manchester (TfGM) | Yes - not in the Vision 2040 strategy but has been done for flooding and critical assets | No | Partially - reactive after a flood event | Yes | TfGM is of less direct importance to the university but will be important to coordinate with them. Their main focus is on carbon reduction rather than adaptation. They are receptive to the issues but have limited capacity. |
| Stagecoach | None | No | No | No | Stagecoach is of less importance and will be influenced by TfGM |

| Stakeholder | Evidence of identification of weather and climate impacts/risks (current and future) | Visible policies and strategies on climate change adaptation and resilience | Defined climate change adaptation / resilience actions | Wider commitments which are potentially supportive to progress adaptation and resilience | Overall assessment |
|---|---|---|---|---|---|
| Go North West/First Bus | None | No | No | No | Go North West is of less importance and will be influenced by TfGM |
| Student landlords | N/A | N/A | N/A | N/A | Whilst no document was analysed, it is reasonable to assume that landlords are indirectly important in terms of their mediating link with students. However, they are a difficult group to communicate with and would have little influence. |
| Greater Manchester Police | None | No | No | Yes | GMP would be important in the course of an event and are reasonably important and influential in terms of developing business continuity plans |
| Trinity High School | None | No | No | No | THS is of less importance to the university and seem to have little interest and very little influence. |
| Greater Manchester Fire Rescue Service | None | No | No | Yes | GM Fire Rescue Service would be important in the course of an event and are reasonably important and influential in terms of developing business continuity plans |

**Annex 3: Checklist for policy/plan evaluation (PGI2)**

| *Question* | *Score* |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | |
| *Section score (out of 10)* | |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | |
| *Section score (out of 30)* | |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-3** award 10 points, for **3>** award 15 points. | |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | |

| | |
|---|---|
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | |
| *Section score (out of 30)* | |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (e.g. the probability of a hazard or ambiguity as to what parts of the campus might be impacted) (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (where in the risk management process is there uncertainty e.g. system boundary, conceptual model, input variables, data (statistical or observational)) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | |
| **OVERALL SCORE (out of 140)** | |

**Annex 4: Individual plan/policy scores from August 2019 (PGI2)**

*Manchester 2020: The University of Manchester's Strategic Plan*

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 5 |
| 2. Does the policy/plan cover climate change related issue? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 0 |
| *Section score (out of 10)* | 5 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 0 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, extreme heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points and move on to next section. | 0 |
| 5. Once identified, how does the policy analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | |
| *Section score (out of 30)* | 0 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to next section. | 10 |
| 7. Does the policy/plan consider a number of different future climate scenarios? For two climate scenarios to be considered different they need to be distinct by way of their focus on a different combination of key factors (e.g. different political climates, the number of climate-related extreme weather events) and a clearly differentiated structure and message (e.g. best- and worst-case scenarios). For **0** clearly defined | 0 |

| | |
|---|---|
| climate scenarios award 0 points, for **1** award 5 points, for **1-3** award 10 points, for **3>** award 15 points. | |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | 0 |
| *Section score (out of 35)* | 10 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC DETAIL GIVEN (5 points), GENERAL ACTIONS/MEASURES (10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (20 points)? | 10 |
| *Section score (out of 30)* | 20 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 11, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |

| | |
|---|---|
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 35 |

**Unweighted score:** 35/140

**Strongest performing area:** Identification of actions/measures

**Weakest performing area:** Planning for changes in weather and Consideration of uncertainty

Clearly identifies climate change as an area of concern impacting across “all of our key activities”.

Fails to engage explicitly with changes in weather, neither extreme nor gradual.

Talks generally about future climate change and the need to be ‘adaptable’ but fails to explicitly identify any future climate scenarios within which the University may have to operate.

Identifies some general measures and actions (e.g. Enabling Strategy 2: World-class estate) to respond to future climate change, but these are not specific to any particular climate-related risk.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University to meet its goals and fulfil key functions.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 5 |
| 2. Does the policy/plan cover climate change related issue? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 0 |
| *Section score (out of 10)* | 5 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, extreme heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 5. Once identified, how does the policy analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 5 |
| *Section score (out of 30)* | 25 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to next section. | 10 |
| 7. Does the policy/plan consider a number of different future climate scenarios? For two climate scenarios to be considered different they need to be distinct by way of their focus on a different combination of key factors (e.g. different political climates, the number of climate-related extreme weather events) and a clearly differentiated structure and message (e.g. best- and worst-case scenarios). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-3** award 10 points, for **3>** award 15 points. | 5 |

| | |
|---|---|
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | 0 |
| *Section score (out of 35)* | 15 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC DETAIL GIVEN (5 points), GENERAL ACTIONS/MEASURES (10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (20 points)? | 10 |
| *Section score (out of 30)* | 20 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 11, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |

| | |
|---|---|
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 65 |

**Unweighted score:** 65/140

**Strongest performing area:** Planning for changes in weather

**Weakest performing area:** Consideration of uncertainty

Clearly identifies climate change adaptation under its 'key theme' of 'a sustainable campus'.

Engages well with future changes in weather, specifying clearly that the urban heat island (UHI) effect and increased incidences of intense rainfall should be incorporated into planning for 'a future campus'.

The identification of an increased UHI effect and pluvial flood risk depict a vaguely defined future climate scenario in which a future campus would operate. No other future climate scenarios are considered.

Identifies some general measures and actions (e.g. avoiding easy to block grating, soft landscaping and tree planting) to respond to future climate change. However, climate change is not integrated into other thematic areas, meaning that these measures are isolated. They are not connected up to, for example, the document's strategic focus on the connectivity and accessibility of the campus.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University campus to meet its goals and fulfil key functions.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 0 |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 5 |
| *Section score (out of 10)* | 5 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 0 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 0 |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 0 |
| *Section score (out of 30)* | 0 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | 0 |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-2** award 10 points, for **3≥** award 15 points. | |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | |

| | |
|---|---|
| *Section score (out of 35)* | 0 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | 10 |
| *Section score (out of 30)* | 20 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty i.e. where in the risk management process e.g. system boundary, conceptual model, input variables, data (statistical or observational)) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 25 |

**Unweighted score:** 25/140

**Strongest performing area:** Identification of actions or measures

**Weakest performing area:** Planning for changes in weather, Scenario planning and analysis, Consideration of uncertainty

Does not list climate change adaptation as a strategic priority area but does include reference to work surrounding the Fire Safety and Disability Discrimination Act. Accessibility and emergency response are likely to be increasingly important to the delivery of adaptation and resilience measures such as green infrastructure.

Fails to engage explicitly with changes in weather, neither extreme nor gradual.

No future climate scenarios are considered.

Refers to a 'future package of works to ensure our campus is more accessible' and 'improvements to back-up power supplies' under its 'Other campus-wider project projects and long-term maintenance' theme. These general actions indicate that long-term improvements in emergency planning and campus accessibility are being prioritised. However, these measures are not linked to any climate change risks.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University campus to meet its goals and fulfil key functions.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 5 |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 5 |
| *Section score (out of 10)* | 10 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 10* |
| *Section score (out of 30)* | 30 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | 10 |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-2** award 10 points, for **3≥** award 15 points. | 5 |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | |

| | |
|---|---|
| *Section score (out of 35)* | 15 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | 20 |
| *Section score (out of 30)* | 30 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty i.e. where in the risk management process e.g. system boundary, conceptual model, input variables, data (statistical or observational)) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 95 |

*refers back to the 'Extreme Weather and Climate Change Impacts, Risks and Adaptation Responses' document which undertook this systematic risk assessment

**Unweighted score:** 95/140

**Strongest performing area:** Identification of actions or measures

**Weakest performing area:** Consideration of uncertainty

Clearly identifies climate change adaptation as a 'direct benefit' of green infrastructure and why the 'design of buildings and the inclusion of green infrastructure' 'matter' to the University.

Explicitly recognises predicted changes in weather as a result of a changing climate as well as the risks and opportunities flood and heat hazards pose to the University campus. Makes use of the systematic risk assessment undertaken as part of the 'Extreme Weather and Climate Change Impacts, Risks and Adaptation Responses' report.

Considers a future climate scenario, following the previously mentioned report, incorporating this into its strategic framework for addressing climatically induced hazards of flooding and heat stress. However, this is based on one vaguely defined future scenario in which flood risk 'intensifies' and the risk of heat stress 'increases'. No other scenarios are considered, and no form of scenario analysis is employed.

Identifies a range of specific measures targeted to particular locations. Draws on existing research and guidance to connect its strategic priorities for the campus to the University's evidence bases.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University campus to meet its goals and fulfil key functions.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 5 |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 5 |
| *Section score (out of 10)* | 10 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 5 |
| *Section score (out of 30)* | 25 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | 10 |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-3** award 10 points, for **3>** award 15 points. | 5 |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | 0 |

| | |
|---|---|
| *Section score (out of 35)* | 15 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | 10 |
| *Section score (out of 30)* | 20 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 70 |

**Unweighted score:** 70/140

**Strongest performing area:** Planning for changes in weather

**Weakest performing area:** Consideration of uncertainty

Clearly identifies that buildings must be 'designed to be adaptable to the predicted impacts of climate change' under its 'Sustainability' standard.

Explicitly recognises predicted changes in weather as a result of a changing climate as well as the risks and opportunities flood and heat hazards pose to the University campus. Specifies target of a 'climate resilience report' under its 'Environmental Sustainability Project Tracker' to detail impacts of these stresses on 'all critical services' through specific predictions of 'hours of future summertime overheating' and 'flood risk that addresses predicted impact of climate change'. This type of systematic risk assessment is not present in the document currently.

Considers a future climate scenario in which the risk of heat stress and flooding has increased but does not consider multiple scenarios, nor does it employ a form of scenario analysis. As part of the previously mentioned target, any 'Climate resilience report' should 'include hours of future summertime overheating' up until 'at least 2050s climatic projects'.

In addition to this 'Climate resilience report' measure, this code of practice also ensures that building designs have incorporated questions regarding climate adaptation. Under its 'Tracker Lite Guidance' project managers must 'consider the projects ability to adapt to future changes in climate' and specifies 'SUDs' and 'landscaping' as potential measures.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University campus to meet its goals and fulfil key functions.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 0 |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 5 |
| *Section score (out of 10)* | 5 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 10 |
| *Section score (out of 30)* | 30 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | 0 |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-3** award 10 points, for **3>** award 15 points. | 0 |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | 0 |

| | |
|---|---|
| *Section score (out of 35)* | 0 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | 20 |
| *Section score (out of 30)* | 30 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 60 |

**Unweighted score:** 65/140

**Strongest performing area:** Identification of actions or measures

**Weakest performing area:** Scenario planning and analysis, Consideration of uncertainty

Does not make specific reference to climate change adaptation but does identify the issues of the 'urban heat island effect' and 'surface water discharge' as key 'benefits' of green roofs. Both of these impacts are directly associated with future climate change.

Explicitly recognises predicted changes in weather as a result of a changing climate as well as the risks and opportunities flood and heat hazards pose to the University campus. Relating to the UHI effect and flood risk from surface water discharge, the documents refers back to previous studies which have undertaken risk assessments.

As it does not specifically reference climate change, explicit or indirectly referenced future climate scenarios are not considered or used.

While not specifically related to the impacts of climate change, this document does identify a range of green roof measures targeted to particular locations. Draws on existing research and guidance to connect its strategic priorities for the campus to the existing green infrastructure evidence bases. Sets out specific procedures to be followed for the design, construction, installation, maintenance and monitoring of green roofs. Also lists survey results for individual buildings across campus indicating where green roofs can and cannot be considered.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University campus to meet its goals and fulfil key functions.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 5 |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 5 |
| *Section score (out of 10)* | 10 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 10 |
| *Section score (out of 30)* | 30 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | 10 |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-2** award 10 points, for **3≥** award 15 points. | 15 |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | 10 |

| | |
|---|---|
| *Section score (out of 35)* | 35 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | 20 |
| *Section score (out of 30)* | 30 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | 10 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty i.e. where in the risk management process e.g. system boundary, conceptual model, input variables, data (statistical or observational)) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | LEVELS, POSITION, NATURE<br>15 |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | 0 |
| *Section score (out of 35)* | 25 |
| **OVERALL SCORE (out of 140)** | 130 |

**Unweighted score:** 130/140

**Strongest performing area:** Scenario planning and analysis

**Weakest performing area:** Consideration of uncertainty

Clearly identifies climate change adaptation as a key target for UoM in the maintenance of its campus and fulfilment of key functions. Identifies specific climatic risks of extreme weather events.

Explicitly recognises predicted changes in weather as a result of a changing climate as well as the risks and opportunities flood and heat hazards pose to the University campus. This is supported by a systematic risk assessment of heat and flood hazards and their potential impacts upon UoM infrastructure.

Multiple future climate scenarios are considered and used as part of an overall analysis.

Identifies a range of specific measures targeted to particular locations in accordance with the predicted and probable incidences of heatwaves and floods.

Considers the uncertainties associated with the predicted impacts it identifies in its measures of probability while also considering different types of uncertainty. Fails to consider the potential impacts of this uncertainty on its suggested measures.

| ***Question*** | ***Score*** |
|---|---|
| **SECTION 1: Introducing climate change as an issue in need of attention** | |
| 1. Does the policy/plan mention climate change (YES or NO)? If YES award 5 points and move on to Section 2, if NO award 0 points and move on to question 2. | 5 |
| 2. Does the policy/plan cover climate change related issues? Climate changed related issues cover mention of the environment and related themes (e.g. sustainability), changes in weather, disaster risk and response, and emergency planning. If YES award 5 points, if NO award 0 points | 5 |
| *Section score (out of 10)* | 10 |
| **SECTION 2: Planning for changes in weather** | |
| 3. Does the policy/plan identify future trends in weather (e.g. hotter summers, increased rainfall) (YES or NO)? If YES award 10 points, if NO award 0 points. | 0 |
| 4. Does the policy/plan identify potential extreme weather events (e.g. flooding, heatwaves) (YES or NO)? If YES award 10 points, if NO award 0 points. | 10 |
| 5. Once identified, how does the policy/plan analyse/interpret these trends and/or extreme weather events? Does it consider SOME GENERAL RISKS (5 points), has it undertaken a SYSTEMATIC IMPACT/RISK ASSESSMENT (10 points), or does it perform NO OBVIOUS ANALYSIS/INTERPRETATION (0 points)? | 0 |
| *Section score (out of 30)* | 10 |
| **SECTION 3: Scenario planning and analysis** | |
| 6. Does the policy/plan consider future climate change scenarios (YES or NO)? If YES, award 10 points and move on to question 7. If NO, award 0 points and move on to Section 4. | 0 |
| 7. Does the policy/plan consider a number of different future climate scenarios? Climate scenarios will usually differ according to greenhouse gas emissions levels and future time period considered (e.g. 2050s, 2080s). For **0** clearly defined climate scenarios award 0 points, for **1** award 5 points, for **1-2** award 10 points, for **3≥** award 15 points. | |
| 8. Does the policy/plan employ a form of scenario analysis (YES or NO)? Consult the Task Force on Climate-related Financial Disclosures' (TCFD) guidance (see: https://www.tcfdhub.org/home/scenario-analysis) if there is uncertainty as to what constitutes a scenario analysis. If YES, award 10 points, if NO award 0 points. | |

| | |
|---|---|
| *Section score (out of 35)* | 0 |
| **SECTION 4: Identification of actions or measures** | |
| 9. Does the policy/plan include any reference to proposed actions or measures to counteract the risks it identifies (YES or NO)? If YES award 10 points and move on to question 10, if NO award 0 points and move on to the next section. | 10 |
| 10. In specifying the need for climate change related actions or measures, does the policy/plan make reference to or propose a NEED FOR ACTION/MEASURES BUT WITH NO SPECIFIC ACTIONS DEFINED (award 5 points), GENERAL ACTIONS/MEASURES (award 10 points) or SPECIFIC ACTIONS/MEASURES TARGETED TO PARTICULAR LOCATIONS (award 20 points)? | 20 |
| *Section score (out of 30)* | 30 |
| **SECTION 5: Consideration of uncertainty** | |
| 11. Does the policy/plan consider the uncertainties associated with the climate change impacts/risks it identifies (YES or NO)? If YES award 10 points and move on to question 12, if NO award 0 points and end review. | 0 |
| 12. How does the policy/plan characterise the uncertainties that it identifies? This can be in terms of LEVELS (low, medium or high) (5 points), POSITION (at what point in the climate resilience model is there uncertainty i.e. where in the risk management process e.g. system boundary, conceptual model, input variables, data (statistical or observational)) (5 points) or NATURE (limited knowledge, variability of human or natural systems, difference in framings, language (Döll and Romero-Lankao, 2016)) (5 points). Indicate one or more of the capitalised characteristics in 'Response' and add their scores together. | |
| 13. Is uncertainty modelled into the recommendations or actions/measures that the policy/plan proposes (YES or NO)? If YES award 10 points, if NO award 0 points. | |
| *Section score (out of 35)* | 0 |
| **OVERALL SCORE (out of 140)** | 50 |

**Unweighted score:** 50/140

**Strongest performing area:** Identification of actions or measures

**Weakest performing area:** Scenario planning and analysis, Consideration of uncertainty

Explicitly recognises climate change adaptation as a key benefit of tree planting in relation to 'rainwater interception' and 'shade/evaporative cooling'.

Does not explicitly recognise predicted trends in weather nor does it make use of any form of risk assessment (it does however refer to the 'Extreme Weather and Climate Change Impacts, Risks and Adaptation Responses' report which does include these assessments. It does however identify specific risks of flooding and heat stress which are directly associated with future climate change.

No future climate scenarios are considered.

Identifies a range of specific measures targeted to particular locations. At points, these measures are related to the UHI effect and suggestions of particular tree species 'better equipped to deal with 'hot sites'' as well as positions for trees in relation to sunlight are made.

Fails to consider the uncertainties associated with climate change and how these might impact upon the ability of the University campus to meet its goals and fulfil key functions.