SCORCHIO

Sustainable Cities: Options for Responding to Climate cHange Impacts and Outcomes

WP3 Workshop Report

Draft 1

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1. INTRODUCTION

The Sustainable Cities: Options for Responding to Climate cHange Impacts and Outcomes (SCORCHIO) is a consortium project funded by the Engineering and Physical Sciences Research Council (EPSRC). The project, lead by the University of Manchester, was begun in 2007 and will run until 2010. The ultimate aim of the research is to develop tools for analysis of adaptation options in urban areas, with a particular emphasis on heat and human comfort in the built environment. In order to fulfil this aim, the project will address the following five objectives:

1. To develop a statistical climate simulator for urban areas that can be used for impact and adaptation studies, taking account of both "greenhouse" climate change and the additional influence of the urban landscape and direct heating.
2. To model typical buildings and their surroundings in order to develop a new, readily usable heat and human comfort vulnerability index that accounts for the effects of building construction, form and layout.
3. To estimate heat emissions from buildings, together with a set of energy-related air pollutant and greenhouse gas end user emission budgets in order to understand the implications of different building adaptation options.
4. To develop GIS-based decision support tools for exploration of adaptation options for urban planning and design.
5. To demonstrate the methods and tools developed in each work package through in depth case studies, working in partnership with practicing planners and designers.

The work has been organised into three work packages. The first work package (WP1) is centred on a detailed investigation of present and future urban temperatures. The second (WP2) uses this information to model and assess impacts and adaptation. The final work package (WP3) focuses on vulnerability assessment and the development of options appraisal tools for planners and designers. The tool will synthesise the results from the earlier SCORCHIO research (WP1 and 2) in prototype GIS-based decision support modules (*see* Box 1).Stakeholder engagement is central to the project and meetings with a core stakeholder group are held on a 6-monthly basis. Work is being carried out using Greater Manchester and Sheffield as case study cities.

Work package 3 began at the end of 2007 and is now beginning the process of drawing together initial findings from WPs 1 and 2. This report documents the findings from a workshop held in March 2008 with the core stakeholder group and a range of other key stakeholders. The purpose of the workshop was to assist with answering a number of key questions about the form and function of the decision-support tools to be developed through the project.

The workshop was broken down into 5 parts with the aim of answering the following specific questions:

1. What are the general aims and scope of the SCORCHIO decision support tool?
2. What do stakeholders require the SCORCHIO tool to provide?
3. What tools already exist and how appropriate are these tools for adapting to heat-related issues facing UK cities?
4. What city-scale scenarios need to be considered in the development of the SCORCHIO tool?
5. Where should local and neighbourhood work be carried out and what types of adaptation options should be considered?

A number of briefing documents were produced ahead of the meeting and the workshop itself consisted of presentations, plenary discussions and break-out group sessions. A list of the participants is given in Appendix 1.

Box 1: SCORCHIO Project Structure

Work Package 1: Downscaling of climate variables for urban areas

Task 1.1 Hadley Model runs for city-scale urban climate assessment

Deliverable: A parameterised family of HadRM3 runs fully consistent with the UKCIP08 runs with the added feature of urban processes, that can be used to assess the effect of changing land cover and anthropogenic heat sources on the urban climate.

Task 1.2 Temporal downscaling of weather variables

Deliverable: Stochastic weather generator hourly outputs of temperature, solar radiation and windspeed, vapour pressure and precipitation.

Task 1.3 Spatial patterns of temperature in urban areas

Deliverable: A database of spatial distributions of temperature for Manchester and Sheffield and methodology for generating future scenarios of urban temperature.

Work Package 2: Modelling impacts and adaptation of the built environment

Task 2.1: Classification of buildings and urban land cover

Deliverable: A building classification methodology for urban impacts assessments with validation in Manchester and Sheffield.

Task 2.2: Thermal modelling of the built environment and vulnerability index

Deliverables: 1. A model for assessment of the impacts of climate change on buildings, within their urban context; 2. A vulnerability index for rapid assessment of urban areas on the basis of building classification and urban climate scenarios.

Task 2.3: Estimation of emissions of heat and energy-related end user air pollutant and greenhouse gas emission budgets associated with buildings

Deliverable: Methods for the assessment of combined end user air pollutant, heat and GHG emissions budgets associated with different building adaptation options.

Work Package 3: Vulnerability assessment and options appraisal tools for planners and designers

Task 3.1: Visualisation of heat scenarios and vulnerability at a city scale

Deliverable: A city-scale GIS for examining scenarios of urban heat and vulnerability to climate change

Task 3.2: Prototype built environment adaptation options appraisal tools

Deliverables: A specification and prototype modules for a formal decision support tool based on GIS outputs, model results, and other project deliverables which will allow the exploration of optimal adaptation options for urban planning and design.

Task 3.3: Case studies of adaptation of the built environment

Deliverable: Two case studies, co-developed with practicing planners and designers in Manchester and Sheffield, to reveal the potential impact of climate change on heat and comfort for building occupants in an area of the city and adaptation options to render the area less vulnerable to future changes in urban temperatures.

2. PART 1: What are the general aims and scope of the SCORCHIO decision-support tool? (Sarah Lindley)

The first presentation gave a brief overview of Work Package 3, outlining the objectives for the 3 sub-tasks (see Box 1) and providing details of the three levels of information it is anticipated the tool will provide: City-scale, Neighbourhood-scale and Building-scale. As part of this presentation there was an indication of the elements of the SCORCHIO tool which are considered to be largely fixed and those where there is more flexibility (Table 2). It is these

latter, more flexible elements that the views and inputs of the stakeholder group will help to shape. The proposed framework for the SCORCHIO tool is given in Figure 1.

Table 2: Characteristics of the SCORCHIO tool

CHARACTERISTIC	DETAILS
Fixed Elements	
Geographical scope	Greater Manchester; Sheffield
Use of urban morphology framework	Greater Manchester has been classified into 29 land use categories, which are compatible with the National Land Use Database, as part of the earlier ASCCUE (Adaptation Strategies for a Changing Climate in the Urban Environment) project.
Thematic focus	Heat and thermal comfort in the urban environment
Some aspects of climate model runs	Greenhouse gas emissions scenario A1B[1] will be used for all underlying urban heat island simulations (see Part 4).
GIS framework	The tool will be developed within the GIS environment.
Flexible Aspects	
Some aspects of climate model runs	The contribution of anthropogenic heating, the proportional change of land use (% vegetation, bare soil, water, urban) and/or surface properties (e.g. reflectivity of solar radiation, storage of heat by urban structures) can all be altered to examine future development changes on a city-scale.
Case study areas	3-4 case study areas each for Manchester and Sheffield, selected from those nominated by stakeholders (see Part 5), will provide the basis for the neighbourhood/building scale modelling.
Content and form of data outputs	Which variables (climate, emissions and energy use) and how should they be presented.
User-based preferences	Any additional functionality or information the tool should provide? What adaptation options should be considered?

The SCORCHIO tool was seen as a useful way of 'optioneering', e.g. providing options to compensate for high density developments which are/could be vulnerable to high temperatures. It was also raised that the SCORCHIO tool covers just one aspect of a whole range of variables associated with climate change. The importance of other issues such as transport and flooding was stressed and although it was recognised that the tool is

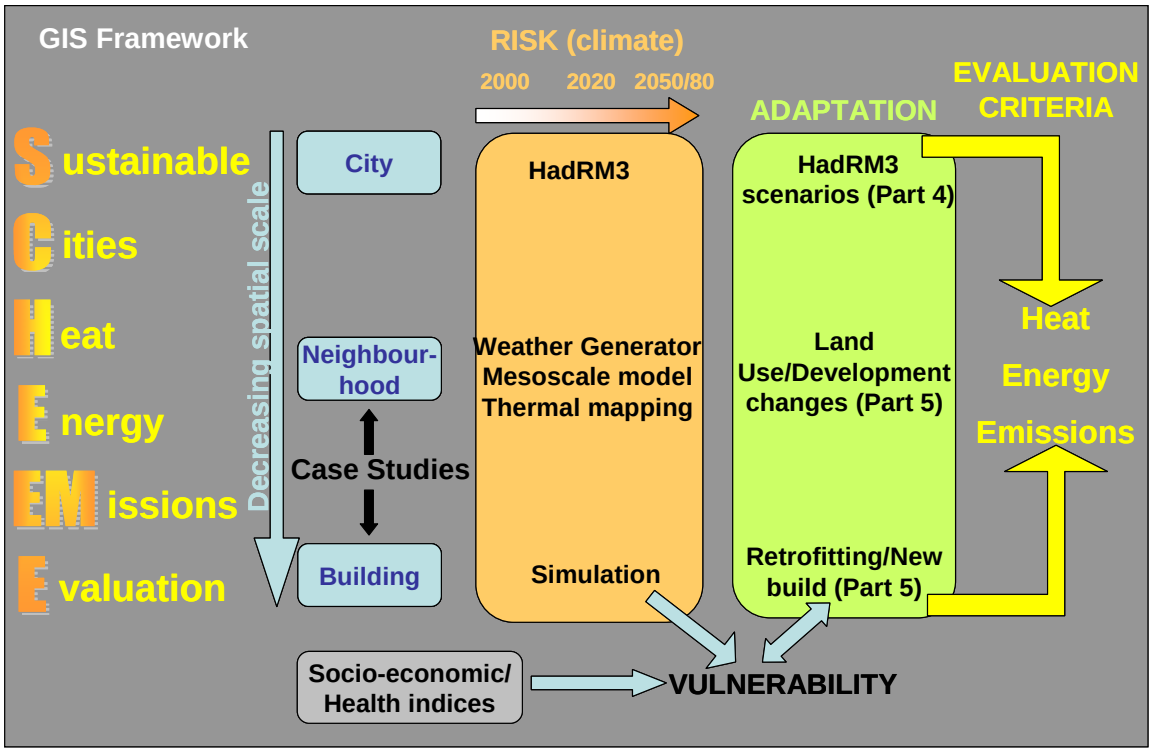
[1] See Briefing Document 1.1

necessarily focussed on urban temperatures, there were requests to consider wider compatibility of the results with other tools focusing on these other elements.

There was some discussion about how the fixed spatial urban morphology units link with OS MasterMap data and Middle/Lower Super Output Areas. Work is currently ongoing at Newcastle, as part of the SCORCHIO project, to refine the existing urban morphology units using the automated disaggregation of OS MasterMap data. Although some output could be generated for Super Output Areas (SOAs), it was noted that this geographical framework would not be suitable for all of the SCORCHIO outputs as the SOAs are determined according to population rather than land use.

There was some concern that the fixed spatial units may become quickly outdated due to ongoing development in Manchester. This is particularly important in terms of case study area selection and is discussed under Part 5. Other suggestions were that a similar process of Local Authority auditing of results could take place as that undertaken as part of the Adaptation Strategies to Climate Change in the Urban Environment (ASCCUE) project.

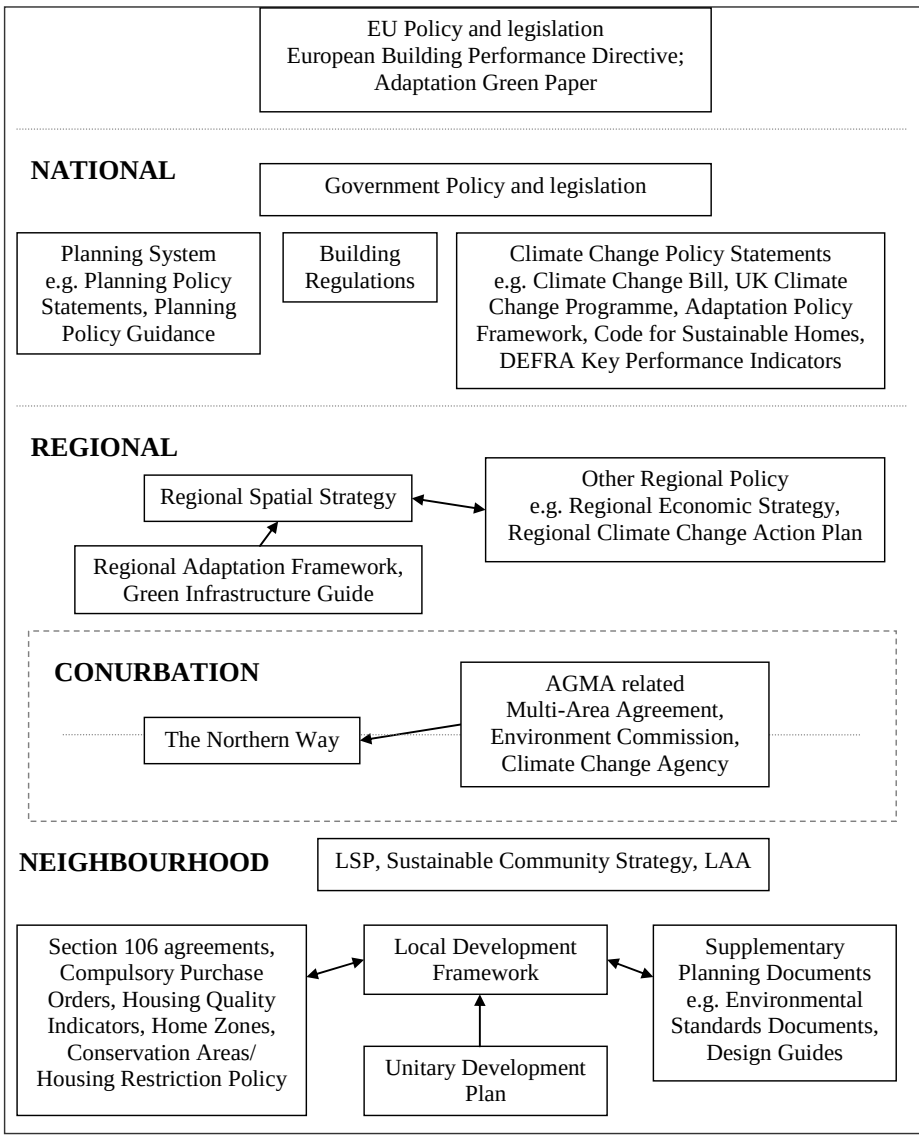
Figure 1: Framework for the SCORCHIO decision support tool



3. PART 2: What do stakeholders require the SCORCHIO tool to provide? (John Handley)

Part 2 began with an overview of the policy context for the development of the SCORCHIO tool. A summary of some of the major policy drivers at EU, national, regional, conurbation and neighbourhood scales was provided (see Figure 2). This presentation highlighted the potentially large policy grounding for SCORCHIO and its associated tools. Indeed it was noted that there were still additional policy elements which could be added to Figure 2 dealing with energy policy, building regulations and other related areas such as transportation policy.

Figure 2: Climate Adaptation to the Urban Heat Island: Policy Context



Although many welcomed the idea of tailoring research findings to wider policy goals, some concerns were raised about the difficulties in matching scientific outputs with the very directed information requirements of, for example, Local Authority policy. It was recognised that there is a gap between what is being learnt from scientific research and the sort of information that stakeholders are being asked to provide. Furthermore, there is a limit to what sort of information science can currently provide and the format that this information can be provided in, for example associated with the scale and coverage of findings.

There was discussion about how the SCORCHIO outputs and associated tools could feed into the national performance indicators. LAs have to select a subset of appropriate indicators from those available and will be required to provide self certification regarding their performance in relation to each selected indicator. The most relevant indicator for SCORCHIO is NI 188: Adapting to climate change, but there are also possible links with some of the other indicators (see Table 3). It was also noted that several other indicators

would have some relevance, such as those associated with transportation (for example, with respect to the impact of anthropogenic heat emissions in the urban environment).

The SCORCHIO work could also have implications for alleviating/identifying areas of fuel poverty. The research team mentioned that some thermal mapping work had taken place during winter 2007/08 which could potentially be used to help provide information for this purpose.

The point was also raised that while changes to the City Region Governance include the work of the Environment Commission who are responsible for delivering carbon reduction initiatives such as mini-Stern and Manchester is my Planet, there is also a separate Planning and Housing Commission responsible for Place Shaping / the Spatial planning agenda. It is this commission who will be leading on the production of a Sub Regional Spatial Strategy and who are currently leading and project managing work such as the Greater Manchester Strategic Flood Risk Assessment and the Green Infrastructure work with TEP Consultancy.

Table 3: National Indicators related to the SCORCHIO project

NATIONAL INDICATOR	CALCULATION	LINKS TO SCORCHIO
185:CO2 reduction from Local Authority operations	$\left(\frac{x_{t+1} - x_t}{x_t}\right)*100$ x_{t+1} = amount of CO_2 emission in year t+1 x_t = amount of CO_2 emission in year t	Buildings within case study areas might be simulated under different adaptation options which will provide energy consumption and emissions output. This could then feed into plans for adaptation of council buildings.
186: Per capita CO2 emissions in the LA area	$\left(\frac{\left(\frac{h_t + b_t + r_t}{pop_t}\right) - \left(\frac{h_{t+n} + b_{t+n} + r_{t+n}}{pop_{t+n}}\right)}{\left(\frac{h_t + b_t + r_t}{pop_t}\right)}\right)*100$ h = tonnes CO_2 from domestic housing b = tonnes CO_2 from business and industry r = tonnes CO_2 from road transport pop = LA population (thousands) t = baseline year (2005) $t + n$ = latest year of data	Buildings within case study areas might be simulated under different adaptation options in order to provide a measure of energy consumption and end-user per capita CO_2 emissions. These results could feed into plans for adaptation of buildings.
187: Tackling fuel poverty	$\left(\frac{x}{y}\right)*100$ x = number of households assessed on income related benefits who are in energy inefficient homes (SAP rating < 30) y = number of households on income related to benefits for whom a SAP assessment has been carried out.	The SCORCHIO outputs are not directly related to the calculation of the fuel poverty indicator. However, information could be provided to show winter urban temperature patterns and future trends associated with the SCORCHIO scenarios. It is also possible that the vulnerability indices may provide useful information for the assessment of fuel poverty vulnerability.
188: Adapting to	Authorities report level they have reached as	This is the main focus of

climate change	follows: Level 0: The authority has not assessed and managed climate risks and opportunities. Level 1: The authority has undertaken a comprehensive, local risk-based assessment of current vulnerabilities to weather and climate, both now and in the future. It has developed possible adaptation responses explicitly related to other relevant council strategies, plans, partnerships etc Level 2: The authority has identified the most effective adaptation responses to address the risks and opportunities, explicitly related to other council strategies, plans and operations. This will yield a set of locally specific, preferred options. Level 3: The authority has developed an adaptation action plan to deliver necessary steps to achieve the existing objectives set out in council strategies, plans etc in light of projected climate change. Level 4: The authority has implemented an adaptation action plan, and a process for monitoring and review to ensure progress with each measure.	SCORCHIO. Outputs from SCORCHIO would relate to Level 2 which the authority can then use to progress to Levels 3 and 4.

4. PART 3: What tools already exist and how appropriate are these tools for adapting to heat-related issues facing UK cities? (Claire Smith)

This question was tackled through providing an initial presentation of the various tools identified through a review of appropriate academic and grey literature sources. The findings of this review were summarised in Document 3.1 (see Appendix 3). The presentation introduced several tools associated with the three spatial scales covered in the SCORCHIO project (City, neighbourhood and building). It was noted that tools were developed across a range of platforms and had different aims and objectives. Participants were then given the opportunity look more closely at three selected tools through a hands-on session (Table 4). Finally, participants were asked to evaluate the tools using a prepared questionnaire and feedback general comments (Table 5). The findings from these sessions will be used to help determine the form and function of the SCORCHIO tools.

A second questionnaire asked participants to consider the general characteristics of the SCORCHIO tool, its data requirements, output formats and platforms. A summary of findings is given in Appendix 3.

Table 4: Tools demonstrated in the hands-on breakout groups

Group	Tool	Spatial Scale	Platform	Details
1	MIST	City	Web-based	Sailor & Dietsch (2007). Freely available from: http://www.heatislandmitigationtool.com/
2	CITYGreen	Neighbourhood	GIS	More details available from: http://www.americanforests.org/ productsandpubs/citygreen/
3	AUSSM	Building	Fortran program with GUI	Tanimoto et al (2004). Freely available from: http://ktlabo.cm.kyushu-u.ac.jp/

Table 5: Evaluation of Existing Tools. Each column relates to an individual response.

AUSSM	AUSSM	AUSSM	AUSSM	AUSSM	AUSSM	CITYGreen	CITYGreen
4 4 1 3	4 5 3 4	3 3 2 5	3 4 2 3	3 3 1 3	3 2 1 4	4 2 4 3	3 3 4 4
Yes	Don't know	Yes	Yes	Yes	Yes	Yes	Yes
% change/ Graphs 2 1 1 1 3d-models		Raw data/ Graphs 1 1	Raw data/ Graphs 4 3	Raw data/ Graphs 1 3 1 1	Raw data/ Graphs 4 2	Raw data/ Graphs 3 3	% change 2 2 1 1
City-scale temp and windspeed				Costs of climate impacts/ adaptation	Energy consumption		
Quick, simple				Very fast, looks good	Fast	Links in with current systems	Good overall concept
Cannot define building context		Used technical language		Limited help, undefined terms	Potential for users to run rmodel	Not very user-friendly	Seemed complicated
Design variables would be useful						Would require training	
No	No	Maybe	Maybe	Maybe	Yes, to link with other aspects e.g flooding	No	MAybe

Tool Evaluated	MIST	MIST	AUSSM
Please rate the following criteria on a scale of 1-5:			
Ease of use	1	2	3
Flexibility	3	4	4
Speed	1	5	3
Clarity of Results	2	3	2
Do the inputs seem feasible?	Don't know	Yes	No
How were the results presented?	Other	Raw Data	Graphs
To what extent is data in this format useful			
Raw data	1		
% change	1		
Maps	1		
Graphs	1		
Other (Specify)			
Are there any other output variables that would be useful to your organisation?		Carbon emissions, energy data	
Is there anything in particular that you liked about the tool?			Simple
Is there anything in particular that you disliked about the tool?		Too general	
Any Additional comments about the tool?		Not enough localised data	Needs to be user-friendly
Would this tool be useful in your organisation?	Maybe	Maybe – to give a generalised idea of strategy	Yes,in the context of the sustainable communities

5. PART 4: What city-scale scenarios need to be considered in the development of the SCORCHIO tool? (Doc 4.1) (Mark McCarthy): SCORCHIO climate model simulations

This session comprised an overview of the three proposed Hadley Centre Regional Climate Model experiments being carried out as part of the SCORCHIO project. These will form the basis for development of the city-scale scenarios (using a weather generator and additional spatial interpolaton techniques) and will complement the scenario runs undertaken as part of UKCIP08.

- Experiment 1: Greenhouse gas induced transient climate change; anthropogenic heating from current energy statistics; current land use classification.
- Proposed Experiment 2: As Experiment 1 with gradually increasing anthropogenic heating (change from 25 Wm^{-2} to 75 Wm^{-2})
- Proposed Experiment 3: To be decided

This overview was followed by a plenary discussion. In this, several points were raised which will help the research team decide on an appropriate design for Experiment 3 and to reassess the proposed Experiment 2.

- whether gradual changes over a long period were realistic or whether increases would be expected throughout the timescale of the experiments. An important distinction between CO_2 emissions and energy use was made at this point – highlighting that trends in CO_2 emissions are not necessarily equivalent to trends in anthropogenic heat emissions within urban areas.
- Whether it would be better to undertake a larger number of shorter experiments to look at a wider variation of changes rather than one single Experiment 3.
- Whether researchers should review the specific requirements from Experiment 3 following assessment of the results from Experiments 1 and 2 in recognition that it is likely the results from Experiments 1 and 2 will provide a guide to an appropriate form for Experiment 3.
- Whether inputs could be selected which are sensitive to things that LAs are able to influence, for example a consideration of policy drivers and see how these could be translated into model runs.
- Whether issues associated with the multifunctionality of areas could be incorporated.

Table 6: Experimental options for the Hadley model runs and equivalent city-scale scenario

Model Parameter	Example City-Scale Scenario
Changes to the proportions of urban and other land-cover types	Development on greenbelt
Increasing anthropogenic heat emissions	Increasing energy use and transportation
Increasing albedo	The use of high reflectivity building materials
Changes to surface roughness	Changes to the urban environment that affect wind
Changes to heat capacity	Decreasing thermal mass of buildings

6. PART 5: Where should local and neighbourhood work be carried out and what types of adaptation options should be considered? (Docs 5.1 and 5.2) (Claire Smith)

Participants were asked to propose potential case study sites to form the basis of the detailed neighbourhood and building scale research to be carried out in SCORCHIO Task 3.3 (see Box 1). In order to help inform the process of proposing case study locations a set of guidelines for the selection of areas was supplied to participants ahead of the workshop and a pro forma provided to give further details of each of the areas proposed.

Some of the criteria provided were as follows:

• Size of the case study area – it was suggested that areas be a minimum of 1km^2 and a maximum of 5km^2, or 2-3 of the ASCCUE neighbourhood scale Urban Morphology Type (UMT) units;

• Availability of a case study 'champion' to facilitate data collection and to provide other assistance to the research team, such as providing input for the evaluation of prototype tools;

• the availability of links to existing groups/projects (such as Manchester South, Piccadilly Gardens Group, New East Manchester);

• Availability of and access to appropriate data (land-use, height etc);

• Availability of an opportunity for adaptation;

- the nature of site as new build or existing stock (including approximate age);
- the nature and use of buildings as residential, commercial, city centre, retail or mixed; and
- the general location and setting of the site as city-centre, inner city, suburbs or semi-rural.

Five case study areas were proposed for Greater Manchester and a further two have been nominated following the workshop (Table 7). It was suggested that the SCORCHIO team will provide some results for all the case study areas nominated (including, for example meteorological measurements for all areas during the ground and flight transects). However, due to time and resource constraints it was noted that it would only be possible to model 3-4 areas within Greater Manchester in more detail with a further 2-3 areas in Sheffield.

A range of climate change adaptation options will be modelled for the detailed case study areas, which will allow the user to assess the options according to criteria including, vulnerability to heat, greenhouse gas emissions and energy consumption. The building/neighbourhood-scale adaptation options are flexible and will be chosen based on user requirements. Some examples of the kind of adaptation options envisaged are listed in Box 2.

Table 7: Proposed Case Study Areas

Name	Situation	Size	Land Use	Further information
Oxford Road Corridor	City Centre	2-3	Academic, health, commercial, residential	Major transport corridor; Links with the i-tree project
Brunswick	Inner City	1-2	Predominantly residential with some commercial	MCC currently procuring PFI to include re-design and refurbishment of council housing.
Collyhurst	Inner City	1-2	Predominantly residential with some commercial	Major redevelopment planned – Collyhurst Information Pack will be available May 2008
Stockport	Town Centre	2-3	Retail, industrial residential	Situated close to a major road; limited greenspace; extensive regeneration planned; 2 major applications in place
Radcliffe	Small Town Centre	2-3	Commercial and residential	Surrounding green areas; close proximity to Irwell; high density developments proposed; new school. Area has been subject to flood risk assessment
Rochdale	Town Centre		Retail and Commercial	Major re-development planned
Salford:				
1. Pendleton	Inner City	2	Mixture of early 20th century terraced housing and modern high and low rise housing and mixed use development.	Planning guidance is currently being drafted for the regeneration of Pendleton over next 15-20 years.
2. Lower Broughton	Inner City	1	Predominantly residential with	Large scale re-development planned. Detailed flood risk assessment of area has

			some commercial	been completed.
3. Media City	Inner City	2-3	New commercial development by Salford Quays	Long term re-development focused on the creation of new and refurbished office space.
Sheffield:				
1. Sheffield Hallam	Inner City	1-2	Retail, Education, Residential	Major re-development planned
2. Upper Don Valley	Inner city and suburban location	3-4	Retail, Commercial, Residential, Sport	Major re-development planned

Box 2: Building/Neighbourhood Adaptation Options

Development Layout
- Orientation
- Solar access/shading design (e.g. TCPA projections: 30 degrees either side of due south will enable 80% of dwellings to have access to unobstructed sunlight; asymmetric designs – taller buildings positioned to the north to minimise overshadowing; block proportions will tend toward rectangular shapes, eg 100 x 50 m rather than 60 x 60 m square.)
- Use of water/greenspace

Improvements to the Building Envelope
- Increasing thermal mass (Construction – light-, med-, heavy-weight; can also examine the effect of insulation positioning: floors, ceilings, walls, roof).
- Green roofs
- Improving ventilation

Reducing Solar Gains
- Positioning of the glazing.
- Reducing the glazing percentage.
- Implementing improved glazing types (e.g. solar control, Low-E etc)
- Use of shading (Diffusing, slatted, electrochromic switchable, louvres, overhangs; under various controls: temp, solar, glare etc).

HVAC System
- Mechanical ventilation design, operation and efficiency
- Cooling system fuel and Coefficient of Performance
- Natural ventilation

Workplace Scenarios
- Greater number of people working at home – decrease internal gains, reduction in traffic

7. CONCLUSIONS AND NEXT STEPS

The workshop had a broad remit but made useful progress towards answering the questions initially posed. In particular there were some useful links made to LA policy requirements and helpful observations to assist in the design of Experiment 3 of the climate model runs. There were a relatively large number of case study locations proposed each with interesting features and differing perspectives on adapting urban areas to climate change. It was agreed that for all case study areas some data would be provided even through it would not be possible to carry out detailed modelling in every location.

The next stage of work will follow up on the case study suggestions and conclude on the most appropriate case studies for the neighbourhood and buildings scale research. To this end, case study area champions have been contacted and asked to provide some more detailed information and some example data by April 23rd. The research team has also proposed site visits of each case study area. This will fulfil two needs, it will enable further dissemination information about the SCORCHIO project to interested parties, as was requested at the workshop, and will also help in the process of making a more informed decision.

Work will also now begin on developing the city-scale tools and progress on all aspects of the project will be reported through the regular stakeholder meetings and through the dedicated SCORCHIO website.

APPENDIX 1: Participants at the workshop

In addition to the stakeholder group, 8 members of the SCORCHIO research team assisted in the facilitation of the workshop: Roger Courtney (Stakeholder Champion), Geoff Levermore (Project Leader; Manchester), Clare Goodess (University of East Anglia), John Handley (University of Manchester), Susan Lee (Sheffield University), Sarah Lindley (Manchester University), Mark McCarthy (Hadley Centre, Met Office), Claire Smith (University of Manchester). Table A1 provides a list of the participants and their affiliations.

Table A1: List of Participants

Name	Organisation	Name	Organisation
Mike Ballard	Manchester Housing	James Noakes	Wigan MBC
Garry Banks	Arup	Andy Nolan	Sheffield City Council
Keith Boxer	Manchester Knowledge Capital	Cyril Ogunmakin	Bruntwood
Michelle Colley	Acclimatise	Marian Raines	Salford City Council
Mike Davies	UCL-LUCID project	Mei Ren	Faber Maunsell
Stephen Finnegan	Arup	Jonathan Sadler	Manchester City Council
David Hodcroft	Bury MBC	Steve Simmons	Sheffield City Council
Katrina Holt	MCC Planning	Barry Simons	Rochdale MBC
Will Horsfall	Salford City Council	Roger Street	UKCIP
Tony Hothersall	Red Rose Forest	Matthew Tidmarsh	Trafford MBC
Andy Hunt	Trafford MBC	Steve Whipp	United Utilities
Hannah Jones	Stockport MBC	Tim Whitley	Arup
Paul Needham	Environment Agency	Richard Wood	Stockport MBC

APPENDIX 2: Document 3.1: Climate Change Decision Support Tools

	SMURF (Sustainable Management of Urban Rivers and Floodplains)	TERRA vision	UKCIP Adaptation Wizard
Reference	Environment Agency (2005)	Van Voris et al (1993)	Connell and Willows (2003)
Platform	Web-based	GIS with GUI	Web-based
Function	To determine the impact of future development on surrounding river and drainage network	To assess impact of global climate change on composition and biomass of forest	Framework to encourage climate-proof decision-making.
Format	InfoWorksRS, SIMCAT and/or rule-based models	Temp and ppn outputs from GCM feed into the hierarchical forest gap models.	Guides the user through four key stages using a series of questions.
Spatial-scale	Neighbourhood	Individual tree up to regional	Business
Inputs	Climate scenario, river section	Traits & environmental response of tree species, land use characteristics, site temperature & soil moisture	Answers to a series of questions.
Outputs	Flow, temperature, ecological, water quality data	Spatial maps showing the change in forest composition and biomass over time.	An audit trail of answers to key questions.
Location	West Midlands	Pacific Northwest	UK
Comments	Cannot examine adaptation options in the web-based version but can examine information for different climate conditions.	Proof of concept demonstration.	This tool is not use to communicate climate impacts, it is used to develop an understanding of how climate change can be integrated into D-M process
Available for Download?	Y (SMURFweb only) http://www.smurf-project.info/websmurf/	N	Y (http://www.ukcip.org.uk/resources/tools/adapt.asp)

	MIST	AUSSM	Neighbourhood Greening	ENVI-met
Reference	Sailor and Dietsch (2007)	Tanimoto et al (2004)	Randall et al (2003)	Bruse and Fleer (1998)
Platform	Web-based	GUI	Extension for ArcView 3.x	Windows interface
Function	To assess UHI mitigation strategies in terms of climate, air quality and energy consumption.	To assess the effect of the heat island in terms of climate and building thermal performance.	To examine the effect of strategic management and creation of greenspaces	To analyse the effect of small scale changes in urban design on the local microclimate.
Format	Nested mesoscale model (MM5). Building energy consumptions modelled using DoE-2 simulations.	Coupled mesoscale urban climate – building simulation (DOE) model		3-d microscale model
Spatial-scale	City	Building	Neighbourhood	Neighbourhood/city?
Inputs	Proportional change in albedo/vegetation	Meteorological data, urban/building design data, surface land cover, HVAC systems data	Building polygons w dwelling occupancies, road/path/ pavements polylines, existing trees points shapefiles.	Building/plant locations and heights. Plant types and charateristics, soil type/saturation, emissions sources
Outputs	Change in temp, ozone levels, energy consump	Numerical output data – air/surf T, radiative flux, waste heat etc.	Methods of incorporating greenspace, benefits of greenspace quantified in lay terms	Atmospheric, surface, soil variables
Location	US	Tokyo	Developed for US but could be applied elsewhere?	Anywhere (given input data)
Comments	Modelled buildings: residential, office, retail; pre/post-1980	Also contains results of simulations under various conditions to allow basic analysis of heat island.	1-2 month customisation process. Only works with ArcGIS 3.2 or earlier	This is a very detailed model and produces large amounts of data. The Clim-bot add-on might help with the visualisation.
Available for Download?	Y (http://www.heatislandmitigationtool.com/)	Y (http://ktlabo.cm.kyushu-u.ac.jp/	Y http://www.eng.mcmaster.ca/civil/sustain/downloads.html#ng	Y http://www.envi-met.de/index.html

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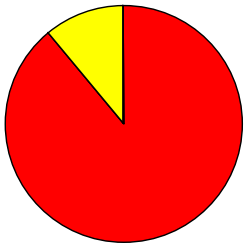
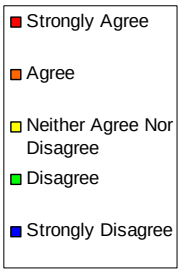
APPENDIX 3: Results from the Decision Support Tool Format and Function Questionnaire

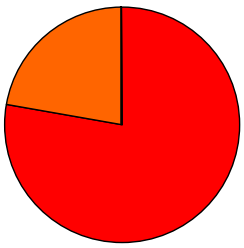
A2. Information on the following topics is of interest to me:

Temperature Change

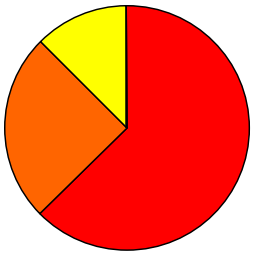


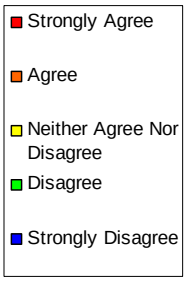


Energy Consumption

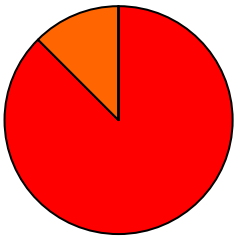


Emissions Budgets

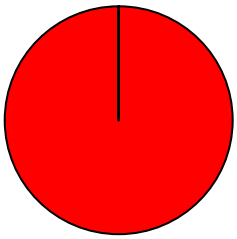


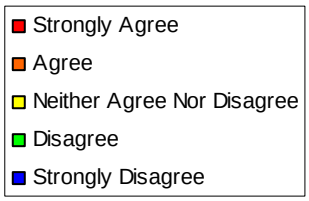


Vulnerability of People



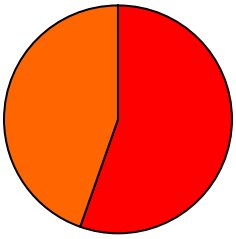
Vulnerability of Infrastructure

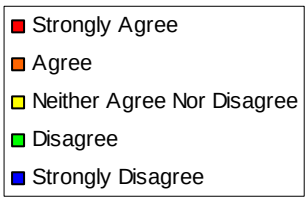




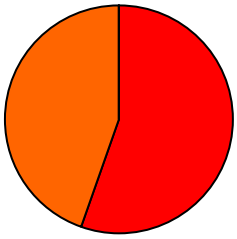
A3. Information in the following format is of interest to me:

Averages



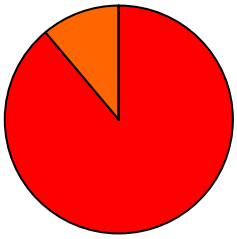


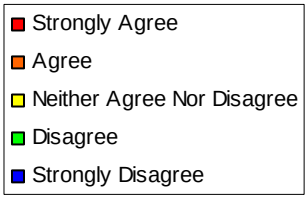
Extremes



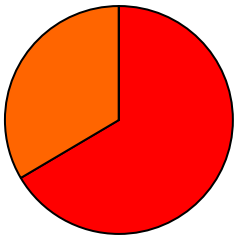
A4. Information at the following spatial scales is of interest to me:

City

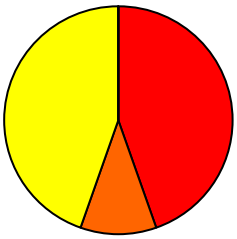


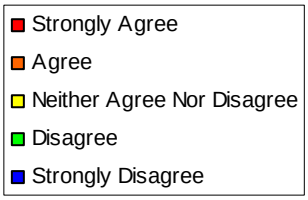


Neighbourhood

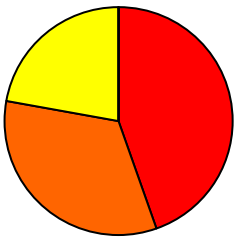


Street



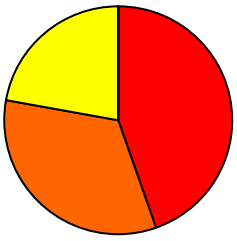


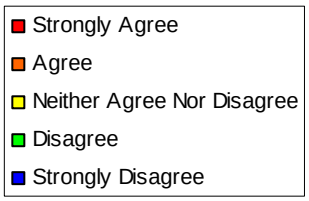
Building



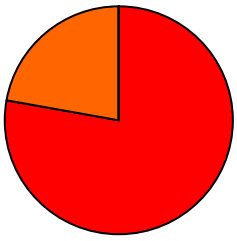
A5. Information covering the following time periods is of interest to me:

Pre-2000

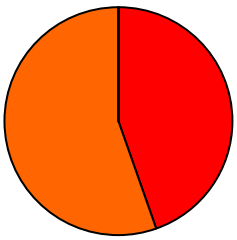


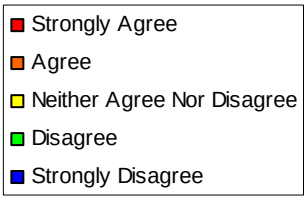


2000-2020



2020-2050





2050-2080