Institution: The University of Manchester

Unit of Assessment: 17a (Geography)

Title of case study: Urban Climate Risks and Adaptation Responses

1. Summary of the impact

University of Manchester (UoM) research has made a key contribution to adaptation planning strategy for urban climate change, at a range of scales. Impact was achieved via the generation of data, and the creation and refinement of tools and frameworks that offer a distinct geographical perspective and a means of generating local evidence on urban climate risks, vulnerabilities and adaptation potential. Proof of principle was established within Greater Manchester, with extensive and ongoing use of research findings to support urban adaptation. Subsequently, the research has guided additional localities, and contributed to national policy formulation. More recently, a number of cities – including on mainland Europe and the African continent – have used the research within local adaptation planning, and related green infrastructure policy and practice.

2. Underpinning research

Understanding urban climate risks and formulating appropriate adaptation responses are new and challenging requirements. Decisions made now will shape the future of cities for years, either by exacerbating climate impacts and inequalities, or by providing a means to offset them. To assist and frame their decision-making, practitioners require clear, locally relevant evidence. This case is based upon this need; expressed via a series of interdisciplinary projects, all based at UoM's Centre for Urban and Regional Ecology (CURE):

- (2013-2014) 'ClimateJust' (**CJ**) Joseph Rowntree Foundation (JRF) (£90k)
- (2010-2013) 'Climate Change and Urban Vulnerability in Africa' (**CLUVA**) EU FP7 (€342k)
- (2008-2012) 'EcoCities: The Bruntwood Initiative for Sustainable Cities' (**EcoCities**) Bruntwood/Oglesby Charitable Trust (£950k)
- (2010-2011) 'Climate Change, Justice and Vulnerability (**CCJV**) JRF (£86k)
- (2008-2011) 'Green and Blue Space Adaptation for Urban Areas and Eco Towns' (**GRaBS**) EU INTERREG IVC Priority 2: Environment and Risk Prevention (€270k)
- (2007-2010) 'Sustainable Cities: Options for Responding to Climate cHange Impacts and Outcomes' (**SCORCHIO**) EPSRC (£364k)
- (2003-2006) 'Adaptation Strategies for Climate Change in the Urban Environment (**ASCCUE**) EPSRC (£287k)

Key UoM staff:– Geography: Dr Sarah Lindley (Senior Lecturer in GIS, 2001-); Dr Claire Smith (Lecturer, 2008-10); Dr Joseph Kandeh (Research Associate, 2010-11); Dr Susannah Gill (2003-2007, now visiting); and Mr Nigel Lawson (Honorary Fellow, 1996-). Selected contributors at UoM: Prof. John Handley (Planning); Prof. John O'Neill (Philosophy); Prof. Geoff Levermore (Engineering); Dr Roland Ennos (Biological Sciences); Prof. Ann Webb (Environmental Sciences). These projects have yielded outcomes in many areas; a distinctive path can be charted spanning **five distinct strands**, progressing from conceptual to outward-facing:

1. **The characterisation of the urban system through Urban Morphology Types** (UMTs) (ASCCUE/SCORCHIO/CLUVA). The UMT approach combines biophysical and planning-relevant characteristics of neighbourhoods, to provide a geographical framework for analysis, assessment and planning. UMT units improve upon those derived from standard land-use classes, since urban physical geography is determined by both urban form and function [D][F].
2. **The development and application of conceptual frameworks for spatial risk assessment and management** (ASCCUE). A UMT-based overlay framework provides a distinct basis for the exploration of combinations of hazard, vulnerability and exposure for different scenarios. This has provided the basis for further work, including ongoing assessment of ecosystem services and the foundation for methods and tools for use by urban practitioners [E][F].
3. **The production of empirical datasets on urban hazard exposures, principally associated with temperature** (ASCCUE/SCORCHIO). The biophysical grounding of UMT units supports the representation of urban climate hazards, their drivers and related phenomena such as the Urban Heat Island (UHI) effect. SCORCHIO used UMTs to analyse urban temperature patterns and their drivers, under contemporary summertime UHI conditions in Manchester of up to 3°C (day) 5°C (night) [B]. UMT data underpinned the assessment of anthropogenic heat emissions, estimated to reach 75 Wm^{-2} for parts of the city [C]. SCORCHIO validated ASCCUE's

modelling studies which showed increasing green space by 10% can keep surface temperatures during extreme heat events at or below current (baseline) levels [B]. This evidence base is now being used by urban planners and managers in cities across the UK, and has inspired similar research and impact work elsewhere.

4. **The production of empirical datasets on socio-spatial vulnerability and climate disadvantage** (CCJV). Representations of hazard-exposure alone are imperfect determinants of the unequal impacts of climate-related events. To understand 'climate disadvantage' social vulnerability must also be taken into account. CCJV developed and applied a new conceptual framework for mapping the dimensions of local social vulnerability to heat and floods in the UK. Extremely socially vulnerable neighbourhoods tended to be urban and/or coastal, and two thirds showed compounded social vulnerabilities. Distinct regional and sub-regional patterns were also identified. Social deprivation was confirmed as being strongly connected to social vulnerability, but geographical patterns were linked with other determining factors too [A].
5. **The development of methods, tools and resources through which adaptation options can be assessed** (ASCCUE/SCORCHIO/GRaBS/Ecocities/CJ). Foundational research has been translated into a range of practitioner-oriented resources, with [A][D][F] essential precursors to subsequent projects with a wholly or predominantly knowledge-transfer remit.

3. References to the research (all references available upon request - AUR)

The research has been published in a number of influential peer reviewed climate and built environment journals.

[A] (2011) Lindley, S. J., O'Neill, J., Kandeh, J, Lawson, N., Christian, R. & O'Neill. M. 'Climate Change, Justice and Vulnerability'. York, *Joseph Rowntree Foundation* (AUR)

[B] (2011) Smith, C. L., Webb, A., Levermore, G. J., Lindley, S. J. & Beswick, K. "Fine-Scale Spatial Temperature Patterns across a UK Conurbation" *Climatic Change* 109(3/4) 269-286 (REF2014) doi:10.1007/s10584-011-0021-0

[C] (2009) Smith, C. L., Lindley, S. J. & Levermore, G. J. "Estimating Spatial and Temporal Patterns of Urban Anthropogenic Heat Fluxes for UK Cities: The Case of Manchester" *Theoretical and Applied Climatology* 98(1/2) 19-35 (REF2014) doi:10.1007/s00704-008-0086-5

[D] (2008) Gill, S. E., Handley, J. F., Ennos, A. R., Pauleit, S., Theuray, N. & Lindley, S. J. "Characterising the Urban Environment of UK Cities and Towns: A Template for Landscape Planning" *Landscape & Urban Planning* 87(3) 210-222 (REF2014) doi:10.1016/j.landurbplan.2008.06.008

[E] (2007) Lindley, S. J., Handley, J. F., McEvoy, D., Peet, E. & and Theuray, N. "The Role of Spatial Risk Assessment in the Context of Planning for Adaptation in UK Urban Areas" *Built Environment* 33(1) 46-69 (RAE2008) www.jstor.org/stable/23289472

[F] (2006) Lindley, S. J., Handley, J. F., Theuray, N., Peet, E. & McEvoy D. "Adaptation Strategies for Climate Change in the Urban Environment: Assessing Climate Change Related Risk in UK Urban Areas" *Journal of Risk Research* 9(5) 543-568 (RAE2008) doi:10.1080/13669870600798020

4. Details of the impact

In line with the five strands outlined above, three types of impact have emerged: the use of **frameworks** and principles; the uptake and use of **data** produced from the research; and the direct use of findings to support decision making around **policy and practice**. Hitherto, serviceable evidence in this field has been hard to access, and habitually tricky to synthesise in a meaningful manner. This research effectively resolves this impasse via: **Directed stakeholder partnership programmes** (ASCCUE/SCORCHIO); **Knowledge-transfer programmes** (GRaBS); and **Funders directly assisting policy and practice/or as direct users** (EcoCities/CCJV/CJ). The majority of beneficiaries are planning, development or environmental management practitioners. Significantly, whilst much of the impact concerns policy and practice in climate adaptation, there is strong evidence of pedagogical impact, principally around web-based resources for schools, awareness-raising and training [4]. As a whole, users fall into two broad groups:

- **Partners in research** or research-related knowledge transfer activities (often formally recognised in project proposals). These groups demonstrate the most extensive use of findings, and assist in the shaping and dissemination of research. For instance, SCORCHIO utilised a dedicated 'stakeholder champion' in order to persuade the Government of the need to prioritise action on overheating in UK cities, with DCLG subsequently *"investigating evidence*

and policy options around overheating and the built environment as a priority" [2].

- **Second-wave adopters** including many local authorities. Whilst not directly involved in the research, these users are reached through subsequent targeted dissemination and outreach activities by researchers, funding bodies or third parties [1].

In **Greater Manchester** research uptake has significantly influenced policy and practice. The value of UMTs was recognised by the Association of Greater Manchester Authorities (AGMA), with Manchester City Council (MCC) referring at length to ASCCUE's approach to the consequences of climate change, and formalising the strong partnership between MCC and UoM within a 'Memorandum of Understanding' in 2009 [1]. The MCC collaboration has also informed local campaigns (e.g. the 'Call to Real Action' blog), with Ecocities and SCORCHIO also referenced on Salford City Council's local information portal, and in their 2010 climate strategy [1]. Rochdale MBC used SCORCHIO heat emissions and building-modelling work to guide energy management strategies for Rochdale town centre, with ASCCUE evidence supporting their 'green infrastructure' emphasis [1]. Similarly, Wigan MBC have made extensive use of research outputs from CCJV and SCORCHIO, their Sustainability Manager noting that *"this data… is an invaluable resource for considering the vulnerability issues of Wigan… we are revising our climate change strategy and action plan and will place a particular focus on climate change adaptation. The data will be integral to how we develop this"* [9]. Finally, consultants Scott Wilson used ASCCUE materials (UMT data) within their core Greater Manchester evidence base for AGMA [1], and Community Forests North West have produced a 'Green Infrastructure' plan informed by UoM research [4].

National impact: UoM research has inputted into the 2012 'UK Climate Change Risk Assessment' [2], and the Adaptation Sub-committee's work on spatial indicators [3]. UMT data have been provided to local authorities, consultants and groups including Natural England and the Environment Agency, via a UoM-approved data agreement. Data have also been used by **local authorities outside Greater Manchester**, via research partnerships (e.g. London Borough of Sutton), or independently (e.g. Islington Council), where findings are worked into bespoke adaptation guides [1]. Such 'independent users' are often made aware of the research through **national advisory networks**, such as the Planning Advisory Service (PAS) who have effectively summarised the research, linking directly to ASCCUE and SCORCHIO [3]. The model developed in Manchester is also gaining traction, with a consultancy report written for the 'Local and Regional Adaptation Partnership Board' noting UHI work in Birmingham that is *"building on the University of Manchester's ASCCUE project"*, extolling the close working relationship between UoM and MCC [1]. Other examples of the uptake of this research include the use of ASCCUE by the Technology Strategy Board [3], by Groundwork UK and by the Glasgow and Clyde Valley Green Network Partnership, as part of their parliamentary lobbying activities [4].

Regional impact: Extending the reach of the initial research [A], JRF and four regional climate change partnerships have sponsored engagement activities. These have provided a 'fresh perspective' on risk and vulnerability beyond a focus on hazard-exposure, and explored the 'mainstreaming' of adaptation planning into existing activity [6]. Accordingly, the Leicestershire Climate Ready Plan (Feb 2013) has a nominated lead, with a responsibility to 'map socio-spatial vulnerability to climate change in Leicestershire' [10]. An independent evaluation of JRF's 'Climate Change and Social Justice' programme identified [A] as one of its most important pieces of commissioned research, with "*the maps of social vulnerability and climate impacts… used by the Chair of the* [UK Government] *Adaptation Sub Committee, Lord Krebs, in public presentations"* [6]. Practitioners also welcomed *"tangible data not previously presented to policy makers"*, with JRF's Programme Manager citing a local authority testimonial: "*I think it could make a difference to how services are delivered in the future for example through the relocation of adult day care centres"* [6]. Following an invited presentation to the Scottish Government (May 2012), a follow-up to CCJV was funded and will be used in shaping the forthcoming Scottish Climate Change Adaptation Programme [7]. The Welsh Government have also used CCJV vulnerability data for engagement purposes, a representative noting that [A] was "*particularly useful as this had a Welsh perspective and looked at a number of different angles that I had not seen covered elsewhere e.g. deprivation and access to services*"[6]. UoM will contribute to two ministerial events in Wales, later in 2013.

International impact: CLUVA has facilitated development of UMT datasets for five **African cities** (Addis Ababa, Dar es Salaam, Saint-Louis, Douala and Ouagadougou). In Addis Ababa, the dataset is forming the backbone of a city 'Master Plan' (May 2013), with the City Planning Project Office noting: *"The green infrastructure plan being developed as part of the Addis Ababa Master plan is using the concept of Urban Morphology Types and the geographical framework developed through mapping corresponding UMT units for the city. The decision to use this framework has come about because of the work published by Gill et al… The UMT framework has provided an important geographical framework through which indicators of urban ecosystem services and the multi-functionality of green structures within Addis Ababa can be expressed… providing an evidence base for justifying green structure priorities for the city"* [8]. UoM is also working closely with early adopters of ASCCUE outputs, the Mersey Forest (MF), to maximise the international impact of CLUVA ecosystem service assessment work; MF report: "*an exciting opportunity to take the approaches we have been developing ....and apply them in a vastly different context"* [5].

Finally, the **European Commission** has commended ASCCUE, utilising findings in their work on vulnerabilities inherent in the 'compact city' [5], and awarding GraBS with the European Commission's DG for Regional Policy 'RegioStars Award' for the best project in the Sustainable Growth category (one of 5 awards from 107 entries). The jury stated: *"While there are many projects working on the environmental aspects of green and blue infrastructure, this project goes further in assessing the social and economic benefits…"* [5]. As a result of the co-creation of adaptation responses, 11 European municipalities and regions – including the Province of Genoa and Nieuw-West in Amsterdam – now have evidence-based adaptation strategies in place.

5. Sources to corroborate the impact (all claims referenced in the text)

[1] **Regional Adaptation Planning & Climate Change Guidance**: (2012) Rochdale MBC 'Climate Change Adaptation Supp. Planning Document' (June) (p.2); (2010) Salford City Council 'Salford's Climate Change Strategy' (p.46); (2009) Islington Council 'Climate Change Adaptation: Good Practice Guide 3' (p.4) (2009) MCC 'Manchester Climate Change Call to Action: Full Report' (January) (pp.9,22-23); (2009) CAG Consultants/Mud Island Marketing 'Local & Regional Adaptation Partnership Board Adapting to Climate Change: Local areas' Action' (June) (pp.6,106-108); (2008) AGMA/Scott Wilson 'Strategic Flood Risk Assessment for Greater Manchester: Sub-Regional Assessment' (August) (pp. 34,84); (2008) AGMA 'Green Infrastructure in Greater Manchester Project: Phase 1 – Final Report'

[2] **UK Government**: (2012) DEFRA 'The UK Climate Change Risk Assessment: Evidence Report' pp. (22,162); (2011) DCLG 'Departmental Adaptation Plan (May) (p.25)

[3] **National Guidance**: PAS: 'Dealing with Vulnerability and Adaptation…' & 'Economic Development, Infrastructure and the Built Environment'; (2012) HR Wallingford 'Development of Spatial Indicators to Monitor Changes in Exposure and Vulnerability…' (July); (2010) Technology Strategy Board 'Design for Future Climate: Opportunities for Adaptation in the Built Environment' (June) (pp.16-17) (2008) CABE Space 'Public Space Lessons: Adapting Public Space to Climate change' (p.3)

[4] **Civil Society**: (2010) Community Forests Northwest 'Green Infrastructure to Combat Climate Change: A Consultation… '(September) (pp.12,16; actions 1j, 3b, 3e); (2010) Groundwork 'City Cooling Training Outlines Action for Climate Change' (GW Northwest) (10th May) & (2009) 'Memorandum submitted to the House of Commons Environmental Audit Committee: Adapting to Climate Change' (2nd October); (2009) Metlink: Resources for Teaching Weather and Climate in Schools 'UHI Manchester'; (2008) GCVGNP response to 'Glasgow 2014 – Delivering a Lasting Legacy: Consultation'

[5] **International**: (2013) Mersey Forest 'Mersey Forest experience helps inform African cities project' (18th April); (2012) 'RegioStars 2012 – 'Presentation of the Finalists' (p.26) & Project Videos; GraBS Action plans (from website); (2010) European Commission 'World and European Sustainable Cities Insights…' (p.28)

[6] Testimonial from Programme manager, Joseph Rowntree Foundation (June 2013)

[7] Testimonial from Principal Researcher, Scottish Government (July 10th 2013)

[8] Testimonial from Member, Addis Ababa Master Plan Development Team (8th March 2013)

[9] Testimonial from Sustainability & Climate Change Manager, Wigan Council (15th May 2013)

[10] Testimonial from Coordinator, Climate East Midlands (5th September 2013)