Institution: University College London

Unit of Assessment: 16 – Architecture, Built Environment and Planning

Title of case study:

Adapting to the impacts of climate change on cultural heritage

1. Summary of the impact

UCL research by Cassar et al has provided the vital evidence to occasion a culture change in how heritage professionals nationally and internationally approach adaptation to climate change for historic properties. Beneficiaries have included UNESCO, EU-ROPA and English Heritage. This has been instrumental in ensuring that climate change effects are an intrinsic part of management plans for historic sites, commissioned training and research, and improved the advice provided by commercial organisations in the heritage sector.

2. Underpinning research

The tension between drying flooded historic wooden structures and their conservation has been the subject of long debate. Views have been polarised around whether rapid drying to bring buildings back into use quickly for economic, health and social reasons would have the unintended consequence of long term damage. Research by the Centre for Sustainable Heritage (CSH) at the UCL Bartlett Faculty of the Built Environment specifically addresses the issue that climate change is predicted to increase damage to fragile structures as a result of increased flooding and fabric saturation, and has demonstrated the effect of forced drying on saturated wooden buildings. While it has been known for a long time that drying wooden structures too quickly can cause physical stress to the fabric, our modelling illustrated how dangerous moisture gradients develop.

Between 2002–03, CSH carried out a scoping study on *Climate Change and the Historic Environment* for English Heritage. This captured, for the first time, the observations of heritage managers on the impact of climate change on buried archaeology, historic buildings, parks and gardens. This was the prelude to two major collaborative projects.

EPSRC-funded research (2003–06) was driven by the need to understand the behaviour of water saturated building fabrics. Conservation advice for the drying out of historic buildings was that this process should be carried out slowly to avoid hygrothermal stresses in the building fabric. However, there is pressure from owners and insurers to dry out buildings rapidly so that they can be quickly brought back into use and to restore conditions unfavourable to the recurrence of wetting. The research determined the stresses in the historic fabric caused by rapid drying compared to the extent of related damage such as salt efflorescence that occurs due to slow drying. The research modelled the hygrothermal performance of historic building fabrics and a Stakeholders Dissemination and Scientific Research Report was published **[a]**.

This was followed by a project funded by the European Commission (2004-07) and driven by the need to predict and describe the effects of climate change on Europe's built cultural heritage over the next 100 years, and to develop mitigation and adaptation strategies for the historic buildings, sites, monuments and materials likely to be worst affected. A *Vulnerability Atlas and Adaptation Guidelines* for heritage managers were produced to enable visualisation of the built heritage and cultural landscape under future climate scenarios and to model the effects of different adaptation strategies. CSH was responsible for modelling the drying of flooded historic wooden buildings under different climate scenarios. These research results were published in a conference book **[b]**, and in three thematic pages on wetting and drying of wood, brick and sandstone in 2010 in *The Atlas of Climate Change Impact on European Heritage* **[c]**. CSH was also responsible for editing and authoring parts of the Adaptation Guidelines to support the interpretation of this atlas. The project was conducted in collaboration with the Institute for Atmospheric Sciences and Climate (Sabbioni, C.; Italian National Research Council) and the School of Environmental Sciences (Brimblecombe, P.; University of East Anglia). CSH research focused on the impact of climate change on indoor-outdoor interactions through the building fabric and on the indoor historic environment, while partner teams focused on outdoor heritage.

UCL researchers in CSH during the time of the underpinning research were: Nigel Blades (Lecturer), Phill Biddulph (Research Fellow), May Cassar (Professor), Theo Chen (Research

Fellow), Robyn Pender (Research Fellow), Ian Ridley (Senior Lecturer), Matija Strlic (Senior Lecturer) and Joel Taylor (Lecturer).

3. References to the research

[a] Cassar, M. and Hawkings, C. (eds.) (2007) *Engineering Historic Futures: Stakeholders Dissemination and Scientific Research Report*. London: UCL Centre for Sustainable Heritage. [http://eprints.ucl.ac.uk/2612/1/2612.pdf]

[b] Blades, N., Cassar, M. and Biddulph, P. (2008) *Optimizing Drying Strategies to Reduce Down Times for Actively-Used Flood Damaged Historic Buildings*, Contributions to the IIC London Congress CONSERVATION AND ACCESS, Edited by David Saunders, Joyce H. Townsend and Sally Woodcock, 15–19 September. [Available on request]

[c] Sabbioni, C., Brimblecombe, P. and Cassar, M. (eds.) (2010) *The Atlas of Climate Change Impact on European Cultural Heritage: Scientific Analysis and Management Strategies*. London & New York: Anthem Press:, pp.146 (specifically on pp. 62–66, 70–71, 100–101, 104–107, 110–112) [ISBN 978-0-85728-283-5; Available on request]

The quality of the underpinning research is demonstrated by the peer-reviewed funding received:

- Cassar, M. (PI), *Climate change and historic environment; A scoping study*, English Heritage PNUM 3167, April 2002 – March 2003 (£50,000). This grant led to output [a] above.
- Cassar, M. (PI), *Engineering Historic Futures: Adapting Historic Environments to Moisture-Related Climate Change*, EPSRC GR/S18359/01, April 2003 – October 2006. This grant led to output [b] above.
- Sabbioni, C. (PI), *Global Climate Change Impact on Built Heritage and Cultural Landscapes (Noah's Ark)*, European Union 6th Framework Programme for Research SSPI-CT-2003-501837), June 2004 – May 2007. This grant led to output [c] above.

4. Details of the impact

Perhaps the most significant impact of the research described in Section 2, which underpins all others, is its vital contribution to creating a paradigm shift in how people – and particularly the heritage sector in the UK, Europe and the rest of the world – understand the risks of climate change to cultural heritage. Research by CSH was the first to highlight these risks and, in so doing, focused attention on both the impacts and the mitigation and adaptation strategies needed to safeguard cultural heritage from these threats. This research has above all informed international policy and for the first time brought to the attention of decision makers the potential of damage to cultural heritage across the globe from climate change.

Research by CSH has thus had wide-reaching influence on international and national heritage policy, through UNESCO, the Council of Europe and English Heritage. Through this means, research has had an impact on many of the most important historic properties in the UK, Europe and globally. For instance, English Heritage lists 374,081 listed buildings or groups of buildings, 19,717 scheduled ancient monuments, 1,601 registered historic parks and gardens, 9,080 conservation areas and 17 World Heritage Sites. The UNESCO World Heritage List includes 725 cultural properties in 153 countries. The management of a large proportion of these properties, and of listed buildings and World Heritage Sites in particular, is affected by the CSH's research findings. As a result, the focus of 'Heritage Counts 2008', the annual survey of the state of England's historic environment produced by English Heritage (who had commissioned the original CHS research) on behalf of the Historic Environment Forum was on climate change **[1]**.

This CHS research **[b, c]** provided the vital evidence on the impacts of climate change for international groups involved with heritage conservation. Before then heritage managers focussed on average rather than extreme climate conditions affecting cultural heritage. This is demonstrated by the debate the research instantly occasioned, and its subsequent adoption in key international frameworks. For example, the Decision at the 31st Session of the UNESCO World Heritage Committee in Christchurch, 2007, requested *'the World Heritage Centre and the Advisory Bodies to integrate policies and strategies established by the World Heritage Committee on the issue of*

climate change in the implementation of the strategy for risk reduction at World Heritage properties'. In 2008, UNESCO World Heritage Centre published a Policy *Document on the Impacts of Climate Change on World Heritage Properties* which referred to CSH research as *'a model for other regions of the world'* **[2; pp. 5–6]**. Also in 2008, UNESCO's *Management Plans for World Heritage Sites: A Practical Guide* advised the inclusion of reference to climate change impacts: *'International climate research has shown beyond doubt that climate change is both progressing and accelerating ... World Heritage is also affected. If effects are visible or feared, observations and counter measures should be described in the management plan'* **[2]**.

These were implemented in management plans which took effect during the impact period, and UCL research expertise was deployed to support this. For example, the 2007 update of the *Tower of London World Heritage Site Management Plan's Objective 7: Assess the risks to the Tower posed by climate change and review the options for mitigation of those effects*, states that: *'Historic Royal Palaces has begun a programme to assess the risks of climate change and review the options for mitigation of its effects. It is assisting the Centre for Sustainable Heritage, University College London, in developing a study to assess risk, and examine adaptive capacity.'* **[3; item 6.4.29]**.

In 2008, the International Institute for Conservation of Historic and Artistic Works (IIC) also organised a roundtable discussion on 'Climate Change and Museum Collections' at which this research **[b, c]** was presented as part of the panel of experts. This was the first time that awareness of climate change impacts on museum collections was recognised at an international level; until then, the focus had been mainly on the impacts on buildings and landscapes **[4; p.2]**.

This research also led the Council of Europe European and Mediterranean Major Hazards Agreement (EUR-OPA) to commission a report on the *Vulnerability of Cultural Heritage to Climate Change* (November 2008) followed by a workshop which produced a *Draft Recommendation on the Vulnerability of Cultural Heritage to Climate Change* **[5]**. This draft recommendation was approved at the 57th meeting of the Committee of Permanent Correspondents (European state parties) of the EUR-OPA Major Hazards Agreement (Dubrovnik, Croatia, 15–16 October 2009) **[6]**. This agreement is an important platform for co-operation in the field of major natural and technological disasters between Europe and the south of the Mediterranean. Thus approval meant EU ministerial recognition of the risks posed to cultural heritage by climate change. Recognising the importance of incorporating this research into practice, the Council of Europe sponsored 7 European Master-Doctorate Courses and workshops between 2007 and 2012, most of which took place within the census period. These courses, based on the EUR-OPA report **[5]** were attended by 152 postgraduate students from 46 countries who chose to follow research careers or professional careers in the heritage sector. The course was co-designed by UCL researchers who based their teaching explicitly on research into wetting/drying of historic structures and into the adaptation strategies for historic buildings developed at UCL **[7]**.

In the UK, research has had a significant effect on understanding of the impact of climate change on cultural heritage. In Spring 2008, researchers were invited by English Heritage to contribute to its *Conservation Bulletin: A Bulletin of the Historic Environment*, which focused on the issue of 'Adapting to a Changing Climate' **[8]**. As the leading opinion former in heritage circles, English Heritage's *Conservation Bulletin* is published twice a year and is circulated free of charge to more than 15,000 conservation specialists, planners, opinion-formers and decision-makers throughout the UK and abroad. By presenting research by CSH in order to spell out threats and opportunities, it shows how English Heritage recommends conservation in the context of climate change.

The significance of CSH research, and its application to individual properties, is demonstrated by the use to which it has been put by heritage professionals. The research on the stresses caused by rapid drying **[a]** was conducted in partnership with an insurance company and a dehumidification company. Both benefitted commercially from the research in ways which exemplify the wider impacts on the sector. As indicated in Section 2, insurance companies typically advocate rapid drying after flooding so that a building can be brought back into use, a belief which was challenged by research. One partner, Ecclesiastical Insurance, specialises in heritage insurance in the UK, Ireland, Australia and Canada, with a turnover of £497.7 million in 2012. This insurance company, in particular, received confirmation of what it had anecdotally believed to be the case: as their then Chief Surveyor reported, CSH research *'provided the evidence Ecclesiastical Insurance needed to*

support its slow approach to drying of flood damaged historic building in order to reduce the risk of damage to the structure, fixtures and fittings from rapid drying' **[9]**. This confirmed that Ecclesiastical Insurance's advice to its property surveyors was correct and that rapid drying of flood damaged properties was to be avoided. The involvement in the research project of Historic Scotland's Brodick Castle and The National Trust's Blickling Hall, both of which were subject respectively to driving rain and flooding due to rainwater run-off, gave these two heritage organisations opportunities to further their knowledge on the impact of climate change, and in turn, fed into their improved management plans. For example, the National Trust has continued its scientific research on flooding effects at Blickling Hall, with UCL support **[10]**.

5. Sources to corroborate the impact

[1] English Heritage report focusing on climate change based on UCL research [http://bit.ly/18ULpac, PDF].

[2] UNESCO, *Policy Document on the Impacts of Climate Change on World Heritage Properties*, World Heritage Centre, CLT-2008/WS/6, Paris, 2008 [http://bit.ly/1aBop6C, PDF]; and UNESCO, Management Plan for World Heritage Sites (2008) [http://bit.ly/1cBbenD, PDF, para. 5.3.2]

[3] Tower of London *World Heritage Site Management Plan* (2007) [http://bit.ly/HxnGXI, PDF]

[4] International Institute for Conservation (IIC), 'Climate Change and Museum Collections, The Inaugural Event of 'Dialogues for the New Century', Roundtable discussions on the Conservation of Cultural Heritage in a Changing World, The National Gallery, London, 17 September 2008. [http://bit.ly/HDEKvB, PDF]

[5] Report commissioned by EUR-OPA - Sabbioni, C., Cassar, M., Brimblecombe, P. & Lefevre, R.A., *Vulnerability of Cultural Heritage to Climate Change: Report for E. FERNANDEZ-GALIANO*, Council of Europe, European and Mediterranean Major Hazards Agreement (EUR-OPA), November 2008. [Available on request]. This was subsequently backed up by a Council of Europe event titled 'Workshop on Vulnerability of Cultural Heritage to Climate Change, European and Mediterranean Major Hazards Agreement (EUR-OPA)' and European University Centre for Cultural Heritage (CUEBC)', Ravello, Italy 14–16 May 2009.

[6] European and Mediterranean Major Hazards Agreement (EUR-OPA) & Council of Europe, *Draft Recommendation 10 -1: On Reducing Vulnerability in the Face of Climate Change*, 16 April 2010 [http://bit.ly/1hJiUUM, PDF]; and (EUR-OPA), *Recommendation 2009-1 of the Committee of Permanent Correspondents, adopted at its 57th meeting in Dubrovnik, Croatia,* 15–16 October 2009 [http://bit.ly/1a4vcCQ, PDF]

[7] The courses included, for example, European Master-Doctorate Course, Vulnerability of Cultural Heritage to Climate Change, European University Centre for Cultural Heritage and European and Mediterranean Major Hazards Agreement (EUR-OPA) at the European Youth Centre, Council of Europe, Strasbourg, 7 – 11 September 2009 [http://bit.ly/HxnQOK]; and European Course on Management and Protection of Cultural Heritage Facing Climate Change, 4–9 October 2010 [http://bit.ly/HDEXP7]

[8] English Heritage, *Conservation Bulletin, A Bulletin of the Historic Environment*, 57, Spring 2008, pp. 7–11 [http://bit.ly/HsY51N, PDF]

[9] The impact on Ecclesiastical Insurance advice can be corroborated by the former Group Chief Surveyor, Ecclesiastical Insurance.

[10] UCL Centre of Sustainable Heritage et al, *Project Parnassus: Protecting Cultural Heritage from Flood and Driven Rain Monitoring in Blickling Hall*, August 2012 – January 2013 [http://bit.ly/1cKvYp6, PDF]