Institution:
University of Oxford

Unit of Assessment:
17B Geography

Title of case study:
'Greening' the conservation of ruined heritage sites using soft capping and ivy.

1. Summary of the impact

The impact of this research has been to change architectural conservation practice to utilize plants as agents of conservation rather than remove them from ruins and other heritage sites. The impact stems from new scientific evidence based on integrated laboratory and field studies carried out at the School of Geography and the Environment in Oxford, by Professor Viles and her team, demonstrating that plants and other organic growths can be protective and contribute to successful and cost-effective conservation of heritage sites. The impact has been realised through close collaboration with English Heritage throughout the research process.

2. Underpinning research

From the mid-1990s, novel research at the margins of geomorphology and ecology carried out by Heather Viles and colleagues in Oxford has evaluated the bioprotective and biodeteriorative roles of different species and communities through empirical studies (linking laboratory experiments and field trials) and the development of theoretical models. This interdisciplinary research indicates that biodeteriorative impacts are often minor (and have been over-stated in the past), whereas bioprotective effects can be pervasive and strong (and have been under-estimated in the past) **[Section 3: R1]**. In architectural conservation practice however, plants are usually seen as causing deterioration and removed, in ignorance of this scientific evidence. Ruins pose a considerable challenge for conservation, as the loss of roofs removes protection to walls, encourages colonization by plants, and accelerates deterioration. There are at least a thousand ruined sites in the UK, as well as many thousands worldwide, and thus decisions about best conservation practice for ruins will have wide-ranging impact.

a) Soft capping research project: As a result of an invited talk on this research at a Heritage Conservation Seminar hosted by the Department of Archaeology, University of York in the late 1990s, Prof Viles was asked to bid for English Heritage funding for a pilot study to develop a methodology to evaluate the impacts of soft capping on the top of ruined walls. Soft capping consists of a thin layer of soil (5 – 10 cm) planted with drought-tolerant vegetation (e.g. grass or sedum plants). Soft capping grows naturally on ruined wall heads and English Heritage were keen to scientifically assess whether it had any protective role, as initial trials at some of their ruined sites had proved encouraging. The results of this pilot study were published in an English Heritage Research Transactions volume **[R2]** and led to an ongoing, eight-year research project (funded by English Heritage and led by Viles (Oxford) and Wood (English Heritage)). The project has developed an innovative, integrated programme of laboratory and field experiments on test walls and on-site testing across England to provide a broad evaluation of the efficacy of soft capping.

The research has provided extensive empirical demonstration that soft capping reduces the thermal fluctuations at wall heads, minimising the risk of frost damage **[R3]**. Also, the research has demonstrated that soft capping can have a regulating effect on moisture regimes towards the top of ruined walls, reducing water penetration into the walls and runoff down the external face **[R4]**. So far, the research has found no evidence of accelerated deterioration under soft capping. A range of different types of soft capping have been evaluated, including grass and sedums.

b) Ivy on walls research project: As a result of the developing collaboration with English Heritage on soft wall capping, a further research project was designed in discussion with them to evaluate the role of ivy on historic walls, as ivy is both commonly found at many ruined sites and blamed for much deterioration. This has become a seven-year research project (also funded by English Heritage), which involves a novel programme of laboratory analyses, detailed investigations on test walls, and on-site monitoring across England. The major research findings, so far, are that ivy provides an effective thermal blanket for wall faces and also prevents particulate pollutants reaching the wall **[R5, R6]**. Also, no significant deteriorative impacts of ivy's aerial rootlets have been found, and on- going research at our test wall site is providing unprecedented scientific evidence for when, and why, ivy roots grow into walls, and what the impacts are.

These English Heritage-funded research projects have materially benefitted from, and, in turn, influenced, a number of other research projects by Heather Viles and colleagues, which have developed novel non-destructive test methods for investigating moisture in walls (Leverhulme-funded) and looked at algal greening of walls (EPSRC-funded).

The research has been led by Heather Viles, starting with her arrival in the School of Geography and the Environment, University of Oxford, in 1996. The key researchers included a number of DPhil students, research technicians and post-doctoral researchers within her group: Dr Larissa Naylor (DPhil student, 1998-2001), Dr Nick Carter (DPhil student, 1998-2002), Dr Troy Sternberg (PDRA, 2007-2009), Dr Julie Eklund (PDRA, 2008-2011), Zoe Lee (research technician, 2008-9), Hong Zhang (Research technician, 2008- present), Dr Martin Coombes (PDRA 2012-present).

3. References to the research

Supporting grants: English Heritage soft wall capping (£219k) and ivy on walls (£195k) – both non-FEC; EPSRC climate change and greening of walls (£800k), the Leverhulme Trust climate change and moisture regimes (£164k).

References: (All of the following are international peer-reviewed outputs, except **R2** which was published in English Heritage's 'gold standard' publication vehicle)

R1: Carter, N.E.A. and Viles, H.A. (2003) Experimental investigations into the interactions between moisture, rock surface temperatures and an epilithic lichen cover in the bioprotection of limestone. Building and Environment, 38: 1225-1234.
(Illustrates the development of multi-method experimental techniques to evaluate the role of organisms on building surfaces)

R2: Viles, H.A., Groves, C. and Wood, C. (2002) Soft wall capping experiments. In, John Fidler (ed.) English Heritage Research Transactions, Stone, 2: 59-73.
(Presents the results of the pilot study experiments, and provides a novel experimental approach to evaluating the pros and cons of soft capping).

R3: Viles, H.A. and Wood, C. (2007) Green walls? Integrated laboratory and field testing of the effectiveness of soft wall capping in conserving ruins. In, Prikryl, R. and Smith, B.J. (eds.) Building stone decay: from diagnosis to conservation. Geological Society Special Publication, 271: 309-322.
(First presentation of our integrated field and laboratory testing approach)

R4: Sass, O. and Viles, H.A. (2006) How wet are these walls? Testing a novel technique for measuring moisture in ruined walls. *Journal of Cultural Heritage*, 7: 257-263.
(Provides proof of utility of 2D resistivity surveys to monitor moisture under soft capping on historic walls)

R5: Sternberg, T., Viles, H.A., Cathersides, A. (2011) Evaluating the role of ivy (Hedera helix) In moderating wall surface microclimates and contributing to the bioprotection of historic buildings.

Building and Environment 46(2): 293-297.
(First report of thermal blanketing role of ivy, based on England-wide monitoring)
R6: Sternberg. T., Viles H.A., Cathersides, A. and Edwards, M. (2010) Dust particulate absorption by ivy (Hedera helix L) on historic walls in urban environments. Science of the Total Environment, 409(1): 162-168.
(First report of the role of ivy in absorbing dust and how this protects historic walls).

4. Details of the impact

The impact of this research has been twofold: (a) changed conservation practice to incorporate plants in architectural conservation; and (b) enhanced information for conservators about the roles of plants in the conservation of ruins.

(a) Changing conservation practice to include plants in architectural conservation has been influenced directly and indirectly by the research **[R2]**. English Heritage has begun to adopt soft capping, and has advised many other organisations on the use of the technique **[Section 5, C1]**. For example, the results of the first phase of field trials at Hailes Abbey (where we monitored changing moisture levels in walls with and without soft capping **[R4]**) were used by English Heritage south west region as evidence of the success of soft capping, after which larger areas of the ruin were soft capped as a preventive conservation strategy. Subsequently, and uniquely in the UK, the whole site was soft capped in early 2013. This project cost £50,000 and has received much attention and discussion **[C2]**. Further afield, the Institut du Patrimoine Wallon sought advice on how to soft cap 11th century ruined walls of the abbey church at Stavelot, Belgium, given its hostile climatic conditions **[C3]**. Building on the results of the research, the work went ahead in November 2011. The managers of other sites have also subsequently expressed interest (e.g. Chaco Canyon, New Mexico). Similarly, the soft capping research **[R2, R3, R4]** forms the major scientific evidence for the performance of soft capping in the two-volume report commissioned by Historic Scotland, launched at a seminar on 15th September 2011, and underpins their trials of the technique in Scotland **[C4]**. Indirectly, the research on ivy has been very influential having received considerable media coverage, provoking many requests for advice from independent building owners, architects and others wanting to know whether ivy could be safely left to grow on historic walls.

(b) Enhanced information dissemination about the potentially positive roles of plants in conserving ruins has been underpinned by the research as presented at two seminars in London which introduced the soft wall capping research findings (2007) and the ivy on walls research findings (2010) to large audiences (c 200 and 100 people respectively) of conservation professionals (architects, surveyors, inspectors of monuments) from English Heritage and cognate bodies. Speakers from the research project teams outlined the aims, methods and scientific results of each project. Points raised during the discussion were included in the design of the second phase of each research project. Written versions of all the presentations from both seminars have been published on-line to make the results freely available to all **[C5, C6].** Both projects feature on the English Heritage website. The ivy project seminar report was number 11 on the top 50 downloads from the English Heritage website between Jan and May 2012, having been downloaded 1240 times.
The impact of these reports is evidenced by the number of enquiries from conservation professionals wanting both further information and a chance to input to the research. Follow up queries were frequent with well over 30 emails and other requests for advice received. For

example, a conservation architect, telephoned Heather Viles, in June 2009, after the soft capping seminar to discuss the team's results in comparison with his experiences at Thirlwall Castle and suggest new research directions **[C7]**. A building physicist also emailed requesting further information on the ivy findings to help inform his conservation advice, saying '…Your team's work could be of great interest to Building Physicists too. Ivy may be a good solution to add extra insulation to new buildings…I am busy with thermal simulations of low cost housing. Insulation made from oil is expensive and my hope is that natural growth around buildings can provide micro-climates that reduce the needed level of insulation.' **[C8]**.

Further impacts from the research include invitations to give talks on the research to a range of professional bodies, courses and meetings in the UK and abroad, reaching a combined audience of well over 400 architects and conservation practitioners (e.g. the Stone Conservation conference at the International Stone Show in London, Conservation Masterclasses at West Dean College, APS Masonry in Oxford, Getty Conservation Institute, Los Angeles, International Stone Deterioration and Conservation Congress, Columbia University). The media coverage of the ivy on walls seminar led to an invitation to submit a paper on the project to a widely-read conservation publication (Viles, HA, Sternberg, T and Cathersides, A. (2011) Is ivy good or bad for historic walls? Journal of Architectural Conservation July 2011). As a result of an EPSRC KTS project with Historic Scotland our research findings have also been incorporated in their INFORM guides on 'Biological Growth on Masonry: Identification and Understanding' and 'Growing Old Gracefully: Appreciating the Appearance of Historic Masonry Buildings' **[C9, C10]**.

5. Sources to corroborate the impact

C1: English Heritage: Building Conservation and Research Team and Landscape Team leaders – will confirm the impact of the research on English heritage conservation practice.

C2: Hailes Abbey soft capping project described in Heritage Calling blogpost (24.4.2013) http://heritagecalling.wordpress.com/2013/04/24/turfing-the-walls-at-hailes-abbey/ and Pitchcare magazine (11.7. 2013) http://www.pitchcare.com/magazine/soft-capping-our-heritage.html

C3: Email from Gestionnaire de projets, Institut du Patrimoine Wallon (21/9/2011) (held on file) confirms enquiry about the relevance of the soft capping technique to Belgian ruins.

C4: Morton, T et al (2011) Soft capping in Scotland, Historic Scotland Research Report http://www.arc-architects.com/aboutus/documents/SoftCappinginScotlandVol1.pdf

C5: Lee, Z., Viles, H.A., and Wood, C.H. (eds.) (2009) Soft capping historic walls: A better way of conserving ruins? English Heritage Research Project Report, 69pp, http://www.english-heritage.org.uk/professional/research/buildings/building-materials/soft-wall-capping/

C6: Sternberg, T et al (2010) Ivy on Walls Seminar Report, 62pp, http://www.geog.ox.ac.uk/research/landscape/rubble/ivy/ivy-report.pdf

C7: Conservation Architect, Berwickshire – will confirm the relationship between his conservation practice and the soft capping research.

C8: Email from buildingphysics.co.za (3/6/2012) (held on file) confirms interest in ivy research and potential for ivy as an agent of insulation.

C9: Historic Scotland INFORM guides: a) Biological growth on masonry: Identification and understanding (Jan 2013 Julie Eklund and Maureen Young) http://conservation.historic-scotland.gov.uk/bio-growth-masonry-inform.pdf, b) Growing old gracefully (Feb 2013, Julie Eklund and Katherine Hummelt) http://conservation.historic-scotland.gov.uk/publication-detail?pubid=9909

C10: Historic Scotland: Technical Conservation Team leader will confirm interest in soft capping and ivy research findings.