Institution: Royal Holloway University of London

Unit of Assessment: 7 Earth Systems and Environmental Sciences

Title of case study: Changing public, professional and political understanding of wildfire

Period when the underpinning research was undertaken: 2000-2018

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Andrew C Scott	Distinguished Research Professor in Ancient and Modern Fire Systems	1985-2020

Period when the claimed impact occurred: 2014-2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

Wildfires have accelerated due to climate change at national and international levels, placing people, wildlife habitats and environments at great risk. In 2019, the United Kingdom had the 3rd largest area affected by wildfires in Europe. Led by Professor Andew Scott, Royal Holloway's research on wildfires over time has responded to the challenges posed by fire by investigating how scientific knowledge can build greater engagement with policy-relevant communities and wider publics. This research changed understanding of the environmental and social-economic effects of wildfire. It has informed national and international policy and been used by practitioners in three main areas: (1) Influencing fire-relevant policies in the European Union, United Nations and national and local authorities in the UK concerning the management of current and future wildfires; (2) in national policy concerning wildfire suppression and in the professional training fire-fighters; (3) Informed understanding of wildfires by politicians, the public, journalists and the wider media.

2. Underpinning research

Fire has been part of Earth's history for over 400,000,000 years. Charcoal fragments embedded in rocks provide vital clues that reveal the story of fire over time and space. Despite the growing recognition of the importance of wildfire and deliberate fires in shaping ecosystems and landscapes, there is an urgent need to better understand how the evolution and biology of ecosystems responds to fire. Communities need to recognise better which species are fire-resistant, fire-sensitive and capable of being managed by those affected communities. As climate change fuels more extreme wildfire events, there is an added urgency to ensuring that policy-makers and publics understand that fire management is going to require ever great attention and sensitivity to rapid ecological change. The growing prevalence of invasive species and extreme weather, for instance, will challenge existing responses to and strategies for wildfire management.

Led by Professor Andew Scott at Royal Holloway, research collaboration with colleagues in Earth Sciences (Professors Chaloner and Collinson) and members of the International Pyrogeography Research Group (led by the University of Tasmania), focussed on improving knowledge of pre-Quaternary fire systems **(R1)**. By examining charcoal embedded in rocks around the world, the group highlighted the role of fire in deep time and began to reconstruct the role of wildfire in the evolution of humanity. The research addresses how fire knowledge is integral to understanding better the current and future nature and role of fire in global ecosystems. Research needs to focus further on ensuring that robust scientific knowledge contributes to ways of knowing and understanding that include and engage governments and wider publics in fire governance.

There two strands of research. The first investigates how charcoal preserves the anatomy of the plants being burned. It was shown that there were significant periods of increased fire occurrence over deep time that relate to high oxygen concentrations in the atmosphere. This had a significant impact on how plants evolved to live in such fiery landscapes **(R6)** and developed traits to cope with fire in the modern world. We used the past record of fire before human influence on fire as a baseline from which to assess the influence of human activity on local and global fire systems, as well as assessing the impact of climate change on wildfire **(R2 and R3).** Our studies of periods of rapid climate change such as the Paleocene-Eocene Thermal Maximum, 55,000,000 years ago, and at the beginning and end of the Younger Dryas, 12.5ky ago, demonstrated how fire systems coped with climate perturbations.

The second, related, area of research considers how fire knowledge can inform public understanding and contribute to policy recommendations. The research collaboration and integration led to recommendations for change in policies for land managers, fire services and politicians in framing legislation on wildfire and climate change **(R4).** The research was also published in more accessible formats designed to showcase the sources and techniques used to understand and analyse fire within the Earth System as a whole **(R5, R6)**.

3. References to the research

The following articles are all published in highly regarded journals and with established academic publishers, all have been peer reviewed, and supported by grant funding from the Leverhulme Trust and NERC.

(R1). Scott, A.C. 2000. The Pre-Quaternary History of Fire. *Palaeogeography, Palaeoclimatology, Palaeoecology* **164**, 281-329 (DOI: 10.1016/S0031-0182(00)00192-9).
594 citations on Google Scholar.
(R2). Bowman, D.M.J.S., Balch, J.K., Artaxo, P., Bond, W.J., Carlson,J.M., Cochrane, M.A., D'Antonio, C.M., DeFries, R.S., Doyle, J.C., Harrison,S..P., Johnston, F.H., Keeley, J.E., Krawchuk, M.A., Kull, C.A., Marston, J.B., Moritz, M.A., Prentice, I.C., Roos. C.I., **Scott, A.C.,** Swetnam, T.W., van der Werf, G. R., Pyne, S.J. 2009. Fire in the Earth System. *Science* **324**, 481-484.
2140 citations on Google Scholar, also in the top 5% of all research outputs scored by Altmetric (score 158). (DOI: 10.1126/science.1163886)
(R3). Bowman, D.J.M.S., Balch, J., Artaxo, P., Bond, W.J., Cochrane, M.A., D'Antonio, C.M., DeFries, R., Johnston, F.H., Keeley, J.E., Krawchuk, M.A., Kull, C.A., Mack, M., Moritz, M.A., Pyne, S.J., Roos, C.I., **Scott, A.C**., Sodhi, N.S. and Swetnam, T.W., 2011. The human dimension of fire regimes on Earth. *Journal of Biogeography* 38, 2223-2236 (DOI: 10.111/j.1365-2699.2011.02595x).
The paper has 691 citations in Google Scholar.
(R4). Scott, A.C., Chaloner, W.G., Belcher, C.M., Roos, C.I. 2016. The interaction of fire and mankind: *Phil. Trans. R. Soc. B*. volume 371, Issue 1696 252pp.
(DOI: https://doi.org/10.1098/rstb.2015.0162).
Scott's key contribution. e.g. Supplementary online material: Policy challenges and research agenda for the UK. At https://royalsocietypublishing.org/doi/suppl/10.1098/rstb.2015.0469
(R5). Scott, A.C., Bowman, D.J.M.S., Bond, W.J., Pyne, S.J. and Alexander M. 2014. *Fire on Earth: An Introduction.* J. Wiley and Sons. 413pp. Available from HEI on Request.
Over 220 citations in Google Scholar.
(R6). Scott, A.C. 2018. *Burning Planet. The story of fire through time.* Oxford University Press. 224 pp. ISBN 978-0-19-873484-0. Available from HEI on Request.

4. Details of the impact

A key challenge for this research is to ensure that publics and policy-makers understand the current and future role of wildfire and how we manage fire occurrence and intensity. The underpinning research been achieved through strong and long-lasting collaborations of over twenty years with other academics, learned societies and policy-making communities. Building

these relationships, particularly with the International Pyrogeography Research Group (led by the University of Tasmania) and Royal Holloway colleagues, encouraged knowledge transfer, policy impact and capacity building. The beneficiaries include academic and professional communities, policy-makers and wider publics.

Informed public policy and services pertaining to wildfires and climate change. There is a shared concern for the role and impact of fire and its relationship with climate change There have been three main pathways to impact: direct citation, acting as an expert adviser and participant in expert fora. The research findings generated by Scott and his co-researchers was directly cited by official reports generated by international governmental, inter-governmental and non-governmental organizations. Scott's findings, and the data that underpinned the research, was used by policy communities to quantify the impact that wildfire is having on global radiative forcing and climate change. This has been used in the most recent Inter-governmental Panel on Climate Change assessment **(S1)** and the European Union's Policy Document: Science for Disaster Risk Management 2017 **(S2).** The research was also used in parliamentary and congressional debates about wildfires. For example, the US House Bill 1526, the Restoring Healthy Forests for Healthy Communities Act (2013 to 2014) that advised on the policy implementation to show the diversity of fuel and vegetation types susceptible to fire. Alongside the public citation of research findings, Scott has also acted an expert adviser for parliamentary and policy-relevant communities. In 2019, a Parliamentary Office Science and Technology (POST) briefing paper 'Climate change and UK wildfire' that cited 7 of Scott's research outputs **(S3).** Royal Holloway's research informed provided the paper and POST's key recommendations were published on the bases of the research **(R4)** were used in the summary of the findings. The United Kingdom Government's Review of Wildfire Policy (2019) included evidence from Scott as has the 2020 3rd UK Climate Change Risk Assessment **(S5).**

Scott acted an expert for relevant professional stakeholders. For example, Scott is a member of the England and Wales Wildfire forum that provides policy advice for the UK government **(S4).** Paul Hedley, the Chief Fire Officer of Northumberland Fire and Rescue Service (NFRS) and the National Fire Chiefs Council (NFCC) lead for wildfires within the UK writes **(S4):** *"I have successfully proposed Professor Scott membership to the Chair and the Secretariat of the EWWF and given his international standing, his research, knowledge, and networks I believe he has a vital role to play in the EWWF's on-going evidence based development of wildfire policy across a diverse range of sectors".* A key element of this drive to influence and policy is to engage with politicians (such as Jeremy Hunt MP, former Foreign Secretary) and to make them aware of the complex issues both through discussion and papers **(S5).** Jeremy Hunt MP writes: *"I am aware that the excellent contribution he makes as a member of the England and Wales Wildfire forum, which provides policy advice for the UK government on all aspects of wildfire, including most recently, plant flammability and behaviour, is very well respected in Westminster"* **(S5).** *"Professor Scott's substantive work on this issue has had a considerable impact on national and international policy and perceptions for policy makers and practitioners and has influenced the conclusions of policy reports by international governmental, and inter-governmental organisations, demonstrating the substantial effect fire can have on climate change. This understanding has undoubtedly raised the issue of wildfire significantly higher on the political agenda".*

Changes to training, education policy and professional development. Scott's research has changed the professional training offered to UK Fire Services. One of the insights offered to the fire-fighting services was the changing nature and severity of fire. Fire services recognised that they needed to better understand plant flammability and diverse fire behaviour. Paul Hedley of the England and Wales Fire and Rescue Service wrote: "*The outcomes of work undertaken by Professor Scott continues to shape the way we adapt and change to the challenges presented by the increasing frequency and severity of wildfires in the UK to not only save our countryside and urban areas but also to potentially reduce injuries and save lives".* **(S4)** Scott continues to provide expert advice to the England and Wales Fire Service on flammable vegetation in particular. Scott's research findings are also being used in the training offered by the Forestry Service, who themselves offer training to the England and Wales Fire Service **(S6).** Rob

Gazzard, **a** Senior advisor for Forestry Commission Contingency Planning, Technical Guidance and Wildfire, noted "*His own (Scott's) contributions to the UK Wildfire Research Group for which I am the coordinator, through his talks and published research has proved important in shaping current policies on wildfire across a number of sectors. His published research on wildfire in Earth history has changed perceptions of wildfire and has had a direct impact in a range of areas of wildfire science and policy. In my role of training land managers and fire fighters to increase wildfire prevention I now use his material based upon his research in my courses. His research has led me to change the way I explain wildfire to a range of stakeholders in our training courses and policy documents. Without your research our perception of the role of wildfire in the Earth System would be very different and the insights your research has provided is proving important in considering future fire policy in relation to climate change*" **(S7)**. In 2020, Scott became part of a community initiative in Surrey with the Fire and Rescue Service, Police and NGOs to provide guidance and advice on wildfire threats to the public **(S5).**

Enriched public understanding and media on wildfire and its impact on global ecosystems. Scott and his research team are committed to sharing the benefits of research as far as possible. Between 2014 and 2020, Scott was invited to contribute to a diverse range of media publications and outlets. These included blogs/news (e.g. Huffington Post), online magazines (e.g. *Zócalo Public Square*), specialist magazines (e.g. *International Fire Fighter*), popular scholarship (e.g. *Fire: A Very Short Introduction* published by Oxford University Press), and national and international media (e.g. BBC World Service). He is in demand as an expert commentator on the continued impact of wildfire and the dilemmas faced by communities and local authorities as they seek to adjust and manage fires that do not necessarily 'die down' in winter months and/or cooler temperatures. Scott has been interviewed by journalists based in North America, Australia, continental Europe and the UK, including appearances on television and radio programmes. For example, Scott appeared in a 60-minute programme on wildfire recorded for 'Science for the People' (2018) was broadcast through 30 radio stations and the podcast downloaded 15,000 times **(S8).** And a BBC radio programme recorded on fire and climate change (2016) on the World Service had a global reach of 270,000,000 and was also repeated on BBC Radio 4 **(S9).** Journalists have also acknowledged that Scott's research and participation in various radio and television programmes has greatly improved their understanding of fire science and the role of fire over millennia. Scott's work with public media also led to his research being featured on the knowledge platform for disaster risk reduction run by the United Nations Office for Disaster Risk Reduction (UNISDR) and in Kew Gardens' *State of the World's Plants* (2017).

Scott's public-facing scholarship has been widely praised for its accessibility and clarity of thought. *The Times* noted, "*We need to think about fire and recognize the evolution of our firery world. His book, the product of a lifetime's obsession is the place to start thinking"* and in the *New Scientist* "*What we need, says Scott, is a transformation in our attitude to this essential cog in the Earth's working. Consider the alarm raised"*. Scott's research has also changed perceptions of wildfire leading to the incorporation of his research in new plans for exhibitions, finalised in 2020 at the Museum of Science and Natural History in Japan (for 2022) **(S10),** as well as cultural exhibitions in the USA. Anna Kaye, Colorado artist and exhibition organizer, for example writes "*I have read the pioneering research in several publications of Professor Andrew C. Scott. Burning Planet: The Story of Fire Through Time has changed my views, inspired and enhanced my work as an artist, as well as my efforts to create a large-scale environmental exhibition.*" **(S10)** He has also won praise for his public communication and ability to communicate complex ideas in an accessible and informed manner. As Paul Hedley wrote*: "I have been in contact with Professor Scott following the 3rd national Wildfire Research Group meeting held in London in February 2019 after first seeing him present at the November 2017 UK Wildfire Conference "Wildfire Resilience in a UK Context" in Bournemouth* **(S4)***. The presentation focused upon the potential impact of a devastating wildfire in Surrey, and looked at factors such as climate change, fire management, non-native fuel, effects on infrastructure and the analysis of wildfire threat and risk. In the paper the reality of this scenario based on fire research both on modern and ancient fire systems and on forward modelling was*

considered. Many of the challenges faced by UK fire and Rescue Services were outlined within Professor Scott's presentation" **(S4).**

5. Sources to corroborate the impact

[S1]. Paper **[R2]** Used by the Intergovernmental Panel on Climate change Published 2014. Climate Change 2013 – The Physical Science Basis: Working Group. Chapter 8 Anthropogenic and Natural Radiative Forcing.
[S2]. Papers **[R2, R3, R4]** used in European Union Policy Document: Science for disaster risk management 2017. Pp. 294-335 [2,3,4] https://publications.europa.eu/en/publication-detail/-/publication/4bc0e055-3712-11e7-a08e-01aa75ed71a1/language-en/format-PDF
[S3]. Parliamentary Committees: Contributed and refereed Parliamentary Briefing document (POST 603) on "Climate change and wildfire frequency" (https://www.parliament.uk/postnotes) as part of the parliamentary review of wildfire.
[S4]. Testimonial from Paul Hedley, the Chief Fire Officer of Northumberland Fire and Rescue Service (NFRS) and the National Fire Chiefs Council (NFCC) lead for wildfires within the UK.
[S5]. Testimonial from Rt Hon Jeremy Hunt MP, (Former Foreign Secretary)
[S6]. UK Wildfire Resilience 2017 Report incorporating Scott's advice surrounding flammable vegetation https://www.dorsetforyou.gov.uk/countryside-coast-parks/dorset-heaths/pdfs/uk-wildfire-resilience-2017.pdf and PDF article recognising the release of the hand book (available from HEI on request).
[S7]. Testimonial from Rob Gazzard, (Senior advisor for Forestry Commission Contingency Planning, Technical Guidance and Wildfire).
[S8]. Science for the People, California (USA): Wildfires (60 mins) March 23 2018 http://www.scienceforthepeople.ca/episodes/wildfire. Syndicated to 30 radio stations and websites and downloaded 15,000 times.
[S9]. August 2016 BBC World Service: The Forum with Bridget Kendall - Fire: How Climate Change is Altering our Attitudes to Wildfires. https://www.bbc.co.uk/programmes/p045g1dp (Heard in more than 100 countries with a global audience of 270 million). http://www.bbc.co.uk/programmes/b08349jl
[S10]. Testimonial from Anna Kaye, Colorado artist and exhibition organizer (https://www.annakayeart.com/)