

Impact case study (REF3)

Institution: University of Exeter		
Unit of Assessment: UoA 14 Geography and Environmental Studies		
Title of case study: Effecting a paradigm shift in water industry approaches to water resource management.		
Period when the underpinning research was undertaken: 2010 - 2020		
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:
Prof. Richard Brazier	Professor, Earth Surface Processes	2006 - present
Dr Karen Anderson	Associate Professor in Remote Sensing	2004 – present
Dr David Luscombe	Research Fellow	2013 – present
Dr Emilie Grand-Clement	Research Fellow	2010 – present
Dr Naomi Gatis	Research Fellow	2014 – present
Leon DeBell	Research Technician	2013 – 2016
Dr Donna Carless	Research Technician/ Fellow	2015 – present
Dr Amanda Robinson	Research Assistant	2017 – present
Dr Ben Jackson	Research Assistant	2018 – present
Period when the claimed impact occurred: 2013-present		
Is this case study continued from a case study submitted in 2014? Y		
1. Summary of the impact		
<p>Historically, the water industry has provided clean drinking water through expensive engineering solutions. Climate change and population growth are challenging the economic viability of such approaches, with business-as-usual costs projected to double by 2030.</p> <p>Research led by Professor Richard Brazier and his team has provided the environmental and financial evidence base to justify catchment restoration as a cost-effective water management mechanism effecting a paradigm shift towards nature-based solutions in the water industry.</p> <p>The research has quantified improvements in drinking water quality and natural habitats across >3000ha of peatlands and led to changed practices in South West Water (SWW) delivering a reduction in water treatment costs with a 65:1 benefit to cost ratio. Consequently, similar catchment management practices, funded by UK Government and the water industry are being adopted both regionally and nationally.</p>		
2. Underpinning research		
<p>The focus of Professor Brazier's team has been to understand and quantify the environmental and economic benefits of moorland restoration at a landscape scale. Research was undertaken to support the South West Water (SWW) Upstream Thinking programme which applies landscape-scale measures, including moorland restoration, to improve raw water quality at source and thus drive down water treatment costs.</p> <p>In 2010, to understand whether catchment management represents a value-for-money investment, SWW commissioned Prof. Brazier, to undertake an expert review of the Exmoor Mire Restoration Project, a pilot project within Upstream Thinking. Working with Dr Sean Arnott of the Environment Agency, Prof. Brazier developed a comprehensive hydrological monitoring plan for 326 hectares of restored mire, which incorporated water quality and quantity, biodiversity, and greenhouse gas (GHG) emission research. The research concluded that there could be significant environmental and economic value in restoring large areas upstream of SWW supply and abstraction points [3.1], but that quantitative evidence on the return on investment was required, particularly in terms of enhanced water and carbon storage capacity and water quality.</p>		

During 2010-15, the team evaluated the effectiveness of the Mires-on-the-Moors project, a £2.2M collaboration with the Environment Agency, SWW, Exmoor National Park Authority and Natural England. The project restored 2000 hectares of bog by blocking drainage ditches to enhance water storage, improve downstream water quality, raise water table levels, and reduce GHG emissions.

Funded by SWW, NERC and Innovate UK the team then implemented a 4-year ecohydrological monitoring plan, using the most comprehensive network of monitoring equipment in any UK upland [3.2]. Water levels were recorded every 15 minutes at 200 locations, alongside water quality and greenhouse gas fluxes across headwater catchments. Early monitoring and remote-sensing data (2011-13) provided a pre-restoration benchmark showing that peatlands were abnormally dry [3.2], with few intact blanket bogs [3.3], which lost excessive amounts of carbon via both fluvial [3.4] and gaseous pathways [3.5].

During 2015-2020, SWW funded the team to quantify the impacts of restoration on water quantity, quality, and greenhouse gas fluxes. The resultant research demonstrated that:

- restored bogs release up to 43% less dissolved organic carbon (DOC) to surface waters than damaged peatlands [3.4];
- water loss decreased by 22-35% during storms, and the average water table rose by up to 10cm post-restoration [3.2];
- dry, damaged mires release 1-5 tonnes of carbon per hectare per year; re-wetted mires start storing, rather than emitting carbon in less than 5 years [3.5].

Justified by this research, peatland restoration on Exmoor to date is estimated to have prevented 870 tons of CO₂ from being emitted to the atmosphere each year [3.5]. However, the team also showed that the peatland resource in the south west uplands is vast (up to 1000km²), but extensively damaged [3.6], thus has lost significant amounts of carbon in the past, which could be restored in the future, demonstrating the legacy potential of this research to support the drawdown of carbon for years to come.

The underpinning research attends to the contribution that peatland restoration can contribute to the water quality, of direct impact to water industry stakeholders. This industry focus marks the change in direction from REF 2014 where stakeholder interests were directed to the agriculture community, with underpinning research addressing the effects of soil erosion and land management on soil quality, diffuse pollution and on water quality in the UK river system.

3. References to the research

- 3.1** Grand-Clement E, Smith D, Anderson K, Ross M, Luscombe D, Gatis N, and Brazier R.E. (2013). Evaluating ecosystem goods and services after restoration of marginal upland peatlands in South-West England. *Journal of Applied Ecology*, 50(2): 324-334. <https://doi.org/10.1111/1365-2664.12039>.
- 3.2** Luscombe D.J., Anderson K, Gatis N, Grand-Clement E, and Brazier R.E. (2016). How does drainage alter the hydrology of shallow degraded peatlands across multiple spatial scales? *Journal of Hydrology*, 541(B): 1329-1339. <https://doi.org/10.1016/j.jhydrol.2016.08.037>.
- 3.3** Luscombe D.J., Anderson K, Gatis N, Grand-Clement E, and Brazier R.E. (2015). Using thermal airborne imagery to measure near surface hydrology in upland ecosystems. *Hydrological Processes*, 29(6): 1656-1668. <https://doi.org/10.1002/hyp.10285>.
- 3.4** Grand-Clement E, Luscombe D, Anderson K, Gatis N, Benaud P, Brazier, R.E. (2014). Antecedent conditions control carbon loss and downstream water quality from shallow,

damaged peatlands. *Science of the Total Environment*, 493(15): 961-973.

<https://doi.org/10.1016/j.scitotenv.2014.06.091>.

3.5 Gatis N, Luscombe D.J., Grand-Clement E, Hartley I.P., Anderson K, Smith D, Brazier, R.E. (2016). The effect of drainage ditches on vegetation diversity and CO₂ fluxes in a *Molinia caerulea*-dominated peatland. *Ecohydrology*, 9(3): 407-420.

<https://doi.org/10.1002/eco.1643>.

3.6 Carless D, Luscombe D.J., Gatis N, Anderson K, Brazier R.E. (2019). Mapping landscape-scale peatland degradation using airborne lidar and multispectral data. *Landscape Ecology*, 34(6): 1329-1345. <https://doi.org/10.1007/s10980-019-00844-5>

4. Details of the impact

Historically, the water industry has provided clean drinking water through expensive engineering solutions. Climate change and population growth are challenging the cost-effectiveness of such approaches, with business-as-usual costs projected to double by 2030. In response, all UK water companies are exploring nature-based approaches to water resource management. Until recently, their reliability and cost-effectiveness was unquantified. This research impacts the water industry by quantifying the environmental and economic return of alternative approaches to water resource management:

4.1 Demonstrable environmental benefits

Novel research generated high-resolution understanding of moorland ecohydrology resulting in an optimal approach to deliver peatland restoration which led to:

- Reduced discolouration of water supply and reduced water treatment costs, with a 65:1 benefit-to-cost ratio [3.1]. Water discolouration (commonly caused on Exmoor by Dissolved Organic Carbon (DOC) exports from the peatland) is a major cause of complaints. As a result of the peatland restoration process SWW report up to 43% decrease in DOC export [5.1].
- Increased water retention in restored catchments, with water loss decreasing 22-35% for a given rainfall input (6,630 Olympic-sized swimming pools from Exmoor [5.2]), and an average water table increase up to 10cm (in some areas as much as 21cm). This has improved water supply resilience [5.1].
- Natural flood management and reduced flood risk, positively impacting on Environment Agency national policy on flood management, releasing spend of £1.2M in the south west, securing £15M nationally and informing the decision on how to allocate £6BN capital investment in flood risk management schemes between 2021 and 2027 [5.3].
- Enhanced carbon storage in soils and vegetation; restoration on Exmoor will prevent loss of 104,000 tCO₂e over 20 years, at a value of ca. £1.04M [3.1]. This understanding has shaped planning for future environmental management. The Environment Agency Area Director (Devon, Cornwall and the Isles of Scilly) commented: '*Prof. Brazier's research has helped the Environment Agency to influence the development of the next Dartmoor National Park Authority Management Plan, which now has a section on natural processes. The land restoration work which he has been part of will contribute directly to land restoration targets in Defra's 25 year Environment Plan and the UK Peatland Strategy 2018-2040*' [5.3].

These benefits are endorsed by industry awards [5.4] the Wildlife and Countryside Link, ranking SWW 1st in their 'Blueprint for Water' assessment [5.5] of environmental performance and recognition of direct research impact by the Environment Agency:

'Prof. Brazier's research and his approach to communicating the results has had a significant impact on the way that flood risk is managed, both in the South West region and across the country' [5.3].

This paradigm shift is further endorsed by the Environment Agency's national Executive Director of Flood & Coastal Risk Management, who said:

'The climate crisis is accelerating flood risk in this country and means we need new and integrated ways of managing that risk. This year the Environment Agency launched its new flood and coast strategy to 2100. At the heart of that strategy is the recognition that we won't be able to build our way out of this problem – we need to blend the environment and engineering – on a catchment scale to create the best resilience to climate change. This brings natural flood management and natural solutions to the fore when tackling increased flood risk' [5.6].

4.2 Transformational change of culture and practice within the water industry

SWW is a regulated monopoly and must generate profit for shareholders whilst demonstrating cost-effectiveness. The research has led directly to a cultural change in how water resources and quality improvements are planned/approved, by demonstrating that catchment restoration would allow SWW to meet regional demand for water without building new infrastructure. This avoided costs of £2-3M for every million litres per day of water stored [3.1]. Research also informed real-time optimisation of restoration work, leading to increased reliability, and reduced operational costs; for example, at one water treatment works, shutdowns reduced from 19 to zero over an identified 2-month period, delivering savings of £50K [5.1].

The research also led to reduced discolouration of water supply and water treatment costs, with a 65:1 benefit-to-cost ratio (3.1). Discolouration is a major cause of complaints, SWW advised that for every 1 in 1000 complaints avoided (thousands of complaints are received every year), they save £0.5M in regulatory penalties (5.1).

The research impact has enabled SWW to satisfy the Environment Agency, Ofwat and shareholders that landscape restoration is cost-effective, delivering wider benefits at lower cost than conventional engineering. In their business plan for 2015-20 [5.7], the research enabled SWW to secure £12M investment (plus £4M from Defra) for large-scale restoration of southwest peatlands. This included a Payments for Ecosystem Services scheme, in 2015 which is paying farmers £850K over 25 years to store water and carbon. In their 2020-25 business plan [5.8], the research enabled SWW to secure £17M to deliver land restoration targets in Defra's 25-year Environment Plan and the UK Peatland Strategy.

SWW now have evidence-based confidence to adopt innovative approaches to water management. Ofwat fast-tracked SWW's 2020-25 business plan, commending their *'innovative approach to securing resilient and sustainable water resources, creating an internal water resources market'* and *'strong evidence of partnerships and catchment strategies'* [5.9].

The impact also has national reach; SWW's positive reporting of the research [5.2], further endorsed by the EA [5.3], may encourage other water companies to adopt similar approaches. The Committee on Climate Change used research outputs in a report recommending that the area of upland peat restoration be tripled [5.10].

4.3 Securing long-term impact through natural capital approaches

Finally, as a direct result of the impact of this research, in their 2020-2025 business plan [5.8] SWW committed £21M co-funding to establish a dedicated research centre at the University of Exeter. The Centre for Resilience in the Environment, Water and Waste (CREWW) embodies the ethos of co-creating environmental solutions to water resource

management and will be a place to realise the potential of future impact on the water industry, an ambition that has been validated by an award of £10.5M from Research England.

The research undertaken has underpinned a paradigm shift within South West Water and the wider water sector, by demonstrating the multiple benefits of nature-based approaches to water management compared with conventional engineering solutions. Nature-based approaches have been shown to be a cost-effective means of delivering reduced discolouration of water supply and water treatment costs, increased water retention within catchments (thereby reducing flood risk and improving water supply resilience) and enhanced carbon storage in soils and vegetation. This has led directly to a cultural change in how water resources and quality improvements are planned and approved. Nature-based approaches are now widely supported across water companies, regulators, and government, and are accepted as an integral mechanism for managing precious natural resources in the face of climate change and population growth.

5. Sources to corroborate the impact

- 5.1. Letter from Managing Director, South West Water, 31 January 2019.
- 5.2. WWT (Water and Wastewater Treatment) Magazine, 7 February 2014: <https://web.archive.org/web/20201117084326/https://wwtonline.co.uk/news/exmoor-peat-bogs-contain-rainfall-says-study> (Archived: 17/11/20)
- 5.3. Letter from Environment Agency Area Director (Devon, Cornwall and the Isles of Scilly), 1 March 2020.
- 5.4. Summary of awards won by the Upstream Thinking programme (Ecostar report)
- 5.5. Blueprint for Water endorsement (Blueprint Environment Scorecard p3 and press release, January 2019, <https://www.wcl.org.uk/environmentscorecards.asp>)
- 5.6. Testimony from former Executive Director of Flood and Risk Management, the Environment Agency, 16 December 2020.
- 5.7. SWW business case to Ofwat 2015-20: <https://www.southwestwater.co.uk/waterfuture/business-plan-2015-2020/>
- 5.8. SWW business case to Ofwat 2020-25: <https://www.southwestwater.co.uk/waterfuture/business-plan-2020-2025/>
- 5.9. Ofwat commendation of SWW business plan Water Briefing, 31 January 2019. <https://www.waterbriefing.org/home/regulation-and-legislation/item/15819-2019-price-review-ofwat-fast-tracks-three-water-companies-with-high-quality-plans> (Accessed: 16/4/2020)
- 5.10. Managing the land in a changing climate, Adaptation Sub-Committee Progress Report 2013: https://www.theccc.org.uk/wp-content/uploads/2013/07/ASC-2013-Book-singles_2.pdf