**Institution:** University of Southampton

**Unit of Assessment:** Geography, Environmental Studies & Archaeology

**Title of case study:** 17B-04 Transforming River Management & Restoration Through Applied Geomorphology

## 1. Summary of the impact

Research by the University of Southampton into river processes and restoration has contributed significantly to the adoption of fluvial geomorphology as a tool for river management. The research quantified for the first time, the cost of sediment management in rivers to the UK economy and environment, arguing that improvements could be achieved by applying fluvial geomorphology. The research developed new evidence, tools and training that were adopted by river management agencies and consultants for the scoping, assessment and planning of projects. This has resulted in cost-savings through reduced river maintenance, improved river environments, and the creation of a new employment market for graduates with geomorphological training.

## 2. Underpinning research

Reducing the costs of river management on the economy and environment, whilst balancing the needs of communities for protection against flooding and erosion is a global challenge (Convention on Biodiversity COP10), and has been a focus for UK government (Defra), conservation and river management agency's policy and operational practice (c.f. recent White papers published in 2011- "Water for Life", "The Natural Choice"). It is into this challenge that research at Southampton Geography & Environment has contributed. This research has led to academic leadership in river restoration and key publications that have influenced the understanding of our relationship and approach to managing and restoring river environments.

1. Managing rivers for sediment, flood risk and erosion. Professor Sear led the first research **[3.1]** to assess river management agencies' approaches to problems such as riverbank erosion and sediment accumulation in flood channels (1991-1998). Results showed that UK agencies were spending £20m p.a. removing sediment from rivers and preventing erosion. Furthermore, many projects were simply unnecessary, or could be more sustainably addressed by a better understanding of sediment dynamics and restoring natural processes **[3.1]**. Subsequently (1996-2009), research focussed on the development and application of methods and techniques (termed Fluvial Audits) to integrate fluvial geomorphology into river management operations **[3.1]**. This has led to key publications on the role of fluvial processes in delivering environmental benefits, and how these contribute to flood and erosion risk **[3.2]** – work that was recognised as "*one of the most important pieces of research that has been carried out to examine what might happen to UK flood risk in the future*". Evans, E.P. et al., (2008). These approaches have been transferred via FAO funded research (2011-13) to understand the role of channel dynamics during extreme flooding, on food security in Pakistan.

2. Understanding the benefits and uncertainties of river restoration. River restoration was implemented as a tool to enhance river channels damaged by centuries of river management. Initially focussed on ecology, research led by Sear since 1994, argued that such a narrow focus was unsustainable without a better understanding of the physical processes **[3.3]**. Subsequently (2004-2010), Sear and others at Southampton, demonstrated the importance of understanding sources of uncertainties inherent in restoring river ecosystems, highlighting how failure to acknowledge and embrace it, would lead to failures in achieving restoration goals **[3.4]**. This resulted in a keynote paper (2010) outlining the evidence and arguments for a process based approach for restoring river ecosystems, published in the high impact journal Bioscience **[3.5]**.

3. Quantifying the links between fine sediment delivery from the land surface and its impact on river ecology. Sear's research from 1993-date and others have pioneered process based approaches to understanding the impacts of (largely) anthropogenically derived fine sediments on

the ecology of river ecosystems. Fine sediments including organic matter and nutrients, are recognised as the dominant reason for UK rivers failing to meet European targets for river ecology. The research provides fundamental evidence on how the impacts occur across different species groups, and clearly sets out a reasoned argument for adopting more targeted approaches to setting sediment targets **[3.6 and references cited in 5.3].**

## 3. References to the research


**3.1** Sear, D.A., Newson, M.D. & Thorne, C.R., Applied Fluvial Geomorphology, Thomas Telford, 2010, 249p (Peer reviewed).

**3.2** Watkinson, A.R. Nicholls,R.J., Sear, D.A. & Ledoux, L. Environmental impacts of future flood risk, in Thorne, C.R., Evans, E.P. & Penning-Rowsell, E. (Eds) Future Flooding and Coastal Erosion risks, Thomas Telford, London, 2007, 29-44 (Peer reviewed).

**3.3** Sear, D.A. (1994) River restoration and geomorphology. Aquatic Conservation. 4, 169-177. (Peer reviewed)

**3.4** Darby, S.E. & Sear, D.A., eds., River Restoration: managing the uncertainty in restoring physical habitat, J.Wiley & Sons, Chichester, 2008, 21-42. (Peer reviewed).

**3.5** Beechie,T.J., Sear,D.A., Olden,J.D., Pess,G.R., Buffington,J.M., Moir,H., Roni,P., & Pollock,M.M. (2010) Process-based Principles for Restoring River Ecosystems, Bioscience, 60,3:57-68. (Peer reviewed).

**3.6** Collins, A.L., Naden, P.S., Sear, D.A., Jones, J.I., Foster, I.D.L. & Monnow, K. (2012) Sediment targets for informing river catchment management:international experience and prospects, Hydrological Processes, 25, 13, 2112-2129. (Peer reviewed).


## 4. Details of the impact

The application of fluvial geomorphology has changed the approach of river authorities around the world to the management and restoration of waterways, in part as a result of 20 years of research led by Professor Sear, which began in the early 1990s when he developed new methods and quantified the fiscal and environmental costs of sediment management to the UK economy. River management agencies and environmental engineering consultants now routinely apply tools and training he and his co-authors developed for the scoping, assessment and planning of river restoration and river management projects **[5.1-5.3]**, resulting in the creation of a new employment market for graduates with geomorphological training **[5.3]**. River restoration is a £billion global industry and the main river management tool for redressing the impacts of human modification of rivers. Sear's pioneering research in this area has helped support the UK River Restoration Centre (RRC) via his role as Director (currently Associate Director) **[5.1]**, when he was instrumental in setting up the annual RRC conference which attracts international practitioners and scientists in river restoration and is a key industry KE event **[5.1]**.

Southampton research has led to the development of tools like Fluvial Audits, guidebooks and E-learning training packages, all of which are currently shaping the river management policy and practice of the Environment Agency **[5.3]**, Natural England **[5.5]** and the Scottish Environment Protection Agency **[5.6]**. The Guidebook of Applied Fluvial Geomorphology (2003; 2010) has become the default reference on geomorphology within the organisations mentioned above **[5.1-5.3]**. Alongside the production of these tools, geomorphological research at Geography & Environment at Southampton has been used to underpin the Environment Agency (EA) and Scottish Environment Protection Agency (SEPA) policy and guidance on sediment management **[5.7-5.9]** which is used on a routine basis to support engineering and river restoration practices **[5.2,5.3,5.5]**. Direct knowledge transfer from this research into industry has been supported via training to more than 100 EA staff **[5.2]**, which has influenced operational practice **[5.3-5.4]**. Most recently (2012-13), this has involved training of 120 EA staff in Hydromorphology **[5.3]**, whilst the E-learning modules have been taken by over 500 river managers and consultants in the UK and abroad **[5.2]**.

The Fluvial Audit methods developed by Sear and his colleagues in GeoData have been adopted by all the key commercial environmental consultancies like Jacobs, Halcrow and Atkins **[5.1-5.2]** and have been used to guide strategic and operational river management and restoration projects on more than 70 rivers across the UK, in the United States and Asia (e.g. Goswami). The method was an integral part of the first international demonstration river restoration site on the River Cole at Coleshill (UK), beginning in 1994, and was developed by Sear and colleagues in GeoData into the standard tool for use in River Restoration strategies for SSSI and SAC rivers **[5.5]**, the latter being cited as a best practice example in Natural England's evidence to the Government Committee on Environment, and resulting in improvements to the aquatic environment over 100 kilometres of UK river **[5.4]**.

In 2004, Sear's research contributed to the Office of Science and Technology's Foresight Future Flooding Report, which set the agenda for the Defra 'Making Space for Water' consultation exercise leading to the 2005 Defra policy document 'Making Space for Water'. These marked a shift away from structural (embankments, flood channels) and hard engineering solutions for flood and erosion risk management, and instead placed more emphasis on working with natural processes and adopting catchment based solutions. Through this process the Foresight evidence was used to underpin the 2009 Draft Water Bill (10, pg 7) which is impacting on current policy and practice in UK water management **[5.3, 5.5]**.

Most recently, NERC funded (NE/I002219/1) research led by Sear on the catastrophic flooding in Cumbria in 2009 has contributed to Environment Agency (EA) policy on sediment management **[5.1]**, and has, through his work on the LWEC (Living with Environmental Change) working group on Flood and erosion risk research, led to the inclusion of fluvial geomorphology within the LWEC National Research Strategy for Flood and Coastal Erosion Risk Management in 2011, and the developing research strategy for EA/Defra on Working with Natural Processes (Invited participant Sheffield Workshop Sept. 2013).

Thus, Geography and Environment research at Southampton, led by Professor Sear, has had a demonstrable impact on river environments and their management within the UK, through the provision of evidence (e.g. Cumbrian Flood Impacts), guidance (E-Learning, Guidebook, and Training) and Knowledge Transfer (e.g. Foresight Report) direct to industry and government.

## 5. Sources to corroborate the impact

Although limited to 10 references, further information is available via the individuals who have provided letters of Commendation, and additional web/documentary evidence is available should this be required.

**5.1** Corroborating letter from Principal Consultant, Atkins Global, Hydromorphology and River Restoration/Management.

**5.2** Corroborating statement from Technical Specialist, Environment Agency.

**5.3** Corroborating letter from Head of Fisheries and Biodiversity, Environment Agency.

**5.4** Corroborating letter from Principal Freshwater Ecologist, Natural England.

**5.5** Corroborating statement from former Head of Flood risk management and Environment Agency.

**5.6** Pahuja, S., Goswami, D., (2006) A fluvial geomorphology perspective on the knowledge base of the Brahmaputra, Development and Growth in Northeast India: The Natural Resources, Water, and Environment Nexus Background Paper, No. 3, World Bank, 51p.

**5.7** Environment Agency (2004a) *Environment Agency Policy – The Removal of Gravel from Rivers*, Policy Number 359_04. (available upon request)

**5.8** Environment Agency 2013: Good practice management of in-channel sediments: http://evidence.environment-agency.gov.uk/FCERM/en/SC060065/MeasuresList/M1/M1T1.aspx?pagenum=2

**5.9** SEPA (2010). Engineering in the water environment:good practice guide Sediment management, http://www.sepa.org.uk/water/water_regulation/guidance/engineering.aspx

**5.10** DEFRA (2009). Flood and Water management Bill (Draft)- Impact Assessment - new definition of Flood and Coastal Erosion Risk Management and strategic overview. http://archive.defra.gov.uk/environment/flooding/documents/policy/fwmb/fwmiafcerm.pdf