

Hugh Graham CV

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Personal Statement

I am in the latter stages of writing up my PhD (submission date of September 2021) which I am doing alongside my work as a geospatial/numerical modeller in the Geography department at the University of Exeter (UoE). Using spatially distributed models, time series data analysis, statistical analysis and remote sensing data (off the shelf and acquired with drones), I study the impact of reintroducing the Eurasian beaver in Great Britain with a particular focus on how they affect hydrological flow regimes ([Puttock, et al., 2021](#)), [riparian woodland structure](#) and predicting the distribution of their habitat and dam building activity ([Graham, et al. 2020](#)). During my time at UoE, I have developed a passion for programming and open source approaches to science and I would therefore welcome the opportunity to pursue this as a career.

Initially, my interest in coding was focused on statistics and data visualisation but, as I have developed as a programmer, the value and importance of structured, reproducible workflows and open source software has become clear. The power of science is in its utility and, without code, this can only be finite. I thoroughly enjoy helping others to find coding solutions; both in terms of teaching others how to solve problems but also because I find that this dramatically improves my own learning through exposure to novel challenges.

I predominantly use R and Python for data analysis and software development. However, I have proven myself adept at self-learning code when needed and would relish any opportunity to learn new languages. Access to new problems and continuous learning are the aspects of programming that I enjoy the most.

As a researcher, working within a large group of 20+ active research staff in [CREWW](#), I believe that I have a strong understanding of the ways in which many in academia use programming software and the ways in which this can be improved.

I collaborate with many people, within our research group, across a diverse range of fields to improve the development of software, access to open source datasets and reproducible workflows. For example:

- I have recently developed an R package [\[EAlidaR\]](#) which enables users to download high resolution LiDAR data, produced by the Environment Agency, directly into R. As a research group we use this data to undertake hydrological and vegetation modelling; however, manually downloading the data from DEFRA's portal has always been a time-consuming and

limiting factor. This package helps to overcome these issues. This will prove essential for our forthcoming work to develop a national-scale open source terrain model and river network.

- Many of us within the research group use drone imagery to construct 3D models using Structure from Motion (SfM) Photogrammetry. In order to improve the reproducibility and accuracy of these models, I have developed two Python packages to streamline processing. Firstly, [{sfm_precision}](#) a python module for Agisoft Metashape, which calculates SFM precision entirely within Metashape using their Python API. This builds on [James et al., 2017](#), who devised the method, but removes the need for multiple different programs and increases speed and storage efficiency. Secondly, [{sfm_gridz}](#) a python package to compute differences between digital elevation models with consideration of each model's precision and error. These packages are extremely useful when working in structurally complex systems where an accurate understanding of uncertainty is critical. This was required for one of my PhD chapters - investigating the impact of beaver on riparian woodland.
- Much of the SFM work that we do is computationally intensive and I have therefore helped to move some of this processing to Exeter University's ISCA HPC facility as part of [Cunliffe, et al., 2020](#). This has been a really exciting project and I would enjoy the opportunity to further improve and develop my skills with HPC.
- Within our group, there is also a need to use Met Office NIMROD rainfall radar data. This dataset provides rainfall estimates at a 1km resolution nationally at 5 minute time steps. I have developed a [workflow](#) to download this data from the Centre for Environmental Data Analysis (CEDA) FTP server and then process this for a user-specified region to retrieve rainfall time-series data which our group use for hydrological analysis/modelling. The workflow has been used for several projects including: [Upstream Thinking](#), [Whole Catchment](#), [Mires Project](#) and our in-review paper titled: '*Beaver dams attenuate floods: a multi-site, multi-scale study*'.

Beyond work, I enjoy getting outdoors whenever possible, in particular I like to make the most of the South West's beaches and rivers by going spearfishing and kayaking. In fact, I have also contributed to an open source project called [Is The Dart Running?](#) which uses a machine learning approach to predict the water level of the River Dart to determine if the river is high enough to kayak.

Education

2015-ongoing, University of Exeter

PhD, Understanding the Impact of reintroducing the Eurasian Beaver (*Castor fiber*) in Great Britain. Fully-funded by the Wellcome Trust and UoE. I am currently working part time on my PhD alongside other research projects.

2013-2014, University of Birmingham

MSc, River environments and their management (Dist.)

Dissertation - 78%: An investigation into the impact of the Demon Shrimp (*Dikerogammarus haemobaphes*) on the benthic invertebrate community of the River Cherwell. [Link to thesis](#)

2009 -2012, University of Exeter

BSc (Hons), Geography (2:1)

Dissertation - 78%: A laboratory flume experiment investigating the interaction between bed-load transport, erosion and channel geomorphology.

Employment

University of Exeter – Researcher

01/03/2019 – present

I am working in partnership with Natural England, The Environment Agency, Natural Resources Wales, Scottish Natural Heritage and the Wildlife Trusts to model Eurasian beaver habitat and estimate the distribution and density of their dams for Great Britain. This has required the upscaling of our previous work ([Graham, et al. 2020](#)), developed as part of my PhD, to a national scale. This requires the calculation of numerous hydrological, topographic and vegetation metrics from a range of remotely-sensed datasets using geospatial processing. Moving this workflow from the landscape to national scale has been very challenging but hugely rewarding. Alongside this work, I have also produced an [ArcGIS plugin](#) which enables those using the model outputs to interrogate and extract relevant data and statistics. This process has required me to work closely with the geospatial teams across the partnership to develop a stable and user-friendly tool.

APEM Ltd., Cardiff - Aquatic Consultant

15/10/2014 - 01/10/2015

APEM Ltd. is an aquatic consultancy specialising in both freshwater and marine environments. My key roles included: data analysis and visualisation, geospatial analysis and mapping with ArcGIS, report writing and field work.

RMA environmental limited, Tiverton – Work Placement

01/05/2013 – 14/06/2013

RMA environmental ltd. is an environmental consultancy. During my placement at RMA, I was responsible for report writing, mapping with QGIS software and data analysis.

Other Qualifications/Skills

Programming with R and Python

Mapping and spatial analysis in QGIS, GRASS GIS, Arc GIS/Pro and their respective python APIs

Extensive experience with Agisoft Metashape SFM software and its Python API

Experience with Bash and Shell scripting

Full and clean driving License

Publications

Brazier, R. E., M. E. Elliott, E Andison, R. E. Auster, S Bridgewater, P Burgess, J Chant, et al. 2020. "River Otter Beaver Trial: Science and Evidence Report. River Otter Beaver Trial, Devon." <https://www.exeter.ac.uk/creww/research/beavertrial/>.

Brazier, Richard E., Alan Puttock, Hugh A. Graham, Roger E. Auster, Kye H. Davies, and Chryssa M. L. Brown. 2021. "Beaver: Nature's Ecosystem Engineers." *WIREs Water* 8 (1): e1494. <https://doi.org/10.1002/wat2.1494>.

- Campbell-Palmer, R., A. K. Puttock, H. A. Graham, K. Wilson, G. Schwab, M. J. Gaywood, and R. E. Brazier. 2018. "Survey of the Tayside Area Beaver Population 2017-2018." <https://www.nature.scot/naturescot-research-report-1013-survey-tayside-area-beaver-population-2017-2018>.
- Campbell-Palmer, Róisín, Alan Puttock, Kelsey A. Wilson, Alicia Leow-Dyke, Hugh A. Graham, Martin J. Gaywood, and Richard E. Brazier. 2021. "Using Field Sign Surveys to Estimate Spatial Distribution and Territory Dynamics Following Reintroduction of the Eurasian Beaver to British River Catchments." *River Research and Applications* 37 (3): 343–57. <https://doi.org/10.1002/rra.3755>.
- Cunliffe, Andrew M., Karen Anderson, Fabio Boschetti, Richard E. Brazier, Hugh A. Graham, Isla H. Myers-Smith, Thomas Astor, et al. n.d. "Global Application of an Unoccupied Aerial Vehicle Photogrammetry Protocol for Predicting Aboveground Biomass in Non-Forest Ecosystems." *Remote Sensing in Ecology and Conservation*. Accessed July 12, 2021. <https://doi.org/10.1002/rse2.228>.
- Graham, Hugh A., Alan Puttock, William W. Macfarlane, Joseph M. Wheaton, Jordan T. Gilbert, Róisín Campbell-Palmer, Mark Elliott, Martin J. Gaywood, Karen Anderson, and Richard E. Brazier. 2020. "Modelling Eurasian Beaver Foraging Habitat and Dam Suitability, for Predicting the Location and Number of Dams Throughout Catchments in Great Britain." *European Journal of Wildlife Research* 66 (3): 42. <https://doi.org/10.1007/s10344-020-01379-w>.
- Puttock, Alan, Hugh A. Graham, Josie Ashe, David J. Luscombe, and Richard E. Brazier. 2021. "Beaver Dams Attenuate Flow: A Multi-Site Study." *Hydrological Processes* 35 (2): e14017. <https://doi.org/10.1002/hyp.14017>.
- Puttock, Alan, Hugh A. Graham, Donna Carless, and Richard E. Brazier. 2018. "Sediment and Nutrient Storage in a Beaver Engineered Wetland." *Earth Surface Processes and Landforms* 43 (11): 2358–70. <https://doi.org/10.1002/esp.4398>.
- Puttock, Alan, Hugh A. Graham, Andrew M. Cunliffe, Mark Elliott, and Richard E. Brazier. 2017. "Eurasian Beaver Activity Increases Water Storage, Attenuates Flow and Mitigates Diffuse Pollution from Intensively-Managed Grasslands." *Science of The Total Environment* 576 (January): 430–43. <https://doi.org/10.1016/j.scitotenv.2016.10.122>.

Conference Presentations

- Presenter at 8th International Beaver Symposium 2018, Nørre Vosborg, Denmark
- Poster Presentations at European Geosciences Union 2018, Vienna Austria:
 - Graham, H., Puttock, A., Benaud, P., Cunliffe, A., Elliott, M., Anderson, K., Brazier, R.E., 2018a. Determining the impact of the Eurasian Beaver (*Castor fiber*) on the vegetation and wetland structure of a riparian system using structure from motion (SFM) photogrammetry. 20, 796. [Link](#)
 - Graham, H., Puttock, A., Wheaton, J.M., Macfarlane, W., Elliott, M., Anderson, K., Brazier, R.E., 2018b. Predicting the expansion and impact of the Eurasian Beaver (*Castor fiber*) at catchment scales. 20, 782. [Link](#)
- Presenter at State of Beaver Conference 2017, Canyonville, Oregon.

References

Professor Richard Brazier (Professor of Earth Surface Processes)

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