Hugh Graham CV

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Employment

University of Exeter – Geospatial Research Assistant (*01/03/2019 – present*)
I am the lead Geospatial data analyst on several research projects 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. Building on our previous work (Graham, et al. 2020), developed as part of my PhD, I up-scaled the model for the entire British river network. This required the automated reading and processing of hydrological, topographic and vegetation metrics from a range of remotely-sensed datasets using a geospatial processing pipeline comprising Python, R and GRASS GIS. Moving this workflow from the landscape to national scale has been very challenging but hugely rewarding and I have learned a huge amount in terms of designing stable workflows for processing big spatial data.

To accompany this work I have produced an ArcGIS plugin and R shiny App to allow our partners to explore, interrogate and download the data.

In this role I have also collaborated on a variety of ecological and conservation projects such as:

- Modelling Above ground biomass using drone-based Structure from Motion to create gloablly relevant allomtric models in low stature ecosystems Cunliffe, et al., 2021

- Forest connectivity modelling, in partnership with Cornwall County Council, in support of their nature recovery program to evaluate the feasibility of a range of species reintroductions.

APEM ltd., Cardiff - Aquatic Consultant (*15/10/2014 - 01/10/2015*)
My key roles included: data analysis and visualisation, geospatial analysis and mapping with ArcGIS, report writing and field work.

RMA environmental limited, Tiverton – Environmental Consultant (*01/05/2013 – 14/06/2013*)
During my placement at RMA, I was responsible for report writing, mapping with QGIS software and data analysis.

Education

2015-ongoing, University of Exeter PhD *(submission Decemeber 2021)*
PhD, Understanding the Impact of Reintroducing the Eurasian Beaver (Castor fiber) in Great Britain.

Using spatially distributed models, time series analysis, statistical analysis and remote sensing, I study the impact of reintroducing the Eurasian beaver in Great Britain with a particular focus on: riparian woodland structure (Graham, et al., in review), hydrological flow regimes ((Puttock, et al., 2021), modelling future population dynamics to understand ecological carrying capacity and the impact of varying management

regimes (Graham, et al., in review) and predicting the spatial distribution of their habitat and dam building activity (Graham, et al. 2020).

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.

Key Qualifications/Skills

Very strong proficiency with R and Python programming languages:

- I have focused much of my learning, whilst at UoE on improving my programming skills with a particular focus on geospatial. The following projects illustrate the range of data that I work with across a variety of different environmental disciplines.
- {EAlidaR}, an R package that enables users to download high resolution LiDAR data, produced by the Environment Agency, directly into R. My current research group use this data to undertake hydrological and vegetation modelling; however, manually downloading from the data portal has always been a time-consuming and limiting factor; this package helps to overcome these issues. The package has been used to increase efficiencies in the identification of archeological features and has been cited in recent academic literature Rhodes, et al., 2021.
- Our research group frequently use Met Office NIMROD rainfall radar data. These data provide rainfall estimates at a 1km resolution nationally at 5 minute time steps. I developed a workflow to download this data from the Centre for Environmental Data Analysis (CEDA) FTP server and process it for user-specified regions to retrieve large rainfall time-series data (>10 years at a 5 minute resolution). The workflow has been used for several projects including: Upstream Thinking, Whole Catchment, Mires Project and Puttock, et al., 2021 .
- {rayvista} is an R package that enables rapid access to geospatial data for generating 2.5D and hillshade visulasations. This project has received wide community engagement and the package is freuently downloaded
- I have experience contributing to open source projects. For example, I provided a patch for the the widely used {maptiles} R package and I have also helped to develop a web app called Is The Dart Running? which uses a machine learning approach to predict the water level of the River Dart (SW England) to determine if the river is high enough to kayak.

Extensive experience with version control

- I use Git version control sotware and GitHub on a daily basis to manage and track the progress of my software development, report writing and data analysis.

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

- I have been using GIS software for >8 years and have gained a strong background in geographic concepts such as coordinate reference systems, geographic transformations, raster and spatial vector processing and the use of SQL to calculate efficient spatial queries.

Experience with High Performance Computing

- SfM work is often computationally intensive and I have therefore helped to move some of this processing to UoE's ISCA High Performance Computing (HPC) facility as part of Cunliffe, et al., 2020. This required the scheduling of distributed computing using command line tools in combination with Python. I would enjoy the opportunity to further improve and develop my skills with HPC, particularly for cloud-based processing.

Extensive experience with Agisoft Metashape SFM software and its Python API

- I work extensively with drone-based Structure from Motion (SfM) photogrammetry to understand changes in vegetation structure. 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. These packages were developed as part of our in review manuscript: "Using aerial photogrammetry to detect significant canopy height change resulting from beaver foraging."

Strong statistical analysis skills

- I have a strong interest in statistical data analysis and have experience applying a range of statistical modelling techniques including: General Linear Models (GLM), Mixed effects models, General Additive Models (GAM), Principal Component Analysis (PCA), Quantile regression, Logistic Bayesian models and Fuzzy inference. Many members of my current research group reach out to me for advice and discussions relating to statistical methods and their applications across a variety of different study fields.

Cartography

- I also enjoy using code for cartography. Some recent examples of my maps can be found here.

Experience piloting drones to undertake Structure from Motion surveys.

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. 2020a. "River Otter Beaver Trial: Science and Evidence Report. River Otter Beaver Trial, Devon." https://www.exeter.ac.uk/creww/research/beavertrial/.

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Campbell-Palmer, Róisín, Alan Puttock, Kelsey A. Wilson, Alicia Leow-Dyke, Hugh A. Graham, Martin J. Gaywood, and Richard E. Brazier. 2020. "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*. https://doi.org/https://doi.org/10.1002/rra.3755.

Cunliffe, A, K Anderson, F Boschetti, R Brazier, H Graham, I Myers-Smith, T Astor, et al. 2021. "Global Application of an Unoccupied Aerial Vehicle Photogrammetry Protocol for Predicting Aboveground Biomass in Non-Forest Ecosystems." *Remote Sensing in Ecology and Conservation*.

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.

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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.

References

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