CURRICULUM VITAE

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Summary

Employment

2006 – Independent statistical consultant, J Heffernan Consulting Limited
2000–2006 Lecturer in Environmental Statistics, Dept of Mathematics & Statistics, Lancaster University.
1998–2000 Research Associate, Dept of Mathematics & Statistics, Lancaster University.

Post School Education

1995–1998 Ph.D. Statistics (Lancaster University).
1992–1995 B.Sc. (Hons) Mathematics & Statistics, with French minor (Lancaster University) First Class. Awarded prize for best Mathematics and Statistics degree.

Statistical consulting

I have worked as an Independent Statistical Consultant since 2006. My specialist area is Extreme Value Statistics, and in particular the Multivariate aspect of this subject. Much of my consulting has involved helping clients to use some of the statistical tools which I developed whilst part of Lancaster University's Extreme Values group – a research group with international recognition for its contribution to the field. Some of these tools (notably Heffernan and Tawn, 2004) have been widely adopted within the flood risk assessment industry for tackling spatial or multivariate problems. I have also played a key role in developing an open source R software package, `texmex`, which implements these methods. This is used by other extreme value statisticians, and I use the package myself for the majority of Extreme Value Statistical projects which I work on. My consultancy work has involved an eclectic range of statistical projects beyond the area of Extremes, including research support, data analysis, developing and delivering bespoke training courses, and providing strategic advice to clients on the statistical aspects of their work.

The following list gives a brief description of a selection of relevant projects I have worked on as a statistical consultant:

Extreme Value Analyses, Jacobs (formerly ch2m) (2015 –)
I have been involved in a number of separate projects working within inter-disciplinary teams to deliver state of the art assessment of flood risk on UK rivers. My contributions have been to advise on, and deliver, Joint Probability Analyses of combinations of variables which contribute to flood events. In some projects this has been spatial variables (*e.g.* fluvial flow on different rivers within a network) or different parameters (determining the strength of extremal dependence between different sources of flooding, for example fluvial and tidal).

Extreme Value Analysis of Pipe Collapse Pressures, VerdErg Pipe Technology Limited (2017)
VerdErg Pipe Technology have developed a new approach to testing collapse pressures of pipeline to be used in ultra-deepwater installations. This new technology allows data to be collected in sufficient quantities to make statistical analysis feasible for the first time in this setting. I have worked with VerdErg to apply Extreme Value Statistics to their data to give improved estimation of risk associated with pipe collapse. This work has resulted in a published paper and we currently have a Patent Application pending on our new approach.

Statistical support, Fathom (2017)
Fathom was formed out of the University of Bristol Hydrology Research Group, a world leading authority in modelling flood risk. Their goal is to create a detailed, accurate and comprehensive flood risk map of the entire planet. This will be used to inform risk assessment, planning decisions, emergency preparedness and disaster response. I have been involved with their modelling team, helping them to develop their extreme value tools for flood mapping on continental scales.

Professional Development Training, Royal Statistical Society (2016 – 2018)
The Royal Statistical Society runs a series of public training courses, providing Continuing Professional Development for practising statisticians. I teamed up with Harry Southworth (*Data Clarity Consulting Ltd.*) to deliver a two day professional level course for the RSS on Extreme Value Statistics. This course has been attended by statisticians from a variety of sectors including Flood Risk, Re-insurance, Clinical Safety, Data tech, Financial, and is now in its third year.

Statistical support and advice, JBA Risk Management (2012 – 2017)

JBA Risk Management is a supplier of natural hazard modelling to the insurance and re-insurance industries. I have provided statistical input to their modelling of multivariate extremes within the process of spatial risk mapping. This has included the delivery of custom written in-house training in extreme value methods applied to their environmental hazard datasets.

Course on Extreme Value Modelling for Offshore Sea States (2014)

This training course was written for a consortium of met-ocean analysts and offshore wind engineers, using their own data examples. The course gave an introduction to Statistical Extreme Value Theory and associated methods, together with computer tutorials in the use of the software to provide hands-on experience of extreme values analysis. Discussion focussed on specific applications in the offshore setting and the statistical challenges that arise in this area, in particular how to respond to the practical limitations met when dealing with very small data sets.

Multivariate Extremes R package development, AstraZeneca (2010–2012)

This work built on the joint publications Southworth & Heffernan (2012) which offer the novel application of statistical extreme value methods to clinical safety data. I collaborated with statisticians at AstraZeneca to develop an R package `texmex`, implementing threshold based univariate extreme value methods, and the conditional multivariate extreme value method of Heffernan and Tawn (2004). My contribution included the development of a suite of unit tests for the package, reproducing previously published results.

I continue to develop and maintain this package, and use it extensively for my own Extreme Values work.

Multivariate Extreme Value Analyses for Offshore Sea States, Fugro Geos (2009–2014)

These projects involved the updating of off-shore sea state criteria. The aim was to describe the conditional distributions of one or more variables given values of a further variable which were higher than levels seen in available data records. Making proper allowance for the dependence that arises between variables at high levels is important for making informed decisions about realistic loadings on structures.

Course on Extreme Value Modelling for Clinical Safety Data, AstraZeneca (2011)

This training course provided support for the Extreme Values R package `texmex`, which was originally developed for AstraZeneca (above). The course provided an introduction to the theory and methods underpinning this R package, together with computer tutorials in the use of the software to provide hands-on experience of safety data analysis using the package.

Extreme Values Statistics for Met-ocean Applications, OceanMetriX (2008 – 2017)

I have been involved in a number of projects concerning novel application of Extreme Value Statistics to a variety of met-ocean problems. The problems have presented challenges such as accommodating process non-stationarity, or temporal clustering of extreme events, in the estimation of long-run probabilities of rare events.

Extreme Values Statistics for offshore dynamics, Orcina Ltd (2008)

Orcina is a software house serving the offshore engineering industry. Orcina's main product is a software package for the design and analysis of marine systems. I have contributed to a project to extend the software's functionality to offer Extreme Value analysis of the dynamic model data which is output by the software.

Extreme Values Statistics for Flood Investigation, Freehills (2008)

I was involved in the investigation of a major flood by the legal representatives of an Australian mining company whose property was severely affected by the flood. I contributed as part of an interdisciplinary team offering technical expertise to assess the extreme nature of the flood. An important part of this work was the communication of technical ideas, and their impact, to non-mathematicians.

Expert witness, High-Court Investigation into sinking of bulk carrier MV Derbyshire (2000)

I became involved in the Re-opened Formal Investigation with Prof Jonathan Tawn mid-way through the hearing, when concern was raised about results of previous Extreme Values statistical analyses. We were asked to repeat the statistical analysis, explain the anomalous results and analyse the problem using best statistical practice. We had to provide a detailed report, to be broadly accessible by a non-statistical readership. The initial time-scale for completion of the analysis and report, and Court appearance, was two weeks.

I was responsible for the data handling, R code development, statistical analysis and report writing part of the work. Working to such a tight deadline and in such a high-profile setting meant that automated code testing and data validating routines were imperative as we could not afford to make mistakes.

Bulk carrier safety, Dept of the Environment, Transport and the Regions (DETR) (2000–2001)
Following the High-Court investigation, Prof Tawn and I were invited to form the statistical arm of a team carrying out a large designed experiment using wave tank data to make recommendations about bulk carrier safety. Our work formed part of the recommendations made to the International Maritime Organisation regarding Bulk Carrier Hatch cover strength, and since the resulting change in regulations, over 7 000 bulk carriers have been strengthened or built with stronger hatch covers; none have sunk. Based on past evidence, more than 100 such sinkings would previously have been expected in the same period.

Publications

Theses:

Ph.D. thesis (Lancaster University, 1998)."Joint modelling of Point Process and Geostatistical measurement data", supervised by Prof. Peter Diggle, examined by Prof. Sylvia Richardson.

Papers/Articles:

1. Heffernan, J.E., Walker, A. and Liu, P. (2018) Improved Estimation of Ultra-deep Water Pipe Collapse Pressures by using Extreme Value Theory. *Quality Engineering*, to appear.
2. Eastoe, E.F., Heffernan, J.E. and Tawn, J.A. (2014) Nonparametric estimation of the spectral measure, and associated dependence measures, for multivariate extreme values using a limiting conditional representation. *Extremes*, Volume **17**, Issue 1, pp 25–43.
3. Southworth, H. and Heffernan, J.E. (2012) Multivariate extreme value modelling of laboratory safety data from clinical studies. *Pharmaceut. Statist.*, doi: 10.1002/pst.1531.
4. Southworth, H. and Heffernan, J.E. (2012) Extreme value modelling of laboratory safety data from clinical studies. *Pharmaceut. Statist.*, doi: 10.1002/pst.1510.
5. Heffernan, J.E., Barry, J., Devlin, M. and Fryer, R. (2009) A simulation tool for designing nutrient monitoring programmes for eutrophication assessments. *Environmetrics*, **21** (1), 3–20. Published Online: 3 Apr 2009
6. Heffernan, J.E. and Resnick, S.I. (2007) Limit laws for random vectors with an extreme component *Ann. Appl. Probab.*, **17**, No. 2, 537–571.
7. Butler, A., Heffernan, J.E., Tawn, J.A., Flather, R.A., Horsburgh, K.J., (2007) Extreme value analysis of decadal variations in storm surge elevations. *Journ. Marine Systems* **67**, 189–200.
8. Butler, A., Heffernan, J.E., Tawn, J.A. and Flather, R.A. (2007) Trend estimation in extremes of North Sea surges. *J. Roy. Statist. Soc. C (Applied Statistics)* **56**, Part 4, 395–414.
9. Heffernan, J.E., Tawn, J.A. and Zhang, Z. (2007) Asymptotically (In)dependent Multivariate Maxima of Moving Maxima Processes. *Extremes* **10**, 1-2, 57–82.
10. Eastoe, E.F., Halsall, C.J., Heffernan, J.E. and Hung, H. (2006). A statistical comparison of survival and replacement analyses for the use of censored data in a contaminant air database: A case study from the Canadian Arctic. *Atm. Env.* **40**, 6528 – 6540.
11. Heffernan, J.E. and Resnick, S.I. (2005). Hidden Regular Variation and the Rank Transform. *Adv. Appl. Probab.* **37** (2), 393–414.
12. Butler, A., Heffernan, J.E., Flather, R.A. and Tawn, J.A. (2004). Spatial estimation of extremal trends in North Sea surge elevations. In *Flood Risk Assessment: the Proceedings of the IMA Conference on Flood Risk Assessment*, 117–126, IMA, Southend.
13. Heffernan, J.E. and Tawn, J.A., (2004). A conditional approach for Multivariate Extreme Values (with discussion), *J. Roy. Statist. Soc. B* **66**, Part 3, 497–546.
14. Heffernan, J.E. and Tawn, J.A., (2004). Extreme values in the dock. *Significance* **1** Issue 1, 13–17.
15. Heffernan, J.E. and Tawn, J.A., (2003). An extreme value analysis for the Investigation into the sinking of the M.V. Derbyshire. *Appl. Stats.* **52**, Part 3, 337–354.

16. Heffernan, J.E. and Tawn, J.A., (2001). Extreme value analysis of a large designed experiment: a case study in bulk carrier safety. *Extremes* **4**, 359-378.

17. Tawn, J.A. and Heffernan, J.E. (2001). Summary of statistical analysis of the seakeeping model tests, 41–54, of Proceedings of the Royal Institution of Naval Architects conference *Design & Operation of Bulk Carriers – Post M.V. Derbyshire*. London.

18. Heffernan, J.E. (2000) A directory of coefficients of tail dependence, *Extremes* **3**, 279-290.

19. Coles, S.G., Heffernan, J.E. and Tawn, J.A. (1999) Dependence measures for extreme value analyses, *Extremes* **2**, 339-365.

20. Currie, J.E. (1999). On the analysis of spatial point process data with inaccurately observed covariate information. *Statistics for the environment 4:Pollution assessment and Control* Eds. V. Barnett, A. Stein and K. Feridun Turkman. John Wiley & Sons Ltd.

21. Stanley, K.N., Wallace, J.S., Currie, J.E., Diggle, P.J. and Jones, K. (1998). The seasonal variation of thermophilic *Campylobacters* in beef cattle, dairy cattle and calves. *Journ. Appl. Microbiol.* **85**, 472-80.

22. Stanley, K.N.,Wallace, J.S, Currie, J.E.,Diggle, P.J., Jones, K. (1998). Seasonal variation of thermophilic *Campylobacters* in lambs at slaughter. *Journ. Appl. Microbiol.* **84**, 1111-1116.

23. Wallace, J.S., Stanley, K.N., Currie, J.E., Diggle, P.J. and Jones, K. (1997). Seasonality of Thermophilic *Campylobacter* populations in chickens. *Journ. Appl. Bacteriol.* **82**, 219-224.

24. Hurley, M.A., Currie, J.E., Gough, J. and Butterwick, C. (1996). A Framework for the Analysis of Harmonised Monitoring Scheme Data for England and Wales. *Environmetrics*, **7**, 379-390.

Poster/conference papers:

1. Quinn, N., Wing, O., Heffernan, J., Smith, A., Sampson, C., Neal, J., and Bates, P. (2018) Stochastic Simulation of Fluvial Inundation at Continental Scales EGU2018-4973 European Geosciences Union General Assembly, Vienna, April 2018.

Software packages:

1. Harry Southworth and Janet E. Heffernan (2014). `texmex`: Statistical modelling of extreme values. R package version 2.3.